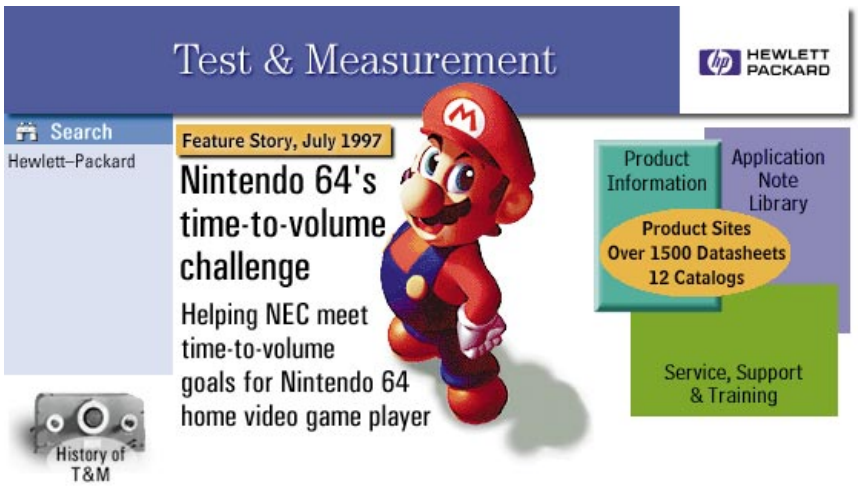
Table of Contents

Table of Contents for the HP Test & Measurement Catalog 1998

HP's Test & Measurement website offers news, updated product and support information, and more—24 hours a day

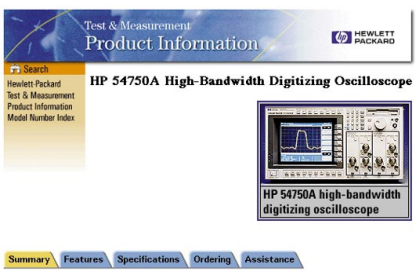


The range of resources offered at HP's Test & Measurement website continues to expand.

To solve both your test needs and your information needs, visit HP's Test & Measurement website regularly.

http://www.hp.com/go/tmc98
Continual improvements give you better access to news, product and support information, application literature, and more. You can use this online service 24 hours a day to get the latest information to help you choose the products and services you need—and use them effectively. Visit the website frequently to learn of new developments. You will also find monthly feature stories showing test and measurement products in use.

To help you get the most from your instruments, many pages include support information, demonstrations and software, usage tips, and answers to frequently asked questions.



Product Information
Besides providing updated feature and specification information, product web pages contain additional information such as product definitions. Powerful search capabilities let you find products by name, keyword, and model number.

Product Sites
Study typical applications; obtain tips for making optimized purchase decisions; and learn the technology behind instruments and systems.

Selection Guides
Interactive guides such as the Power Supply Selector make it easy to find the HP products that most closely match your application needs.

Newsletters
Read Test & Measurement News Online for the latest products and literature. Find useful information for telecommunications operators in Telecommunications News Online.

Industry Information Areas
See how HP T&M products can help you in your industry.

News Releases
Search all of the Test & Measurement new product releases and news releases.

Application Note Library
Application Notes, Product Notes, and Programming Notes can help you solve problems or learn how to better use test equipment. View abstracts and order and/or download documents. Key notes now include award-winning interaction and animation.

Service, Support & Training
Find products, services, and training to help you succeed in the web pages devoted to hardware support, software support, application consulting, and training. The entire worldwide education catalog is available.

Configuring a System
Custom System Information explains how HP can help you solve a non-standard problem or provide you with a totally integrated test solution.

Sales & Service Contacts
Up-to-date lists of Sales Offices, Service Centers, Call Centers and more.

Local Sites
Find information of local interest in the HP Test & Measurement web pages for your country.

History of Test & Measurement
A brief history of how Bill Hewlett and Dave Packard started HP.

Evolving to help serve you better
The features mentioned here are only a snapshot of what's available at the website. Visit HP's website regularly and watch our information capabilities grow!

Quickly find the information you need

HP offers a vast range of test and measurement products, services, and support material for a wide span of applications. To help you efficiently find the solutions you're seeking, we provide various information search aids and tools, including the following:

- **Alphabetical Index**
  Beginning on this page, this index lists major product types and services, as well as key words relating to many T&M application issues.
- **Numerical Index**
  The HP products and services in this catalog are listed by model number in the index that starts on page 18.
- **Application Notes Index**
  A wealth of helpful HP T&M support literature is arranged by subject matter in the index that begins on page 604.
- **Online Reference Tools**
  Electronic reference and support capabilities, including a powerful search engine, are available at HP's site on the World Wide Web. They let you obtain updated technical data, application information, and much more, 24 hours a day. For additional details, see facing page.
- **HP Touch Tone Fax Service for US and Canada**
  Technical information for test and measurement products and services is available 24 hours a day, seven days a week, by dialing 1-800-800-5281.

Printed on recycled paper containing 20% post consumer fiber.

B

C

D

E

M

S

U

V

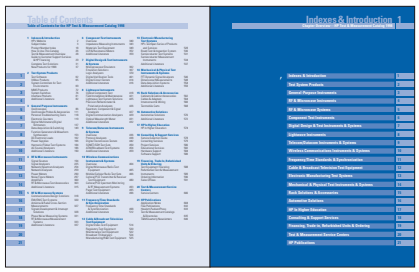
W

X

9

How to Use this Catalog

Table of Contents



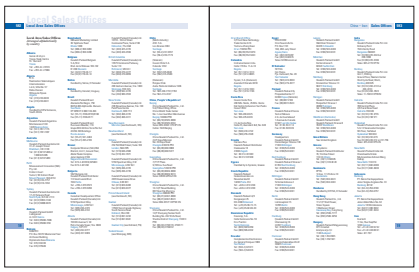
1

Easily find the major section of products or systems that you need. Refer to major sections by the number on the thumb tabs. Major sections and subsections are listed throughout the contents by page number. The contents of each major section and additional references are repeated for you on the first page of each section.
See page 1.

New Products for 1998

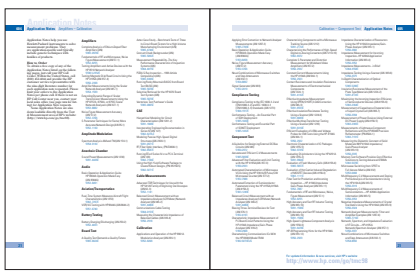
Hewlett-Packard introduces hundreds of new products each year. This full-color section features 47 new products for 1998 from HP's Test & Measurement Organization. These exciting and innovative new products reflect HP's commitment to research and development investments. They also illustrate major technology and market trends.
See page 37.

Sales Offices



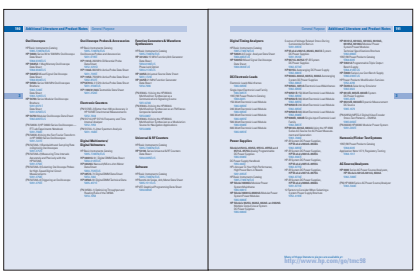
When you need an HP sales representative, refer to the complete list of worldwide HP sales offices. Offices are listed by country and include complete addresses. If no HP T&M office is listed for your country or area, contact one of the headquarter offices that are also listed.
See pages 591 – 598.

Application Notes



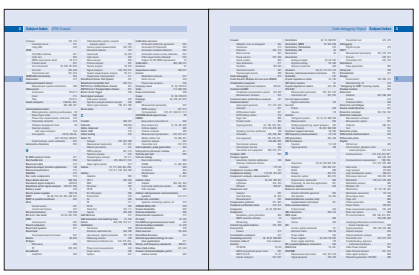
The 1998 Catalog contains a comprehensive listing of Application Notes, all of which are available to you free of charge.
See pages 604 – 631.
This literature covers topics such as impedance, modulation, and semiconductors, and provides information to help you solve many test and measurement problems. A completely updated list of Application Notes is available at (http://www.hp.com/go/tmc98).

Additional Literature & Product Notes



HP has published considerable additional information on the instruments noted at the end of most sections of the Catalog. This includes focused data sheets, brochures and catalogs. In addition, Product Notes, written for specific instruments, are available on request. You may obtain this literature from our website (http://www.hp.com/go/tmc98), or use our convenient reply card in the back.

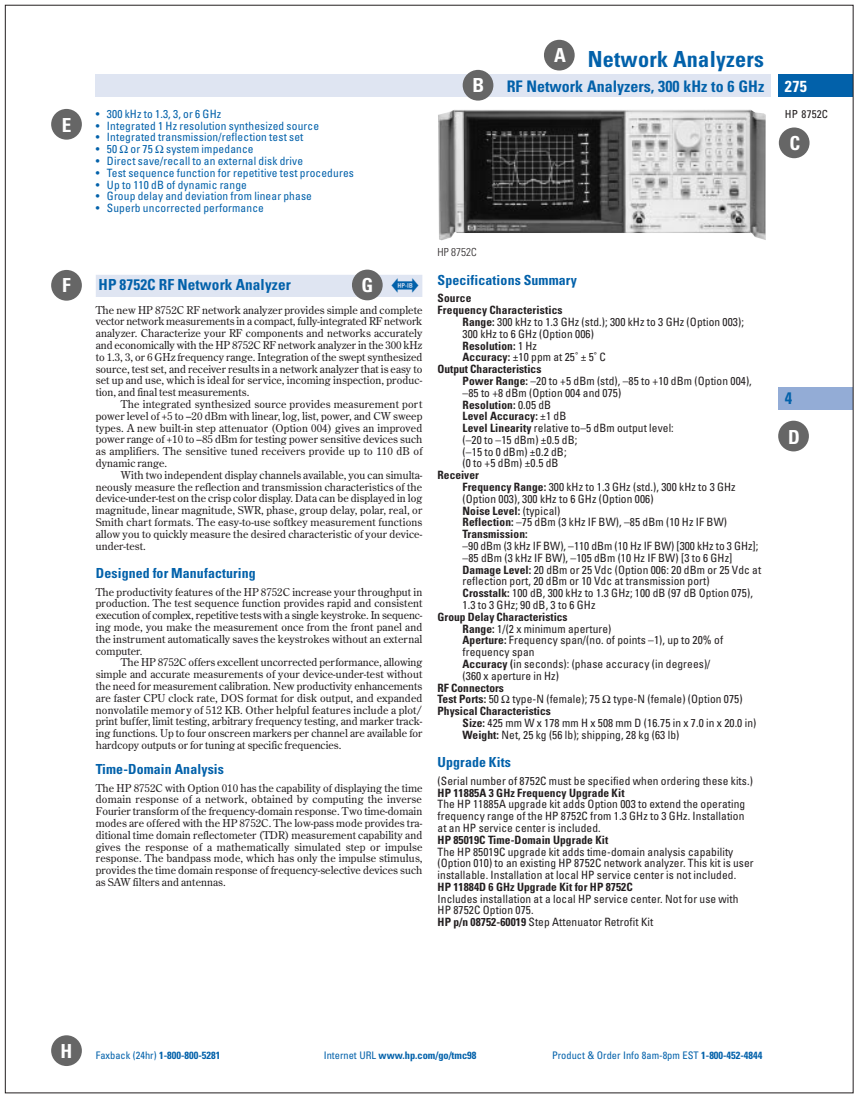
Indexes



There are two indexes in this catalog. The Subject Index references product categories, key terms, applications, and other useful information.
See page 3.

The Product Number Index allows you to find HP products if you already know their product numbers. All new products for 1998 are identified. Page numbers in bold type indicate the main references for that product.
See page 18.

Product Descriptions



The body of this catalog contains over 10,000 new and existing test and measurement products from HP. Although not every HP product is included, you will find all relevant categories, and references to other sources.

A General product headline
Identifies the broad product category of the instrument, system or service described in the section.

B Product description
Defines the specific purpose and function for the product described.

C Product number
Defines the specific HP model numbers and versions that are described on the page.

D Section tab number
Relates to the Section numbers identified in the Table of Contents, and defines a product family.

E Product features
Give an "at-a-glance" view of the key features of the products on the page.

F Specific product identification
Defines the features and specifications of one model in the family of products on the page.

G Product attribute marks
Define, by symbols described below, which special features or services apply to this product.

H HP action and help locations

1

Symbols

NEW

This symbol identifies all new products for 1998 throughout the general products and systems pages.

HP-IB

This symbol is used throughout the catalog and identifies products that have HP-IB (IEEE-488) capability.

UID

This symbol identifies programmable instruments that support the Hewlett-Packard family of Instrument Drivers, which allow test code development using standard links in multiple vendor hardware, and are based on the VISA I/O libraries. Additional information is available at (http://www.hp.com/go/inst_drivers).

X11

This symbol identifies products that include an HP interface for simplified FTP and NFS LAN/WAN remote access and control via an X11 window display. This HP networked user interface adds instrumentation resources to client-server computing systems and increases the capability of existing network connections.

Bill Hewlett (right) and the late Dave Packard (left) are the founders of the Hewlett-Packard Company.

The Hewlett-Packard Test & Measurement Organization

The company that Bill Hewlett and Dave Packard started in 1939 in a garage in Palo Alto, CA offered size, price and performance advantages in its initial product, the HP 200A audio oscillator. Today, the HP Test & Measurement Organization (TMO) that produces this catalog is the world's leading supplier of standard and customized test and measurement solutions, including test systems, equipment, instruments, accessories, components, and services. Customers such as you are the focus of the nearly 19,500 people in HP TMO who produce the unmatched variety of TMO hardware and software products, as well as low-risk, broad technology-based, tailored test and measurement solutions and professional services.

As we enter our 59th year, Hewlett-Packard Company is a leading global manufacturer of computing, communications, and measurement products and services recognized for excellence in quality and support. HP has 114,600 employees and had a revenue of $38.4 billion in its 1996 fiscal year. We strive to make a fundamental, positive difference to your firm's business and to your job performance. We are accomplishing this by continuing to grow our measurement, computation, and communications capabilities. HP endeavors to be increasingly flexible and innovative in fashioning the timely, effective, and affordable solutions you need now and will need in the future.

Your Single Source for T&M Solutions

The exceptional depth and breadth of HP TMO products and services allows you to use Hewlett-Packard as a single source, whether you need complete, integrated, expandable, and upgradeable standard products, or customized solutions. In addition to standard products and new details on custom test solutions, this catalog includes products for such important growing and emerging fields as telecommunications and data communications networks, and multimedia.

To best serve some applications, we have established strategic alliances with a select group of industry-leading companies that share our dedication to excellence in products and service. Together, HP and its Channel Partners are able to provide you with superior turnkey solutions.

Open Industry Standards

Because open systems (systems in which different manufacturers' products can work in unison) reduce test costs, time, and risk, HP takes a leadership role in developing industry standards and in implementing many of them. Among the many standards supported by HP TMO are VXI, Modular Measurement Systems (MMS), HP-IB, and SCPI.

A Total Commitment to Quality

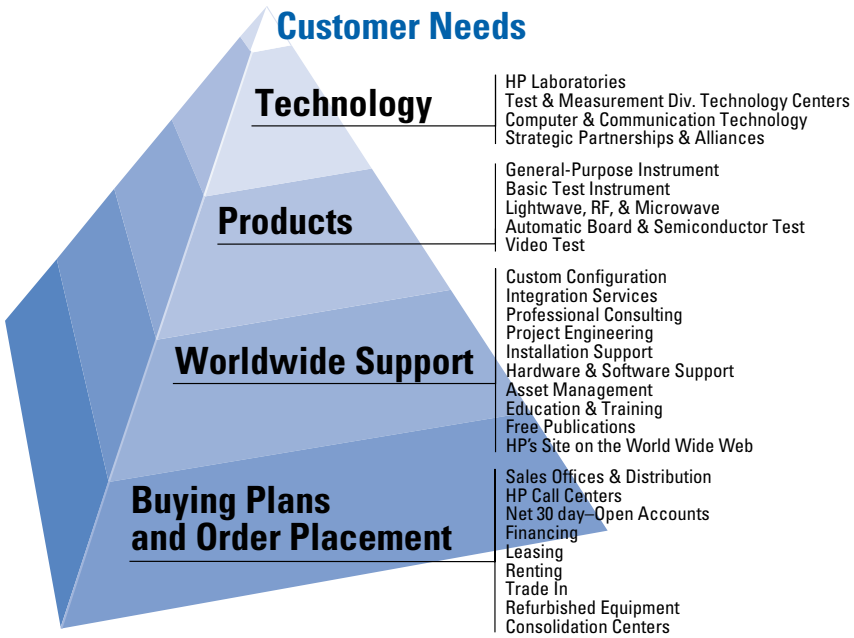
HP employees uphold high standards for performance, reliability, and service, earning the company a well-deserved reputation for excellence. Continual refinements in employee empowerment and processes have produced our comprehensive Quality Maturity System (QMS), which is dedicated to providing you with the highest levels of satisfaction, even as your needs change. The standards within HP's QMS exceed the intent of ISO 9000, the set of international standards for quality management and quality assurance.

Nearly all HP Test & Measurement divisions and HP calibration laboratories worldwide are ISO 9000 registered. Selected laboratories are accredited to ISO Guide 25. The integrity of the periodic audits by independent experts required for continued ISO 9000 registration enables many customers to augment their internal quality systems without costly audit teams. To make it easier to put HP equipment immediately into service, we include an ISO 9000 compliant calibration certificate with almost every new instrument.

In keeping with the scope and impact of HP's QMS, we are constantly working to improve your overall HP experience. This includes providing better, faster service. For example, to answer questions, offer objective advice, and render quick assistance, we continue to expand our technical call centers. To make updated information—and much more—available to you 24 hours a day, we are increasing the online services available at HP's site on the World Wide Web. And to help you get significantly faster delivery of the products you order, we are streamlining our production processes, scheduling methods, and handling procedures—on a worldwide scale.

Acquiring complete test and measurement solutions has never been easier. Hewlett-Packard offers a powerful, first-class combination of technology, products, support services, and buying plans—all backed by the full resources of a worldwide industry leader, all based on a total dedication to quality and excellence.

The pyramid diagram illustrates the broad range of HP products and services available to you. Your needs are our highest priority. They are the capstone of the pyramid, the focus of everything we do. Our test and measurement professionals will apply all of the HP strengths appropriate to your business situation to help you acquire instrument and system solutions that are ideal for your needs.



The full strength and resources of Hewlett-Packard are behind every product we sell, every service we provide, every customer we serve.

Integrated solutions
If standard or custom configured products can't meet your test system requirements, HP can plan, design, build, install, and support a custom solution, using the best equipment and software from HP and other quality industry sources to ensure your complete satisfaction. If you need complete project management, HP project teams will deliver your solutions on time and on budget. Some test and measurement situations require variations of standard products and systems. When needed, HP can provide added functionality, tailored performance characteristics, special operating software, and modified configurations.
See pages 31 and 580.

Professional consulting services
Skilled HP professionals are available to supplement your resources—on an as-required basis—in the planning, development, and operational phases of your test system. **See page 579.**

Installation support
To get your test system up and running more rapidly and with fewer problems, HP experts can assist in setup, installation, and commissioning.
See page 578.

Hardware support
HP repair and calibration services maximize the uptime of your HP products and ensure consistently high levels of measurement accuracy. Flexible service plans and support options provide fast, convenient repair and calibration at your site or at service centers worldwide. **See pages 584 and 585.**

Software support
You can get up-to-date information and software for your HP test and measurement solutions through response center services, software updates and notification services. **See page 586.**

Service & Support web site
Visit the HP Service & Support web site for current information on hardware, software, application consulting and training (http://www.hp.com/go/tmservice).

Asset management
From simple inventory and data collection to comprehensive, long-term management of your equipment, HP offers accurate, timely asset management services you can trust, tailored to your needs.

Education and training
Highly-trained instructors with access to the latest technology teach courses in measurement theory and practice, equipment operation, applications, and hardware and software maintenance. These classes, available worldwide, can help you maximize the value of your HP instrument and computer products and systems, and can enhance your staff's efficiency and productivity.
See pages 582 and 583.

Free publications
HP offers hundreds of customer publications free of charge, including hardware and software manuals, newsletters, specialty catalogs, application notes and extensive product literature. Use this material to conduct product searches, benefit from techniques developed by experts, learn how to maintain equipment, and more. **See page 632.**

HP's site on the World Wide Web
To meet your information needs fast, 24 hours a day, and to provide unique new support functions, HP has a test and measurement site on the World Wide Web. This online service provides updated information on new products and services, a calendar of events, an application note index, and much more. Visit (http://www.hp.com/go/tmc98). Get more details on page 2.

Buying Plans and HP Call Centers

With HP's flexible financing options, you can implement test and measurement solutions when you need them, on terms tailored to your budget. Financing plans even apply to multivendor systems containing non-HP products.

Sales offices, distributorships and Call Centers

You can obtain assistance in selecting or configuring test and measurement solutions from your local HP sales office or distributorship. Calls are routed to the person best qualified to help you. Knowledgeable professionals also provide current prices or formal quotes. In many countries you can contact HP Call Centers to locate the appropriate sales or support organization. Toll-free service is provided wherever feasible. **See page 591.**

Financing

HP offers financing plans to USA customers that schedule payments to accommodate your cash flow requirements. Similar plans are available worldwide. **See page 588.**

Leasing

The HP EasyLease is a 12- to 60-month plan for USA customers that provides attractive leasing terms and can include fair market value purchase options. Similar plans are available worldwide. **See page 588.**

Renting

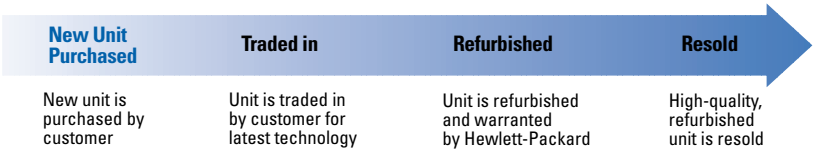
The HP EasyRent financing plan is ideal for customers facing tight budget constraints. It combines the low rate of a longer-term financing plan with exit options, to achieve the ease of a shorter-term plan. Fair market value purchase options are available. Similar plans are offered worldwide. **See page 588.**

QuickShip

Some products are available through QuickShip—HP's expedited delivery service. Contact your local HP Call Center or your local sales representative to confirm QuickShip availability.

Trade-in Options and Refurbished Equipment

To help you maximize your equipment budget and keep your technology current, HP offers several trade-in options and high quality refurbished equipment.



Trade-in

Whether you want to trade in a single instrument or a pallet of used equipment, HP helps you take advantage of the value of underutilized test equipment in your inventory. Our trade-in options, designed to make it easy for you to stay competitive and upgrade to the latest available technology, are continuously available throughout the year.

Refurbished equipment

High-quality, used equipment—refurbished by HP to our own rigorous quality standard—is available with full HP warranty and support. Any used instrument you purchase from HP has a guaranteed support life of at least two years—many have a support life up to five years. You don't need to worry about obsolete products or parts—we'll continue to provide support until the product support life ends.

To learn more about HP's trade-in opportunities and growing pool of high quality, refurbished instruments, contact your local sales office. **See page 589.**

HP Technology

HP has unmatched expertise in measurement, computation, and communication. This proficiency results from traditionally high investments in research and development, as well as from the knowledge, skills, and dedication of thousands of employees. Advanced technology continually flows from the HP laboratory facility in Palo Alto, California, and from the R&D facilities at HP sites across the U.S. and around the world. Your HP solutions can incorporate state-of-the-art hardware, software, and problem-solving methodologies.

HP Products

This catalog details the over 10,000 new and existing HP test and measurement solutions—an unmatched range. The expanded Table of Contents and the subject and product number indexes help you quickly find the general-purpose or application-specific instruments or systems you need.

Support Services

Comprehensive HP support services can assist you with every aspect of finding and applying test and measurement solutions.

Consolidation Centers

Efficient delivery of your order is an HP priority. Our consolidation centers help ensure simultaneous and on-time delivery of all the products you order, regardless of how far those products must travel to reach your delivery site.

Combine HP T&M Skills and Experience with HP Products for Complete Solutions

In technology businesses today there is a "race to market" with leading edge, high quality products. Not only are schedules short, but R&D resources are tight, as staffs are asked to do more with less. The test and measurement challenge of these issues is to provide more information on components and systems in less time, with fewer people, at lower cost, and with less time spent developing or learning the test equipment and processes.

Hardware plus software plus support
In this business environment, test and measurement customers need more from their suppliers than just products, they need total solutions to problems, not just a piece of equipment, and very often help in defining the solution to meet their specific needs. Hewlett-Packard can meet all these requirements, and does so consistently.

On customer request, HP experts apply their extensive knowledge of measurement, computing, communication technologies and products to a broad range of activities. They can analyze requirements, determine test system specifications, plan schedules, design and integrate systems, and install and support complete test and measurement solutions.

Widest range of products, support, services, and training
Innovative new and existing HP T&M standard products include standalone instruments and accessories, "rack and stack" type system elements, such as HP-IB/IEEE-488 products, and modular platforms such as VXI and MMS products. This unmatched span of products gives customers exceptional problem-solving flexibility.

To bring all this to your problem, we offer services ranging from consulting, to designing, building, installing, and supporting turnkey test and measurement systems. The result is a cost effective "Complete Solution" on a schedule.

Give us a call to let us show how we can help you.

Let HP Help You Solve Your Problem

Make or buy?
Should you build your own test and measurement system or contract with an outside supplier?

Consider that by engaging HP you can:
- Concentrate on designing and developing new products and applications.
- Capitalize on the expertise of HP test and measurement professionals
- Meet more aggressive development schedules
- Optimize your processes

Choose the best; choose HP
Whether your test requirements are small or large, simple or complex, when you purchase a custom test system from HP, you:
- Choose the test and measurement leader—the strong, knowledgeable, reliable international supplier you can trust.
- Obtain unrivaled, indepth expertise and leadership in an ever expanding sphere of sophisticated measurement systems tools and technologies.

Helping Customers Improve Their Business Results: Case Studies

In the following pages we have compiled four examples of the successful development of "Complete Solutions" by HP and a customer. These come from large and small companies worldwide, who have a variety of needs. The thing they have in common is that in cooperation with HP, they were able to solve a major test and measurement problem.

Siemens Automotive Sytems (Germany)
The automotive marketplace requires quality, low cost, mass production of a continuous stream of new products, presenting the challenge to develop a new, flexible, manufacturing approach with the test instrument system as an integral part.

Lockheed Martin Missiles and Space Company (United States)
A new NASA series of "faster, better, cheaper" space missions presented the challenge to develop a reliable "Lunar Prospector" for a fraction of the cost and with an accelerated schedule, including an inexpensive, multipurpose test system.

Microelectronics Technology Inc. (Taiwan)
The rapidly changing and complex technology of the communications market presented the challenge of shortening development cycles and providing the R&D department with leading edge, but flexible, test systems customized for the language and supported locally.

Netwave Technologies, Inc. (United States)
As part of the ISO certification process, a wide range of test equipment from various manufacturers had to be calibrated to ISO 9000 standards. Yet the budget was limited and the time schedule was short.

Siemens Automotive Systems achieves more throughput and flexibility at reduced cost with HP TS 5400 System

Siemens Automotive Systems test site with HP TS 5400 System performing "blackbox" test on production units.

When the management of Siemens Automotive Systems in Regensberg, Germany decided to introduce new manufacturing processes that would provide more flexibility in production and reduce costs, they turned to HP.

Siemens Automotive products include engine control units, airbag control systems, trip computers, pilot systems, infrared locking and relay units. The company is widely recognized among BMW, Mercedes, General Motors, Ford, Honda and other customers for its "black box" components, the electronic brains of most car-driver-environment systems. Today's car buyers require more of these high technology components to make driving safer, faster and more economical. This means there are more frequent new product introductions, and less time available to reach market. New testing methodology, that would readily accommodate modifications required for this stream of new products, was a key element in the success of this Seimens manufacturing strategy.

Needed more flexibility at lower cost

In planning the new system, the team of international managers, familiar with the company's objectives, realized early that control of the production processes alone was insufficient to support the level of innovation they needed to develop and introduce the many new types and versions of automotive electronic parts. What was needed was an integrated, open systems hardware/software environment. This was selected over a proprietary system approach as it was more adaptable to changes in products and production. In addition, it was less costly than developing fixed solutions.

HP project managers coordinated the overall effort

HP engineers provided solutions for the integration of the systems into the manufacturing environment, such as custom operator interfaces optimized for prototyping or volume manufacturing needs. In addition, they developed measurement methods, and designed and verified algorithms for critical applications, all on Siemens' extremely tight schedule.

To enhance the overall test development capacity, HP identified and qualified an outside test partner. This relationship, originally under HP control, is now a direct relationship with Siemens, providing these high levels of services at even lower cost.

The entire project was accompanied by training sessions to bring Siemens engineers up to speed on the new systems.

Solution based on HP 5400

The system that was developed, called the "Ventury System" is based on personal computer (PC) hardware running Windows®-compatible test and/or control programs. It is based on a standard VXI rack and contains primarily HP VXI instrument modules. Standardizing on the engine control units, for example, improved the synergy between various departments within the company. The simple programming and fast C-coded control programs led to increased throughput for higher volume production on the order of a factor of two to four times. In addition, the HP TS 5400 requires a minimum amount of training.

Over the expected life of the system, which stretches well into the next century, Siemens expects that this approach can save several million dollars, in addition to the advantages of time to market and product flexibility. At the same time, Siemens customers are assured that they will be receiving well conceived, fully tested, high quality products at a reasonable cost.

Lockheed Martin Lunar Prospector Program achieves aggressive cost and schedule goals with HP Test System

When Lockheed Martin Missiles and Space Company contracted to build the NASA-supported Lunar Prospector spacecraft for orbit around the moon, it did so on a comparatively small budget and within a very aggressive schedule. The cost at $63 million is roughly one fourth of the cost of the first lunar orbitor of 1966, stated in 1997 dollars, while the total schedule was just 30 months, after receiving the go-ahead.

New NASA Discovery mission series is faster, better, cheaper

The Lunar Prospector is the first peer-reviewed, competitively selected mission in NASA's new Discovery Series of "faster, better, cheaper" solar system exploration missions. These innovative Discovery missions encourage close working relationships among industry, university and government partners. Hewlett-Packard is participating by providing Lockheed Martin with a complete system for integrating and testing the spacecraft's bus and payload, which will gather information about the moon's surface composition, magnetic and gravity fields, and potential resources that could support human life.

The simple nature of the Lunar Prospector spacecraft itself posed significant challenges. For instance, the purposeful elimination of back-up components on board helped to reduce cost and weight, but came at the trade-off of reliability from redundancy. This means that all systems not only needed to be ready for the launch, but must operate reliably for the entire 18 month mission to follow. As a result, effective testing throughout the entire manufacturing cycle was critical.

HP Lunar Prospector Electrical Test Set is dual purpose

Working in concert with Lockheed Martin Missiles & Space, HP was given the latitude to find creative ways to cut time and costs associated with test system development. The resulting HP Lunar Prospector Electrical Test Set (LPETS) is used for two purposes: to power and test the satellite during manufacturing as well as immediately prior to launch at Cape Canaveral. LPETS includes power supplies and solar array simulators, as well as digital and analog stimulus-response testing capabilities. Using a VXI mainframe, LPETS does stimulus-response testing on the satellite's altitude control system, separation systems and Sun and Earth-Moon sensors which are used for navigation.

HP's strategy minimized costs and cut development time

Part of HP's strategy for developing LPETS quickly and inexpensively was using commercial, off-the-shelf components as much as possible and keeping hardware and software cost to a minimum. Not only are off-the-shelf solutions typically less expensive and of high quality, but they are currently available. Given the short time frame, HP needed system elements immediately, not in several months. In addition, the use of HP VEE graphical programming language played a major role in meeting cost containment and time-to-launch goals.

Development of the LPETS system is also an example of effective concurrent engineering efforts. As Lockheed Martin and its scientific experiment partners were designing and building the spacecraft, HP was gathering technical specifications, enabling HP to configure and build the LPETS, bringing hardware, software, and support expertise together to provide a total solution not only for the Lunar Prospector program, but for future programs as well. With slight modification, LPETS will be re-used on the forthcoming IMAGE mission, which will study the global response to the Earth's magnetosphere to the variations in the solar wind.

HP Lunar Prospector Electrical Test Set (LPETS) at Lockheed Martin site, performing test during Lunar Prospector manufacturing phase.

HP Hardware, Software, and Support Total Solutions let MTI reduce time-to-market while increasing test capability and flexibility

Microelectronics Technology Inc. (MTI) is a microwave parts and components design and manufacturing company based in Taiwan, and focused on the communications market. Situated in what has been dubbed the "Silicon Valley" of Taiwan, MTI has become internationally recognized as an industry leader in several fields of the communications industry.

Their customers are mainly large communication equipment manufacturers in Europe and the USA. Motivated by recent trends in mobile and personal communications, MTI has successfully entered the global personal communications market.

MTI executives, with HP Consultant and Account Manager, stand before display of MTI communications products tested by HP test system. From left to right: Tony Chen, Consultant HP; William W. S. Wang, Director of Special Products MTI; Jason L.C. Chang, Vice President R&D MTI; Lobo Wang, Senior Account Manager HP.

Keeping up with change

To keep up with the rapidly changing and complex technology of the communications market, and to shorten the product development cycle, it was important that their R&D department was equipped with leading edge design, development and test solutions.

"MTI has always been focused on RF technology. We define our own products and write our own application software, so as to shorten the design cycle for faster time-to-market. This is the key to our success and the way to survive," reports Mr. Wang Wen-xun, Assistant Manager Specialized Electronic Department of Taiyang Technology, of MTI. "In the past we used hardware set-up methods for our tests, in which any test setup could only perform tests on a particular component. Once the standard is changed, all procedures have to be redone, causing delays," he added.

Flexibility and support are key

MTI needed a more flexible test system for their R&D Department, and a partner who could be relied upon to deliver and support such a system locally. After evaluating alternative suppliers, MTI chose HP as the best match in terms of pricing, performance, flexibility and support.

Mr. Wang believes that the key factor affecting the purchase decision was after-sales service and technical support. To cope with the fast pace of development in the microwave communication market, strong support is needed during the research and development stage. "The software programs of HP were written by technical experts in Taiwan, hence any problem that may arise can by solved by the original programmers directly and efficiently," he explained. "Support from alternative suppliers would have generally been an individual technician. However, HP Taiwan has established an integrated team of over 30 engineers to provide local support. In addition, these are part of a global team of over 17,000 support specialists worldwide, to make a best effort to respond to any MTI request or inquiry on equipment as soon as possible," he added.

Solutions build for the future

The cooperation between MTI and HP over the past years has established a good mutual understanding. MTI says the equipment, technology and services provided would make HP a reliable partner of MTI in the future. This is especially important when looking forward to the integration of telecommunication, electronic media and computer businesses. The rapid changes in these converging fields will provide unlimited development opportunities for those who are flexible and fast to market. "Time is money," emphasizes Mr. Wang.

As MTI's experience demonstrates, HP's Test and Measurement hardware, software and support solutions capability potentially offer the expert, cost effective alternative.

Cost-effective HP support services help Netwave Technologies meet the requirements of ISO 9000

Netwave Technologies, Inc., (now located in Pleasanton, California), develops and manufactures wireless LAN PC cards and access points for mobile PC users. Its products give customers wireless access to local area network services, including intranets and the Internet.

As the global presence of Netwave Technologies grew, the company's management knew that many of its international customers would demand that Netwave Technologies, a former division of Xircom, become ISO 9000 certified. (ISO 9000 is the industry standard for quality assurance that covers everything from R&D to manufacturing, sales, and marketing.) To remain competitive, the company had to comply with the standard.

Equipment calibration needed

As part of the ISO 9000 certification process, all of the test equipment in the Netwave Wireless LAN business unit, formerly located in Mountain View, California, had to be calibrated. The budget was limited, and time was critical, due to ISO and internal funding deadlines.

Netwave Technologies required a known vendor who could negotiate a contract quickly and begin work immediately. They needed a single supplier who would fit the budget parameters and who had the flexibility and creativity to develop a workable solution for all of its calibration needs for manufacturing and engineering. Price and quality of work were critical.

The standard HP calibration process provided more service than Netwave Technologies required. But HP also offers customized services, equipment, and systems, so other options could be explored. HP created a custom calibration program that could meet the cost target and deadlines.

Calibrate only functions actually used

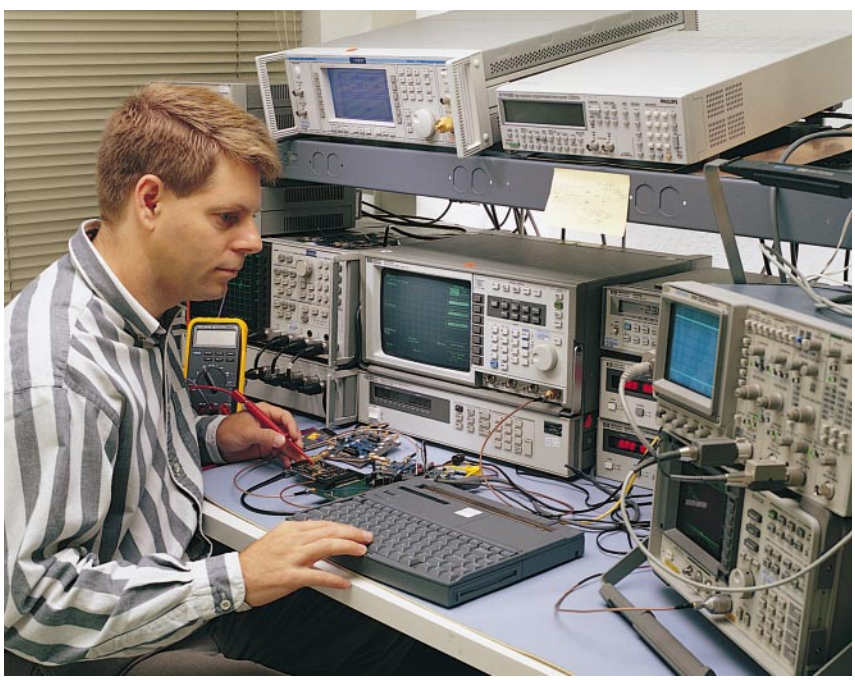
The key to lowering costs and still meeting the technical requirements for ISO 9000 certification was the plan to calibrate only those instrument functions that were pertinent to the wireless networking products of Netwave Technologies, rather than all of the test equipment's functions. This "calibrate where necessary" approach reduced the required number of calibration operations by up to 50 percent on many pieces of equipment. The inventory consisted of a wide range of test equipment from HP and other manufacturers—network analyzers, function generators, oscilloscopes, and power meters.

HP performed the calibration at the customer's facility, working after hours and on the weekend, so that testing down time was eliminated on the manufacturing floor and in the engineering lab. This not only saved time for Netwave Technologies, but also saved several thousand dollars. Because HP's calibration laboratory in Mountain View, California is ISO 9000 certified, there was no need for Netwave Technologies to inspect the HP facility, which saved more time.

Program completed before deadline

The customized calibration process met the ISO 9000 technical requirements, and HP completed the program before the deadline that ISO had imposed.

According to Jerry Ulrich, Xircom's former chief financial officer and the current president of Netwave Technologies, "We were completely satisfied with the project for a number of reasons. HP was very responsive to our business needs and budget pressures. Their solution was a creative, technically astute calibration plan that was implemented with an absolute minimum of interference to our normal operations. Overall, HP gave Netwave the exact level of quality service needed, when needed, and within budget."



By developing a program for calibrating only the specific instrument functions used for product tests, HP saved Netwave Technologies thousands of dollars.

A wise choice: HP professional consulting and engineering services

Let HP's expert consultants assist you with your test and measurement activities whenever needed—for example, when you lack the internal engineering resources.

HP offers professional resources—skilled, dedicated men and women—to supplement your resources. You can trust them to assist you with as many of your system development and operational phases as necessary.

Our worldwide staff includes field- and factory-based experts in low- and high-frequency measurement and high-speed data acquisition system designers; communication, networking, and computer solution experts; project managers and specialists; manufacturing process experts; field/factory authorities; and experienced teachers and trainers. Their common goal is to meet your T&M related business needs in the best possible way.

Because HP consultants have diverse knowledge and expertise, they provide a wide range of professional services. You can enlist their help to:

- Evaluate your development and manufacturing processes
- Perform feasibility studies
- Determine T&M system requirements
- Manage complete test projects
- Provide advice on manufacturing and test processes
- Obtain information on industry and technology developments
- Develop hardware and software
- Train your operators, programmers, and maintenance personnel
- Support and maintain your T&M systems and more!

Learn more about HP's complete test and measurement solution services

The specially-engineered products and systems in this section illustrate how Hewlett-Packard creates innovative, fully-integrated, test and measurement solutions.

Chances are, you've relied on HP as a test and measurement supplier for years. Why not consider us for your custom T&M solutions as well? We can be your most knowledgeable outside resource by providing you access to our broad base of measurement instrumentation, computer, and communication system knowledge and experience. The companies highlighted in the section, and many others, have benefited from letting HP help them solve their difficult challenges.

For additional details on how you can take advantage of HP's expanded custom engineering and consulting services, see pages 578 and 586.

Innovative products that make a difference

The exciting new products in this section of the catalog offer you important new capabilities and enhanced benefits. They reflect the wide scope of HP's research investments and underscore an unwavering commitment to meeting your changing test and measurement needs with continually improved instruments, systems, software, and services.

Among the characteristics and trends illustrated by the new products in this section are the following:

Increased value—and affordability, with nothing left out, has been achieved through improved designs, patented measurement techniques, higher integration, and efficient manufacturing.

Ease of use—one-button test capabilities boost efficiency and make sophisticated HP instruments simple to operate, and improved graphical interfaces help you achieve results faster.

Breakthroughs—unique solutions to long-standing problems have been developed by HP engineers, continuing a legacy of product innovations.

Higher performance—new, extended performance limits permit insights into problems that were previously impossible to analyze.

More powerful methodologies—new, advanced troubleshooting techniques let you analyze problems with unprecedented speed.

Modularity—modular test solutions give you greater measurement flexibility with considerable economy—a combination that offers value now and in the future.

Faster test speeds—higher measurement throughputs increase productivity in both engineering and production environments.

Improved data-analysis capabilities—new HP instruments make it easier than ever to complete the entire test and measurement task, including data analysis and report preparation.

Upgradeability—the flexible architectures used in many HP instruments enable timely software performance and feature upgrades, extending the equipment's useful life, and safeguarding capital investments.

Portability—many new HP analysis instruments are exceptionally small and lightweight, so they are easily carried to the problem site for efficient troubleshooting.

Application-specific solutions—HP now has an expanded capability to support the complete test engineering solution process, from consulting services to fully configured test systems, and offers more standard products optimized for applications such as data communications and video.

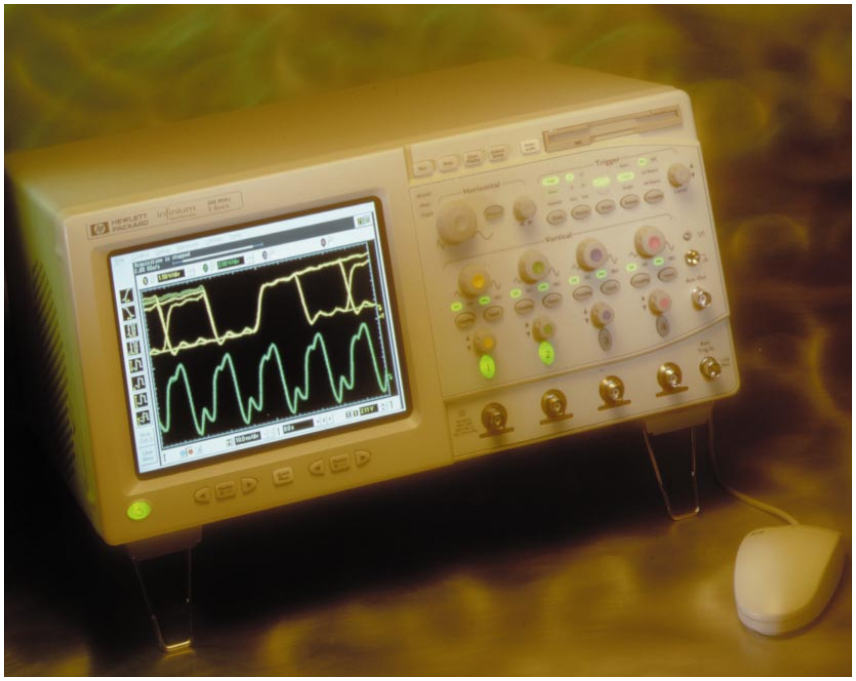
User familiarity—leveraging familiar user elements of computers to allow you to spend more time on your project and less time learning the instrument.

Web enabled—more instruments that interface directly to the internet to make HP and other resources more readily available.

More products, more solutions

HP, the worldwide test and measurement leader, offers you the industry's most extensive, most trusted line of standard and custom solutions. The new products for 1998 build on a vast base of existing products. To obtain a more complete picture of how HP products and services can help you, please refer to the main product section, which begins on page 61. If you need additional information on a specific application, contact your HP sales representative.

Uncomplicated, accessible oscilloscopes offer high performance with low frustration



Innovative HP Infinium oscilloscopes offer bandwidths of 500 MHz to 1.5 GHz, sample rates up to 8 Gsamples/s, and new advanced triggering capabilities.

The HP Infinium family of oscilloscopes delivers a new level of performance and makes powerful measurement features accessible and uncomplicated. Basic functions are simple. The front panels of HP Infinium oscilloscopes are designed to be similar to an analog oscilloscope's front panel. There are no soft keys or menu keys adding clutter. The controls are easy to find and recognize.

The oscilloscope's graphical user interface (GUI) is based on Windows 95, so you don't have to relearn its operation, even if you haven't used it in a long time. With the GUI, just drag one of 16 measurement icons and drop it on the waveform feature you want to measure. Or, you can draw a box around a waveform feature, click inside the box, and Infinium will zoom in automatically.

An Information System built into HP Infinium oscilloscopes can be accessed from the exact point of confusion using a context-sensitive Help button. A Setup Guide with 24 step-by-step procedures helps you make advanced measurements such as jitter, or set up advanced features such as violation trigger.

For more information, see page 106.

For detailed specifications, circle 1 on the reply card (last page) or contact your local HP sales representative.

Multifunction data acquisition and control system

Test mixed I/O signals fast, without adding extra VXI measurement modules.

The HP DAC1000 multifunction data acquisition and control system is a lower-cost (up to 30 percent less) alternative to proprietary solutions. Available in a 6-slot, C-size VXI mainframe with an HP-IB interface, it includes the new HP E1419A 16-bit precision scanning A/D converter and control module, which operates at 56,000 channels/second.

The HP DAC1000 system has 32 channels of analog input, plus 32 channels that can be configured for various combinations of analog and digital I/O and counter functions. Input measurement capabilities include voltage, resistance, temperature, strain, pressure, frequency/totalize, and digital state. Control outputs include voltage/current, square and pulse with pulse width modulation, stepper motor control, and digital. Intelligent measurement and control features minimize programming and provide engineering unit conversions and real-time decision-making capability.

For more information, see page 556.

For detailed specifications, circle 2 on the reply card (last page) or contact your local HP sales representative.

VXI test system products greatly reduce test system hardware costs

You can achieve dramatic cost reductions by using HP's new VXI mainframe, mezzanine modules, and C- and B-size cards in your next test system.

HP's entirely new line-up of VXI products reduces the typical hardware costs for building a VXI test system by more than 35 percent. They also decrease system integration time while improving ease of use, system speed, and system reliability. The products include:

- the HP E8400A 13-slot, C-size mainframe with innovative cooling and basic system monitoring
- the HP E2251A C-size mezzanine module card carrier that combines the European M-Module architecture with the VXI architecture
- nine HP E2200 series M-Modules for flexible, economical switching, digital I/O, and serial interfacing
- the HP E1563A (2-channel) and HP E1564A (4-channel) C-size digitizers that offer 14-bit resolution, 0.1% accuracy at up to 800 K samples/s
- the HP E1419A C-size, 64-channel, multifunction data acquisition and control card
- the HP E1441A arbitrary waveform generator, which produces waveforms at a rate of 40 MB/s with 12-bit accuracy, has built-in 15 MHz sine/square waves, and includes enhanced sweep and modulation capabilities
- the HP E8460A C-size, 256:1 reed relay multiplexer with multiple reconfigurable topologies
- the HP E1339A B-size, 72-channel digital output/relay driver

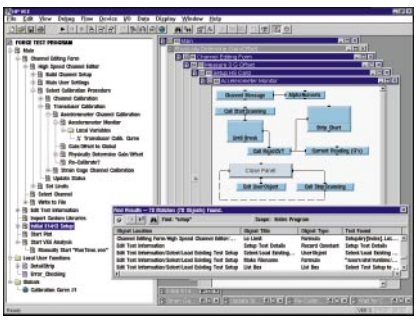
These new products lead HP's drive to bring the benefits of VXI within reach of the test department budgets of medium to small companies. All comply with the open, international VXI*plug&play* standard, and every instrument comes with a VXI*plug&play* instrument driver for the Windows 95/NT framework.

You can access more information at the HP VXI test system Web site: www.tmo.hp.com/tmo/pia/html/VXIbusProducts.html

For more information, see page 68.

For detailed specifications, circle 3 on the reply card (last page) or contact your local HP sales representative.

Save time with upgraded graphical programming language



HP VEE 4.0's professional development environment provides a look-and-feel similar to popular operating systems, for instant familiarity.

HP has made a major revision of its popular graphical programming language for developing test and measurement applications. HP VEE 4.0 has improved performance and new ease-of-use features. The software decreases development time for manufacturing test, design characterization and verification, and data-acquisition applications.

A new compiler encodes HP VEE programs for quicker execution. Typical computation-intensive routines now execute 40 times faster than in previous versions of the software. Applications in which input/output performance and instrumentation characteristics constrain execution speed run 150- to 400-percent faster.

The new professional development environment offers a program explorer, multiple document interface, and debugging capabilities. Navigation tools facilitate the management of large programs.

Free evaluation copies of HP VEE 4.0 can be downloaded from the Internet (http://www.hp.com/go/hpvee.com). Application notes, user tips, and technical information are also available at this Web site.

For more information, see page 62.

For detailed specifications, circle 4 on the reply card (last page) or contact your local HP sales representative.

Powerful, one-box ac power source/analyzer

The new HP 6811A ac power source/analyzer provides uncompromising, powerful testing capabilities at a lower price than multiple-box ATE solutions.

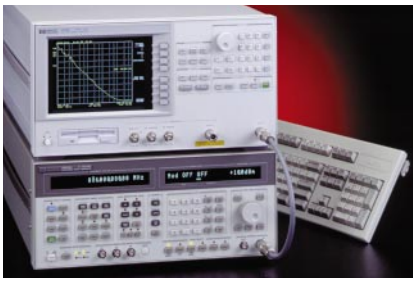
The new HP 6811A is an integrated solution that provides a comprehensive set of capabilities for ac power testing. It also includes dc output capability. This product meets the unique measurement and power-generation requirements of low-power product testing, offering built-in power analyzer, programmable line-impedance network, arbitrary waveform generator and power amplifier functionality.

The ac power source/analyzer eliminates the need for higher-cost, over-rated ac sources for testing low-power products because it sources peak currents up to 40 amps. This is 12 times its maximum rms current rating, which represents the highest crest factor available at 375 VA. The HP 6811A's 16-bit accuracy and dynamic range allow it to measure low-level rms currents and power for characterization and functional testing with extreme precision.

For more information, see page 186.

For detailed specifications, circle 5 on the reply card (last page) or contact your local HP sales representative.

Improved oscillator testing



HP 4352S VCO/PLL signal test system offers improved efficiency for oscillator design and production test.

Wireless communication architectures require synthesized local oscillators that provide low phase noise, fast frequency lock time, and low power consumption. The HP 4352S VCO/PLL signal test system provides enhanced measurement capabilities for evaluating voltage-controlled-oscillators (VCO) with embedded phase-lock-loops (PLL), as well as free-running VCOs from 10 to 3000 MHz (26.5 GHz optional).

The test system's signal analyzer measures key parameters such as VCO tuning characteristics (frequency, sensitivity, RF power), phase noise, spectrum signature (spurious, harmonics), FM deviation, RF transient (VCO tuning drift, PLL frequency transition), and dc power consumption. Besides these measurement capabilities, it supplies dc power, generates ultra-low-noise VCO test control voltage, and produces digital control signals for the PLL.

The noise floor of the HP 4352S is a low –157 dBc/Hz at 1 MHz offset, typical. Measurement speed is optimized for high throughput; for example, in the phase noise mode, the system covers a sweep from 100 Hz to 10 MHz frequency-offset in 7.1 seconds. RF transient measurements can be performed with 50-Hz frequency resolution and 12.5-μs time resolution to measure frequency lock time.

For more information, see page 334.

For detailed specifications, circle 6 on the reply card (last page) or contact your local HP sales representative.

Flexible data acquisition at a low price

Modular system fits up to 120 channels of 6½ digit measurements in a single frame.

The modular HP 34970A data acquisition/switch unit establishes a breakthrough price for capabilities that include 6½ digit (22-bit) measurements, 0.004% basic dcV accuracy, and scan rates of up to 250 channels/second. It can be configured as a data logger or data acquisition system, and as a high-performance switching and signal routing solution.

As a data logger, the HP 34970A offers 11 built-in measurements with internal signal conditioning. It operates standalone with 50,000 readings of nonvolatile memory. You can independently set scale factors, alarm limits, and measurement functions on each channel. Free HP BenchLink Data Logger software (Microsoft Windows 3.1-, '95-, and NT-compatible) makes it easy to configure the instrument and display, analyze, and archive data on a PC.

For automated test and benchtop automation applications, the instrument's three slots and choice of eight plug-in switch and control modules allow easy customization. Available modules include low-frequency and RF multiplexers, matrix and general purpose switches, plus a multifunction module with digital inputs and outputs, analog outputs, and an event counter.

For test applications that require only a switching capability, the HP 34970A can be ordered without the internal digital multimeter. This provides a high-quality switching solution for a fraction of the cost of existing systems. You can get up to 120 single-ended channels per frame, or as many as 96 matrix cross-points in a half-rack size instrument.

For more information, see page 147.

For detailed specifications, circle 7 on the reply card (last page) or contact your local HP sales representative.

Improved one-box solar array simulator

The HP SAS is a complete one-box solar array simulator.

The new HP E4350B/E4351B (60 V at 0-8 A/120 V at 0-4 A) solar array simulators are dc power sources that accurately and quickly simulate the complex I-V curve characteristics of solar array panels subjected to the environmental conditions of space.

These one-box supplies offer complete flexibility in programming a wide range of curves:

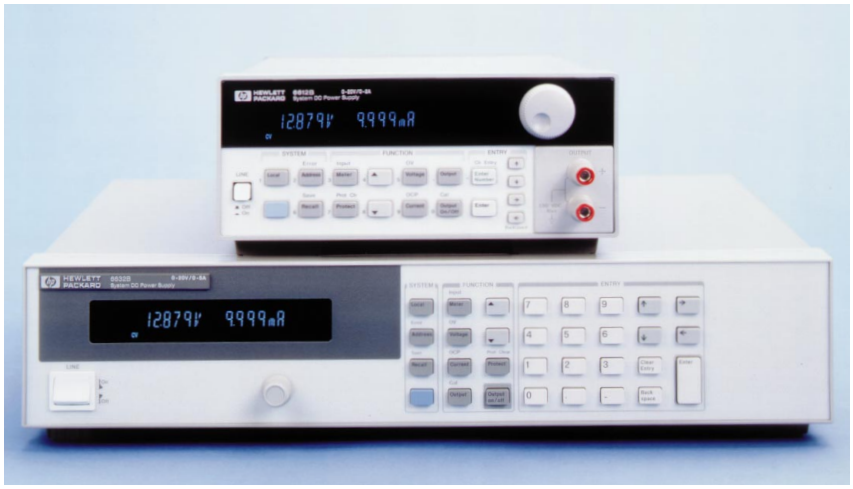
- Simulator mode: the I-V curve is generated according to four input parameters (Imp, Vmp, Isc, Voc)
- Table mode: the I-V curve is constructed from a user-defined table of points
- Fixed mode: a rectangular I-V characteristic is produced

The HP E4350B and E4351B provide an output power of up to 480 W and output currents up to 8 A. They can be integrated easily to meet your power requirements, then quickly reconfigured when a new requirement comes along. The supplies offer low output capacitance, quick response times, and high shunt and series switching frequencies.

For more information, see page 179.

For detailed specifications, circle 8 on the reply card (last page) or contact your local HP sales representative.

Power supplies extend the range of output voltages



These power supplies simplify tests of a wide variety of low-power devices and products.

Four new models have been added to the HP 6610 series (50 W) and HP 6630 series (100 W) power supplies, to provide a wider range of maximum output voltages: 8, 20, 50, and 100 V.

These economical supplies are flexible, one-box test solutions. They simplify system integration, save test set-up time, ease programming, and conserve test system space.

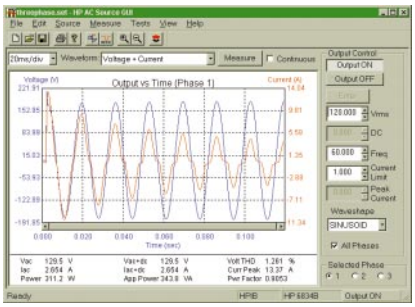
All models offer fast programming response time for high test throughput, and a precision low-current measurement capability—down to microampere levels—for accurate tests of low power modes of operation. As a result, these high-performance power sources meet difficult, high-volume production test challenges.

Applications include production testing wireless telecommunications and battery-powered products. The extended range of output voltages addresses test needs for a great variety of digital and analog components, assemblies, and products.

For more information, see page 171.

For detailed specifications, circle 9 on the reply card (last page) or contact your local HP sales representative.

GUI offers simple, quick ac source operation



The oscilloscope view of the HP ac source GUI's main window provides static, time domain and harmonic measurements of voltage, current, and power.

The new HP ac source graphical user interface (GUI) is a software utility that makes it easier to set up and run sophisticated tests when using HP 6800 series ac power source/analyzers and HP 6840 series harmonic/flicker test systems (in normal ac source mode). The GUI lets you quickly perform tests because there is no software code to write, or any front-panel keystrokes to memorize.

The GUI's advanced features include:

- single-screen setup and measurement
- graphical and tabular transient development and execution
- development, viewing and downloading of harmonic and arbitrary waveforms
- graphical displays of voltage and current harmonic or waveform measurements
- command log window for viewing commands sent to and data received from the ac source

This software is compatible with Windows 95 and Windows NT 4.0, and supports HP-IB and RS-232 interfaces. The GUI is shipped with every HP 6800 series and HP 6840 series model.

For more information, see page 189.

For detailed specifications, circle 10 on the reply card (last page) or contact your local HP sales representative.

Fast power meters and sensors

HP EPM power meters and HP ECP series power sensors provide state-of-the-art measurement capabilities. They offer fast measurement speed, wide sensor dynamic range, and sensors with calibration factors stored in EEPROM. The HP EPM single- and dual-channel power meters and HP ECP series sensors are general-purpose instruments for use throughout the electronics industry in manufacturing, R&D, and field operations, from installation to maintenance of RF and microwave systems.

Faster measurement speed is essential in high-volume manufacturing to improve productivity. An HP ECP series sensor, along with an HP EPM-441A power meter, provide a fast measurement mode of up to 200 readings per second.

The HP ECP series sensors are designed for power measurements of CW signals and cover a –70 to +20 dBm dynamic range, which eliminates the cost of an additional sensor. This single-sensor solution also saves times by eliminating sensor reconnections and the need to perform zero and calibration procedures.

The HP ECP series sensors have their calibration factors stored in EEPROM, so potential measurement errors caused by incorrectly keyed-in calibration factor data are eliminated. At power-on, or when the sensor is connected, the calibration factors are automatically downloaded into the power meter.

For more information, see page 291.

For detailed specifications, circle 11 on the reply card (last page) or contact your local HP sales representative.

High-performance HP matrix switches

The new HP 87406B and HP 87606B coaxial matrix switches.

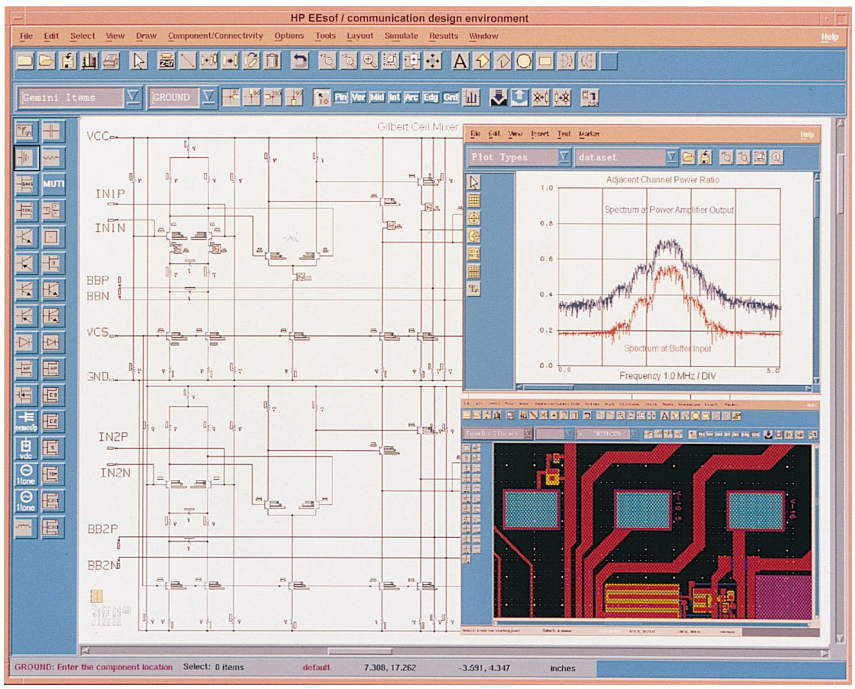
The HP 87406B and HP 87606B 6-port, coaxial matrix switches provide test system designers with a valuable tool for 3x3, 2x4, and 1x5 signal routing. Primarily used in rack and stack test architecture, these broadband switches simplify and enhance the versatility of test system interfaces.

These matrix switches feature excellent repeatability and reliability, increasing measurement confidence and lowering cost-of-ownership. Repeatability is under 0.03 dB typical, while life exceeds 5 million cycles. The HP 87406B and HP 87606B operate from dc to 20 GHz. Insertion loss is 1.0 dB max.; isolation is <70 dB; and VSWR is <2.0:1. Input power is 1 W avg./50 W peak (10 ps, maximum) with SMA (type f) connectors.

For more information, see page 306.

For detailed specifications, circle 12 on the reply card (last page) or contact your local HP sales representative.

Advanced Design System simulates communications path, offers RF, DSP and electromagnetic simulators



Offering unprecedented speed and accuracy in RF system simulation, HPEEsof's Advanced Design System combines proven technology with innovation.

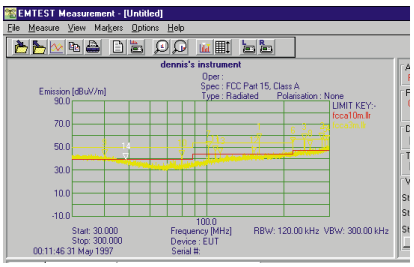
HP EEsof's Advanced Design System is a new EDA solution developed specifically to simulate the entire communications signal path. This unique solution, available for both PC and UNIX platforms, integrates HP EEsof's proven RF, DSP, and planar electromagnetic simulators into a single, flexible design environment. The result is a software solution that takes you from behavioral-level system design all the way down to RTL or component-level circuit design, all within one user interface and one database.

The Advanced Design System provides capabilities for communication system design and system architecture, including RF system simulation; DSP design and synthesis from behavioral to RTL; RFIC simulation, including time-domain, frequency-domain, and envelope simulation; microwave circuit design, including MMIC and hybrids, from simulation to layout; and RF board-level design. It also integrates into enterprise framework tools such as Cadence and Mentor.

For more information, see page 318.

For detailed specifications, circle 13 on the reply card (last page) or contact your local HP sales representative.

Automated EMI measurements



HP 11961A pre-compliance software lets you quickly configure HP 8590EM series EMC analyzers rapidly to perform EMI measurements and generate reports.

The HP 11961A is a Windows-based software package that has been developed to provide a user-friendly interface to the HP 8590EM series of spectrum analyzers for EMC measurements. This pre-compliance software allows you to quickly configure an analyzer to perform EMI measurements and generate reports.

The HP 11961A software package features up to 8000 measurement points; limit lines—standard and user-generated; test equipment correction factors; and peak, quasi-peak, and average measurements. Compile, save, and print standard reports showing measurement data, annotated data, and limit lines. Powerful graph and data formatting tools let you enhance the data presentation. Traces from separate measurement runs can be overlaid.

For more information, see page 325.

For detailed specifications, circle 14 on the reply card (last page) or contact your local HP sales representative.

Powerful DSP-based surveillance receiver

The HP E6501A Option 003 VXI receiver provides powerful DSP-based signal-search and demodulation capabilities from 20 MHz to 3000 MHz.

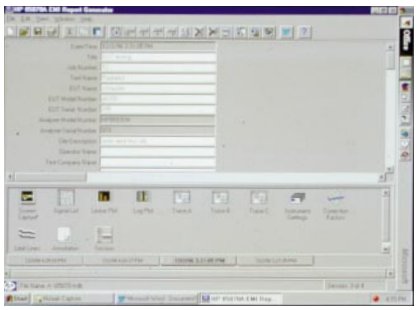
The HP E6501A VXI receiver provides frequency coverage from 20 MHz to 1000 MHz (or 3000 MHz, optionally) for surveillance and spectrum-monitoring applications. Combining a high-dynamic range, fast-stepping tuner with powerful DSP-based IF processing, the HP E6501A gives systems integrators a receiver subsystem for fast spectrum searches, and multiple-channel demodulation and direction finding (DF) requirements.

Based on flexible VXI architecture, the HP E6501A provides systems benefits including easy reconfiguration, multiple function capability, scaleability, and upgradeability. For example, the 1-GHz base system can be easily upgraded to 3 GHz with the addition of a VXI module. And multiple channels can be configured to either improve instantaneous demodulation capture range or provide coherent digital down conversion for DF applications.

For more information, see page 330.

For detailed specifications, circle 15 on the reply card (last page) or contact your local HP sales representative.

Link EMC analyzers with PCs



Low-cost software provides an affordable solution for linking EMC analyzers with Windows 95-based PCs.

Developed for design and EMC engineers, HP 85878A EMI report-generation software runs on Microsoft Windows 95-based personal computers to help store data and make it easy to generate reports from HP's EMC analyzers and EMI receivers.

Automated measurements performed by the HP 8590EM series EMC analyzers, HP 8546A and 8542E EMI receivers, and HP 84125A/B microwave EMI receiver systems each produce 11 different information elements: displays, measurement lists, log and linear graphs, trace data, correction factors, and more. All of these elements can be easily transferred to a PC and archived by the HP 85878A.

A time stamp and header identify each file of measurement information for easy identification, and files can be found quickly using the file-search function that is part of HP's report-generation software.

For more information, see page 325.

For detailed specifications, circle 16 on the reply card (last page) or contact your local HP sales representative.

Fast, easy-to-use portable spectrum analyzer offers new measurement reliability features

Speed, performance, and ease of use characterize HP's new low-cost spectrum analyzer.

The HP ESA-L1500A is a new low-cost, fully synthesized, 9-kHz to 1.5-GHz spectrum analyzer. It has the speed and performance required in manufacturing test combined with the rugged ease of use expected of a field instrument.

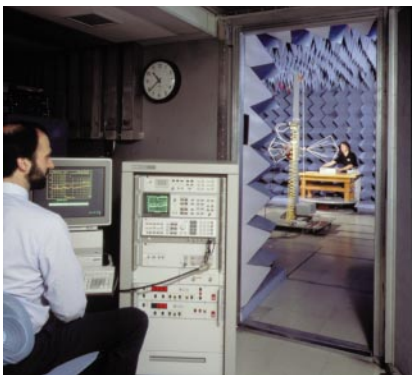
This tough, portable instrument helps reduce manufacturing test costs with its 5-ms sweep time and high-speed remote test capabilities. Additionally, the HP ESA-L1500A built-in limit lines and pass/fail messages help test engineers get fast and easy results.

The phase-locked synthesizer adds stability and repeatability to frequency measurements, and the automatic background alignment feature provides continuous calibration. For field applications, this instrument has 5-minute warmup and can be powered from 12 Vdc. In addition, it is encased in rubber and has a rain-resistant front panel, shielded vents, and a side-mounted fan for accurate operation in adverse weather conditions.

For more information, see page 215.

For detailed specifications, circle 17 on the reply card (last page) or contact your local HP sales representative.

Flexible PC-based EMI software



HP 85869PC EMI measurement software provides EMI/EMC engineers with great flexibility.

The new HP 85869PC EMI measurement software makes automated military-standard (MIL-STD) and commercial radiated and conducted measurements of EMI, using HP 8571A and HP 8572A EMI receivers.

Time-saving features of the HP EMI measurement software help speed the measurement process. These include: a report generator for complete measurement reports; a function that discriminates between narrowband and broadband signals; a "zoom local" function that provides a closer look at signals; and the ability to tune and listen to individual signals.

The new software runs on Windows 3.1- and Windows 95-based computers. A low-cost upgrade option (Option 832) is also available for current HP 85869A workstation customers who want to work in a PC environment. All data libraries, setup tables, and custom subroutines can be transferred easily from the workstation version to the new PC version. An IEEE 488 interface card (Option 488) is available to manage communications with the measurement system and peripherals.

For more information, see page 322.

For detailed specifications, circle 18 on the reply card (last page) or contact your local HP sales representative.

Full-featured microwave counters for field, factory, or lab

The HP 53150 series delivers rugged durability with no sacrifice in performance.

The HP 53150 series microwave counters offer laboratory-level performance and accuracy in a rugged yet lightweight package with the low cost of ownership you expect from an HP product. With their remarkably small footprint and optional battery operation, these counters are ideally suited for the field environment, as well as the most demanding laboratory or factory test application.

Behind the clean, uncluttered front panel of the HP 53150 series is a very powerful portable microwave counter. Some outstanding features of these precision measuring instruments include a single, ultra-wide input (from 50 MHz to 46 GHz) with power measurement capability; optional battery or 12 V dc operation; and standard HP-IB and RS-232 programming. They also offer both frequency and power offsets, measurement averaging, a bright "see anywhere" LCD display, a battery charge indicator, and a peaking meter for power measurements.

For more information, see page 133.

For detailed specifications, circle 19 on the reply card (last page) or contact your local HP sales representative.

Simplify multiport measurements

The HP 87075C multiport test set provides the fastest device measurement throughput available.

The HP 87075C multiport test sets are fully specified interconnect solutions that address the needs of suppliers of broadband and CATV (75 ohm) multiport RF devices. The test sets, coupled with the HP 8711 family of RF economy network analyzers, offer significant improvements in RF connectivity, local area networking, and advanced automation capabilities. Calibration time has been reduced to an amazing 1.5 seconds with this system.

The network analyzer and test set are specified as a system, which provides a verifiable measurement platform. Networking capability and internal IBASIC automation allows you to effortlessly send and receive test data from each station, to analyze trends, and to improve processes. These data-management capabilities allow you to perform better device analysis and to speed data-archival tasks.

For more information, see page 272.

For detailed specifications, circle 20 on the reply card (last page) or contact your local HP sales representative.

Single-connection, single-sweep VNA systems

Convenient on-wafer measurements with the HP 8510XF using a Cascade Microtech wafer probing station and APC 110 probes.

Covering a wide frequency range in millimeter-wave has been virtually impossible due to the frequency limitation of each waveguide band. The HP 8510XF network analyzer systems have been designed to measure broadband devices to 110 GHz, in 1.0 mm coax or on-wafer, fully calibrated, in a single sweep. All frequency band switching is performed internally, eliminating the need for an external controller.

The HP 8510XF system is designed for convenient on-wafer measurements using a wafer probing station with 1.0-mm probe. The new test heads are especially designed for mounting on probe stations, allowing them to move with the probe tips so there is no relative movement between the two. This wafer probe configuration prevents RF cable flexing, improves measurement performance and enables single touchdown probing to 110 GHz.

The HP 8510XF is available in two standard configurations. The E7340A measures from 2 to 85 GHz, while the E7350A measures from 2 to 110 GHz. Option 005 extends measurements down to 45 MHz.

Any existing HP 8510-based system can be upgraded to an HP 8510XF. Upgrade packages may vary depending on the existing system.

For more information, see page 288.

For detailed specifications, circle 21 on the reply card (last page) or contact your local HP sales representative.

Combination analyzers tackle multiple tests

The HP 4395A and HP 4396B combination analyzers help to save money, reduce learning, and shorten test times.

The new HP 4395A and 4396B network/spectrum/impedance analyzers perform vector network, spectrum, and optional impedance measurements in lab and production applications. Coverage is from 10 Hz to 1.8 GHz. By using one analyzer for multiple test functions, you get precision measurements and test convenience, yet save money and reduce learning and test time.

In production, the combination analyzer increases your test throughput, since it is easy and fast to switch between different types of functional tests. Production tests can be optimized with these instrument capabilities:

- high test speed for vector network analysis
- fast narrow-band spectrum analysis with stepped FFT
- list sweep
- limit lines
- test automation with built-in HP IBASIC.

These are full-capability combination analyzers. The HP 4395A and 4396B make no trade-offs among vector network, spectrum, and impedance performance. And their small footprint saves valuable bench space in any environment.

For more information, see page 254.

For detailed specifications, circle 22 on the reply card (last page) or contact your local HP sales representative.

Fast, accurate, phase-noise measurements

The HP E5500 series offers unmatched measurement speed, offset range, and flexibility.

The new HP E5500 series of phase-noise measurement solutions have been designed to minimize the production ATE test times for one-port VCOs, DROs, crystal oscillators, and synthesizers, and to maximize the capability for R&D benchtop applications. The Windows NT 4.0 interface provides instant access to all measurement functions, making it easy to configure a system, define or initiate measurements, and analyze data.

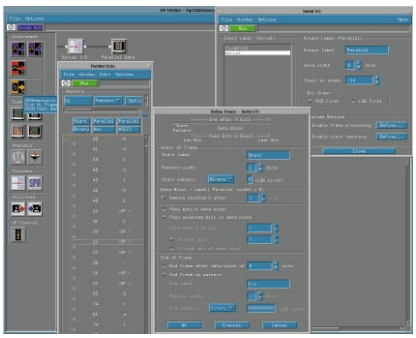
The HP E5500 series phase-noise measurement solutions provide unmatched measurement integrity, repeatability, and accuracy. With test times of less than 3 seconds (1 kHz to 100 kHz) and less than 30 seconds (10 Hz to 1 MHz) achievable, the HP E5500 A-series meet the high-throughput and overall low cost-of-test needs for higher volume devices.

The HP E5500 B-series, with a standard offset range capability from 0.1 Hz to 100 MHz, provides the capability, flexibility and versatility to meet changing needs of R&D engineers.

For more information, see page 331.

For detailed specifications, circle 23 on the reply card (last page) or contact your local HP sales representative.

Easily view and analyze serial data



With the HP B4601A serial analysis tool set, you can easily view and analyze serial data in a parallel word format

Having the right tools to acquire and view serial data streams in the context of system activity is essential for evaluating and debugging complex digital designs. The HP B4601A serial analysis tool integrates the HP 16505A prototype analyzer with HP's powerful 16500 logic analysis system to meet the unique debug needs of system designers who use serial buses.

With the HP B4601A, you can:

- time correlate real-time serial traces to system activity
- convert acquired serial bit streams into an easy-to-view parallel word format
- remove stuffed bits from the data block
- process frame and data portions separately
- reconstruct serial data from a signal that has no external clock reference

The serial analysis tool set is an optional package for the HP 16505A prototype analyzer.

For more information, see page 373.

For detailed specifications, circle 24 on the reply card (last page) or contact your local HP sales representative.

Ease first-level troubleshooting by performing multiple measurements with a single probe tip

The HP LogicDart includes many powerful features, and its new browser facilitates even fine-pitch digital circuit tests.

The HP LogicDart (HP E2310A), a personal digital troubleshooting tool for bench and field-site work, takes logic probe capabilities to an unprecedented level of sophistication. Now, from a single probe tip, you can monitor logic activity, get timing diagrams, measure voltage and frequency, and even compare waveforms. And the HP LogicDart is fast and intuitively easy to use. The thin profile and sharp point of its probe tip make working with small topologies easier and more precise.

The HP LogicDart has an advanced graphic display and powerful capabilities that far exceed those of standard logic probes. Data is presented both audibly (distinctive tones indicate high and low conditions) and visually (with graphic timing displays and blinking LEDs).

For analyzing signal timing, the handheld test tool displays three inputs simultaneously with up to 10-ns resolution, and stores up to ten waveform displays. Each channel has independent edge, pattern, and edge/pattern combination triggering. Pan and zoom capabilities allow precise delta-time measurements.

Additionally, the HP LogicDart measures dc voltage, resistance, diode test, and frequency. The 3½-digit-resolution dc voltage measurement function lets you verify voltage buses, look for loading problems, and check logic thresholds. The instrument's continuity measurement function can be used to verify that connections match the schematic diagram, even before power is applied to the circuit.

Visit our website for a free demonstration (http://www.hp.com/info/LogicDart).

For more information, see page 118.

For detailed specifications, circle 25 on the reply card (last page) or contact your local HP sales representative.

Add 200 MHz to your logic analysis system

The HP E2474A 200-MHz state analysis unit is designed to analyze fast host and cache buses.

With the HP E2474A 200 MHz state analyzer, HP delivers a faster logic analyzer for accurately making critical measurements on high-speed designs. The HP E2474A is a front-end, high-performance sampler designed to add 200-MHz capability to an existing HP 16500 logic analysis system. When combined with an HP 16505A prototype analyzer, HP 16500 mainframe, and HP 16555/16556 logic analysis cards, the HP E2474A provides faster state speeds with wide channel count and more precise setup and hold time windows than any other solution previously offered by HP. It is a highly useful addition to your logic analysis system for debugging broadband host buses and fast devices.

The new module ensures accurate capture of valid data while the system runs at full speed. The HP E2474A can easily adapt measurements to your design by setting the threshold level, adjusting the setup and hold time on 8- and 9-bit boundaries of each pod, and fine-tuning those adjustments. With this state analyzer module, you can be certain that you have captured the "true" state when it occurred, and can be confident that the captured data is valid.

For more information, see page 378.

For detailed specifications, circle 26 on the reply card (last page) or contact your local HP sales representative.

New data generator/analyzer platform

The HP 81200 is a new platform for characterizing digital hardware. A choice of two mainframes (shown in the background) and a compact display & entry panel help to optimize configuration cost and size.

The new HP 81200 Data Generator/ Analyzer Platform helps engineers in design and engineering environments to characterize digital devices and systems. The HP 81200 configurations are compact and accessible so that characterization under near-to-real conditions can be performed at an early stage in the design or manufacturing cycle, thus reducing risks, costs and time-to-market.

Communication and computing devices can require very complex stimuli. To meet this need, the HP 81200 provides sequencing and looping so that its 1 Mb channel memory can generate very deep patterns. Programmable output levels, pulsewidth and delay are independent for each channel so that performance at and beyond working conditions can be measured.

The performance measurements are easy because they are implemented under the same user interface as the stimulus. The HP 81200 captures, and, if required, compares data in real time so that an error map or error count can be observed while stimulus parameters are adjusted. Capture-timing and thresholds are, of course, programmable so that limiting device output conditions can be established as well. Dual thresholds are available so that "bad" pulses with undefined levels can be detected.

Bench-users will appreciate the HP 81200s "switch on and go" philosophy and will adapt rapidly to the Windows-type instrument control. The HP 81200 is supplied ready-to-use (all software and hardware in place and connected) with the desired number and types of channels.The software supports any channels that the user may choose to add at a later date.

For more information, see page 406.

For detailed specifications, circle 27 on the reply card (last page) or contact your local HP sales representative.

Encoder systems offer precise measurements and positioning

Master arm assembly and mechanical pushpin (used with the HP E1710A system only).

The HP E1710A angular and HP E1720A linear encoder systems are PC-compatible sets of opto-mechanical and electronic components. They provide ultra high resolution (16 nanoradians angular or 0.6 nm linear) measurements and servo-controlled positioning for use in dimensional metrology and motion control. They are compact, integrated solutions for precisely controlled angular or linear positioning used in writing servo tracks in the data storage industry. And they are immune to turbulence created by spinning disks and from other changing conditions of the servo track writing environment.

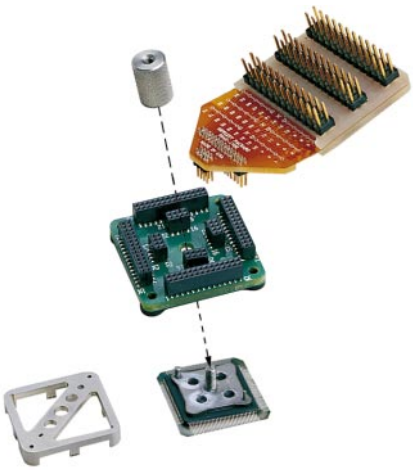
Individual components of the HP E1710A and HP E1720A systems are available if you need to integrate specific HP E1710A and HP E1720A functions into systems of your own design. The HP E1710A is available with the HP E1710A Option 001 master arm assembly. This combines a power amplifier, motor, arm and mechanical pushpin (HP E1710A Option 002) in an easy-to-use, integrated package.

For companies already familiar with HP 10889B Servo-Axis board, the HP encoder makes for an easy transition, since most of the C functions used for the new HP Encoder systems are the same as those used with the industry's popular HP 10889B.

For more information, see page 553.

For detailed specifications, circle 28 on the reply card (last page) or contact your local HP sales representative.

Low-cost probing adapters



The HP elastomeric probe offers a durable, low-cost solution for TQFP, CQFP, and PQFP packages.

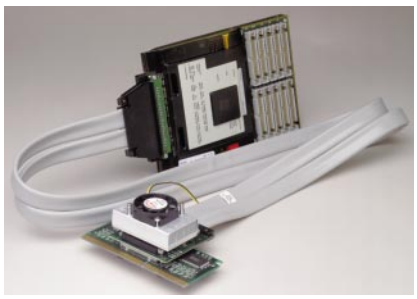
HP's elastomeric probes are an inexpensive, rugged, and easy-to-use solution for acquiring signals from TQFP, CQFP, and PQFP packages that require a minimal "keep out" area around the device. The probe makes contact with the pins of a device by using an elastomer material. Redundant connections for each pin ensure reliable, rugged connections. A retainer is glued to the top of the device for a solid connection to every pin.

The ¼ flex adapters bring the signals from the elastomeric probe adapter to general-purpose headers for easy connection to logic analyzers, oscilloscopes, or other test equipment. Four ¼ flex adapters are required to view all signals on a device. Each ¼ flex adapter covers the pins on one side of the QFP device. Packages supported include 144 TQFP, 160 QFP, 176 TQFP, 208 QFP, and 240 QFP.

For more information, see page 395.

For detailed specifications, circle 29 on the reply card (last page) or contact your local HP sales representative.

Powerful, flexible probing tools offer invaluable insights into computer systems operations



Use HP's preprocessors and emulation solutions to quickly determine the cause of difficult problems in systems with Intel Pentium Pro and Pentium II processors, Motorola CPU32-series devices, and Siemens C167 series microcontrollers.

Firmware designers, software developers, and hardware engineers who need better tools for development, debugging, and analysis are helped by five new flexible, cost-effective HP solutions.

- The HP E2466C preprocessor interface makes a fast, reliable connection to a Pentium II processor-based system and allows engineers to easily trace system operation. The preprocessor and its inverse assembler software for the HP 16500 logic analysis system simplify analysis by decoding program execution into familiar Intel architecture mnemonics with MMX technology extensions, and by labeling bus timing diagrams. To reduce the time needed to find the cause of critical Pentium II system problems, the HP E2466C uses the power of the HP 16505A prototype analyzer in conjunction with the HP 16500C logic analysis system.

  For more information, see page 391.

- The HP E3493A processor probe for Pentium Pro and Pentium II processors provides a processor run control capability for up to four processors, and can read and modify the contents of all processors' registers, system memory, and I/O.

  For more information, see page 391.

- HP E8115A family preprocessors connect an HP logic analyzer to a target system containing a Motorola CPU32 series microcontroller, to allow simultaneous hardware/software analysis and quicker hardware/software integration. Connecting directly to the microcontroller, they provide timing, state per clock cycle, and state per bus cycle data on every signal. When used with the HP B3470A software analyzer and an HP E3458A processor probe, these preprocessors produce correlated assembly-level and source-level viewing of code execution.

  For more information, see page 367.

- The HP 64798E emulator probe and HP 64798EY emulator bundle allow real-time debugging of an embedded system with a Motorola 68EN302 processor running at 20 MHz.

  For more information, see page 362.

- The HP E3474A emulation solution for Siemens C167 series microcontrollers offers the powerful capabilities of a conventional emulator, divided among several separate units for reduced cost and increased flexibility. It delivers real-time, zero-wait state emulation at clock speeds up to 25 MHz.

  For more information, see page 367.

For detailed specifications, circle 30 on the reply card (last page) or contact your local HP sales representative.

Industry's first HDSL tester

The HDSL Installer's Assistant provides a complete end-to-end solution that can save hours during a single installation.

The HP CERJAC HDSL Installer's Assistant is the industry's first portable test set designed specifically to speed and simplify installation and maintenance of high-bit-rate digital subscriber lines (HDSL). The product combines circuit-access, line-qualification, and T1-testing capabilities to provide technicians with the full range of tools needed for HDSL turn-up and maintenance, all in a single, field-ready unit.

An alternative to the cumbersome equipment often used today, the HDSL Installer's Assistant features a built-in load-coil detector and permits use of customer-provided HDSL plug-in cards. The user can perform pre-installation testing of the actual plug-ins used to provision the circuit. An integrated tone tranceiver allows time-saving cable loss measurements.

The HDSL Installer's Assistant accepts most common physical form factors, and works with a wide range of manufacturer's HDSL plug-in cards. It can detect up to four load coils, and its integrated tone transceiver supports both 196-kHz and 392-kHz testing. T1 bit-error-rate test-pattern options include QRSS, 3:24, and "All Ones" and "All Zeros" patterns for B8ZS-coded lines. The unit weighs about 15 pounds and measures 12 x 12 x 7 inches.

For more information, see page 446.

For detailed specifications, circle 31 on the reply card (last page) or contact your local HP sales representative.

New broadband test capabilities facilitate the development of ATM networks and equipment

Numerous hardware and software products add more test capabilities to the HP BSTS for design, monitoring, troubleshooting, and conformance testing ATM networks and equipment.

If you're deploying ATM equipment and services over switched virtual circuits (SVCs), new HP BSTS automated, reference-based software tools let you evaluate and troubleshoot your implementations against the latest ATM Forum UNI, NNI, PNNI, and ILMI signaling standards. Supporting core signaling conformance test suites ensure correct implementation of ATM Forum UNI 4.0 address-registration specifications. Additional new BSTS software products solve frame relay interworking and LAN inter-working problems, and add AAL-2 test capability.

For monitoring and troubleshooting ATM networks according to ITU and Bellcore Operations and Maintenance recommendations, a new OAM protocol test module for the BSTS provides real-time performance monitoring, in-service fault detection, and fault localization. If you need to implement the ATM Forum's Available Bit Rate traffic service for handling data traffic, a new ABR protocol test module allows you to check both the conformance and performance of your protocol implementation in real time.

You can test high-speed networks and equipment with a new 622 Mb/s (OC-12) solution. As well as basic physical layer and ATM protocol conformance testing, it provides high-speed stress testing, performance and QoS measurements, signalling testing, and LAN/WAN interworking.

For more information, see page 454.

For detailed specifications, circle 32 on the reply card (last page) or contact your local HP sales representative.

Complete solution for waveform test

Multimode plug-in modules for the HP 83480A digital communications analyzer.

New additions to the HP 83480A digital communications analyzer family make it the complete solution for test and analysis of waveforms used in digital communications. The HP 83486A and HP 83487A modules allow viewing of signals on multimode fiber at short or long wavelengths.

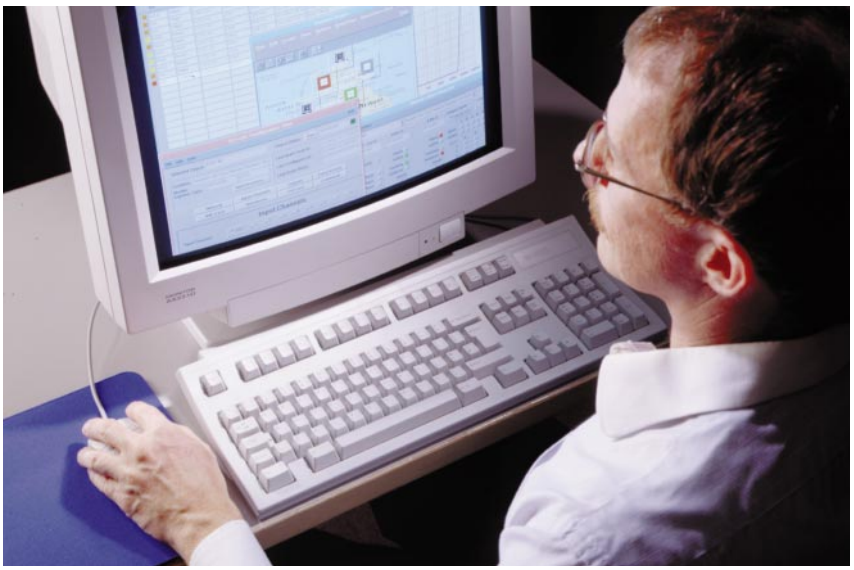
The HP 83486A measures both 1310 and 1550 nm wavelengths (single-mode and multimode), and comes with a built-in 155/622 Mb/s SONET/SDH reference receiver or a 1063/1250 Mb/s Fibre Channel/Gigabit Ethernet reference receiver. The HP 83487A measures wavelengths from 750 to 870 nm and comes standard with a 1063/1250 Mb/s datacom reference receiver.

These new plug-ins use integrated optical receivers that are amplified for high sensitivity and have bandwidths that exceed 2.5 GHz. Each module also provides a 20 GHz electrical channel for viewing electrical signals. Both plug-ins are ideal solutions for physical layer testing in R&D and production test applications.

For more information, see page 430.

For detailed specifications, circle 33 on the reply card (last page) or contact your local HP sales representative.

Easily manage synchronization networks



HP 55452A HP SmartView UX is used for management of a network of HP 55400A SSUs interconnected by LAN.

HP's SmartView family of software makes managing your synchronization equipment very easy. Besides allowing you to monitor alarms and timing quality (MTIE, TDEV), configure and inventory SSUs, and assign different levels of security, these products enable cost-effective synchronization network management. HP's synchronization products support a vast array of TL1 commands, for complete management from a local or remote computer with minimum staffing.

HP SmartView PC makes installing, configuring, commissioning, monitoring, and troubleshooting SSUs easy by providing a graphical user interface in place of typing tedious TL1 commands. Use HP SmartView PC to control and view SSU inputs, outputs, and alarms on any card, and view performance of any input (MTIE, TDEV). You can also prioritize alarms in response to SSU events, view automatic messages generated by an SSU as events occur, and monitor and control several SSUs remotely by modem or LAN, one SSU at a time.

HP SmartView UX, which provides full-sync network management for larger networks, does everything HP SmartView PC does, and much, much more. It makes your entire sync network visible for the first time from a single, remote location (using your data communications network, either LAN or X.25)—at a glance. You are notified quickly of alarms anywhere in your sync system, and you can monitor timing quality or change configuration at any point. And you can make the network management system fully redundant and resilient.

HP SmartView UX includes fault, configuration, performance, and security management (FCAPS). And it easily interfaces to other OSS and BSS applications because it has been fully designed to meet TMN standards (M3400). When linked to these other management systems, you can realize truly cost-effective management of your entire network.

HP SmartView is based on the industry-standard Oracle database and on HP OpenView DM, the most widely used open platform for distributed processing and system integration.

For more information, see page 508.

For detailed specifications, circle 34 on the reply card (last page) or contact your local HP sales representative.

Dual-standard, one-box SONET/SDH testing

The HP 37717C communications performance analyzer provides a one-box, portable solution for SONET/SDH/PDH/DSn and ATM networks.

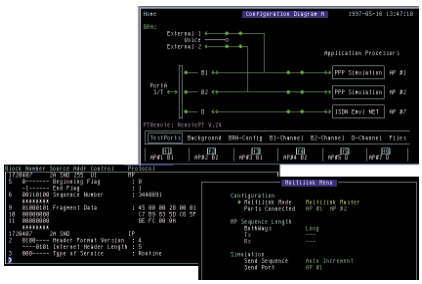
The HP 37717C communications performance analyzer provides all the interfaces under one handle from OC-48/STM-16 through OC-12/STM-4, OC-3/STM-1, OC-1/STM-0 to PDH/DSn rates down to E1/DS1. Testing to ANSI and ITU-T standards is provided in a single instrument. This new capability is provided using the same HP 37717C mainframe, so its user interface and test features mimic those of the lower-rate HP 37717C, thus avoiding costly staff retraining.

Automatic out-of-service scanning eases the installation of network equipment. In-service scanning and protection switching tests help ensure quality of service and prevent loss of revenue. The analyzer provides all tests needed to evaluate new services carried in SONET/SDH networks, including STM-16c and STM-4c concatenated payloads plus mixed payloads for networks carrying mixed rates of traffic (2 Mb/s and 34 Mb/s), comprehensive overhead access, pointer processing, and jitter generation and measurement.

For more information, see page 450.

For detailed specifications, circle 35 on the reply card (last page) or contact your local HP sales representative.

New PPP protocol simulation/monitoring software



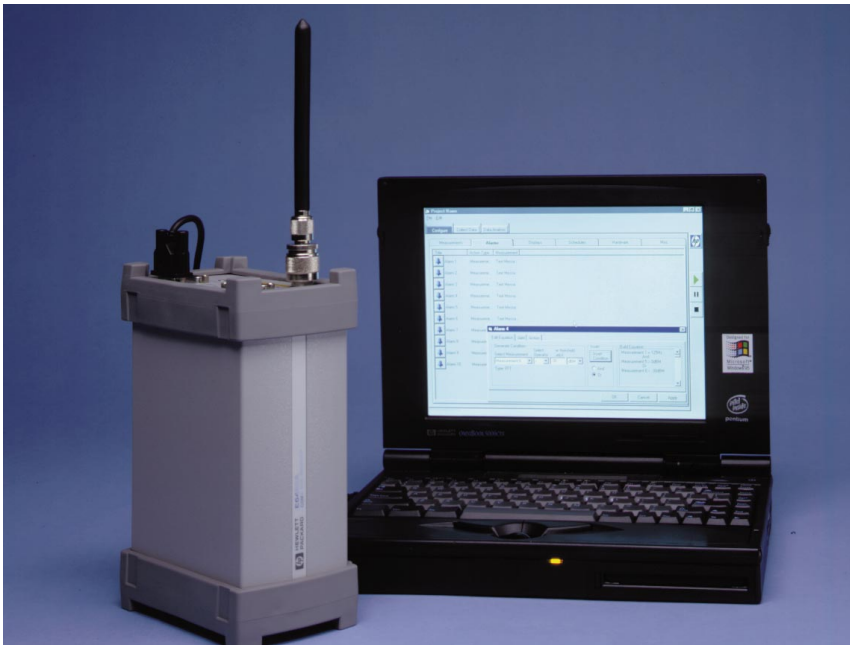
New software for the HP PT series testers provides PPP and Multilink PPP simulation for bundles with up to four physical links.

HP E6284A software for the HP PT series stimulus-and-response protocol testers adds new capabilities for point-to-point (PPP) protocol simulation and monitoring applications. Comprehensive support for the PPP link layer includes automatic detection of compressed PPP headers, and decoding and encoding of all link control protocol (LCP) and network control protocol (NCP) identifiers. A multilink setup menu lets you configure the bundle relationship between individual physical PPP links prior to simulation and monitoring of multiple links. IP protocol information fields are decoded and encoded, and filters and triggers are supported. All field interpretations of the PPP software's supported components are derived from the Internet Assigned Numbers Authority's (IANA) most recent PPP field assignments.

For more information, see page 438.

For detailed specifications, circle 36 on the reply card (last page) or contact your local HP sales representative.

Fast RF coverage verification of wireless networks



Achieve rapid verification of RF coverage for cellular and PCS networks with the HP E7450A.

The HP E7450A, an automated, receiver-based drive system, provides rapid verification of RF coverage for cellular and PCS (Personal Communications Services) networks. The new system helps PCS providers and network equipment manufacturers launch their services more quickly and maintain high RF performance throughout the life of their networks.

Unlike phone-based systems, measurements made with the new HP receiver-based system are independent of the network. This ensures a high level of confidence in measurement results and helps reduce the time required for RF optimization.

The HP E7450A system's automated measurements are fast and repeatable, helping to reduce the time spent driving through a coverage area to gather data. Data can be collected with only a single driver in the test vehicle, to help reduce test costs.

The standard HP E7450A system includes drive-test software and a digital PCS or cellular receiver. The system can be integrated with your existing computers, antennas, mapping software, and GPS (Global Positioning System) receivers, or HP can provide these items.

For more information, see page 494.

For detailed specifications, circle 37 on the reply card (last page) or contact your local HP sales representative.

Improve performance of PCS base stations

The HP 8935 CDMA PCS base station test set provides optimize testing for todays PCS environment.

The HP 8935 CDMA PCS base station test set is the next generation in CDMA base station test equipment. A full-featured, one-box test set, the HP 8935 is designed to meet the needs of installation teams, service providers, and network equipment manufacturers.

The new HP 8935 incorporates a more user-friendly interface with Windows-type pull-down menus. This new interface, coupled with faster measurement speed and automated software for Lucent, Nortel, and Samsung PCS base stations, results in decreased base station off-line time and improved system performance. Errors due to test variability are reduced and measurement data can be output to a printer or to the PCMCIA memory card.

Additionally, HP 8935's firmware is user upgradeable (with a PCMCIA card) to Flash PROM. New features and capabilities can be added without returning the unit to a service center. Complementing this new instrument are helpful options, including PCS CDMA technician training programs that provide installation teams and service providers with a complete CDMA base station solution.

For more information, see page 472.

For detailed specifications, circle 38 on the reply card (last page) or contact your local HP sales representative.

RF signal generators support additional digital communication standards

The HP ESG series of analog and digital RF signal generators offers a wide range of new performance features, including CDMA and additional TDMA (DECT and TETRA) test capabilities.

Test CDMA mobile components and enable transmitter tests by generating a single forward (QPSK) or reverse (OQPSK) channel with Option H03. Standard and modified FIR filters meeting IS-95 requirements are available. The modified filters significantly reduce spurious emissions for adjacent power measurements.

Internally generate the digital modulation (GFSK) required for DECT (Digital Enhanced Cordless Telephone) and (π/4 DQPSK) for TETRA (Trans-European Trunked Radio) standards in addition to the previous offering of communications standards (GSM, NADC, PDC, and PHS) with Options UN3 or UN4.

Other digital enhancements provide a variety of adjustment capabilities including independent I and Q offset and gain, burst profile, data rates, and filter factors. Increased measurement performance is offered with an improved burst profile and an optimization for in-channel (low error vector magnitude) or out-of-channel (low adjacent channel power) measurements. In addition, for GSM additional burst types have been added for an even easier set up.

Both the ESG digital and analog families now offer an internal 0.1-Hz to 50-kHz modulation source with two-tone sinewave output and sweep capability. This allows testing of analog cellular radios functions, such as CTCSS (continuous tone controlled subaudible squelch), and DTMF (dual tone multifrequency) phones. Other enhancements include better nonharmonic spurious specifications for offsets greater than 10 kHz, inverse video selection and save/recall file descriptors for easy identification of stored instrument setups, and a status display that shows sweep progress. For better RF sweep control, a 1-ms dwell time is available.

For more information, see page 202.

For detailed specifications, circle 39 on the reply card (last page) or contact your local HP sales representative.

Accurately troubleshoot cable TV systems

The HP CaLan 3010R/H is a comprehensive testing tool for return path activation, maintenance, and ingress management.

The HP CaLan 3010R/H sweep/ingress analyzer lets you quickly, accurately, and efficiently troubleshoot your cable TV system. To help broadband service providers rise to the challenge of providing two-way services to their subscribers, the HP CaLan 3010R/H now provides dual-path sweep, new digital measurements, and an even faster sweep speed.

One headend box for both forward and reverse sweep lets you make the most efficient use of your bandwidth. This dual-path sweep also means more headend space and less test equipment to buy. You can also quickly and accurately measure the average power of digital carriers—including return path TDMA (bursted) carriers. These measurements will assure you that your subscribers are receiving the highest quality digital signals.

And now HP CaLan's industry-leading sweep speed is even faster. The next time your technician adjusts an amplifier, the results will appear in 650 ms. This speed eliminates wasted time waiting for a slow response. A comprehensive set of features makes this sweep/ingress analyzer the industry's most comprehensive, flexible tool for return path activation and maintenance.

For more information, see page 523.

For detailed specifications, circle 40 on the reply card (last page) or contact your local HP sales representative.

Test the limits of DVB-C

The HP E4441A DVB QAM coder produces fully compliant DVB-C QAM signals with and without calibrated impairments.

The HP E4441A DVB QAM coder is a fully compliant test source for testing DVB-C set-top boxes, devices, or networks. The system can channel code and modulate either internally generated MPEG-2 null packets, Pseudo Random Bit Sequences, or an external MPEG-2 transport stream onto IF/RF to the DVB-C standard. This allows both test and real-world signals to be generated.

The DVB QAM coder and digital signal generator combination provides a precision reference signal suitable for both laboratory and manufacturing test. To simulate poor signal conditions, the DVB QAM coder includes an accurate Gaussian noise source. Noise can be added to the reference in a controlled and calibrated manner. The instrument combination can also produce a range of other signal impairments, such as carrier leakage and I/Q imbalance, to test the limits of receiver design or network performance.

For more information, see page 516.

For detailed specifications, circle 41 on the reply card (last page) or contact your local HP sales representative.

Comprehensive digital video solution

The HP 8594Q QAM analyzer offers comprehensive RF, modulation and data quality testing of DVB-C (digital video broadcast via cable) signals.

The HP 8594Q QAM analyzer is a comprehensive solution for RF modulation and data quality testing for signals compliant with the European DVB-C standard: ETSI standard ETS-300-429. It gives cable TV engineers the measurement capability required to accurately verify the quality of service delivered to the subscriber. All measurements are easy to access, and the results are presented in clear, graphical displays.

This analyzer demodulates and accurately measures the QAM signals carried through digital video broadcast via cable systems. It provides new measurement metrics necessary to characterize QAM signals and troubleshoot problems. Option 195 adds the capability to carry out bit error ratio measurements and basic analysis of the contents of the MPEG data stream. The HP 8594Q graphic displays, clear user interface, and one-button measurement capability make the transition to digital easy for analog cable TV engineers.

The analyzer measures average channel power to verify signal levels, adjacent channel power to identify interference problems, error vector magnitude and modulation error ratio to quantify the modulation quality of the signal, and equalizer filter response, which shows distortions caused by the transmission channel.

For more information, see page 515.

For detailed specifications, circle 42 on the reply card (last page) or contact your local HP sales representative.

Complete test solution for MPEG-2, DVB and ATSC

The HP MPEGscope Plus generator/analyzer offers a complete array of real-time protocol and performance analysis tools for DVB, ATSC, and other MPEG-2 transport stream-based applications. The unit features sophisticated data generation and capture at speeds up to 60Mb/s, electronic-program-guide table decoding, and trigger-based capture of transport errors, all supported by the HP E6277A MPEGscope's real-time measurement and analysis capabilities.

With the new HP E6277A MPEGscope Plus, you can analyze, troubleshoot, or stress test digital video systems in development, evaluation, or operation. The MPEGscope Plus test platform combines powerful real-time analysis, generation, and in-depth protocol and performance evaluation.

Optional applications tailor the MPEGscope Plus to support specific applications. These options include:

- HP E6277A Option 010 video elementary stream compression analyzer and HP E6285A MPEG-2 encoder stress test patterns for encoder performance evaluation
- HP E6277A Option 012 MPEG-2/DVB compliance test suites for standards compliance verification
- HP E6277A Option 014 NTSC decoder stress test patterns for video decoder compliance evaluation.

For more information, see page 519.

For detailed specifications, circle 43 on the reply card (last page) or contact your local HP sales representative.

High-throughput, no-access X-ray inspection

The HP 5DX Series II X-ray inspection system offers solder-integrity analysis.

The HP 5DX Series II X-ray inspection system provides precise and fast analysis of solder integrity on loaded printed circuit boards, enabling process monitoring that dramatically improves first-pass yields. And it does all of this without the need for visual or electrical access.

Test probe access is becoming a limiting test factor on many of today's leading-edge boards. Component leads are often too small for effective visual inspection. And some components are hidden under other devices, or are on the underside of the board. The HP 5DX Series II features cross-sectional imaging that sees right through these problems. The system quickly and automatically scans the board, analyzes X-ray images, and identifies the exact location and characteristics of any defective solder joints. The resolution is so fine it even detects marginal joints that might fail in a customer's hands. Detection of faults on flip-chip components is now possible.

The HP 5DX Series II is fast enough to be used in-line. Capable of inspecting one board every 60 to 90 seconds, the systems keeps pace with the beat rate of most lines of densely populated, double-sided printed circuit board assemblies.

For more information, see page 530.

For detailed specifications, circle 44 on the reply card (last page) or contact your local HP sales representative.

The all-in-one test solution for multimedia chips

Test all functions of a multimedia chip with just one test system: the HP 83000 Multimedia Series.

The HP 83000 Multimedia Series of IC test systems is the perfect all-in-one solution for testing the digital, analog, memory, and high-speed interface components of multimedia chips. Such single-chip devices manage sound, graphics, memory, and video in products such as video games, performing functions that previously required several chips.

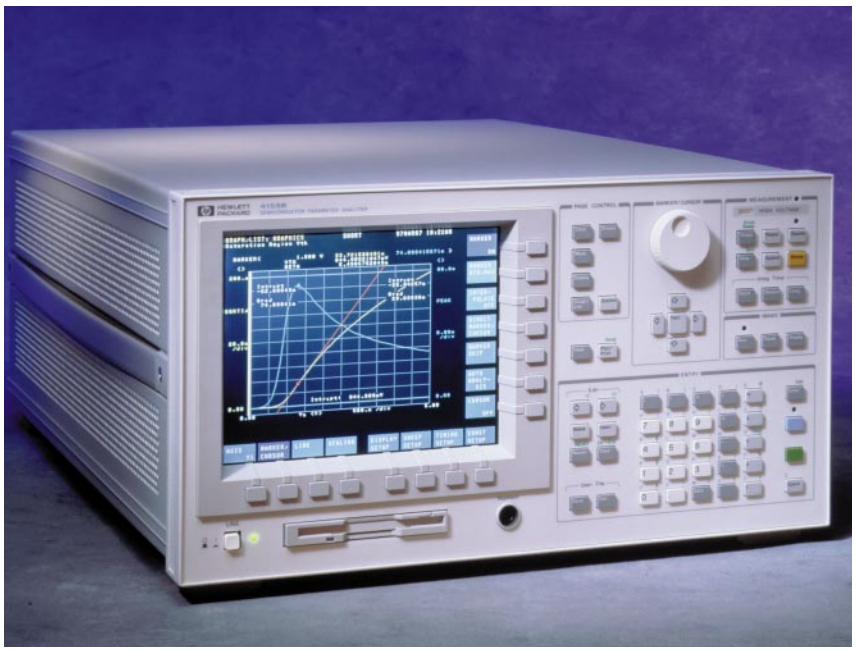
The HP 83000 Multimedia Series provides all testing capabilities required to test these complex devices in one single pass. This shortens the overall test time and reduces test costs.

Two different models of the HP 83000 Multimedia Series are designed to meet the different performance and cost demands of the market, including R&D and high-volume production.

For more information, see page 531.

For detailed specifications, circle 45 on the reply card (last page) or contact your local HP sales representative.

Powerful semiconductor analyzers



Fast and powerful, the HP 4155B/56B offers HP FLEX, for direct control over instrument hardware.

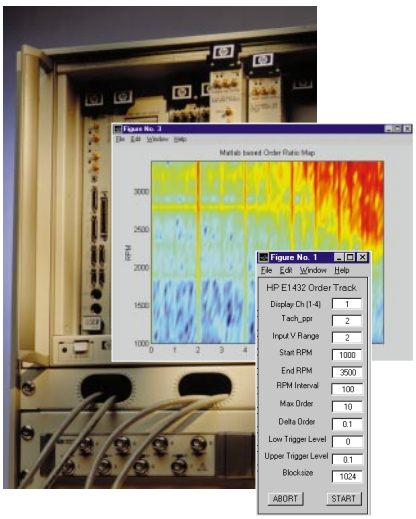
The HP 4155B/4156B semiconductor parameter analyzer continues HP's leadership in providing quick, efficient benchtop test equipment. The throughput of the HP 4155B/4156B is several times faster than that of the existing HP 4155A/4156A, which the new unit replaces. The HP 4155B/4156B also possesses a LAN capability, which allows convenient data and setup sharing on a site-wide, or even worldwide, basis. In addition, a powerful new user command language, HP Fast Language for EXecution (HP FLEX), gives direct and fast control over the instrument hardware.

The HP 4155B/4156B supports the popular open-system standards of the VXI*plug&play* alliance. VXI*plug&play* drivers allow users to choose the programming language with which they are most comfortable. Best of all, HP has added all of these new features without compromising any of the accuracy, reliability, and flexibility that current HP 4155A/4156A users now enjoy.

For more information, see page 534.

For detailed specifications, circle 46 on the reply card (last page) or contact your local HP sales representative.

Control HP hardware directly from Matlab



Four-cylinder automotive engine vibration response from a ten-second engine run up from 1000 to 3500 RPM using a *Plug & Play* library example for Matlab.

If you are one of the more than 400,000 users of Matlab and need to directly control HP's high-performance, multichannel digitizers and source modules, HP is now supplying this control capability as part of its standard *Plug & Play* library for the HP E1432A, HP E1433A, and HP E1434A VXI modules. The combination of Matlab 5.0's n-dimensional arrays, matrix math, color surface shaded 3-D graphics, user interface building tools, and HP's high-performance measurement hardware provide most impressive results with a minimum of programming effort. This environment is really the measurement engineer's programming language that quickly turns measurements into insight.

The above graphic result is an example of Matlab scripts included with the HP E1432A/33A/34A *Plug & Play* library. These Matlab examples, along with additional examples in C, Visual Basic, and HP VEE, give you a great head start in developing your application solutions on top of standards-based HP VXI hardware.

For more information, see page 547.

For detailed specifications, circle 47 on the reply card (last page) or contact your local HP sales representative.

HP VEE Visual Programming Language

- HP VEE for Windows 3.1/95/NT, and Series 700
- HP VEE 4.0 executes 150% faster using compiler NEW
- Create programs faster with powerful graphical objects
- Simplify communication to and from instruments
- Use on PCs and HP workstations

Why HP VEE?

HP VEE is a visual programming language that simplifies your day-to-day tasks in instrument control, measurement processing, and test reporting. It also makes the tasks you face during test development—system integration, debugging, structured program design, and documentation—easier. In fact, every programming task can be simplified and accelerated using the visual approach of HP VEE.

- 80% of HP VEE users get on-the-job results in the first two weeks.
- Two-thirds of HP VEE users incorporate non-HP instrumentation into their test systems.
- Among HP VEE users, the #1 reason for using HP VEE is to save test development time.
- 91% of current users recommend HP VEE to their colleagues.

Source: HP VEE Customers Survey, 1996

Flexible, Powerful, and Fast

HP VEE makes you more productive than ever before, especially with its new compiler for faster program execution, convenient profiler for generating easy-to-understand profiles, and with its industry-standard revision control packages.

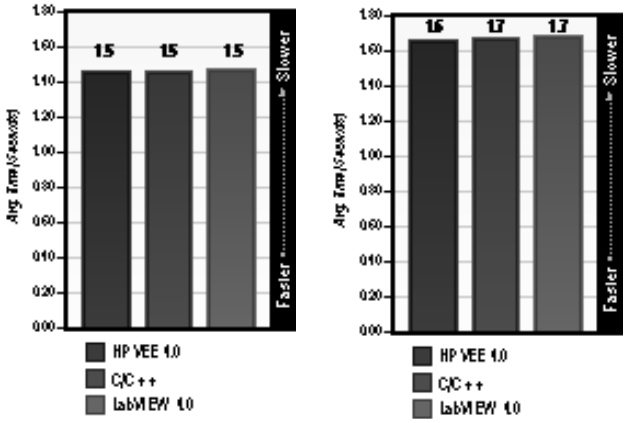
HP VEE provides a simple library that offers the same capability as the ActiveX control. With its library, you can integrate HP VEE functionality into C programs, without needing to learn OLE. Also, powerful debugging tools offer you a method to optimize programs in a minimum amount of time—with built-in error handling, viewing of execution and data flow, and by helping you troubleshoot errors with call stacks and break points.

HP VEE is fast. HP VEE 4.0 provides fast execution using new incremental compiler technology. Its new compiler substantially improves performance while maintaining all the advantages of an interpreter. During test program development, HP VEE 4.0 does an initial compilation and then recompiles only edited functions. After development, compilation occurs only once upon first execution.

Typical test programs, where speed is constrained by I/O performance and instrumentation characteristics, execute 150% to 400% faster in HP VEE 4.0 applications. Additionally, programs developed using earlier versions of HP VEE can be compiled and run in HP VEE 4.0.

Optimize Code Efficiently

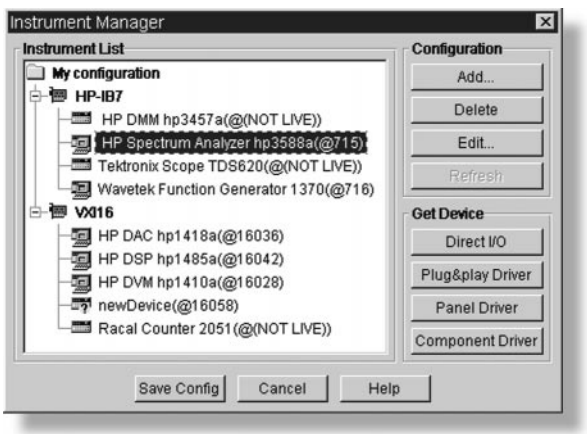
HP VEE 4.0 also provides a Profiler that can quickly generate easy-to-understand profiles of program execution to help you optimize code efficiently. You can also log Profiler results to a file for later analysis. In compile mode, HP VEE 4.0 programs execute as fast as C/C++ and LabVIEW programs.



Internal Hewlett-Packard benchmark tests using a Pentium 90 MHz PC via HP-IB to VXI HP E1440, HP E1472, and HP E1428.

Easy to Use

HP VEE provides a set of powerful objects that you can connect to create a program—making HP VEE easy to use. It leverages the rapidly developing software technology that characterizes today's world, resulting in a tool that automates inherently complex tasks—controlling instruments, creating operator interfaces, sequencing tests, and distributing programs—and simplifies and streamlines the entire programming effort.



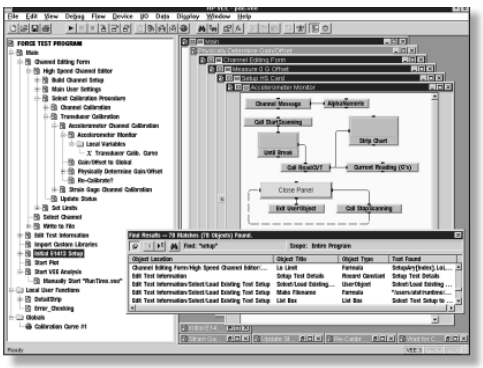
The Instrument Manager automatically configures instrument addressing.

With its streamline instrument control, HP VEE simplifies communication with instruments and other devices. HP VEE 4.0's Instrument Manager scans the bus for devices and automatically handles the interfacing details of your system. You no longer need to build address strings, load drivers, and manage I/O session handles. HP VEE provides easy point-and-click driver control for both HP VEE drivers and VXI*plug&play* drivers. And when you don't have or want to use a driver, HP VEE Direct I/O enables you to communicate directly with instruments via instrument command strings.

You can create operator interfaces, including soft front panels for instruments, in a fraction of the time it takes using a textual programming language. HP VEE offers a wide variety of user interface objects to choose from—toggles, sliders, drop-down lists, buttons for control, dialog boxes, pop-up boxes, and indicators to visually represent data.

With HP VEE, you can link tests in a logical sequence—easier and faster—making you even more productive.

Develop Complex Applications



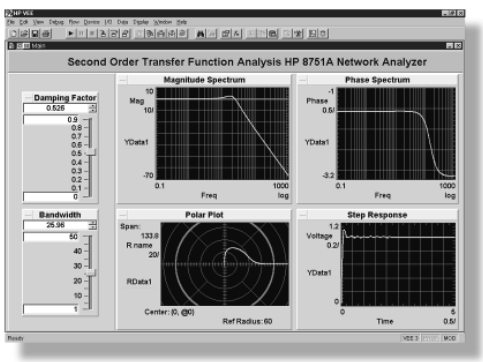
HP VEE's Professional Development Environment provides a look-and-feel common in today's popular operating systems and development environments—making it instantly familiar.

The Program Explorer helps you to quickly understand and navigate through complex programs, both during debug and after the test program is up and running. With document windows, you can easily edit HP VEE functions, search for objects by name, text, type, description, color, location, and other property values.

Integrate with Other Applications

HP VEE can be easily integrated into complex systems comprised of multiple applications. Using HP VEE 4.0's ActiveX tools, you can merge HP VEE functionality into other commercial applications, or into test system programs written in standard text-based languages. Additionally, you can share test data with standard applications, such as Microsoft Excel and Visual Basic.

Broad Feature Set



HP VEE provides a broad feature set that handles your everyday test tasks. These include: controlling instruments, taking measurements, acquiring and processing data, displaying results, and generating reports. That's the fundamental power of HP VEE, and no programming language—visual or textual—does it better. You'll work not just faster but smarter, with distinct bottom-line results including shorter development cycles, lower engineering costs and, ultimately faster delivery of quality products.

With HP VEE, you can use any of over 450 HP VEE drivers, or any industry-standard VXI*plug&play* driver, or control instruments directly—even those you build yourself or those from other vendors—with fast, efficient Direct I/O. With over 200 math and analysis functions that range from elementary math to calculus, you can construct a solution from a long mathematical equation with HP VEE's formula box by simply typing it in. And with 13 flexible and powerful data types, HP VEE reduces development time by automatically handling conversion between data types, building and unbuilding text and binary numbers, and swapping bytes.

Worldwide Service and Support

With HP VEE, you have access to the worldwide resouces of Hewlett-Packard including start-up support, telephone support, service subscriptions, training classes, seminars, and constantly updated information on the World Wide Web. Additionally, through contracts with leading instrument suppliers, HP provides total solutions for test, measurement and data acquisition. Many companies offer hardware/software solutions based on HP VEE. With HP's hallmark service and support after the sale, you can keep your test programs up and running around the world and around the clock.

For details on HP VEE, check out the HP VEE 4.0 web page **(http://www.hp.com/go/hpvee)**. You can download instrument drivers, application notes, and other help resources, as well as a complete evaluation copy of HP VEE 4.0.

Easy to Order

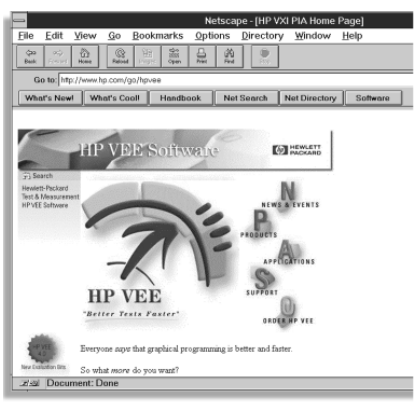
Ordering Information

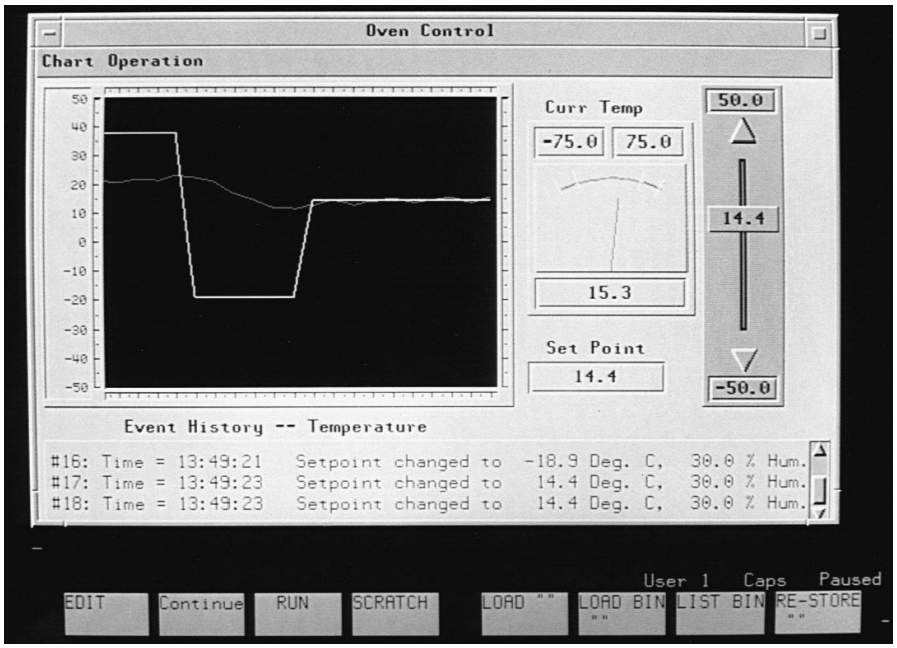
HP E2120E** HP VEE 4.0 for Windows 95/NT (on CD)
HP E2111E** HP VEE 4.0 for HP-UX Series 700
HP E2117E** HP VEE 4.0 site license
HP 82345E** PC Win 95/NT Automation Kit
(HP VEE 4.0 and HP 82341C HP-IB card)

Earlier Versions of HP VEE
HP E2120C** HP VEE 3.1 for Windows 3.1
HP E2110C** HP VEE 3.1 for HP-UX Series 300
HP 82345B** PC Automation Kit
(HP VEE 3.1 and HP 82341C HP-IB card and cables)

University Discounts
(Applicable only with AE16V purchase agreement)
HP E2122E
Opt. WNT** HP VEE 4.0 for Windows 95/NT for Education, 40 development licenses and unlimited runtime, 4 Prentice-Hall books Cost per seat
Opt. PCN** HP VEE 4.0 for Windows 95/NT plus HP 82341C, 40 development licenses and unlimited runtime, 4 Prentice-Hall books and an HP-IB card and cables Cost per seat
HP E2122D
Opt. WIN** HP VEE 3.1 for Windows 3.1 for Education, 40 development licenses, 4 Prentice-Hall books (3.1 version)
Opt. PCW** HP VEE 3.1 for Windows 3.1 plus HP 82341C, 40 development licenses, 4 Prentice-Hall books (3.1 version) and an HP-IB card and cables

** Order Option ABD for German language documentation and Option ABJ for Japanese language documentation.





HP BASIC: The Premier Language for Measurement Automation

HP BASIC is a computer language that is optimized for test and measurement. It includes many test-oriented features:

- I/O libraries integrated within HP BASIC, as opposed to add-on I/O libraries used by other languages.
- Unified I/O, permitting a common approach to instrument control —no matter what interface you use.
- Syntax checking—HP BASIC checks the syntax of every line—as you type it in.
- Automatic use of direct memory access (DMA) if DMA hardware is available.
- Support of separate context subprograms. Code modules are easily reused, shared, or updated.
- Full interrupt processing, with 15 levels of software prioritization.
- Advanced commands for analysis, such as complex data types and matrix manipulation.
- Powerful graphics commands that allow quick development of sophisticated graphics displays, enhanced with the addition of HP BASIC Plus.
- Excellent HP support and documentation.
- Ease of use that lets you create results quickly.

HP BASIC: An Integrated Family of Products

HP BASIC is a family of products supported on many different computer platforms and operating systems:

- HP BASIC/UX runs on HP 9000 Series 700 UNIX workstations. This version gives the programmer access to multi-tasking, networking, and the vast software associated with UNIX.
- HP BASIC for Windows, a compatible Rocky Mountain BASIC for the Windows environment, combining the power and flexibility of HP BASIC with the widespread popularity of Microsoft Windows.
- HP BASIC/DOS, a fully-compatible version of HP BASIC that runs on the HP Measurement Co-processor in a PC. This is the lowest-priced HP BASIC platform.
- IBASIC, a subset of HP BASIC that runs in "smart" instruments such as VXI. IBASIC is often used by instruments to control other instruments, or to execute a complete test program in one instrument.

HP BASIC Accessory Products

- HP BASIC Compiler, a product for users of HP BASIC/WS who want the faster execution and security of a compiler.
- DOS File System, a binary system that gives HP BASIC/WS devices the ability to read and write DOS-formatted disks.
- SMR/UX, a network that allows multiple HP BASIC workstations to share resources such as disks and printers.

HP BASIC Plus

HP BASIC Plus adds even more capabilities to the HP BASIC language. With it, you can create any of over 35 graphic objects—stripcharts, XY graphs, sliders, toggle buttons, menus (pull-down or cascade), on-screen warnings, and more. HP BASIC Plus is available on all HP BASIC platforms.

The latest HP BASIC Plus revision adds the following:

- APP, a keyword that gives you access to all HP BASIC Plus features when the main HP BASIC program is stopped.
- Panel Builder, a tool for creating custom interfaces, including the ability to change size, color, display range, and attributes of any object.
- Notepad, an ASCII file editor that lets you edit code without needing line numbers.
- Help File, a tool that lets you create your own Help files—an excellent feature for new programmers.
- New Widgets, innovative tools for performing a variety of tasks, from displaying X.11 Windows files to formatting hex or octal numbers to creating analog and digital clocks. The new "widget scrolling" feature lets you see all information on smaller widgets, while "widget closure" lets you shut down any widget on screen.
- Online Reference Manual, the entire HP BASIC Reference Manual, now at your fingertips. A new Search capability allows you to quickly find the information you need.
- HP BASIC Plus is included with HP BASIC for Windows.

Ordering Information

HP E2060B HP BASIC for Windows W/HP BASIC Plus. HP BASIC™ development environment for Windows 3.1, Windows 95, or Windows NT includes documentation and security module. A License-to-Use is required for each computer running HP BASIC for Windows.

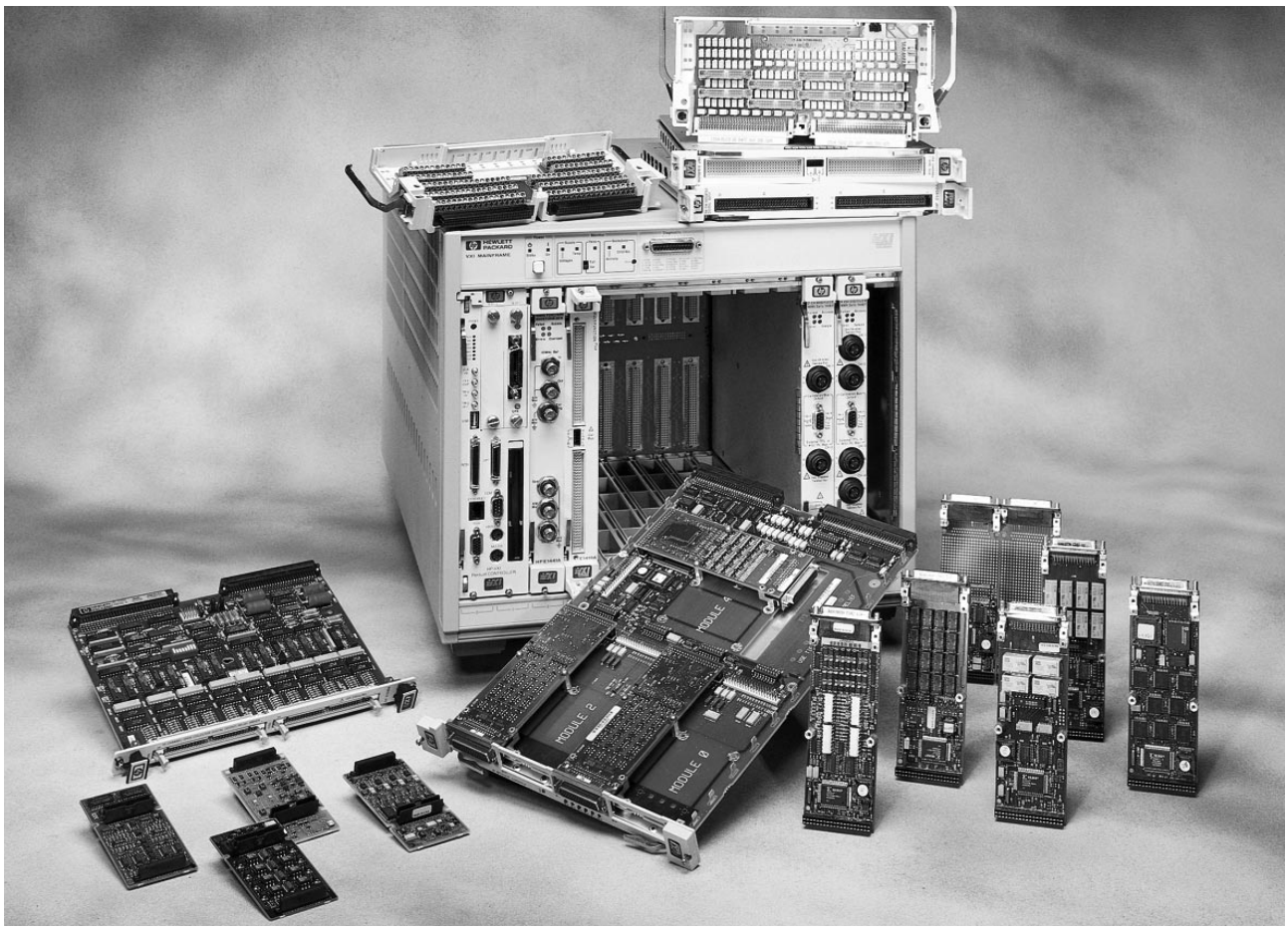
Opt 0CC Upgrade from previous HP BASIC platform or revision

HP E2046A HP BASIC/UX 700 License-to-Use

Opt 0CC Upgrade from previous platform

HP 82324B High-Performance Measurement Co-processor, 1 MB System, License-to-Use, HP BASIC media and core manuals, plus HP BASIC/DOS

- VXIbus: the open standard for test and measurement



VXIbus Introduction

In 1987 a consortium led by several major test and measurement manufacturers, including Hewlett-Packard, introduced VXIbus, a new standard modular instrument architecture. VXIbus was developed to meet the needs for portable applications, particularly for the military, and to provide an industry-standard instrument architecture with an interface speed significantly higher than that of the HP-IB interface. The design of this new architecture allowed the integration of VXIbus products into traditional HP-IB test systems and for standalone applications. Today, the VXIbus Consortium continues to refine the VXIbus standard and Hewlett-Packard remains an active member.

Since the inception of VXIbus, other standards have been developed, which reduce users' dependence on any one vendor. This lowers the risks and provides maximum investment protection in hardware and software purchases and system development. HP's VXIbus products support the industry-accepted VXI*plug&play* instrument drivers[1]. One set of these standard drivers for the MS Windows environment, for example, is supported by any of several popular software packages: HP VEE, Microsoft C/C++, Visual Basic, Borland C/C++, and NI Lab Windows. Other supported environments are DOS, HP-UX, Sun, and Windows NT.

Compact size, high throughput, and flexibility best characterize VXIbus. Today you can use VXIbus products to build a variety of test systems from portable testers for field use and remote data acquisition applications to high-performance data acquisition and functional test systems. While some systems are entirely VXIbus products, many users are integrating VXIbus along with traditional HP-IB instruments. Today VXIbus manufacturers and numerous third-party integrators now are offering dedicated measurement solutions using the VXIbus platform. HP offers several integrated products based on VXIbus. For example, the HP 3587S real-time signal analysis system, the HP HD2000 high-speed data acquisition system, the Model D20 digital functional test system, the HP E1725A time- interval analyzer, and the FTS-40 Functional Test System each consist of a VXIbus mainframe, an embedded controller, and various analog and digital modules. These products are described elsewhere in this catalog.

The pages which follow give a brief overview of the VXIbus Standard and a list of VXIbus products offered. For additional configuration and product ordering information, a separate document is available. For a free HP System Builder's Source Book and CD, p/n 5965-8791E, in the USA call 1-800-452-4844 ext. 7570.

[1] HP jointed the VXI*plug&play* Alliance in 1994 and has contributed to the definition of its industry-standard instrument drivers now provided by numerous VXI manufacturers.

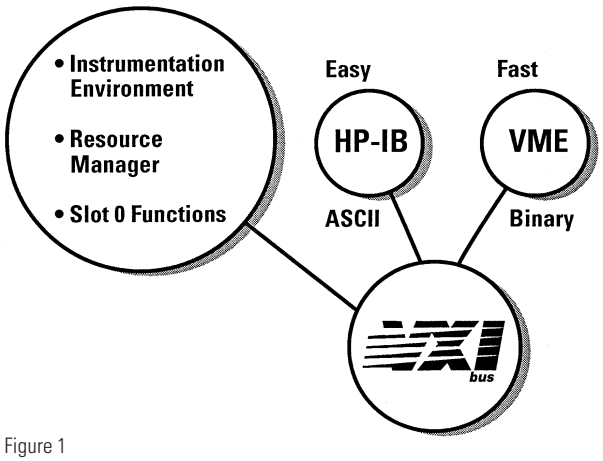


Figure 1

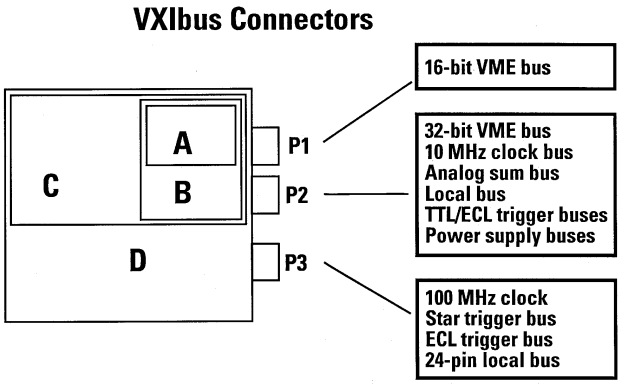


Figure 2

The VXIbus Architecture

VXIbus is defined around the highly-popular VMEbus architecture known for its excellent computer backplane. High-speed data rates of 40 MB/s along with the necessary communication protocols make it ideal for building instrument systems for high throughputs. VXIbus incorporates the ease-of-use features of intelligent HP-IB instruments (for example, ASCII-level programming) into its message-based devices. It also takes advantage of the high-throughput capability of VMEbus devices which are programmed and communicate directly in binary. The analog to these VMEbus devices is the VXIbus register-based device. See Figure 1.

Although VMEbus is an excellent computer backplane, it is not adequate for instrumentation without further standardization. The VXIbus Consortium fully defined the operating environment for instrumentation modules. All VXIbus mainframes must state how much power and cooling they provide. And all VXIbus modules must state how much power and cooling they require. Also, there are strict limits on how much conducted and radiated interference is allowed between modules. These parameters allow you to easily configure a workable system.

VXIbus systems provide backplane management and resource management functions. Slot 0, a unique physical location in every VXIbus mainframe, handles the backplane by providing clock signals, data movement arbitration, and more. The Resource Manager program configures the modules for proper operation whenever the system is powered on.

Mechanical and Electrical

The VXIbus specification defines a scalable family of four module sizes as shown in Figure 2. The two smaller sizes, A and B, are the defined VMEbus module sizes, and are true VMEbus modules in every sense of the word. The two larger sizes, C and D, are additional sizes to allow higher performance instrumentation. Increased module spacing in the C- and D-size systems makes it possible to fully shield sensitive circuits for high-performance measurements. VXIbus is a scalable architecture, and allows smaller module sizes to fit into larger mainframes.

VXIbus provides other resources for instrumentation. These include additional power supply voltages for powering analog and ECL circuits, and implementation buses for measurement synch-ronization and triggering. Included are an analog summing bus and a set of local bus lines for private module-to-module communication. Additionally, stringent EMC and noise requirements are specified to maintain an interference-free environment for sensitive instrumentation.

VXIbus specifies three 96-pin DIN connectors: P1, P2, and P3 (Figure 2). The P1 connector, the only mandatory connector in VMEbus or VXIbus, carries the data transfer bus (up to 24-bits addressing and 16-bits data), the interrupt buses, and some power. The optional P2 connector, available to all card sizes except A-size, expands the data transfer bus and provides the additional resources as shown with particular pin assignments. The local bus indicated is a powerful feature provided by VXIbus. This flexible daisy-chain bus structure allows for adjacent modules to conduct private, high-speed communication: a digital signal processor module receiving data from an accompanying analog-to-digital converter (the HP 3587S real-time signal analysis system), for example.

Power and Cooling

VXIbus specifies a set of guidelines to ensure adequate cooling. Every vendor's mainframe specifications sheet provides cooling specifications for worse-case module configuration. Available airflow as a function of the maximum allowable pressure differential across any module is specified. This is matched against the specified airflow and pressure parameters specified for each module.

Values of peak dc current and peak-to-peak dynamic current are specified for each module. The system integrator can match the total module current loading to the capacity of the mainframe. The dynamic current specification assures ripple-free noise on the mainframe's power supply lines.

Communications

A more standardized set of communication protocols is defined for VXIbus systems to handle autoconfiguration, resource management, and device communication. The Resource Manager, a message-based commander, takes care of the configuration tasks. It sets up the shared address space, manages the system self-test, creates the commander-servant hierarchies, and then releases the system for operation fully configured.

A message-based device, which communicates directly in SCPI (ASCII), is commonly the most intelligent VXIbus device. Typically it uses a microprocessor and is more costly than a register-based device, but is easier to integrate into a VXIbus system. Most message-based devices provide moderate throughput performance in a VXIbus system.

The most basic level of communication is that handled through register-level (binary-level) reads and writes to the registers of the register-based device (in some instances, direct-register access is provided on a message-based device to improve throughput performance). The register-based device is often controlled by an intelligent message-based device, its commander (command module or embedded controller). The commander interprets SCPI (ASCII) instrument commands converting them into binary for communication to the register-based device. To avoid the speed-reducing effects of the SCPI interpretation, compiled SCPI is used to compile the SCPI instrument commands before runtime. Runtime speeds, then, are commensurate with binary-level speeds as though the user had programmed directly in binary.

An IEEE-488-to-VXIbus interface is also defined in the VXIbus specification allowing for easy integration of VXIbus and HP-IB products into one system. HP's Command Module (HP E1406A), for example, provides the HP-IB connection for interfacing to an external HP-IB controller. For high-throughput systems, an industry-standard interface, MXIbus, is available for direct VXIbus backplane access from an external controller. HP's EISA/ISA-to-MXIbus interface (HP E1489C), for example, provides this capability.

Summary

The benefits of industry-standard VXIbus systems are these:

- Downsizing to save costly rack space
- High-performance, high-throughput measurement capability
- Reduced time and cost for system development
- Reduced dependency on proprietary architectures

For more information about HP's ready-to-use, VXI-based mixed-signal test system, refer to page 67 If you are interested in custom VXI solutions or project and integration services for VXI systems, refer to page 528.

HP 75000 VXI Products Information

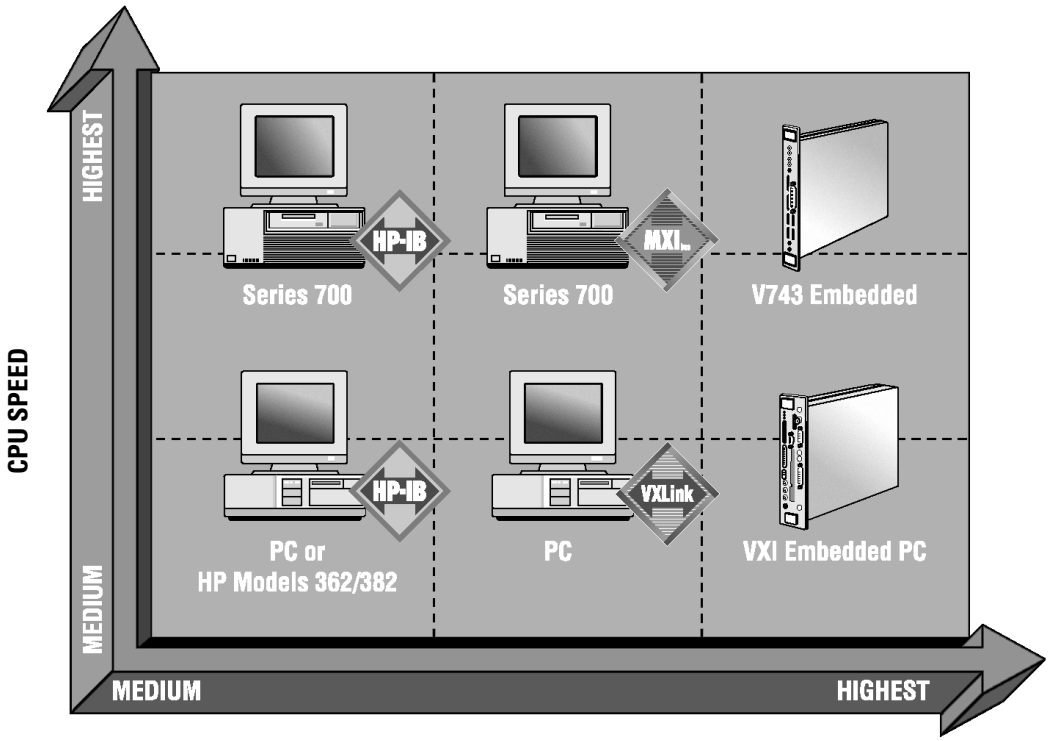
Model No.	Description
Mainframes	
HP E8400A	13-Slot, C-Size VXI Mainframe, medium power NEW
HP E1401B	High-Power Mainframe, C-size, 13-slot; racking options available
HP E1421B	Mainframe, C-size, 6-slot; racking options
HP E1401T	VXI Development Mainframe, C-size, 13-slot
HP E1302A	VME/VXI Mainframe, B-size, 20-slot; embedded PC or HP-IB controller and racking options available
HP E1300A/01A	Mainframes, B-size, 7-slot; built-in 68000 processor and IEEE-488 and RS-232 interfaces; Options: dc power, memory, mass storage, IBASIC
Controllers	
HP E1406A	Command Module, C-1, message-based commander, SCPI translator for register-based modules; optional expanded memory available
HP E1497A/98A	Embedded Controller HP V743 (Series 700), C-1, HP-UX, 64/100 MHz
HP E6232A/33A	VXI Pentium® PC Controller WIN 95/NT
HP E6237A	VXI Pentium® PC Controller LynxOS NEW
Storage	
HP E1488A	Instrument Memory, C-1, RB, 2-16 MB for extending memory of HP E1429/30/45/85
HP E4208C	SCSI Disk, C-1, 2 GB hard drive, 1.44 MB, 3.5-inch floppy NEW
HP E3249B	SCSI System Disk, C-2, 4.2 GB hard drive, 4 GB DAT tape NEW
HP E1562D/E/F	VXI Data Disk, DAT and SCSI-2 Interface Module, C-2 or -3, > 5.0 MB/s data rate, > 4 GB disk storage NEW NEW NEW
Interface	
HP E2071D, HP 82341D	HP-IB Interfaces, ISA/EISA
HP 82341E	HP-IB Interface, high-performance for PCI bus NEW
HP E2050A	LAN/HP-IB (IEEE-488) Gateway; Control HP-IB instrument from client computer over LAN
HP E1482B	VXIbus-to-MXIbus Extender, C-size, 1-slot; Connect two or more VXI mainframes together, or interface to external MXIbus controllers
HP E1489C	EISA/ISA-to-MXI interface; For direct VXI backplane interface to HP 9000 series 700 controllers
HP E2749A	Fiber Channel Data I/O Module NEW
Application Software	
HP E2120E, et al.	HP VEE: Graphical Programming Language; Supports MS Windows and HP-UX, VXI*plug&play*, Windows 3.1/95/NT/HP-UX Frameworks
HP E2060B	HP BASIC for Windows: based on the popular HP Rocky Mountain Basic language

Model No.	Description
Measurement	
HP E1312A, HP E1412A	6.5 Digit Multimeter, B-2/C-1, RB/MB, Vac/dc, Iac/dc, 2/4-w ohms, frequency, period
HP E1410A	6.5 Digit Multimeter, C-1, MB, Vdc/ac, 2/4-w Ω, frequency, period, temperature
HP E1411B, HP E1326B	5 Digit Multimeter, C-1/B1, RB, Vdc/ac, 2/4-w Ω, temperature
HP E1426A	500 MHz Digitizing Oscilloscope, C-2, MB, 4-Ch., 8 b, 20 MSa/s, 500 MHz
HP E1428A	1GSa/s Digitizing Oscilloscope, C-1, MB, 2-Ch., 8 b, 250 MHz bw
HP E1429A/B	20 MSa/s Digitizer, C-1, RB/MB, 12 b, 50 MHz bw
HP E1430A	10 MSa/s A/D with DSP, C-1, RB 1-Ch., 23 b, 4 MHz bw, 24 digital filters, FIFO
HP E1431A	8-Ch. 65 kSa/s Digitizer, 25.6 kHz bw, 16-bit 256 KB RAM FIFO, digital anti-alias filters
HP E1432A	16-Ch. 51.2 kHz Digitizer plus DSP C-1, RB, 16-bit, 4-32 MB FIFO, digital anti-alias filters
HP E1433A	8-Ch. 196 kSa/s Digitizer plus DSP, C-1, RB, 16 b, digital anti-alias filters, 4-32 MB FIFO, 88 kHz bw
HP E1437A	20 MSa/s Digitizer with DSP, C-1, MB/RB, 1-Ch., 23 b, 8 MHz bw, 24 digital filters, FIFO
HP SCMVX008	SCMVX008 Digital Signal Processor, C-1, 260 MHz Tms 320, C40 DSP with 6 expansion slots NEW
HP E3242A	Breakout Box accessory interfaces accelerometers to HP E1432A/33A VXI Digitizers NEW
HP E3243A	Breakout Box accessory interfaces microphones to HP E1432A/33A VXI Digitizers NEW
HP E1313A	32-Ch. or 64-Ch. Scanning A/D, B-size, 3 or 4 slots, RB, 16 b, 100 kSa/s
HP E1413C	64-Ch. Scanning A/D, C-1, RB, 16 b, 100 kSa/s
HP E1414A	Pressure Scanning A/D, C-1, RB, up to 512 channels
HP E1415A	Algorithmic Closed-Loop Controller, C-1, RB, 16 b A/D with signal conditioning
HP E1419A	Multi-Function Measurement and Control NEW
HP E1420B	High-Performance Universal Counter, C-1, MB, 2-Ch., 200 MHz/2 GHz
HP E1332A	4-Ch. Counter/Totalizer, B-1, RB, 4 MHz
HP E1333A	3-Ch. Universal Counter, B-1, RB, 1 GHz
HP E1740A	150 MHz Time Interval Analyzer, C-2, MB, 80 M rdgs/s, 100 ps rms
HP E1416A	Power Meter, C-1, MB, 1-Ch., 110 GHz
HP E1485C	Digital Signal Processor, C-Size, 1-slot, 33 MHz Motorola 96002 DSP with 4 expansion slots NEW
HP E1563A, HP E1564A	2-, 4-Ch., 800 kSa/s Digitizers NEW NEW
M-Modules	
HP E2251A	C-Size M-Module Carrier NEW
HP E2259A	Double-Wide Breadboard M-Module NEW
HP E2261A	Quad RS-232 Interface M-Module NEW
HP E2270A	16-Ch. Form A Switch M-Module NEW
HP E2271A	4x4 Matrix Switch M-Module NEW
HP E2272A	Dual 8-to-1 Relay Multiplexer M-Module NEW
HP E2273A	8-Ch. Form C Switch M-Module NEW
HP E2274A	4-Ch. Form C Power Relay M-Module NEW
HP E2290A	16-bit Digital I/O M-Module NEW
HP E2291A	16-Ch. Isolated Digital Output M-Module NEW

HP 75000 VXI Products Information

Model No.	Description
Sources and Amplifiers	
HP E1340A	Arbitrary Function Generator, B-1, RB, 12 b, 42 Msa/s, 10.2 V p-p (50 Ω), sweep, waveforms: arbitrary plus sine, square, ramp, triangle, sin(x)x, noise, haversine; Optional waveform software available
HP E1445A	Arbitrary Function Generator, C-1, MB, 13 b, 40 Msa/s, 10.2 V p-p (50 Ω), sweep, waveforms: arb, sine, square, ramp; Optional waveform software available
HP E1328A	4-Ch. D/A Converter, B-1, RB, 16 b, 1.3 kSa/s, 10.92 V dc
HP E1434A	4-Ch. 65 kSa/s Arbitrary Source, C-1, RB, 16-20 bit,10 V, sine, 25.6 kHz, bw, random, swept sine, 4-32 MB RAM FIFO NEW
HP E1440A	21 MHz Synthesized Function/Sweep Generator, C-2, MB
HP E1418A	8/16-Ch D/A Converter, C-1, RB programmable isolation, ± 16 V, ± 20 mA, 16 bit 1 kHz update rate
HP E1441A	Arbitrary Waveform Generator NEW
HP E1446A	Summing Amplifier, C-1, RB, 15 MHz, 2-Ch., sine + dc, 20 V p-p (50 Ω)
HP E1750A/52A	Broadband Freq./Pulse Amplifiers, C-1, RB, 10 MHz/10 M PPS, 6-Ch., sine/pulse, 1 Vrms (50Ω)
Digital	
HP E1330B	Quad 8-bit Digital I/O, B-1, RB, 32-Ch., I or O, TTL, 325 kb/s
HP E1339A	72-Ch. Open-Collector Dig Out/Relay Driver NEW
HP E1452A	Pattern I/O Module, C-1, RB 32-Ch., Input or Output, TTL/CMOS, 20 M patterns/s
HP E1458A	96-Ch. Digital I/O, C-2, RB, 96-Ch., I or O, TTL
HP E1459A	64-Ch. Isolated Dig Input/Interrupt NEW
Switches—MUX	
HP E1343A	16-Ch., 3-w, B-1, RB, Reed, < 10 μV, 250 V, 10 MHz, 50 mA
HP E1344A	16-Ch., T/C, 3-w, B-1, RB, Reed, < 10 μV, 250 V, 10 MHz, 50 mA
HP E1345A	16-Ch., 3-w, B-1, RB, Reed, < 4 μV, 120 V, 10 MHz, 50 mA
HP E1346A	48-Ch., 1-w, B-1, RB, Reed, < 50 μV, 120 V, 10 MHz, 50 mA
HP E1347A	16-Ch., T/C, 3-w, B-1, RB, Reed, < 4 μV, 120 V, 10 MHz, 50 mA
HP E1351A	16-Ch., 2-w, B-1, RB, FET, < 25 μV, 16 V, 100 kHz, 1 mA
HP E1352A	32-Ch., 2-w, B-1, RB, FET, < 25 μV, 16 V, 100 kHz, 1 mA
HP E1353A	16-Ch., 1-w, B-1, RB, FET, < 25 μV, 16 V, 100 kHz, 1 mA
HP E1355A	8-Ch., 120 Ω Strain, B-1, RB, Reed, < 4μV, 120 V, 10 MHz, 50 mA
HP E1356A	8-Ch., 350 Ω Strain, B-1, RB, Reed, < 4 μV, 120 V, 10 MHz, 50 mA
HP E1357A	8-Ch., 120 Ω Strain, B-1, RB, FET, < 25 μV, 16 V, 100 kHz, 1 mA
HP E1358A	8-Ch., 350 Ω Strain, B-1, RB, FET, < 25 μV, 16 V, 100 kHz, 1 mA
HP E1460A	64/32/128-Ch. 2/3/1-w, C-1, RB, Armature/L, < 7 μV, 60 V, 1 MHz, 1 A
HP E1476A	64-Ch. 3-w, 32-Ch. 4-w, C-1, RB, Reed, voltage, current, temperature (T/C)
HP E8460A	256-Ch. Relay Multiplexer NEW
Switches—RF MUX	
HP E1366A	Dual 1x4, 50 Ω, B-1, RB, Armature, < 6 μV, 42 V, 1.3 GHz, 1A
HP E1367A	Dual 1x4, 75 Ω, B-1, RB, Armature, < 6 μV, 42 V, 1.3 GHz, 1A
HP E1470A	60-Ch. Cascade RF Multiplexer, 60:1 to 20 3:1, 50 Ω, C-1, RB, Armature, < 6 μV, 30 V, 500 MHz (3:1), 450 mA (AC)
HP E1472A/73A	Six 1x4, 50 Ω, C-1, RB, Armature, < 6 μV, 42 V, 1.3 GHz, 1A
HP E1474A/75A	Six 1x4, 75 Ω, C-1, RB, Armature, < 6 μV, 42 V, 1.3 GHz, 1A
Switches—Microwave	
HP E1368A	50 Ω, 3-Ch. Form C (SPDT), B-1, RB, Armature, 18 GHz
HP E1369A	Switch Driver, B-1, RB, drives switches up to 26.5 GHz
HP E1370A	Switch/Attenuator Driver, B-2, RB, drives switches up to 26.5 GHz
Switches—General Purpose	
HP E1361A	4x4, 2-w, B-1, RB, Armature, < 14 μV, 250 V, 10 MHz, 1 A
HP E1465A	16x16, 2-w, C-1, RB, Armature/L, < 5 μV, 200 V, 10 MHz, 1 A
HP E1466A	4x64, 2-w, C-1, RB, Armature/L, < 5 μV, 200 V, 10 MHz, 1 A
HP E1467A	8x32, 2-w, C-1, RB, Armature/L, < 5 μV, 200 V, 10 MHz, 1A
HP E1468A	8x8, 2-w, C-1, RB, Armature/L, < 7 μV, 220 V, 10 MHz, 1 A
HP E1469A	4x16, 2-w, C-1, RB, Armature/L, < 7 μV, 220 V, 10 MHz, 1A
Switches—Matrix	
HP E1364A	16-Ch., Form C (SPDT), B-1, RB, Armature, < 7 mV, 250 V, 10 MHz, 1 A
HP E1463A	32-Ch. Form C (SPDT), C-1, RB, Armature, < 7 mV, 125 V, 10 MHz, 5 A
HP E1442A	64-Ch., Form C/A (SPDT), C-1, RB, Armature, < 170 mV, 150 V, 10 MHz, 1 A
Optical Switches	
E4502A/ 03A/04A	2-1x4 / 1-1x16 / 2-1x8 Optical Switches, C-1, RB
Special-Purpose Modules	
HP DDCC-37001	Synchro/Resolver Simulator and Indicator C-1, RB
WJC 9119L/R	High-Frequency Tuner (Downconverter), C-1, RB, 32 MHz
HP E6500A	20-3000 MHz VXI Tuner
HP E6501A	20-3000 MHz VXI Receiver
Mass Interconnect	
HP 9420A/21A	Rackmount ICA, High Density, 21 slots, Connector blocks, Cable assemblies
HP 3491A/92A	Rackmount ICA, Low Density, 10 slots Connector blocks, Cable assemblies
HP E3722A, HP 9421A	Hinged ICA, High Density, 21 slots, Connector blocks, Cable assemblies

C-1 means C-size, 1 slot; B-2 means B-size, 2 slot; RB means Register-based; MB means Message-based, DIO means digital input/output



A Wide Range of Instrument Controllers

Hewlett-Packard offers a wide range of test and measurement controllers. HP provides VXI embedded and external controllers based on industry-standard operating systems: HP-UX, MS-Windows (3.1, 95, NT), LynxOS.

Embedded Controllers

Hewlett-Packard provides embedded controllers for both PC-based systems and workstation applications. The HP V/743 VXI embedded controllers—HP E1497A and HP E1498A—offer workstation performance in an integrated C-size package. These high-performance message-based controllers use HP's PA-RISC technology to deliver extraordinary performance and direct VXI access at a very competitive price. Developed specifically as an embedded HP-UX (UNIX) controller for VXI, the V743 controllers provide the high I/O performance of direct VXI backplane support, the space savings of an embedded controller, and the high power and speed of HP PA-RISC. Clock rates of 64 MHz for the HP E1497A, and 100 M Hz for the HP E1498A are available. Also, V743 controllers support all VXI addressing modes (A16, A24, A32), programmable interrupt handling, single channel DMA for VXI extended memory devices, and a 1 MB dual-ported memory buffer for high-speed data acquisition. If you need a PC-based system with the high-performance I/O of VXI, HP offers the HP E6232A and HP E6233A, as well as the HP E6237A for LynxOS real-time application needs. All PC controllers combine the high I/O performance of direct VXI backplane support, the space-saving size of embedded controllers, and the high power of the Intel Pentium processor. A variety of applications use these controllers, such as standalone VXI systems, mixed systems, with VXI and HP-IB instruments, and distributed systems networked together.

External Controllers

From the low-cost HP 712 to the unparalleled, top-of-the-line performance of the J-Class workstations, HP provides external controllers for practically every test and measurement need. The HP 745i, Series 700 controller based on HP's PA-RISC 7100 processor, is rugged and rack-mountable, with built-in HP-IB, four EISA slots, and excellent flexibility. It is completely compatible with all HP 9000 Series 700 controllers and workstations. The Model 712 features the networking functionality you need for test system growth, while offering plenty of built-in interfaces and high-performance graphics. It is a good solution for design, development, and analytical work. Also, the B-Class controllers offer the lowest true-color graphics an EISA expansion slot for HP-IB, and extensive built-in interfaces.

The HP VISUALIZE B-,C-, J-Class workstations complete HP's external controller selections. The J-Class workstations are HP's "personal supercomputers". These controllers use HP's industry-leading 2D/3D graphics to deliver the power and performance you need for computational analysis, advanced 3D design work, and memory intensive workloads. The B-Class controllers are midrange, powerful, and economical. The C-Class workstations provide no-compromise, full computing power for a demanding workload.

HP 9000 Model 745i Controllers

The 745i industrial controller is rack-mountable and modular in design. The 745i controller is binary compatible with the rest of the Series 700 family. It has complete industry-standard built-in Networking Services. It provides performance HP PA-RISC 7100 technology, plus expanded I/O flexibility—especially important for industrial process control and telecommunications.

HP V/743 VXI Embedded Controller

The HP V/743 embedded VXI controllers (HP E1497A and HP E1498A) offer workstation performance in integrated C-size packages. This single-slot system provides HP's 7100LC PA-RISC architecture and complete compatibility with external HP Series 700 controllers. Clock rates of 64 MHz or 100 MHz are available.

The V/743 supports all VXI addressing modes (A16, A24, and A32), programmable interrupt handling, single-channel DMA for VXI extended memory devices, and a 1 MB dual-ported memory buffer for high-speed data acquisition.

Memory configurations of 16 MB, 32 MB, or 64 MB total RAM are available on the V743/100. Standard interfaces include: HP-IB, LAN, Dual RS-232, and SCSI. The HP V/743 controllers require HP-UX releases 9.05 or later.

Investment Protection

Hewlett-Packard is committed to five-year product sales and five-year product support for all HP 9000 Series 700 models. HP continues to develop, upgrade, and add to this product line while still providing compatibility between the various components, when possible. Offering the best support in the industry, Hewlett-Packard will work with you to develop the solutions and systems that are right for you.

The Series 700 is a broad family of PA-RISC workstations with full binary compatibility from top to bottom. The Series 700 software environment, including the industry standard HP-UX, Instant-Ignition (preinstalled system software), and the easy-to-use HP VUE (Visual User Environment) graphical user interface, insure that these systems are both high in performance and easy to use. Finally, a broad range of applications are available in all market areas to help you get more work done.

HP 9000 Series 300 Controllers

The Series 300 selection of controllers from Hewlett-Packard were completely obsoleted October 1, 1997:

- V382 embedded controller—1993
- R362/R382 controllers—October 1, 1996
- HP BASIC/WS, Series 300 HP-UX—October 1, 1997

Support for the Series 300 will continue for 10 years, or until October 1, 2007.

Considerations in Designing Instrument Systems

Several aspects of system design must be considered in creating a new instrumentation system application, under the broad categories of hardware, software, integration and support. The controller is only part of the consideration.

Whether to use open industry standard architectures for hardware and/or software top the list when considering the life-cycle of the application. The consideration is whether to build the system yourself or to employ an in-house or external system integrator. Finally, the types of instruments and performance specifications of the overall system operation must be considered. Today your choice of instrument platforms is broader than ever. You may elect to employ proven rack-and-stack instrumentation, controlled by a standalone instrument controller. Even more attractive might be the new VXI industry-standard open platform. If open industry standards for both the hardware and software aspects of the system are important to you, VXI deserves your investigation.

Hewlett-Packard leads the industry in scalable architecture for the VXI platform, offering a variety of VXI mainframes and embedded VXI system controllers to meet your application and budget.

HP 82324B Measurement Coprocessor

The HP BASIC language, which has its roots in the original Series 200 BASIC, has been ported to a wide variety of platforms, including the HP measurement coprocessors for PCs.

The HP 82324B measurement coprocessor combines hardware and software in one complete, ready-to-install product. It brings together the power of the HP BASIC language and the popularity and flexibility of the MS-DOS operating system.

Ordering Information

HP 82324B High-Performance Measurement Coprocessor includes HP 98616L BASIC 6.2 language on 3.5-in. and 5.25-in. media, documentation, and overlays
- **Opt 102** Add 1 MB or RAM (total, 2 MB)
- **Opt 104** Substitute 4 MB RAM Board
- **Opt 882** Floating-Point Unit, Installed

HP 82325A 1 MB RAM Board
HP 82326A 4 MB RAM Board
HP 82327A Math Coprocessor

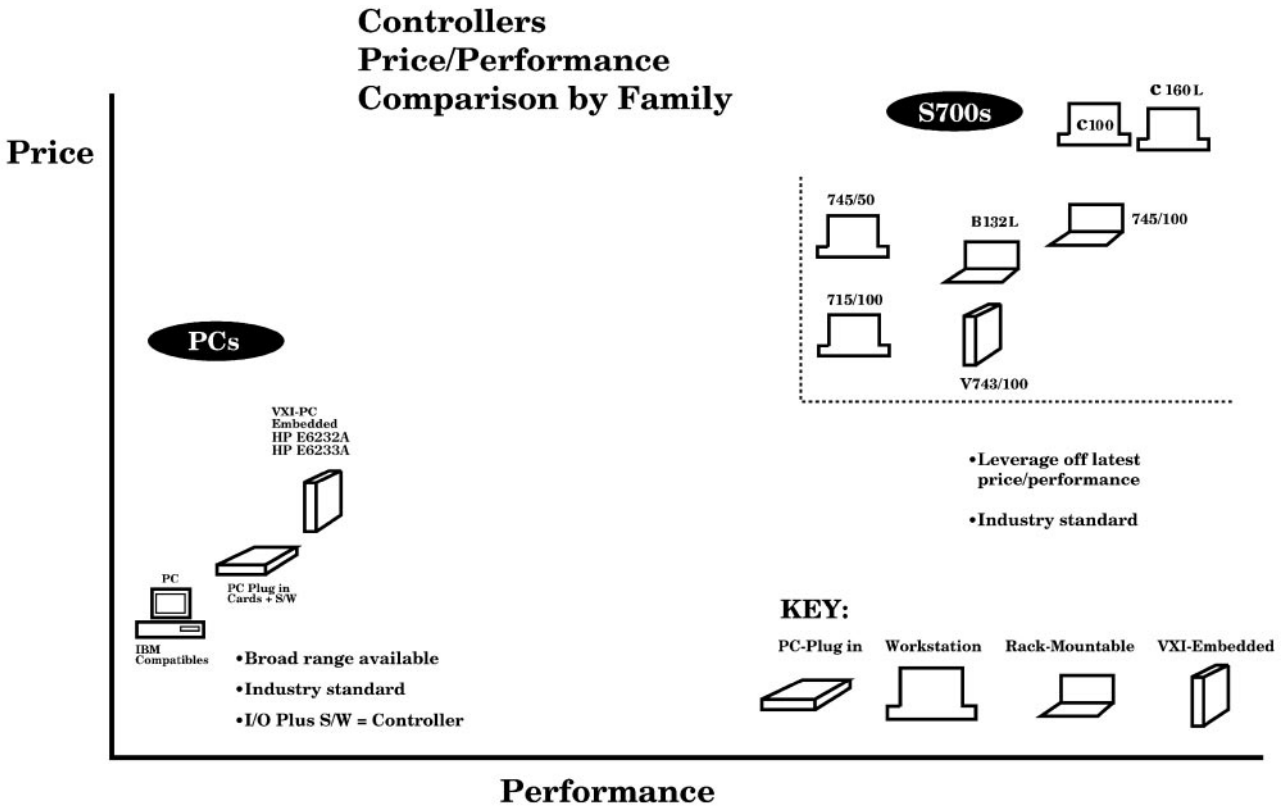
LAN/HP-IB Gateway

The LAN/HP-IB Gateway provides low-cost access to HP-IB instrumentation over your LAN. It lets you use SICL-based or VISA-based applications designed for HP-IB over the LAN without modifying the applications beyond a simple address change. The LAN/HP-IB Gateway allows you to perform a range of measurement tasks on command, store raw or processing data, return information on request, and enjoy access to measurement data locally or remotely.

Ordering Information

HP E2050A LAN/HP-IB Gateway, including gateway hardware, power supply, and power cable
- **Opt APH** SICL for Series 700 workstations (HP-UX 9.0 or later)

Note: You must have SICL with LAN for your workstation HP-IB cables.
Note: You will need LAN cabling (either ThinLAN or Twisted Pair) and HP-IB cables.
HP 10833A 1-meter HP-IB Cable
HP 10833B 2-meter HP-IB Cable
HP 10833C 4-meter HP-IB Cable
HP 10833D 5-meter HP-IB Cable
HP E2051A Rackmount Kit—holds two HP E2050A LAN/HP-IB Gateways



Controller Comparison

	PC		Series 700							
	E6232A	E6233A	745/50	745/100	VXI V743/100	B 160L	C 160	C160L	C180	J280
Operating System										
LYNX-RT	WIN 95	NT	—	—	—	—	—	—	—	—
HP-UX	—	—	•	•	•	•	•	•	•	•
MS-DOS	—	—	—	—	—	—	—	—	—	—
HP-Basic	—	—	•	•	•	•	•	•	•	•
HP-BASIC/WS	—	—	—	—	—	—	—	—	—	—
Processor										
Main Processor	Pentium	Pentium	PA 7100	PA 7100	PA 7100LC	PA 7300LC	PA 8000	PA 7300LC	PA 8000	PA 8000
Clock speed (MHz)	133	166	50	100	100	160	160	160	180	180
Math coprocessor	Built-in	Built-in	Built-in	Built-in	Built-in	Built-in	Built-in	Built-in	Built-in	Built-in
Performance										
SPEC int 95	4.20	4.82	—	—	—	7.75	10.4	7.75	11.8	11.83
SPEC fp 95	3.03	3.40	—	—	—	7.56	16.3	7.56	18.7	19.30
SPEC int 92	—	—	49.2	106.4	100.1	—	—	—	—	—
SPEC fp 92	—	—	78.8	155	137.0	—	—	—	—	—
Memory										
256 MB	128 MB Max	128 MB Max	—	•	—	768 MB Max	1.5 GB Max	768 Max	1.5 GB Max	2 GB Max
128	—	—	•	•	•	•	•	•	•	•
64	—	—	•	•	•	•	•	•	•	•
32	•	•	•	•	•	•	•	•	•	•
16	•	•	•	•	•	—	—	—	—	—
8	•	•	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—
2 MB	—	—	—	—	—	—	—	—	—	—
Display										
1280 x 1024	•	•	•	•	•	•	•	•	•	•
1024 x 768	•	•	•	•	•	—	—	—	—	—
800 x 600	•	•	—	—	—	—	—	—	—	—
640 x 480 VGA	•	•	—	•	—	—	—	—	—	—
Slots Max										
EISA cards	1 (EXM)	1 (EXM)	4	4	0	1+1 PCI/GSC	2 EISA/GSC +	3+1 GSC	2 EISA/GSC +	2 EISA/GSC +
DIO I/O Cards	—	—	—	—	—	—	1 EISA/GSC/PCI	—	1 EISA/GSC/PCI	2 EISA + 1 GSC
Performance										
Spec SPT	—	—	—	—	—	—	—	—	—	—

HP 70000 Modular Measurement System

- Optimized for RF and microwave automatic test systems
- Modular for easier system integration
- Wide variety of products and configurations available

HP developed and supplies an integrated rack of RF test equipment for communication satellite payload test. MMS signal generators, spectrum analyzers and power meters were selected for a compact, EMC-rugged, highly-accurate, 1 GHz to 20 GHz broadband system. The HP 70611A Attenuator/Switch Driver (an MMS system module) is included providing a convenient interface to a custom switch matrix.

Modular Measurement System

The Modular Measurement System (MMS) is an open, industry standard controlled by a consortium. The high-performance, modular platform is especially suited for RF, microwave, and lightwave text applications. It offers the lowest life-cycle cost when you integrate, support, or upgrade your system. The MMS offers system designers a number of advantages:

- A wide variety of over 50 modules offer low frequency, RF, microwave, and lightwave measurement capability.
- Easy system integration is aided by standard- and custom-switching modules, plus an open architecture with design tools that allow you to design and build your own specialized modules.
- Easy-to-use displays allow you to operate a system from local or remote locations, and mainframes and displays can be separated by up to 1 kilometer.
- Electromagnetic compatibility (EMC) design is optimized for microwave environments. Rugged mainframes, shielded enclosures, grounding, and a 40 kHz switched power supply reduce emissions and module-to-module interference.
- Automatic system control can be based on DOS, HP BASIC, or UNIX® operating systems.
- Compatibility with other open standards allows you to make use of new and existing hardware, software, and engineering expertise. MMS and VXI combine easily to solve complex measurement requirements. Both platforms continue to take advantage of their own internal high-speed bus, but can be tied to a common 10 MHz clock reference. Both use common trigger signal levels.

Maximize Your Investment

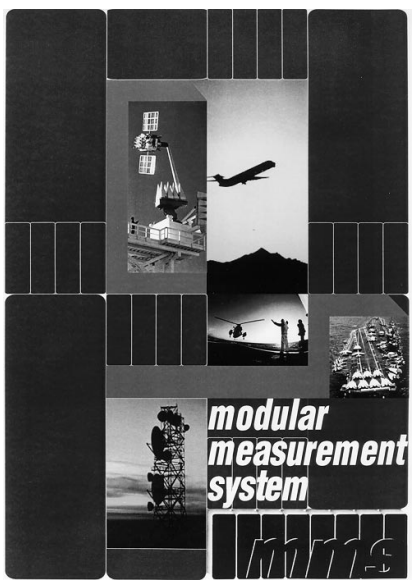
Several factors reduce MMS life-cycle costs:

- MMS integrates quickly, using off-the-shelf mainframes, components, and software packages.
- MMS allows system configuration to provide just the right amount of measurement capability.
- Downsizing enhances ATE systems by reducing rack space.
- A central, shared display allows operator focus and monitors up to four instruments at once in real time. This further reduces rack space. The system will even work without a display, saving more space and reducing cost.
- Built-in diagnostics and modularity team up to maximize system uptime, allowing you to make the best use of your investment.

HP 70000 Modular Measurement System

HP offers a variety of products and services to help you customize your entire system. Multiple support alternatives allow you to customize the logistics of each system to fit installation needs. With MMS, you are assured of the highest performance and best customer support—today, and in the years to come. Your HP sales representative can help you configure the best solution for your specific application.

The following pages highlight selected components and systems in the HP 70000 family. A complete listing of all HP MMS products and most MMS products from other suppliers with full descriptions, specifications, and services is also available.



Key Literature

HP 70000 Modular Measurement System Catalog, p/n 5965-2818E

UNIX® is a registered trademark of UNIX System Laboratories Inc. in the U.S.A. and other countries.

HP 70000 MMS Product Information

HP 70001A

HP 70004A

Mainframes and Displays

Product	Description
HP 70001A System Mainframe	8-slot mainframe for MMS plug-in modules Provides cooling, power, digital communication interface buses (MSIB and HP-IB) Compatible with standard EIA racks Good EMC performance and rugged structural design make it suitable for sensitive measurements in tough industrial environments
HP 70205A Display	Compact, 3-slot module format Provides manual interface and control
HP 70207A PC Display for MMS	PC board, cable and software Provides the MMS display and user interface on a PC Sends graphics directly to any PC peripheral printer or plotter Provides mass storage to any PC peripheral disc or hard drive Options with an HP PC available
HP 70004A Color Display and Mainframe	Integrated mainframe and display with full system interface and control capabilities 4 available module slots

Instruments

Choose from instruments that are single modules or multiple modules configured into a system.

HP 70340A

HP 71708A

Sources

Product	Description
HP 70340A Microwave Synthesizer, 1 to 20 GHz	Synthesized signal generator with add-on frequency extension +13 to –90 dBm amplitude range Harmonic suppression above 55 dBc; no subharmonics
HP 70341A Frequency Extension Module, 10 MHz to 1 GHz	±2 dB output power accuracy and ±0.5 dB flatness 4-slot width + 1-slot extension module
HP 71708A Microwave Source, 2.4 to 25.8 GHz	Excellent LO substitute for radar, phase noise measurement systems; test source for receiver test systems
HP 70428A Microwave Source Module, 2.4 to 25.8 GHz	600 MHz frequency resolution (0.1 Hz option) Up to +16 dBm output power 8-slot system includes mainframe display; 4-slot module

Signal Analyzers

Product	Description
HP 70100A Power Meter, 100 kHz to 50 GHz	Single-channel module with features, capability of HP 437B ±0.5% accuracy in linear mode; ±0.02 dB accuracy in logarithmic mode –70 to +44 dBm power range 1-slot width
HP 70110A Digital Multimeter	1450 readings per second 3 ½ to 6 ½ digits of resolution Measures dc and ac volts, 2-wire and 4-wire Ω , dc and ac current, frequency, power Basic dc accuracy of 5 ppm and common-mode rejection >90 dB 2-slot width
HP 70120A Universal Counter	100 MHz, 200 MHz, 2.4 GHz inputs Minimum sensitivity of 100 mV p-p Built-in TCXO Built-in functions: frequency, period, time interval, rise and fall times, ratios, totalize, pulse width, ac/dc voltage minimum and maximum 1-slot width
HP 70700A Digitizer	20 megasamples per second, 10 bits 256 K memory Waveform recorder and oscilloscope features Up to 8 channels Improves analyzer sweep times 1-slot module
HP 70703A Digitizing Oscilloscope	4-input, 2-channel operation 500 MHz repetitive bandwidth 20 megasamples per second for single-shot measurements to 2 MHz 2-slot width
HP 71500A Microwave Transition Analyzer, DC to 40 GHz	2-channels, sampler-based, internal trigger Time-domain measurements with FFTs Up to 1 ps delta time accuracy
HP 71707A Microwave Downconverter, 2 GHz to 26.5 GHz **HP 70427A Microwave Downconverter Module,** 2 GHz to 26.5 GHz	Translates microwave signals to RF frequencies for phase noise measurements AM noise detection Specified spurious performance System includes mainframe/color display, 4-slot microwave downconverter module

Spectrum Analyzers and Receivers

Product	Description
All HP 70000 series spectrum analyzers offer the following:	10 Hz minimum bandwidth 90 dB calibrated display range 0.1 ppm frequency stability Color display with digital persistence or PC display Wide range of optional performance and features by adding other MMS modules and mainframes
HP 71100C RF Spectrum Analyzer, 100 Hz to 2.9 GHz **HP 71100P RF Spectrum Analyzer,** 100 Hz to 2.9 GHz	Synthesized, high performance RF spectrum analysis –134 dBm sensitivity, –156 dBm with preamplifiers AC or dc coupled RF input 2-mainframe system with 6 slots available or 1 mainframe with PC display
HP 71200C Microwave Spectrum Analyzer, 50 kHz to 22 GHz **HP 71200P Microwave Spectrum Analyzer,** 50 kHz to 22 GHz	Microwave spectrum analysis with optional preselection 2-mainframe system with 5 slots available or 1 mainframe with PC display

HP 71209A

HP 71400C with HP 70810B

HP 71604B

HP 71451B

Spectrum Analyzers and Receivers (cont'd)

2

Product	Description
HP 71209A Microwave Spectrum Analyzer, 100 Hz to 26.5 GHz **HP 71209A Option Z40 Spectrum Analyzer,** 100 Hz to 40 GHz **HP 71209P Microwave Spectrum Analyzer,** 100 Hz to 26.5 GHz	Continuous sweeps from 100 Hz to 26.5 or 40 GHz –138 to –128 dBm sensitivity across the frequency range (HP 71209A/P); –107 dBm at 40 GHz (Option Z40) Built-in external mixer interface for mm applications Rugged 2.4 mm input connector (Option Z40) 2-mainframe system with 5 slots (HP 71209A) or 3 slots (Option Z40) available or 1 mainframe with PC display
HP 71210C Microwave Spectrum Analyzer, 100 Hz to 22 GHz **HP 71210P Microwave Spectrum Analyzer,** 100 Hz to 22 GHz	Fundamentally mixed, highest microwave performance –139 dBm sensitivity at 1 GHz; –133 dBm at 22 GHz; –155 dBm at 22 GHz with HP 70620B preamplifier Dynamic tracking preselector keeps analyzer peaked under all environmental conditions +10 dBm TOI from 10 MHz to 22 GHz 2-mainframe system with 5 slots available or 1 mainframe with PC display
HP 71910A HP 71910P Wide Bandwidth Surveillance Receiver	Includes HP 71209A/P Adds 10 MHz to 100 MHz linear bandwidth capability See page 247

Lightwave and Communication

Product	Description
HP 71400C Lightwave Signal Analyzer, 100 Hz to 22 GHz **HP 71401C Lightwave Signal Analyzer,** 100 Hz to 2.9 GHz **HP 70810B Lightwave Signal Analyzer Module**	Calibrated measurement of intensity modulation from 100 kHz to 22 GHz 1200 to 1600 nm operation (750 to 870 nm option) RIN measurements to –165 dB/Hz Interferometer for laser line width and chirp measurements Systems based on HP 71210C spectrum analyzer 2-mainframe systems with 4 slots available
HP 71450B Optical Spectrum Analyzer **HP 71451B Optical Spectrum Analyzer** **HP 71452B Optical Spectrum Analyzer**	Spectral measurements from 600 to 1700 nm Unique double-pass monochromator Real-time sweep rates –90 dBm sensitivity and 60 dB dynamic Wavelength and amplitude calibration across full measurement range Optional current source and white light source 5 modes of operation (HP 7145B) 1 mainframe system with color display
HP 71501C Jitter and Eye-Diagram Analyzer	Expanded measurement range: 50 Mb/s to > 12 Gb/s Jitter transfer, tolerance, output/generation Test systems, networks, modules or components, MUX/DEMUX Eye-diagram and analysis capability

Product	Description
HP 71603B Gigabit Error Performance Analyzer **HP 71604B Pattern Generator**	100 Mb/s to 1 Gb/s pattern generation and error performance analysis Low-phase-noise clock source User-programmable patterns up to 4 Mb with screen-based editor Ability to trigger anywhere in pattern Variable clock/data delay Automatic setting of threshold and decision point True complementary outputs 2-mainframe systems with color display
HP 71612A Series Gigabit Error Performance Analyzers and Pattern Generators	100 Mb/s to 12 Gb/s pattern generation and error performance analysis 8 Mb programmable pattern Fast transition times, low jitter Burst-mode capability for fiberloop testing Four sub-rate outputs Location of specific errored bits 2-mainframe systems with color display

System Building Blocks

Configure an instrument or system for unique applications using off-the-shelf modules.

Product	Description
HP 70300A Tracking Generator, 20 Hz to 2.0 GHz **HP 70301A Tracking Generator,** 2.7 to 18 GHz	Use with spectrum analyzer for scalar and spectrum analysis Use as RF or microwave source for CW and swept signals Stimulus response capability to measure gain, frequency response, return loss 2-slot width (HP 70300A) 3-slot width (HP 70301A)
HP 70310A Precision Frequency Reference	10 MHz to 100 MHz precision reference signals phase-locked to ovenized oscillator 1-slot width
HP 70620B Preamplifier, 1 GHz to 26.5 GHz 100 kHz to 26.5 GHz **HP 70621A Preamplifier,** 100 kHz to 2.9 GHz	Boost sensitivity of analyzers by 15 to 25 dB –156 dBm sensitivity at 2.9 GHz –150 dBm sensitivity at 22 GHz Optional 100 kHz low-end frequency coverage (HP 70620B) Provide drive signal for excess noise source Built-in switches for preamplifier bypass

System Building Blocks (cont'd)

Product	Description
HP 70875A Noise Figure Measurement Personality	Swept noise figure and gain Microwave measurement range: 10 MHz to 26.5 GHz Calibrated measurements Selectable bandwidths Marker functions and limit lines Menu-driven interface
HP 70900B Local Oscillator	Master control module for spectrum analyzers, lightwave signal analyzers, other systems Synthesized local oscillator for excellent phase noise, stability, frequency accuracy 2-slot width
HP 70860A Upgrade Kit	High-speed controller board upgrades HP 70900A with features of HP 70900B
HP 70861A Upgrade Kit	RAM/ROM board upgrades firmware to HP 70900B capabilities
HP 70902A IF Section, 10 Hz to 300 kHz **HP 70903A IF Section,** 100 kHz to 3 MHz	Adds signal processing elements for spectrum analyzers, lightwave signal analyzers, other systems 10% incremental bandwidth steps Calibrated logging amplifiers 1-slot width
HP 70911A IF Section, 10 MHz to 100 MHz bandwidths	Used in HP 71910A wide bandwidth surveillance receiver 10% incremental bandwidth steps Up to 70 dB IF step gain Linear detection Standard AM and pulse demodulation Standard 321.4 MHz IF output Optional FM demodulation, analog I/Q, 70 MHz IF, 140 MHz IF, and Chebyshev channel filters 2-slot width
HP 70904A RF Section, 100 Hz to 2.9 GHz	Broadband input conversion for spectrum analyzers, lightwave signal analyzers, other systems Broadband, low noise mixer for high dynamic range 70 dB, 10-dB step attenuator (5-dB step option) 1-slot width
HP 70905A RF Section, 50 kHz to 22 GHz	Broadband input conversion for analyzers Broadband, low noise mixer for high dynamic range 70 dB, 10-dB step attenuator 2-slot width
HP 70908A RF Section, 100 Hz to 22 GHz	Fundamentally mixed broadband input conversion for analyzers Highest sensitivity for greater dynamic range Continuously peaked, dynamically tracking preselector 70 dB, 10-dB step attenuator (5-dB step option) 2-slot width
HP 70909A RF Section, 100 Hz to 26.5 GHz **HP 70910A RF Section,** 100 Hz to 26.5 GHz	Diode-pair mixing, built-in preamplifier for improved sensitivity Switchable bypass filter around YIG tuned filter (HP 70910A) Internal switching for connection to external mixers 2-slot width
HP 70907B External Mixer Interface Module	Interface for external mixers, including HP 11974 preselected mixers and HP 11970 harmonic mixers Provides swept LO and tune/span signals 1-slot width

System Integration

Quickly integrate your test system using these resources and tools.

MMS System with HP 70612A

Product	Description
HP 70611A Attenuator/ Switch Driver	Controls up to 31 electro-mechanical mechanical switches or attenuator switch sections Add HP 84940A driver cards to control up to 248 devices Includes interface for manual measurements 1-slot module
HP 70612A Interface Module, 1 x 6 Matrix, DC to 6.5 GHz **HP 70612C Interface Module, 2 x 5 Matrix,** DC to 26.5 GHz	Off-the-shelf solution to interconnection problems 1 x 6 and 2 x 5 common highway switch matrixes Available in frequency bands covering dc to 26.5 GHz MSIB, HP-IB, and manual control
HP 70613A Interface Module, 1 x 6 Matrix, DC to 6.5 GHz **HP 70613C Interface Module, 2 x 5 Matrix,** DC to 26.5 GHz	Attenuator options for adjusting signal strength Rackmount and other custom interface modules available 2-slot modules Custom configurations available

System Accessories

System accessories for the MMS include standard and optional rack cabinets, testmobiles, probes, transmission/reflection test sets, memory cards, external monitors, HIL keyboard, power line frequency option, external power pack, and cabling. See the MMS catalog (described on page 72) for more details.

Custom Engineering

Hewlett-Packard offers engineering and integration services to help you meet your system goals. Our team of experts will ensure that your job is done correctly and cost-effectively. HP can modify existing MMS products, tailoring their functionality to your needs. These enhanced MMS products come with complete operating and service documentation, and are supported at HP service facilities worldwide.

These services are available through your local HP sales representative. See page 591.

Service and Support

The MMS offers many support alternatives. The sytem design allows modules to be exchanged in the field without loss of system calibration. For multiple-module systems, you can add new modules or replace existing ones and run the one-button internal calibration routine. Spares can be stocked based on the MTBF of individual modules — often greater than 15,000 hours. Many MMS instruments have built-in or downloadable diagnostic routines for locating faults. And HP provides for return-to-factory repair and calibration of systems, and offers MIL-STD-45622A certification that is valid for up to three years.

HPVXI
Series
B/C-size
HP 34970A
HP 3488A

Whether you are designing a small, medium, or large test system, Hewlett-Packard's switch family provides you with long-lasting quality, reliability, and performance. Hewlett-Packard offers dedicated switches and modular systems that include instrumentation and fixturing. Whatever your application, the ability to make accurate and reliable connections from instruments to test points is critical. Hewlett-Packard's family of switch products allows you to make a quality measurement system in the minimum amount of time.

HP VXIbus Industry Standard Switch Products

The HP 75000 B- and C-size products provide numerous instruments and switches in the VXIbus instrumentation standard. To meet different application requirements and optimize performance, Hewlett-Packard offers switch modules in various topologies with different types of switching components. To meet your switching needs in test systems, HP provides mainframes for B- and C-size VXIbus products.

Hewlett-Packard introduces new M-Modules and Carrier to provide a low-cost, flexible approach to meet your switching needs. Based on the new European M-Module standard, the new HP E2251A Carrier and new M-Module switches allow you to cost-effectively add multiple small blocks of functionality on one C-size VXI module. Each HP E2251A Carrier can provide access for up to six different M-Modules.

Selecting the Right HP VXIbus Switch Module

The selection of switch modules for automatic switching requires knowledge of the signals to be switched and the tests to be performed. HP VXIbus switches are divided into three topologies for your specific application. These topologies are:

- General-Purpose Modules
- Matrix Modules
- Multiplexer (Mux) or Scanner Modules

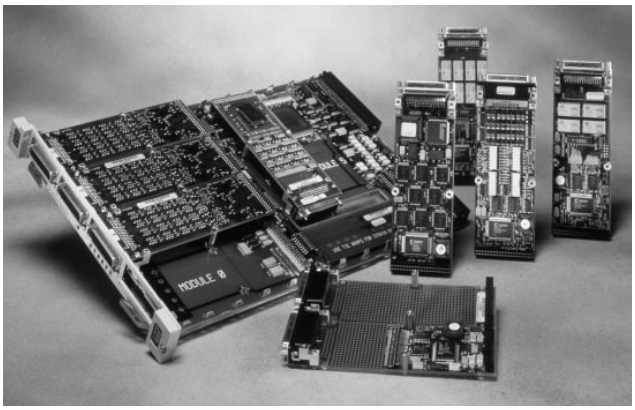
For more detailed information, refer to the HP System Builder's Source Book and CD, p/n 5965-5343E for additional configuration and product ordering information. Also, see the *VXIbus Products, HP 75000 VXIbus Family* section in this catalog.

General-Purpose Modules

A general-purpose module provides individual switches for power switching applications and for controlling various devices and routing general-purpose signals.

Matrix Modules

Hewlett-Packard's matrix switch modules provide a convenient method for connecting a group of test instruments to multiple points on a device. Each crosspoint of most matrix modules switches two wires for the high and low of a measurement. Multiple matrix cards can be connected together for applications that require large matrices.



Multiplexer (Mux) or Scanner Modules

The primary use of a multiplexer is to switch multiple analog signals to a voltmeter or other measuring instrument. Different multiplexers can switch one wire (high with a common low), two wires (high and low), or three wires (high, low, and guard or common). The choice of switching topology can be a trade-off between higher point count with single-ended switching or superior measurement accuracy (for example, three-wire guarded measurements) The factors that differentiate HP's multiplexers are: relays vs. FETs, channel count, maximum voltage, thermal offset, and thermocouple or strain gage bridge measurement capability. Most HP multiplexers use tree switching to reduce unwanted capacitive coupling from open channels. Multiplexer modules are offered in both B- and C- size instruments. A single multimeter and one or more multiplexer modules can act as a single instrument.

HP 3488A for a Reliable System

For environments where switching needs are relatively simple or point counts are not very high, the 3488A meets your needs:

- Multiplexers from dc to μ wave
- Simple matrices
- Digital I/O

For more information, refer to the following pages or ask for Technical Data Sheet p/n 5953-6956.

HP 34970A for Low-Cost Switching

The HP 34970A Data Acquisition/Switch Unit is ideal for cost-sensitive applications with small- to mid-sized channel count requirements. The three-slot mainframe offers eight switch and control modules which cover a broad spectrum of capabilities:

- Low-frequency multiplexing to 300 V
- 2 GHz RF switching (both 50 and 75 Ohms)
- Matrix switching
- General purpose/Form C switching
- Digital input/output
- Analog output
- Event counting

The unit offers excellent density, with up to 96 matrix crosspoints or 120 single-ended channels in a single frame. An additional feature counts and stores every closure of each switch, helping to track relay life and simplify maintenance.

The Switch Module Selection Table on this page provides comparative information for each of the VXIbus switches. For other VXIbus product information, also see *VXIbus Products, HP 75000 VXIbus Family* section in this catalog.

Model #	Description	Size, Slots	Switching Type (L-latching)	Thermal Offset (per ch.)	Max. Volts (DC)	Band-width (–3 dB)	Current Rating	Closed Channel Resistance (Ω, initial)	Lifetime (typ. # of operations)
Multiplexers									
HP E1343A	16-Channel, 3-wire	B, 1	Reed relay	<10 μV	250 V	10 MHz	50 mA	100 ±10%	10^8 no load, 10^7 rated load
HP E1344A	16-Channel T/C, 3-wire	B, 1	Reed relay	<10 μV	250 V	10 MHz	50 mA	100 ±10%	10^8 no load, 10^7 rated load
HP E1345A	16-Channel, 3-wire	B, 1	Reed relay	<4 μV	120 V	10 MHz	50 mA	100 ±10%	10^8 no load, 10^7 rated load
HP E1346A	48-Channel, 1-wire	B, 1	Reed relay	<50 μV	120 V	10 MHz	50 mA	100 ±10%	10^8 no load, 10^7 rated load
HP E1347A	16-Channel T/C, 3-wire	B, 1	Reed relay	<4 μV	120 V	10 MHz	50 mA	100 ±10%	10^8 no load, 10^7 rated load
HP E1351A	16-Channel, 3-wire	B, 1	FET	<25 μV	16 V	100 kHz	1 mA	<3.1 k	(see note)
HP E1352A	32-Channel, 1-wire	B, 1	FET	<25 μV	16 V	500 kHz	1 mA	<3.1 k	(see note)
HP E1353A	16-Channel, T/C 3-wire	B, 1	FET	<25 μV	16 V	500 kHz	1 mA	<3.1 k	(see note)
HP E1355A/56A	8-Channel, 120/350 Ω Strain	B, 1	Reed relay	<4 μV	120 V	10 MHz	50 mA	100 ±10%	10^8 no load, 10^7 rated load
HP E1357A	8-Channel, 120 Ω Strain	B, 1	FET	<25 μV	16 V	500 kHz	1 mA	<3.1 k	(see note)
HP E1358A	8-Channel, 350 Ω Strain	B, 1	FET	<25 μV	16 V	500 kHz	1 mA	<3.1 k	(see note)
HP E1460B	64 2-wire, 32 3-wire, or 128 1-wire	C, 1	Armature, L	<7 μV	220 V	3/10 MHz	0.3, 1 A	<1.5	5×10^6 no load, 10^5 rated load
HP E1476B	64-Channel, 3-wire	C, 1	Reed relay	<2 μV	120 V	100 kHz	35 mA	100 Ohm ±5%	5×10^9 no load, 5×10^7 rated load
HP E8460A	256-Channel Relay Multiplexer	C, 1	Reed relay	50 μV	200 V	—	—	<3	500 M no load, 10 M rated load
HP E2272A	Dual 8-to-1, Relay Multiplexer M-Module	—	DPST, L	<3 μV (typical)	60 V/ 200 V	>10 MHz (typical)	—	0.2 (typical)	10^5 rated load
RF Multiplexers									
HP E1366A	Dual 1 x 4, 50 Ω	B, 1	Armature	<6 μV	42 V	1.3 GHz	1 A	<1	5×10^6 no load, 10^5 rated load
HP E1472A/73A	Six 1 x 4, 50 Ω	C, 1	Armature	<6 μV	42 V	1.3 GHz	1 A	<1	5×10^6 no load, 10^5 rated load
HP E1367A	Dual 1 x 4, 75 Ω	B, 1	Armature	<6 μV	42 V	1.3 GHz	1 A	<1	5×10^6 no load, 10^5 rated load
HP E1474A/75A	Six 1 x 4, 75 Ω	C, 1	Armature	<6 μV	42 V	1.3 GHz	1 A	<1	5×10^6 no load, 10^5 rated load
HP E1470A	60-Channel RF Cascade Multiplexer	C, 1	Armature	—	30 V	500 MHz (1 x 3)	400 MA	<1.5 (typical)	5×10^6 no load, 1×10^5 10 BU RF
Microwave Switches									
HP E1368A	50 Ω, 3-Ch. Form C (SPDT)	B, 1	Armature	—	—	18 GHz	—	—	10^6
HP E1369A	Switch Driver	B, 1	N/A	—	—	Up to 26.5 GHz	—	—	N/A
HP E1370A	Switch/Attenuator Driver	B, 2	N/A	—	—	Up to 26.5 GHz	—	—	N/A
Matrix Switches									
HP E1361A	4 x 4, 2-wire	B, 1	Armature	<14 μV	250 V	10 MHz	1 A	<1.5	10^6 no load, 10^5 rated load
HP E1465B/66B	16 x 16/4 x 64, 2-wire	C, 1	Armature, L	<5 μV	200 V	10 MHz	1 A	<1.8	10^7 no load, 10^5 rated load
HP E1467B	8 x 32, 2-wire	C, 1	Armature, L	<5 μV	200 V	10 MHz	1 A	<1.8	10^7 no load, 10^5 rated load
HP E1468B	8 x 8, 2-wire	C, 1	Armature, L	<7 μV	220 V	10 MHz (2-wire)	1 A	< 1.5	4×10^6 no load, 10^5 rated load
HP E1469B	4 x 16, 2-wire	C, 1	Armature, L	<7 μV	220 V	10 MHz (2-wire)	1 A	<1.5	4×10^6 no load, 10^5 rated load
HP E2271A	4 x 4 M-Module	—	DPST, L	<3 μV (typical)	60 V/ 220 V	>10 MHz (typical)	—	0.3 (typical)	10^5 rated load
General-Purpose Switches									
HP E1364A	16-Channel Form C (SPDT)	B, 1	Armature	<7 μV	250 V	10 MHz	1 A	<1.5	10^6 no load, 10^5 rated load
HP E1463B	32-Channel Form C (SPDT)	C, 1	Armature	<7 μV	125 V	10 MHz	5 A	<0.25	$>5 \times 10^7$ no load, $>3.5 \times 10^4$ rated load
HP E1442B	64-Ch. Form C/A (SPDT)	C, 1	Armature	<70 μV	150 V	10 MHz	1 A	<1.5	$>5 \times 10^6$ no load, $>10^5$ rated load
HP E2270A	16-Channel Form A Switch M-Module	—	SPST, L	<3 μV (typical)	60 V/ 200 V	>10 MHz (typical)	—	<0.2 (typical)	10^5 rated load
HP E2273A	8-Channel Form C Switch M-Module	—	Armature	<20 μV (typical)	60 V/ 200 V	>10 MHz (typical)	—	N/A	5×10^6 no load, 10^5 rated load
HP E2274A	4-Ch. Form C Power Relay M-Module	—	Armature	<20 μV (typical)	60 V/ 125 V	>10 MHz (typical)	—	N/A	5×10^7 no load, 3.5×10^4 rated load

Optical Test Switches: HP E4502A/03A/04A Optical Switch

Note: FET and solid state switch lifetime is independent of the number of switching operations.

HP 3488A

- DC to 26.5 signal switching
- Matrix, multiplexer and general-purpose relays
- Digital I/O control actuation
- Up to 50 channels
- 40 configuration storage registers
- 11 switch and control modules

HP 3488A

HP 3488A Switch/Control Unit

The HP 3488A switch/control unit brings versatile, HP-IB programmable switching to tests requiring multi-channel measurements. The HP 3488A provides signal switching with the integrity and isolation needed for high-performance production test systems. It also offers a flexible, low-cost interconnection for automating experiments on the bench and for developing tests in the lab. The HP 3488A is designed to hold up to five of the following switch and control modules:

- 10-channel relay multiplexer
- 10-channel general-purpose relay
- Dual 4-channel VHF switch
- 4 x 4 matrix switch
- 16-bit digital input/output
- Breadboard
- 3-channel 18 GHz switch
- 7-channel form-C relay
- 2-channel microwave switch
- 1.3 GHz 50 and 75 Ω multiplexers

Flexible Switching

The HP 3488A is an economic approach to flexible switching through plug-in modules. You can select the right combination of switching functions to meet both performance and budget needs. Testing is simplified by having one solution of low-level DVM inputs, high level dc and ac power, and microwave signals to 26.5 GHz. Additional devices, such as microwave relays and programmable attenuators, are easily controlled with digital I/O functions. Custom circuitry can also be implemented on breadboard modules.

Versatile Performance

The HP 3488A can store up to 40 complete switch configurations for convenient recall in automated test programs. Switch operation can be done with multiple-relay closures or with selectable channels in a break-before-make mode. Break-before-make and recallable switch configurations can be combined in a programmable scan list. The HP 3488A uses removable screw terminal connectors that provide easily interchangeable wiring for each test. Built-in self-test assures proper operation.

Multiplexer (Option 010/HP 44470A)

Option 010 is a 10-channel multiplexer for scanning or multiple-signal connections. Channels switch two wires (Hi and Lo) with 2PST relays for DVM inputs and other signals up to 250V and 2A. This module can also be used to multiplex signals to other switching functions, such as the matrix module.

General-Purpose Relay (Option 011/HP 44471A)

This module consists of 10 SPST independent relays for general-signal switching and control of external devices. Quality connections make this module ideal for switching signals when multiplexing is not required, or for supplying switchable power to the device-under-test.

VHF Switch (Option 012/HP 44472B)

The VHF module provides broadband switching for high-frequency and pulse signals. The two independent groups of bi-directional 1 x 4 switches can be used for signals from dc to 300 MHz. All channels have 50 Ω characteristic impedance and are break-before-make within a group of four channels. Each group is isolated from the other and from ground to prevent ground loops. Excellent isolation makes this module ideal for high-frequency signal analyzer measurements requiring a large dynamic range.

Matrix Switch (Option 013/44473A)

Option 013 offers highly-flexible switching with a 4 x 4, 2-wire matrix. Any combination of four input channels may be connected to any combination of four output channels. Each cross point or node in the matrix uses a 2PST relay to switch relay to switch two lines (Hi and Lo) at a time. Multiple 4 x 4 modules can be connected to form larger matrices. Multiplexers can be used in conjunction with this module to effectively expand the number of inputs and outputs of the matrix.

Digital I/O (Option 014/HP 44474A)

This module offers 16 very flexible bi-directional I/O lines and 4 TTL-compatible handshake lines for sensing and control of external devices. The digital inputs can be used to sense contact closures to ground. Each channel provides current sinks for remote switching of external relays, such as the HP 33311 series coaxial switches.

Breadboard (Option 015/ HP 44475A)

The breadboard module provides a convenient way to implement custom circuits and special functions that interface directly to the HP 3488A's backplane control signals.

Microwave Switch (Option 016/HP 44476A)

This microwave switch furnishes three independent SPST 50 Ω coaxial switches with excellent performance from dc to 18 GHz. The 3-mm SMA connector allows you to easily connect cables for multiple-system configurations.

Form-C Relay (Option 017/HP 44477A)

This module provides seven separate SPDT channels for general-purpose switching and control of external devices. Using a power supply, the module can drive programmable attenuators and non-HP coaxial switches.

Microwave Switch (Option 018/ HP 44476B)

The module brings multi-port 50 Ω coaxial switching to your test system. The module can mount any two HP 3331XX coaxial switches. The HP coaxial relays come in 3-, 4-, and 5-port configurations—different switches for a variety of applications. HP coaxial switches that can be used are:

HP Coaxial Switch	Port	Frequency
HP 33311B/Option 011	3	dc to 18 GHz
HP 33311C/Option 011	3	dc to 26.5 GHz
HP 33312B/Option 011	4	dc to 18 GHz
HP 33312C/Option 011	4	dc to 26.5 GHz
HP 33313B/Option 011	5	dc to 18 GHz
HP 33313C/Option 011	5	dc to 26.5 GHz

1.3 GHz 50 Ω Multiplexer (Option 019/HP 44478A)
1.3 GHz 75 Ω Multiplexer (Option 020/HP 44478B)

These modules bring bi-directional switching from dc to 1.3 GHz, with high-channel isolation (>55 dB @ 1 GHz). Each module consists of two groups of 1 x 4 multiplexers. All test connections are made to BNCs on the module's edge. Off-channels can be resistively terminated.

Specifications

Option 010/HP 44470A Multiplexer
Option 011/HP 44471A General-Purpose Relay
Option 013/HP 44473A Matrix Switch and
Option 017/HP 44477A Form-C Relay Switch Modules

Input Characteristics
Maximum Voltage (terminal-terminal or terminal-chassis)**:**
250 V dc, 250 Vac rms, 350 Vac Peak
Maximum Current: 2 A dc, 2 A ac rms
Maximum Power: 60 W dc, 500 VA ac
Thermal Offset: <3 μV
DC Isolation (40°C, 60% RH)
Channel-channel, Open-channel: > $10^{11}\Omega$

AC Isolation/Performance

50 Ω termination	100 kHz	1 MHz	10 MHz
Insertion Loss (dB)	<0.30	<0.35	<0.90
Crosstalk (dB)	<–73	<–53	<–33

Option 012/HP 44472A VHF Switch Module

Input Characteristics
Maximum Voltage
Center-center, Center-low: 250 Vdc, 30 Vac rms, 42 Vac peak
Low-chassis, Low-low: 42 V dc
Maximum Current (per channel)**:** 30 mA dc, 300 mA ac rms
Thermal Offset: <15 μV per channel
Characteristic Impedance: 50 Ω

AC Isolation/Performance

	30 MHz	100 MHz	300 MHz
Crosstalk (dB)			
Channel-Channel	<–100	<–85	<–65
Group-Group	<–85	<–85	<–50
Insertion Loss (dB)	<0.5	<0.75	<1.25
VSWR	<1.06	<1.12	<1.43

All channels break-before-make within a group of 4 channels.

Option 014/HP 44474A Digital I/O Module

I/O Lines
Maximum Voltage: + 30 Vdc (line-chassis)
Output Characteristics: V (high) ≥ 2.4V; V (low) ≤0.4V
I (low) Maximum: 125 mA @V (low) ≤1.25 V; fused at 250 mA
Input Characteristics: V (high) ≥ 2 V; V (low) ≤ 0.8 V
External Increment: Advances HP 3488A to next programmed configuration on falling edge of TTL pulse
Channel Closed: Indicates completion of new configuration; TTL pulse

Option 016/HP 44476A Microwave Switch Module

Frequency Range: DC to 18 GHz
Isolation: > 90 dB
Impedance: 50 Ω
Insertion Loss: <0.05dB
SWR: 1.40

Option 018/HP 44476B Microwave Switch Module

Refer to HP 3331XX product specifications.

Option 019/HP 44478A and Option 020/HP 44478B 1.3 GHz Multiplexers

Input Characteristics
Maximum Voltage: 42 Vdc + ac peak
Maximum Current per Channel: 1 A DC or AC rms
Maximum Power per Channel: 24 W, 24 VA, or 44 dBm
Impedance: 50 Ω (Option 019/HP 44478A), 75 Ω (Option 020/HP 44478B)

AC Performance

	≤10 MHz	≤100 MHz	≤500 MHz	≤1.3 GHz
Insertion Loss (db)				
≤(40° C, 95% RH)	<0.3	<0.7	<1.5	<3.0
≤(25°C, 40% RH), (typ.)	<0.2	<0.5	<1.1	<1.9
Crosstalk (dB)				
Channel-Channel				
Channel-Common	<–90	<–80	<–65	<–55
Group-Group, Module-Module	<–90	<–80	<–70	<–60
VSWR	<1.2	<1.25	<1.35	<1.55

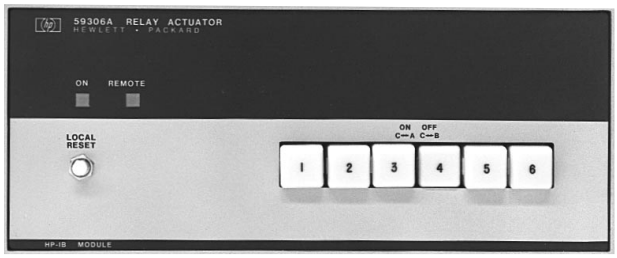
General Specifications

Environmental
Temperature: 0° to 55° C (32° to 130°F);
Humidity: 95%, 0° to 40°C (32° to 105°F)
Power: 86 to 132 V/195 to 250 V, switch selectable; 48 to 440 Hz; 18 VA
Interface: HP-IB
Size: 425 mm W x 89 mm H (without feet) x 292 mm D (16.75 in x 3.5 in x 11.5 in). Allow 76 mm (3 in) additional depth for wiring.
Weight: Net, 8.5 kg (18.75 lb); shipping 16 kg (35.25 lb)
Connectors: Removable screw terminal connector. Each terminal accepts 18 to 26 gauge (16 to 40 mils) wire, with strain relief for wiring.
Opt 012/HP 44472A VHF switch: BNC connectors
Opt 016/HP 44476A and Opt 018/HP 44476B: SMA connectors

Ordering Information

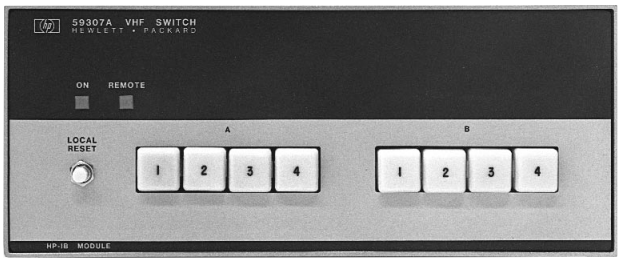
HP 3488A Switch/Control Unit
Switch Modules—Includes Terminal Connectors
Opt 010/HP 44470A 10-channel Relay Mux Module
Opt 011/HP 44471A 10-channel G.P. Relay Module
Opt 012/HP 44472A Dual 4-ch. VHF Switch Module
Opt 013/HP 44473A 4 x 4 Matrix Switch Module
Opt 014/HP 44474A 16-bit Digital Input/Output Module
Opt 015/HP 44475A Breadboard Module
Opt 016/HP 44476A Microwave Switch Module
Opt 017/HP 44477A Form-C Relay Module
Opt 018/HP 44476B Microwave Switch Module
Opt 019/HP 44478A 1.3 GHz 50 Ω Mux
Opt 020/HP 44478B 1.3 GHz 75 Ω Mux
Rackmounting and Manuals
Opt 401 Side Handle Kit (HP p/n 5061-1171)
Opt 907 Front Handle Kit (HP p/n 5061-1170)
Opt 908 Rack Flange Kit (HP p/n 5061-1168)
Opt 909 Rack Flange with Handles (HP p/n 5061-1169)

HP 59306A
HP 59307A
HP 10833A
HP 10833B
HP 10833C
HP 10833D
HP 10834A



HP 59306A

ITEL-45CHUV



HP 59307A

HP 10834A

HP 10833A/B/C/D

HP-IB Accessory Modules

Modules in the HP 59300 series are ideal building blocks to extend the measurement capabilities of instruments. Modules can be interconnected via the HP-IB to HP measuring instruments, signal sources, and recording devices capable of operating directly on the HP-IB. In addition, these modules frequently serve to interconnect with devices which are not themselves capable of direct HP-IB operation.

HP 59306A Relay Actuator

HP-IB

Six Form-C relays provide control of external devices either manually from front-panel pushbuttons or remotely from the HP-IB. Relay contacts are specified to switch 28 Vdc or 115 Vac at 0.5 A. Each relay can be programmed independently or multiple relays can be switched together. Front-panel pushbuttons light to indicate the state of each relay.

The HP 59306A is ideal for providing control of microwave coaxial switches (HP 8761A/B) as well as control of microwave programmable step attenuators (HP 8494 through 8496G/H) using external dc power supplies.

HP 59307A Dual VHF Switch

HP-IB

This module provides two single-pole 4-throw switches controlled from front-panel pushbuttons or remotely from the HP-IB. The HP 59307A is a dc to 500 MHz, 50 Ω switch designed to maintain fast pulse transition times. The switches are independent and bi-directional for optimum use in multiplexing 50 Ω signal lines into measuring instruments. The HP 59307A is ideal to switch a standard delay, frequency, or voltage into a measurement loop for purposes of system calibration.

HP-IB to Centronics Parallel Bus Converter

This bus converter allows instruments with HP-IB ports to transmit data to printers equipped with Centronics I/O ports. No programming is required. Just connect an HP-IB cable between the instrument and converter on one end, and an HP IEEE-1284-compatible parallel printer cable (HP C2950A or HP C2951A) between the converter and printer on the other end, and begin printing.

Data Flow: One-way only HP-IB (input) to Centronics (output)
Data Rate: 15 KB/s
Size: 9.14 cm W x 2.79 cm H x 14.61 cm D (3.6 in x 1.1 in x 5.75 in)

HP-IB Interconnection Cables

Cables for interconnecting HP-IB devices are available in four lengths. The connector block at both ends of the cable has a plug on one side and a matching receptacle on the other so that several cables may be conveniently "stacked" in parallel, thus simplifying system interconnection. Lock screws securely mount each connector block to an HP-IB instrument or to another connector block.

Note: Cables are not always included with HP-IB devices, particularly those that connect directly to an HP controller. (The HP-IB interface for HP controllers provides the necessary cable and connector.) Product listings in this catalog should be checked to see if HP-IB cables are furnished.

HP 10833 cables feature an improved shielding design to help reduce RFI levels in systems. This series of cables has significantly lower radiated emissions than previous HP-IB cables.

The HP 10834A is a shielded HP-IB to HP-IB adapter. It provides additional clearance (approximately 2.3 cm) between the HP-IB cable and the rear panel of the instrument. This allows easier access to switches, cables, and other connectors in close proximity to the connector.

Ordering Information

HP 59306A Relay Actuator
HP 59307A Dual VHF Switch
ITEL 45CHVUB HP-IB to Centronics Parallel Bus Converter*
ITEL 45CHVEB HP-IP to Centronic Parallel Bus Converter** (European version)
HP C2950A HP LaserJet and DeskJet Printer Cable, IEEE 1284-compatible, A-B parallel 2 m (6.6 ft.)
HP C2951A HP LaserJet and DeskJet Printer Cable, IEEE 1284-compatible, A-B parallel 3 m (9.9 ft.)
HP 92284A Centronics Cable 2.1 m
HP 10833A HP-IB Cable, 1 m (3.3 ft)
HP 10833B HP-IB Cable, 2 m (6.6 ft)
HP 10833C HP-IB Cable, 4 m (13.2 ft)
HP 10833D HP-IB Cable, 0.5 m (1.6 ft)
HP 10834A Adapter
HP 8120-3448 HP-IB Cable, 6 m (18.5 ft)
HP 8120-3449 HP-IB Cable, 8 m (26 ft)

* Must order appropriate AC adapter.
**Must order power supply separately. Ask for part number HP 82241A.

HP-IB Interface Cards for PCs

Create Test and Measurement Applications on Your PC

HP-IB (Hewlett-Packard Interface Bus) was originally developed to help standardize interfaces between computers and instruments. For years, it has reigned as the IEEE-488.2 protocol throughout the industry. HP-IB is implemented on a vast range of HP computers and instruments. When you buy HP-IB, you can be sure of automatic, seamless compatibility between computers and instruments throughout your system. HP-IB interface cards and software for external PCs make it easy for you to access and control instruments and exchange data.

HP 82341D/82350A: High-Performance HP-IB Card with Buffering

The HP 82341D/82350A is a 16-bit high-speed HP-IB card that lets you take full advantage of today's faster HP-IB instruments and faster PCs. It offers maximum I/O performance where fast system rates are required. It comes with SICL/VISA software for a Windows 3.1 environment and Windows 95/NT.

HP 82335B: The Standard HP-IB Card

The HP 82335B includes an interface card Command Library software for DOS and Windows 3.1 environments. The HP 82335B supports a variety of popular DOS and Windows languages, especially for operations in a DOS environment where I/O transfer rates are less demanding. The HP 82335B also supports Dynamic Data Exchange (DDE) servers that control both interface and instruments from a variety of DDE-based Windows applications.

System Requirements

For DOS Operation: IBM-PC or compatible with at least 256 KB RAM and DOS 3.1 or higher.
For Windows 3.1 Operation: IBM-PC or compatible with at least a 286 microprocessor (386 is recommended), at least 2 MB of RAM (4 MB is recommended), Windows 3.0 or later, and DOS 3.1 or later.
For Windows 95/NT Operation: IBM-PC or compatible with at least a 386 microprocessor (486 is recommended), and at least 12 MB RAM (16 MB is recommended).

Feature Summary

	HP 82350A	HP 82341D	HP 82335B
Operating System	Windows 95/NT	Windows 3.1/95/NT	MS-DOS, Windows 3.1
I/O Library	SICL/VISA	SICL/VISA	Command Library
Languages	C/C++, Visual BASIC, HP VEE, LabVIEW	C/C++, Visual BASIC, HP VEE	C/C++, Pascal, BASIC for PC (including Visual BASIC), HP VEE
Backplane	PCI	ISA/EISA, 16 bit	ISA/EISA, 8 bit
Maximum I/O	1 MB/s	750 KB/s	355 KB/s
FCC Class A Compliant	Yes	Yes	Yes
Buffering	Built-in	Built-in	None

HP-IB Cables

HP 10833A 1 meter HP-IB Cable
HP 10833B 2 meter HP-IB Cable
HP 10833C 4 meter HP-IB Cable
HP 10833D 5 meter HP-IB Cable

Ordering Information

High-Performance HP-IB for PCIbus
HP 82350A Includes interface card, SICL/VISA software for Windows 95/NT on CD-ROM, manuals, and quick reference card
High-Performance HP-IB Interface
HP 82341D Includes interface card, SICL/VISA software for Windows 3.1/95/NT on CD-ROM, manuals, and quick reference card
Standard HP-IB Interface
HP 82335B Includes interface card, Command Library for Windows 3.1 and DOS, HP-IB peripheral driver software, manuals, and quick reference card
Automation Kits for PCs
Two HP-IB automation kits are available that support popular Test & Measurement languages:
HP 82345B PC Windows 3.1 Automation Kit with HP VEE 3.12
HP 82345D PC Windows 95 and Windows NT Automation Kit with HP VEE 4.0

VISA Software

VISA is an extension of the concept of unified instrument library that HP supported through the initial introduction of SICL (Standard Interface Control Library). VISA is specified by the VXI*plug & play* Alliance. VISA provides a unified input/output, allowing one library of calls that can be used with a variety of interfaces and test system languages. The HP-IB (IEEE) interface family 82341 and 82345 include VISA.

Call HP Direct for fast service and technical assistance. You'll get off-the-shelf delivery. Purchase orders, VISA, MasterCard, and American Express are accepted. Order today and receive complimentary 90-day post-sale support, 1-800-452-4844.

HP-IB Interface Cards for Workstations

The HP E2070C and the high-speed HP E2071D are designed to provide an additional IEEE-488.2 HP-IB interface for the HP Series 700 workstations. The HP 745i has a built-in HP-IB port as well as an EISA backplane. Four additional workstations are supported: the models 715, 725, 735, and 755. The HP E2070C and E2071D are superior, low-cost EISA cards that give you fast access to instrument automation.

Software

The HP E2070C and E2071D are supported by HP's Standard Instrument Control Library (SICL).

HP-IB Benchmarks

Controller	Max. data rate (DB/s)	Start-up time (ms)
745i–E2071D	580	.03
745i–E2070C	230	.03

Note: the transfer rate for the 745i built-in HP-IB port is 750 DB/s.

HP-IB Interface Products

Model	Description
HP E2070C	IEEE-488 HP-IB, EISA interface for Series 700 systems. Includes interface with SICL/VISA (HP E2091E); 2-meter HP-IB cable, HP-IB connection extender and documentation. SICL/VISA software on CD-ROM for HP-UX 9.X and 10.01.
Option 001	IEEE-488.2 HP-IB, EISA interface only.
HP E2071D	High-speed IEEE-488, HP-IB, EISA/VISA interface for Series 700 systems. Includes interface with SICL/VISA (HP E2091E), 2-meter HP-IB cable, HP-IB connection extender and documentation. SICL/VISA software on CD-ROM for HP-UX 9.X and 10.01. Additional Ordering Information: Built-in buffer—best product for multitasking environment requiring high performance. Cannot be used for peripherals—printer, plotter, disks.
Option 001	High-speed IEEE-488.2 HP-IB, EISA interface only.
HP E2074B	GP-IO card, cable, SICL software on CD-ROM for HP-UX 9.X and 10.01 and documentation, a 16-bit parallel EISA interface is supported on HP BASIC/UX/700. Allows access to all applicable HP BASIC statements. Excellent for special, unconventional I/O needs on Series 700.
HP E2075A	GP-IO card for PCs. General-purpose I/O card and SICL software on CD-ROM for PCs with the Windows 95/NT operating system. Compatible with C/C++, HP VEE and Visual BASIC.
HP E2091E	SICL/VISA for Series 700 controllers. Supports built-in HP-IB interface (745i or 747i), or EISA-based HP E2070C or E2071D plug-ins. HP-UX 9.X or HP-UX 10.01 required. Media on CD-ROM.
HP E2094E	SICL/VISA for PCs with Windows 3.1/95/NT. Media on CD-ROM.

Test Software

HP Basic for Windows
5964-0369E
HP Basic Product Family
5962-7100E/EN
HP VEE Evaluation Kit
5965-6508E
1997 System Builders Source CD ROM
5965-8795E
HP VEE Case Studies Brochure
5962-9239E
HP VEE for Windows, DDE between HP VEE & MS Excel
5962-9850E
HP VEE for Windows, Dynamic Data Exchange (DDE)
5962-9849E
HP VEE for Windows, Using DDE with HP VEE for Windows
5962-9852E
Get Started with HP VEE in Minutes
5966-0673E
HP VEE 4.0 Visual Programming Language
5965-6806E
HP-IB Interface Cards for PCs
5965-6113EN
HP 35639A DataViewer Product Overview
5962-9499E
HP 37204A Multi-Point HP-IB Extender Technical Data Sheet
5962-6971E

(PN 2120-2) HP VEE for Windows/Dynamic Data Exchange Between HP VEE for Windows and Microsoft Excel
5962-9850E
(PN 2120-3) HP VEE for Windows/Using a Dynamic Link Library (DLL) with HP VEE for Windows
5962-9852E
(PN 2120-1) HP VEE for Windows
5962-9849E

VXIbus Products

Feeling Comfortable with VXI
5965-6487E
Test System and VXI Products Data Book
5965-5497E
Test System and VXI Products Catalog & CD ROM
5965-8791E
HP VXI, Leading the Fight to Lower Cost of Test
5966-0106E
14 Ways to Work Faster, Smarter, Better
5021-1980
1997 System Builders Source CD ROM
5965-8795E

MMS Products

HP 71000 P-Series Spectrum Analyzers – Modular Spectrum Analyzers with PC Displays, Brochure
5965-5791E
HP 71910A Widewidth Surveillance Receiver, Technical Specifications
5964-3895E

(PN 71500A) Improve Delta Time Accuracies in Semiconductor Device Modeling and Characterization with the HP 71500A
5952-2544E
(PN 71612A) Extending High-Speed BER Testing to 20 Gb/s with the HP 71612A Error Performance Analyzer
5964-6133E
(PN 71612A) HP 71612A Error Location Analysis
5963-2005E
(PN 71612A) Testing 10-Gb/s SONET/SDH Equipment and Components
5965-0858E

System Switches

1997 System Builders Source CD ROM
5965-8795E

(PN 75000) HP IBASIC Product Note
5091-0805E
(PN 75000) Rigorous Stressing of SONET/SDH Alarms Using Programmable 3-Stage Sequences
5965-2742E
(PN 75000) Series 95-1 HP 75000 Series 95 SDH Tributary Test Solutions
5091-8060E
(PN 75000) Series 95-2 HP 75000 Series 95 SONET Tributary Test Solutions
5091-8174E

Interface Products

(PN) Introduction to HP Standard Instrument Control Library (SICL) (82341B)
5963-2228E

Many of these literature pieces are available at:
http://www.hp.com/go/tmc98

Oscilloscopes Hewlett-Packard provides a wide selection of performance from general purpose and troubleshooting, to modular high bandwidth multiple channel instruments, with considerable built-in ease-of-use capabilities.

Mixed Signal
General Purpose
Tools for Mixed Signal Designer
Digitizing
Infinium

Oscilloscope Probes and Accessories Hewlett-Packard offers a wide selection of probes and accessories to fit your application, and maximize accuracy of signal reproduction.

High Impedance Passive
Surface Mount
Differential
Active
High Voltage, Current

Personal Troubleshooting Tools

HP LogicDart Advanced Logic Probe

Electronic Counters Hewlett-Packard offers the industry's broadest line of electronic counters and counter timers, including Frequency Counters, Universal Counters, and Modulation Domain Counters. The breadth of the HP offering allows the best product to be selected for each application, and delivers the most cost effective solution.

Modulation Domain and Time Interval Analyzers
Universal
High Performance RF and Universal
Universal Time-Interval
CW Microwave Frequency
CW Microwave Counter with Power Measurement
Pulse/CW Microwave

Digital Multimeters/Digital Voltmeters Hewlett-Packard offers a range of products from 3½ all the way to 8½ digits, up to 8 ppm basic dc volts accuracy, down to 100 pV and 100 nΩ, up to 100,000 readings per second and change setups more than 340 times a second.

Low Cost 6½ Digital Multimeter
Nanovolt/Micro-ohm Meter
8½ Digital Multimeter
Handheld
Accessories

Data Acquisition and Switching

Low Cost Data Acquisition/ Switch Unit
Modules

Function Generators and Waveform Synthesizers Hewlett-Packard not only offers standard functions like sine, square and triangle waveforms, but in addition, HP instruments address needs such as multichannel signals, arbitrary waveforms, or even a mix of arbitrary and digital signals.

1 MHz to 21 MHz Synthesizers and Function/Sweep Generators
Multi-functional Synthesizers
Universal Source
Function Arbitrary Waveform Generator

DC Electronic Loads

Electronic Load Family
Selection Index

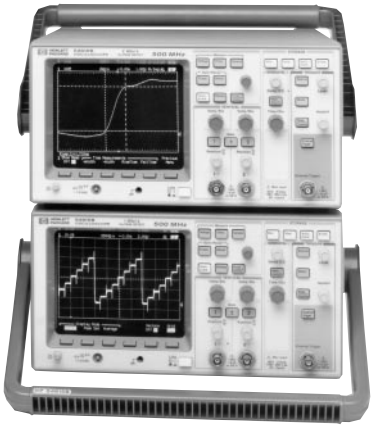
Power Supplies Hewlett-Packard offers a broad line of modular, precision, measurement, dynamic measurement, single and multiple output, general purpose, and system, as well as autoranging capability.

Modular
Dynamic Measurement Single-Output System
Precision Measurement Single-Output System
Multiple-Output System
Precision Measurement Single-Output
Single-Output Systems
Autoranging
Single and Multiple Output
Laboratory

Harmonic/Flicker Test Systems

AC Source Analyzers

AC Power Source Analyzers
Graphical User Interface

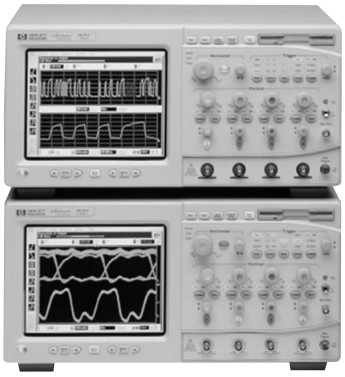


HP 54600-Series Oscilloscope

- High Value General Purpose Oscilloscope
- Up to 500 MHz Bandwidth, 2 GSa/s Sample Rate
- Power of Digital with the Feel of Analog
- Megazoom Deep Memory Technology
- Mixed Signal Capability

	Bandwidth	No. of Chan.	Sample Rate	Memory Depth
HP 54603B	60 MHz	2	20 MSa/s	4000 points
HP 54600B	100 MHz	2	20 MSa/s	4000 points
HP 54602B	150 MHz	(2 + 2)	20 MSa/s	4000 points
HP 54645A	100 MHz	2	200 MSa/s	1 M points
HP 54645D	100 MHz	2 + 16	200 MSa/s	1 M points
HP 54610B	500 MHz	2	20 MSa/s	4000 points
HP 54615B	500 MHz	2	1 GSa/s	5000 points
HP 54616B	500 MHz	2	2 GSa/s	5000 points
HP 54616C	500 MHz	2	2 GSa/s	5000 points

For more information on the HP 54600-series troubleshooting scopes, see page 93.

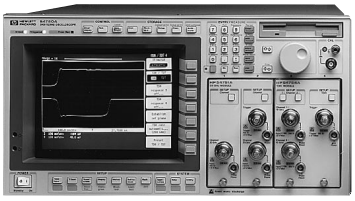


HP Infinium Digitizing Oscilloscope

- High Performance, Low Frustration Oscilloscope
- 500 MHz to 1.5 GHz Bandwidth with up to 8 GSa/s Sample Rate
- Analog-like Front Panel for Simple Troubleshooting
- Easy Access to Advanced Features Through Windows 95® Based Graphical User Interface
- Built-in Information System and Measurement Expertise

Model	Bandwidth	No. of Chan.	Sample Rate	Memory Depth
HP 54810A	500 MHz	2	1 GSa/s	32K
HP 54815A	500 MHz	4	1 GSa/s	32K
HP 54820A	500 MHz	2	2 GSa/s	32K
HP 54825A	500 MHz	4	2 GSa/s	32K
HP 54845A	1.5 GHz	4	8 GSa/s (2 ch. mode) 4 GSa/s (2 ch. mode)	64K (2 ch. mode) 32K (4 ch. mode)

For more information on the Infinium family of digitizing scopes, see page 106.



HP 54700-Series Digitizing Oscilloscope

- High Bandwidth, High Accuracy Oscilloscope
- 12 to 50 GHz Bandwidth
- Rich Set of Features and Measurements
- Single Ended and Differential TDR

	Bandwidth	No. of Chan.	Sample Rate	Memory Depth
HP 54750A	12.5 GHz to 50 GHz	2 or 4	N/A	4 K points

For more information on the HP 54700-series digitizing scopes, see page 103.

Can You Use This Scope Easily?

When choosing an oscilloscope, one of the critical issues is, "How much effort is it to learn to set up, use, and troubleshoot?"

Making Oscilloscopes Easy To Use—What To Look For?

Today's digitizing oscilloscopes have great power and enhanced capabilities. At the same time, features that look good on the specification sheet are not beneficial if you can't really use them conveniently.

Making scopes easy to learn and use has been a major focus for HP, and the results are products that let you spend more time on your test and less on the instrument doing it. "Ease-of-use," however, is one factor that can only be really evaluated with a hands-on trial at your location. In addition, we think that there are some standard questions and issues which are specific to oscilloscopes which tend to define ease-of-use. We invite you to use our ideas in your comparisons to judge for yourself.

- Adjustment – When you adjust a knob, does the scope respond quickly? How about with the measurement features turned on, or Deep Memory enabled?
- Display quality – As your primary interface, does the display show the signal clearly and accurately?
- Find and Use Features – Is it easy to find and use the features you need, or do you have to relearn the scope's operation for each measurement?
- Help Available – Is help readily available when you can't figure something out?

When the decision is made, the scope will be one of your primary tools for a long time, and we want to help you find the one that's right for you.

10 Steps To Selecting The Right Oscilloscope

Since its introduction, the oscilloscope has been one of the most important and most used test and measurement tools. Its capabilities have grown and changed along with electronics technology, and today there are now a multitude of variations in performance and price. As a result, selecting the right one is an important task that can be time-consuming and confusing.

The steps outlined here are intended to speed your selection process and help you avoid possible pitfalls. Whether it's an HP scope or one from another vendor, following this process will help you make sure you end up with the right scope for your needs. A more detailed verstion of this process is available; call HP DIRECT at 1-800-482-4844, or look at the HP T&M website (www.tmo.hp.com/tmo) for more information.

1 Analog or Digital?
Analog scopes have familiar front panel controls and are often considered "easy to use." Digitizing oscilloscopes feature a wide range of functionality which cannot be obtained with an analog scope, and recent advances in user interfaces have greatly enhanced usability. As analog-to-digital converters get faster and less expensive with every passing year, the advantage balance continually tilts further toward the digitizing scope, with its increased measurement capabilities and virtually unlimited functionality. Like many T&M manufacturers, HP offers only digitizing scopes.

2 How Much Bandwidth?
Scope bandwidth is typically defined as the frequency above which a sine wave's amplitude is degraded by more than 3 dB. Trying to look at a signal that's too fast for a scope's bandwidth will introduce errors in amplitude and/or time-interval measurements.

There are two types of bandwidth: repetitive (or equivalent time) bandwidth, and real-time (or single-shot) bandwidth. Repetitive bandwidth applies only to repetitive signals, and the display is built up from samples taken during multiple signal acquisitions. Repetitive bandwidth should typically be at least three times greater than the bandwidth of the signals you want to measure. You can estimate non-sinusoidal bandwidth by the equation **BW=0.35/your signal's fastest rise-time.** Real-time bandwidth is the highest frequency a scope can capture in a single acquisition, and is critical when capturing events that occur infrequently. Real-time bandwidth is tied to sample rate, so if real-time bandwidth is important to you, look carefully at "Sample Rate" in Step 3.

Since more bandwidth usually means more money, you'll want to evaluate the frequency content of the signals you usually view against your budget.

3 How Much Sampling Speed ?
There are basically two types of signals you may want to view with a scope: those that occur repetitively and those that happen infrequently. For repetitive waveforms, a scope can either take all the samples in that occurrence (real-time sampling), or take a few samples each time the waveform occurs and combine the samples into a single picture (repetitive sampling). Infrequently occuring events require the scope to capture enough information on a single occurrence of the trigger to accurately represent the waveform. Here's a useful rule of thumb when comparing sample rate and signal bandwidth: if the scope you're looking at has interpolation (filtering to allow reconstruction between sample points), the sample rate/signal BS ratio should be at least 4:1. Without interpolation, use a ratio of 10:1.

4 How Many Channels?
The number of channels you need depends on your application. Two channel scopes are popular for economical general-purpose troubleshooting. However, if you need to view the relationship of several analog signals you'll want a four channel instrument. Many engineers working on systems with both analog and digital signals also consider four channel scopes. Another newer option, called a mixed-signal oscilloscope, combines the channel count and triggering power of a logic analyzer with the greater resolution of an oscilloscope in a single instrument with a time-correlated display.

5 How Much Memory Depth?
Memory depth is a measure of how many samples the scope can store. If you need to capture a pulse train without interruption, you'll need a scope with enough memory to capture the whole thing. You can calculate the memory depth you need by dividing the length of time you want to capture by the sample rate needed to reproduce the signal accurately.

Effective triggering, so you capture your signal at the right place, can often reduce the amount of memory your scope really needs. It is also important to understand that deep memory digitizing oscilloscopes are typically more complex to operate. Hewlett-Packard has recently introduced a scope (HP 54645 A/D [see page 90]) that combines ease-of-use and deep memory for many 100 MHz applications. For higher bandwidth measurements, you'll want to clearly understand possible trade-off between memory depth and ease-of-use.

Memory depth and sampling rate are intimately related. The memory depth you need depends on the overall time span you need to measure and the time resolution you require. Deep memory instruments are more complex to operate because the user must chose the memory depth that reduces "dead time" needed to fill up the extra memory, or display changing signals inaccurately.

6 What Kind of Triggering Do I Need?
Many general-purpose scope users get by using edge triggering alone. You may find it helpful in some applications, mainly in troubleshooting new designs, to have additional triggering power. Advanced triggering allows you to isolate events of interest to apply the sampling rate and memory depth most efficiently.

In digital applications, it is very helpful to trigger on a specific pattern across channels. In addition, state triggering allows you to sync up you pattern trigger to a clock edge. "Glitch" triggering allows you to trigger on a positive- or negative-going "glitch" or extremely narrow pulse. Other trigger capabilities are often available, and it is important to ask how easy they are to set up and use.

7 Can You Find Those Elusive Anomalies?
Three primary factors affect a scope's ability to display the unknown and complex signals that you encounter in your daily testing and debugging: screen update rate, peak detect, and triggering power (discussed in Step 6).

Update rate gives you an idea of how quickly your scope can respond to signal and control changes, while peak detect helps you capture fast signal peaks in slower signals. Your best bet is to see the scope performing on YOUR signals and view the update rate and peak detect in action, making sure these features aren't compromised by lack of flexibility in other areas.

8 Determine the Analysis Functions You Need
One of the greatest advantages of digitizing oscilloscopes is that they have the abiltiy to make measurements on acquired data and to perform various analysis functions at the touch of a button. The features available vary from vendor to vendor and model to model, but they typically include measurements like frequency, rise time, pulse width and more. Some digitizing oscilloscopes offer Fast Fourier Transform (FFT) capability as well, often at extra cost.

9 What About Probing?
It is easy to forget that the probe becomes part of the circuit as soon as it is attached. As a result it introduces resistive, capacitive, and inductive loading, that can cause to scope to show a different measurement than is actually occuring in the unit under test. The goal, therefore, is to have appropriate probes available for different applications and then choose one that will minimize the loading effects, and allows the most accurate replication of the signal.

10 Can You Use This Scope Easily?
It's pretty obvious—if you can't access the features, or spend too much time learning them, your scope becomes less valuable. Because of this, you'll find detailed thoughts on this on the previous page.

HP 54600B
HP 54602B
HP 54603B
HP 54610B
HP 54615B
HP 54616B
HP 54616C
HP 54645A
HP 54645D

Hewlett-Packard Digitizing Oscilloscopes

Here's a closer look at all of HP's oscilloscopes, from responsive troubleshooting scopes to high-speed, high-performance design tools. Use this table to make a detailed comparison. For more information on a specific product, turn to the page indicated. (Note that the HP 54750A is a modular scope, and specific capabilities depend on the configuration you choose. Please see page 103 for more information.)

General Specifications Chart for HP Digitizing Oscilloscopes

	HP 54603B HP 54600B	**HP 54602B**	**HP 54645A HP 54645D**	**HP 54610B**	**HP 54615B HP 54616B/C**
Bandwidth Repetitive Real time	60 MHz (54603B) 100 MHz (54600B) 2 MHz	150 MHz 2 MHz	100 MHz 20 MHz	500 MHz 2 MHz	500 MHz 250 MHz (54615B) 500 MHz (54616B/C)
Channels	2	4 (2 + 2)	2 (54645A) 2 + 16 (54645D)	2	2
Time interval accuracy (best case) Repetitive Real time	± 100 ps N/A	± 100 ps N/A	± 40 ps N/A	± 100 ps N/A	± 20 ps N/A
Digitizing rate	20 MSa/s	20 MSa/s	200 MSa/s	20 MSa/s	1 GSa/s 2 GSa/s (54616B/C)
Memory/channel	4K samples	4K samples	1M samples	4K samples	5K samples
Vertical resolution	8 bits				
Input voltage ranges (1:1 probe)	2 mV/div to 5 V/div (HP 54602B and HP 54645A: 1 mV/div to 5 V/div)				
Input Z, coupling	1 MΩ, ac, dc, ground	50 Ω, 1 MΩ, ac, dc, ground			
Pulse parameter measurements	Yes				
Waveform math	1 + 2, 1–2, XZ, invert; optional 1 x 2, FFT, differentiate, integrate				
Other analysis functions	Autostore, peak detect, averaging				
Waveform storage	2 pixel (additional memories with optional module)				
Trigger enhancements	Edge, autolevel, HF/LF reject, noise reject, TV field and line; HP 54610B includes trigger view; HP 54645A includes glitch trigger				
Hard copy and disk support	HP printers and plotters, Epson-compatible printers, Centronics printers				
Other	Fast update rate, delayed sweep, roll mode, HP-IB and RS-232 I/O options, optional test and benchtop automation modules. HP 54645A includes MegaZoom memory which enables background acquisition plus easy pan and zoom of 1 million samples.				
For more information, order publication number	5964-9339EUS	5964-9339EUS	5964-9630EUS (54645A) 5964-9634EUS (54645D)	5964-9339EUS	5964-9338EUS and 5964-9339EUS
	HP 54603B: HP 54600B:	HP 54602B:	HP 54645A: HP 54645D:	HP 54610B:	HP 54615B: HP 54616B: HP 54616C:
For more catalog info.	Page 93	Page 93	Page 90	Page 93	Page 93

General Specifications Chart for HP Digitizing Oscilloscopes

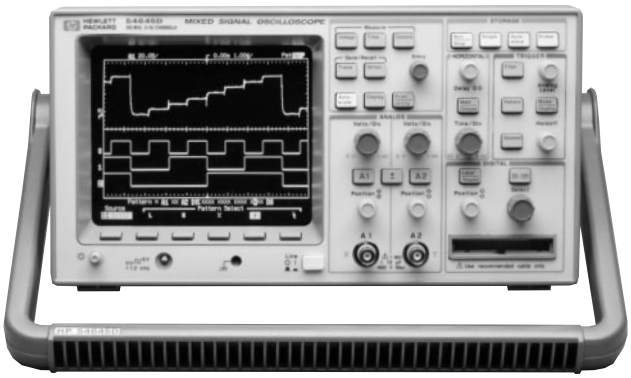
	HP 54810A, 54815A, 54820A, 54825A	HP 54845A	HP 54750A
Bandwidth	500 MHz	50 Ω: 1.5 GHz 1 MΩ: 500 MHz	50 GHz/20 GHz/12.4 GHz
Channels	HP 54810A/20A: 2 (simultaneous acquisition) HP 54815A/25A: 4 (simultaneous acquisition)	4 (simultaneous acquisition)	2 or 4, depending on plug-ins
Time interval accuracy (best case) Equivalent time Real time	 ± 60 ps HP 54810A/54815A: ± 200 ps HP 54820A/54825A: ± 100 ps	 ± 30 ps ± 25 ps	 ±5 ps N/A
Digitizing rate	HP 54810A/15A: 1 Gsa/s on each channel HP 54820A/25A: 2 Gsa/s on each channel	2 channel mode: 8 Gsa/s 4 channel mode: 4 Gsa/s	N/A
Memory/channel	32K	2 channel mode: 64K 4 channel mode: 32K	4K samples
Vertical resolution	8 bits; 12 bits with averaging		11 bits, 15 bits with averaging
Input voltage ranges	1 mV/div to 5 V / div	1 MΩ: 2 mV/div to 2 V/div 50 Ω: 2 mV/div to 1 V/div	1 to 100 mV/div
Input Z, coupling	50 Ω, 1 MΩ, dc, ac (7 Hz, available in 1 MΩ only), ground		50 Ω
Pulse parameter measurements	Yes		Yes
Waveform math	4 functions F1–F4. Select from Add, Subtract, Multiply, Divide, Invert, Magnify, Vs., Min., Max., Integrate, Differentiate, FFT Magnitude		+, –, ÷, X, A vs. B, integrate, differentiate, min, max, magnify, invert, FFT, histogram
Other analysis functions	Peak detect, dual density infinite persistence, variable persistence.		Variable and infinite persistence, averaging, digital BW limit, color-graded display
Waveform storage	4 nonvolatile waveform memories; setups, waveforms, and screen images can be stored to both the floppy drive and the internal 1.4 Gbyte hard drive. Storage to hard drive limited by space only.		1 pixel, 4 waveform, and floppy disk
Trigger enhancements	Edge, glitch, pattern, state, delay by time, delay by events, violation (runt, setup/hold time, pulse width, transition), video, line		2.5 GHz edge trigger, 18 GHz with HP 54118A
Hard copy and disk support	Supports all printers and plotters compatible with Windows 95. Setups, waveforms, and screen images can be stored to both the floppy drive and the internal 1.4 Gbyte hard drive. Storage to hard drive limited by space only.		HP printers, Epson printers, built-in 3.5-inch flexible disk, and HP-IB and Centronics interfaces
Other	Built-in measurement assistance, frustration-reducing analog-like front panel and Windows 95-based graphical user interface with mouse. Large 8.4-inch color active matrix LCD display with fast update rate, full color control. Optional keyboard, alternate pointing devices.		TDR/TDT, built-in eye diagram parametric measurements
For more information	Order publication 5965-5264EUS or visit our website (http://www.hp.com/info/infinium)		HP 5962-0097E
	HP 54810A: HP 54820A:	HP 54815A: HP 54825A:	HP 54845A:
For more catalog info.	Page 106		Page 103

Need more information?

If you'd like to learn more about any of these scopes, call your HP field engineer or one of the engineers at HP DIRECT. Our instrumentation specialists are ready to discuss your application and help you find the right scope for your unique needs. Please see page 604 for a full directory of product and application literature available from Hewlett-Packard.

HP 54645D

- Dual-channel 100 MHz scope with 200 MSa/s
- 1 MB of memory per channel
- 16 logic timing channels with 400 MSa/s on 8 channels and 200 MSa/s on 16 channels
- MegaZoom technology for easy-to-use and responsive deep memory
- Simple easy-to-use controls
- Powerful triggering



New Mixed-Signal Testing Power

With the introduction of the HP 54645D mixed-signal oscilloscope (MSO) to your lab, you will be able to easily view the complex relationships of your circuit's analog and digital operation. On one display you will have both the analog circuit operation displayed on the HP 54645D MSO's 100 MHz oscilloscope channels and the logic timing displayed on up to 16 logic channels. Analog and digital events are aligned in time so that you can easily relate cause and effect in difficult mixed-signal troubleshooting situations.

HP MegaZoom Technology

Often in mixed-signal systems, the events of interest either take place over a long time span or they are widely separated from the trigger event. With 1 million samples per channel, MegaZoom technology captures long time spans with high sampling speed, allowing you to see the fine detail needed to solve elusive mixed-signal problems.

Before the introduction of the HP 54645D MSO with MegaZoom technology, deep-memory oscilloscopes were considered specialized tools because of their complex operation, non-responsive control panel, and excessive display dead time. These problems have been overcome with the development of MegaZoom technology which uses multiple processors optimized for the task of waveform acquisition, storage and display. Now, because of MegaZoom technology, you can have a deep-memory scope in your lab that is the scope that you will use every day. MegaZoom technology gives you a deep-memory scope that responds instantly to your control inputs, has a high speed, low dead time display and has deep memory with easy-to-use pan-and-zoom. MegaZoom isn't a special mode that you must stop and select—it is operating for you all the time.

Seamless Integration of Logic Channels into an Oscilloscope

Seamless integration of scope and logic channels in the HP 54645D MSO gives you an oscilloscope-like operation of both the scope and logic channels. For example, simply turn the time base knob to set the time/division for all scope and logic channels. Seamless integration allows you to set up a trigger edge, glitch or a pattern of high, low, and don't-care levels across any or all of the MSO's 18 input channels. There is no scope-logic mode switch. You don't have to think about the block diagram of the HP 54645D MSO to effectively apply it in your lab.

Powerful Triggering

The HP 54645D MSO provides the triggering power you need to solve your toughest mixed-signal problems in an easy-to-use control system. You no longer need to regulate powerful triggering features such as pattern and glitch to special situations. Because the MSO is an oscilloscope, you will find it ideally suited for everyday use with its simple edge triggering. This is the familiar scope triggering mode and it is the one that will solve most of your problems. You can trigger on a rising or falling edge on any of the MSO's 18 input channels.

Pattern triggering is provided to allow you to set up a pattern of high, low and don't-care levels across any or all of the MSO's 18 channels. In the scope channels, the threshold which determines high or low levels is the scope trigger level.

The advanced triggering gives you a choice of glitch, advanced pattern, or TV triggering. In the glitch mode, the HP 54645D MSO will search for a glitch that is less than a specified width on any of its 18 channels. In addition, you can search for a pulse that is greater than a specified width or within upper and lower limits.

In advanced pattern mode, the HP 54645D MSO uses two trigger patterns and two edge terms. These terms may be combined in one of several Boolean relationships (AND, OR, and THEN). In addition, you may establish trigger qualifiers such as entered, exited, and duration.

The HP 54600 Product Line

The HP 54645D mixed-signal oscilloscope is a member of the popular HP 54600 series of general-purpose scopes. As such, this powerful scope is rugged and built to the same environmental specifications as the other members of this popular scope line. The HP 54645D uses the same interface modules for connecting to printers and computers. BenchLink Scope provides easy interface to your PC.

Other Mixed-Signal Solutions

For those applications where a higher bandwidth scope or a full featured logic analyzer is needed, HP provides additional mixed-signal test solutions. The HP 54620A/C logic analyzer is designed to be used with an oscilloscope. This logic analyzer is very scope-like in its operation and is an ideal companion to your scope. This combination of scope and logic analyzer is very useful in applications requiring more than 100 MHz scope performance. Mixed-signal applications based on a bus-based microprocessor will need the additional capabilities of a full-featured logic analyzer. For these applications, one of the HP 1660 series of logic analyzers can be teamed with the HP 54645A dual-channel oscilloscope with MegaZoom technology or the HP 54645D mixed-signal oscilloscope.

Specifications

Vertical System

Scope Channels: Ch. 1 and Ch. 2
Bandwidth (3dB)**:** dc to100 MHz @ ≥ 10 mv/div (> 75 Mhz @ < 10 mv/div)
ac Coupled: 1.5 Hz to 100 MHz
Rise Time (calculated)**:** ~ 3.5 ns @ > 10 mv/div (< 4.6 ns @ < 10 mv/div)
Dynamic Input Range: ± 32 V or ± 8 div, whichever is less
Math Functions: Ch. 1 ± Ch. 2
Input Resistance: 1 Mohm
Input Capacitance: ~13pF
Maximum Input: 400 V (dc + peak ac)
Range: 1 mV/div to 5 V/div
Accuracy: ± 1.5% FS
Vernier: Fully calibrated, accuracy ± 3% FS
Single-Cursor Accuracy: Vertical gain accuracy ± 1% of full scale; ± 0.5% of position value
Dual-Cursor Accuracy: Vertical gain ± 0.8% of full scale
BW Limit: Approx. 20 MHz
Coupling: ac, dc, GND
Channel Isolation: dc to 20 MHz > 40 dB (with channels at same v/div); 20 MHz to 100 MHz > 30 dB
Inversion: Ch. 1 and Ch. 2

Logic Channels

16 channels (0-15) **in two pods of 8 channels each**
Maximum Input Voltage: ± 40 volts peak
Threshold Range: ± 6.0 volts in 50 mV increments
Threshold Accuracy: ± (100 mV + 3% of threshold setting)
Input Dynamic Range: ± 10 volts about threshold
Minimum Input Voltage Overdrive: To meet the timing specifications, the threshold value must be within 20% of the 50% voltage point of the input signal
Minimum Input Voltage Swing: 500 mV peak-to-peak
Input Resistance: 100 K Ω
Input Capacitance: ~ 8 pF
Channel-to-Channel Skew: 2 ns typical, 3 ns max.
Pre-Defined Thresholds: TTL = 1.4 V, CMOS = 2.5 V, ECL = –1.3 V

Horizontal System, Scope and Logic Channels

Sweep Speeds: 50 s/div to 5 ns/div main and delayed
Accuracy: ± 0.01%
Vernier: Accuracy = ± 0.05%
Horizontal Resolution: 40 ps

Scope Cursor Accuracy

Single Channel: Horizontal accuracy ± 0.2% screen width ± 40 ps
Dual Channel: Horizontal accuracy ± 0.2% of % screen width ± 80 ps

Logic Cursor Accuracy

Single Channel: Horizontal accuracy ± 0.2% of screen width ± 1 logic sample period
Dual Channel: Horizontal accuracy ± 0.2% of screen width ± 1 logic sample period ± channel-to-channel skew
Delay Jitter: < 10 ppm

Delay Range

Pre-Trigger (negative delay)**:** At least 1 screen width or 2.5 msec
Post-Trigger (from trigger point to end of sweep)**:** 500 seconds

Delayed Sweep

Delayed timebase can be as fast as 5 nsec/div. but must be at least 2X the main timebase. Delayed sweep display is the same data acquisition as was the main.
HP MegaZoom Technology (post-acquisition pan and zoom)**:** The time/div and delay controls allow any part of the acquired waveform display to be expanded to the full extent of the memory available.

Trigger System

Modes: Auto, Autolevel, and Normal
Holdoff: ~ 200 ns to ~ 25 seconds
Edge Triggering: Rising or falling on any of the 18 input channels
Pattern Triggering: A pattern of high, low, and don't-care levels and a rising or falling edge can be established across all 18 channels. The analog channel's high level is defined by that channel's trigger level.
Advanced Triggering: Selectable as glitch, advanced pattern, or TV
Glitch: Less than, greater than, or within specified range
Source: Any of the 18 input channels
Polarity: Rising or falling
Minimum Pulse Width Setting: 8 ns
Advanced Pattern: Up to two trigger terms (P1 and P2) and two edge terms (E1 and E2) may be established and these terms can be combined as follows: AND, OR, THEN, Entered, Exited, Duration <, Duration >, and Duration range
TV: Available on scope channels only
TV Line and Field: 0.5 divisions of composite sync required for stable display

Oscilloscope Analog Triggering

Sensitivity: DC to 25 MHz > 10 mV/div ≤ 0.35 div or 3.5 mV;
< 10 mV/div ≤ 1 div or 2 mV;
25 MHz to 100 MHz > 10 mV/div ≤ 1 div or 10 mV;
< 10 mV/div, ≤ 1.5 div or 3 mV
Sources: Ch. 1, Ch. 2, and line

Coupling

dc, ac, HF reject, LF reject, noise reject, HF reject and LF reject –3dB @ 50 kHz

XY

Bandwidth: 100 MHz
Phase Error @ 1 MHz: 1.8 degrees

Acquisition System

Maximum Display Rate: 3 million samples per second with sufficient trigger rate, and vectors off. 60 full screens per second, vectors on.
Average: Selectable as smoothing, 4, 8, 16, 32, 64, 128, and 256 averages
Roll Mode: At sweep speeds of 200 ms/div and slower, data moves across the display from right to left with no dead time

Oscilloscope Acquisition System

Maximum Sampling Rate: 200 MSa/s on each channel
Single-Shot Bandwidth: 50 MHz
Simultaneous capture on both channels
Vertical Resolution: 8 bits
Peak Detection: Can capture and display a pulse at least 5 nsec wide at any timebase setting
Maximum Memory Depth: 1 MB samples per channel

HP 54645D

Logic Acquisition System

Vertical Resolution: 1 bit
Maximum Sampling Rate: 400 MSa/s on one pod, 200 MSa/s on two pods
Simultaneous capture on all channels
Peak Detection: Will capture and display a pulse at least 5 nsec wide at any time base setting
Maximum Memory Depth: 2 MB samples per channel on one pod, 1 MB samples when both pods are used

Display System

Display: 7-inch raster monochrome CRT
Resolution: 255 vertical by 500 horizontal points
Controls: Front-panel intensity
Vectors: Selectable on/off
Graticle: 8 x 10 grid, frame, and none

Advanced Features

Automatic Measurements: Measurements are continuously updated, markers indicate measurement
Voltage: V_{AVG} (dc), V_{RMS}, V_{PP}, V_{MIN}, and V_{MAX}
Time: Frequency, period, + pulse width, –pulse width, duty cycle, rise time and fall time (rise time and fall time are scope only)
Cursors: Manually- or automatically-placed readout of time, 1/time, voltage. Additionally, logic channels can be displayed as binary or hex values.

Setup Functions

Autoscale: Finds and displays all active scope and logic channels, sets edge trigger mode on highest numbered channel, sets vertical sensitivity on scope channels and thresholds on logic channels, time base to display 1.8 periods
Save/Recall (non-volatile)**:** 10 set-ups can be saved and recalled from non-volatile memory
Trace Trace (pixel) **Memory:** 2 volatile
User-Defined Channel Labels: All channels may be assigned a user-defined label of up to 6 characters. Labels displayed in place of first division of waveform.

General

Please refer to HP 54600 Series specifications on page 99.

Ordering Information

HP 54645D Mixed-Signal Oscilloscope
Accessories supplied: Two each HP10074A 10:1 divider probes with readout, 16-channel logic input probe assembly, removable front panel ground connector, user's guide and service manual, power cord
- **Opt 001:** RS-03 Magnetic Interference shielding added to the CRT
- **Opt 002:** RE-02 Display Shield added to the CRT to reduce radiated interference
- **Opt 101:** HP 10098A Front-panel Cover and Pouch Kit
- **Opt 103:** HP 54654A Customer Training Kit
- **Opt 104:** HP 1185A Carrying Case
- **Opt 106:** HP 34810B HP BenchLink Scope Software
- **Opt 1CM:** HP 5062-7345 Rackmount Kit
- **Opt W50:** Additional two years of warranty

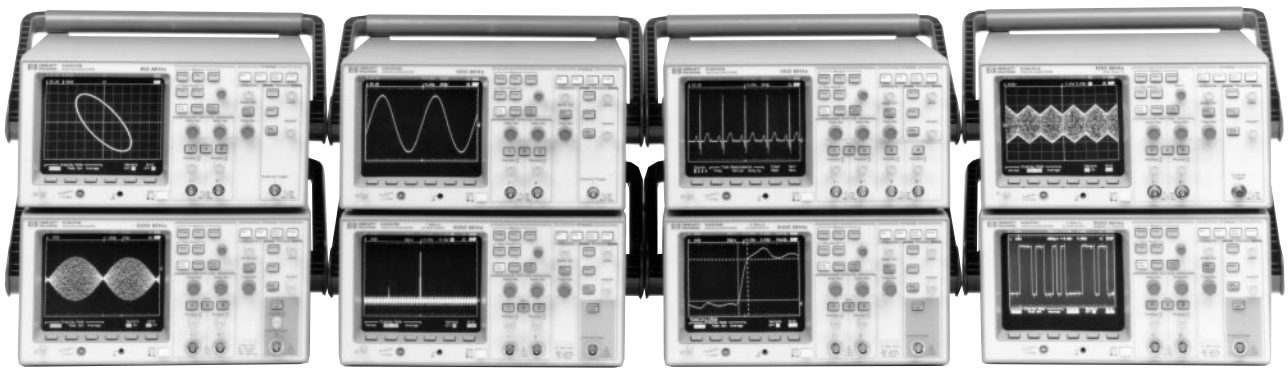
Accessories
HP 10074A: 10X Probe with Readout
HP 10070A: 1X Probe

See the MSO in Action

To see the HP 54645D mixed signal oscilloscope in action and for answers to any questions you might have, call your local HP sales and service and request a free copy of the product presentation CD ROM, or visit our website (http://www.hp.com/info/mixsig1).

Part Number 5964-9538E (international)
Part Number 5964-9538 EUS (USA version)

- Analog look and feel
- 1 Meg of memory (HP 54645A)
- Automatic and cursor-based measurements of frequency, time, and voltage
- Up to 2 GSa/s sample rates
- Glitch detection
- Add-on interface and enhancement modules for hard copy, remote programming, and FFT



HP 54600 Family of Oscilloscopes

The HP 54600 family of oscilloscopes offers you the comfortable feel of analog scopes and the measurement power of digital scopes, all at a price you can afford. This family of oscilloscopes gives you the ability to view waveforms you can't see with your analog scope, and they provide the familiar controls and interactive displays you've grown accustomed to. To solve your most difficult test problems, these scopes provide powerful digital features, such as pre-trigger viewing, peak detect, waveform storage, and measurement automation.

This combination of analog feel and digital power enhances your troubleshooting ability. You can expect bright, crisp displays of your most demanding signals at all sweep speeds and delayed sweep magnifications. Storage for glitch and transient analysis is as simple as pressing a button. Pre-trigger viewing lets you view events that an analog scope would miss.

This class of oscilloscopes, made possible through HP's advanced integrated circuit technology, presents this power in a small, lightweight package and at a price that fits your budget. The display update rate of up to one and a half million points per second provides a display with unprecedented interactivity. For example, amplitude-modulated waveforms and other rapidly changing signals are shown onscreen with the detail and fidelity you expect.

Enhanced Modules for Add-On Flexibility Now and in the Future

HP 54600 series interface and enhancement modules increase the capabilities of the HP 54600 series scopes. When one of these modules is attached to the back of an HP 54600 series scope, features like FFTs, remote programming via RS-232 or HP-IB, unattended waveform monitoring and hard copy can all be added. Please see page 96 for more details.

Eight Models: One Is Right for You

With eight models to choose from, you will be able to pick the oscilloscope that best meets your measurement and troubleshooting needs while meeting the constraints of your budget. The dual-channel 60 MHz HP 54603B is ideally suited for classroom use and other situations where budgets are tight. The HP 54600B offers dual-channel 100 MHz performance for field service and production test applications. With its 150 MHz bandwidth, 1 mV/division sensitivity, and triggering to 250 MHz, the HP 54602B is the "lab quality" general-purpose scope for your bench today, and in the years to come.

The HP 54610B may the lowest priced 500 MHz oscilloscope on the market, but it does not compromise on measurement quality. The HP 54615B boosts the sample rate to 1 GSa/s while preserving the intuitive analog feel and instantaneous response, common in all the members of the HP 54600 family. At the top of the HP 54600 line, the HP 54616B (monochrome) and the HP 54616C (color) provide 500 MHz bandwidth and 2 GSa/s sample rate. The HP 54645A, 100 MHz MegaZoom oscilloscope, brings deep memory to the family. MegaZoom technology makes using the one megabyte of memory effortless.

Model	Bandwidth	Channels	Sensitivity	Maximum Sample Rate
54603B	60 MHz	2	2 mV to 5 V/div.	20 MSa/s
54600B	100 MHz	2	2 mV to 5 V/div.	20 MSa/s
54645A	100 MHz	2	1 mV to 5 V/div.	200 MSa/s
54602B	150 MHz	4 (2 + 2)	1 mV to 5 V/div.	20 MSa/s
54610B	500 MHz	2	2 mV to 5 V/div.	20 MSa/s
54615B/	500 MHz	2	2 mV to 5 V/div.	1 GSa/s
54616B/C	500 MHz	2	2 mV to 5 V/div.	2 GSa/s

If you need more details, please refer to the Performance Characteristics on page 98.

Oscilloscopes

General Purpose and Troubleshooting

HP 54600B
HP 54602B
HP 54603B
HP 54645A

- 60 MHz to 150 MHz Bandwidths
- Fast update rates
- Analog look and feel
- 1 Meg of memory (HP 54645A)

HP 54602B, 150 MHz Oscilloscope

The HP 54602B is a powerful general-purpose scope, with four channels, and 1 mv/div sensitivity.

Key Features

- 4 channels (2 + 2), two 150 MHz full feature and two 250 MHz limited attenuation channels
- 1 mV/div to 5 V/div sensitivity
- 4K memory
- Responsive front-panel controls
- High screen-update rate, 1.5 million points/second

HP 54600B, 100 MHz Oscilloscope

The HP 54600B is ideal for production test, field service and education—anywhere you need a solid, dependable, general-purpose scope at a low price.

Key Features

- 100 MHz bandwidth
- 2 channels
- 4K memory
- 2 ns to 5 s/division timebase

HP 54603B, 60 MHz Oscilloscope

Even with tight budget restrictions, the HP 54603B delivers the features and performance of an HP oscilloscope. For colleges and universities, this scope is a great way to introduce students to the world of professional test equipment.

Key Features

- 60 MHz bandwidth
- 2 channels
- 4K memory
- 5 ns to 5 s/division timebase
- 7-inch raster CRT

HP 54645A, 100 MHz MegaZoom Oscilloscope

The HP 54645A is no ordinary 100 MHz oscilloscope. It may look and operate like the rest of the HP 54600 series but there is one big difference—it is running with a megabyte of memory.

Key Features

- 100 MHz bandwidth
- 200 MSa/s sample rate, on both channels
- 1 megabyte of memory, on both channels
- Fast screen-update rate, 3 million points/second
- 1 mv to 5 V/division vertical sensitivity
- 2 ns to 50 s/division timebase

HP 54645A MegaZoom Oscilloscope

The HP 54645A oscilloscope brings the advantages of deep memory with none of the disadvantages usually associated with this class of oscilloscopes. The HP 54645A is a dual channel 100 MHz oscilloscope with 200 MSa and a full 1 MB of memory behind each of its channels. Through the application of MegaZoom technology, this deep-memory oscilloscope has a high speed/low dead time display and a highly-responsive front panel. Unlike all other deep memory scopes which force the user to choose between fast response and deep memory, MegaZoom technology gives you a scope that is always fast and deep. Pan-and-zoom operation is as simple as turning the time/division knob. No special menus or controls are required to take full advantage of the HP 54645A's deep memory.

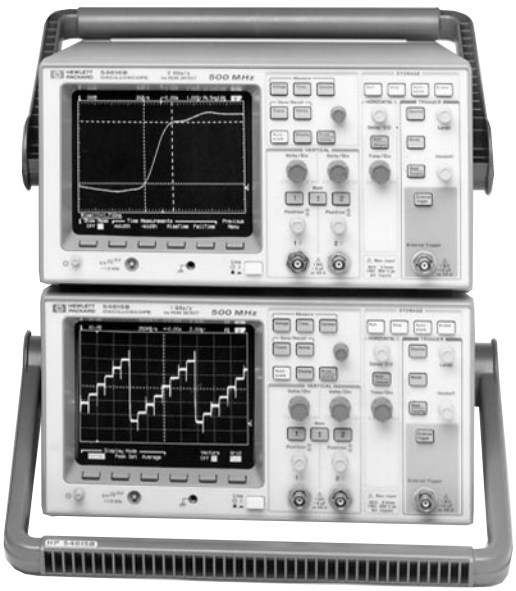
A powerful glitch trigger extends the power of MegaZoom technology in solving your toughest troubleshooting problems. Simply set up the desired pulse width that represents a worse case situation and after the scope finds it, pan and zoom through the deep waveform record to find out exactly what was going on in your circuit that caused the problem.

Multiple-Processor Architecture

HP uses a multiple-processor architecture in the HP 54600 series of oscilloscopes. This is one of the ways in which HP delivers ease of use, with a responsive high update-rate oscilloscope. The parallel processing utilized in the HP 54600 series allows acquisition and display systems of the oscilloscope to function independent of the human interface and measurement systems. This makes for a general-purpose troubleshooting scope that is responsive to changes in your waveform, as well as responding to changes initiated from the front panel.

- 500 MHz bandwidth
- Up to 2 GSa/s sample rates
- Fast update rates
- 500 MHz bandwidth
- Up to 2 GSa/s sample rates

HP 54610B
HP 54615B
HP 54616B
HP 54616C



The 500 MHz Members of the 54600 Series

There are four choices for 500 MHz general-purpose troubleshooting scopes. These scopes are designed with troubleshooting and debug in mind. Simple, responsive, direct-access controls coupled with a responsive display make debugging easy.

HP 54610B Oscilloscope

The HP 54610B is the lowest cost 500 MHz scope on the market today. It provides a high-quality 500 MHz scope for troubleshooting repetitive signals.

Key Features

- 500 MHz bandwidth
- Low cost
- 4K memory
- High display-update rate, 1.5 million points/second
- 1 MΩ/50 Ω selectable inputs

HP 54615B Oscilloscope

The HP 54615B is a 500 MHz scope with a 1 GSa/s sample rate. The 1 GSa/s sample rate allows the single-shot capture of phenomena up to 250 MHz.

Key Features

- 500 MHz bandwidth
- 250 MHz single shot
- 1 GSa/s sample rate, on both channels
- 1 ns peak detect, on all sweep speeds
- 5K memory
- Built-in power for HP active probes
- Fast screen-update rate, 0.5 million points/second
- 1 MΩ/50 Ω selectable inputs

HP 54616B/C Oscilloscope

The HP 54616B (monochrome) and the HP 54616C (color) offer the highest sample rate available in the HP 54600 series. At 2 GSa/s, these scopes can capture signals up to 500 MHz, single shot or repetitive. With features like 1 ns peak detect, 5K of memory, responsive display and 1 Meg or 50 ohm inputs, this scope will meet your troubleshooting needs today and in the future.

Key Features

- 500 MHz bandwidth
- 500 MHz single shot
- 2 GSa/s sample rate, on both channels
- 1 ns peak detect, on all sweep speeds
- Color (HP 54616C)
- 5K memory
- Built-in power for HP active probes
- Fast screen-update rate, 0.5 million points/second
- 1 MΩ/50Ω selectable inputs

1 ns Peak Detect

When activated, the peak detect of the HP 54515B and HP 54616B/C runs the samplers at no less than 1 GSa/s at all sweep speeds. HP's implementation of peak detect does not effect the bandwidth of the scope and is operational at all sweep speeds.

Powerful, Efficient and Compact

When you think about powerful 500 MHz digital scopes, the first thing that might come to mind is large and complicated. The HP 54600 family has four models that are neither, making them ideal troubleshooting and debugging oscilloscopes. These scopes are compact (can fit under a plane seat) and weigh under 15 pounds. They also retain some of the attributes that were valued in analog scopes. Knobs that allow direct access control of vertical and horizontal scaling and positioning are just one of the many features that make these scopes easy to use. High update rate and a real-time vector display respond instantly to changes in your waveform. This powerful combination will help you get answers fast.

- Hard-copy output to printer or plotter
- Remote instrument control
- Enhanced automatic measurements
- Extended trace storage, math operations, and FFT
- Unattended signal monitoring

A Full Family of Add-On Interface and Enhancement Modules

The HP 54600 series scopes use a complete range of optional interface modules for hard-copy output, remote programmability, and custom test functionality. These modules plug into the back of most HP 54600 series scopes, adding advanced capability to your general-purpose, trouble-shooting scope. You can create a measurement solution for your specific test needs. No other scope in its class can offer these capabilities—and the price is right.

HP 54650A HP-IB Interface Module

This module provides full remote control and hard-copy output to HP-IB printers and plotters. Programming is in accordance with IEEE-488.2. With the addition of this module, the oscilloscope's two trace memories become non-volatile.

HP 54652B RS-232/Parallel Interface Module

This module provides computer interface via RS-232 and printing via parallel in one module. The RS-232 interface also can be configured for printing when not being used for remote programming. With the addition of this module, the oscilloscope's two trace memories become non-volatile.

Hard copy output to HP's most popular printers

HP 54657A HP-IB and 54659B RS-232 and Parallel Measurement/Storage Modules

The HP 54657A and 54659B measurement/storage modules bring enhanced measurement and storage power to your HP 54600 scope. Added features include:

- FFT
- Up to 100 non-volatile trace memories
- New automatic measurements with user-defined levels
- New channel-to-channel delay and phase measurements
- Real-time clock for time- and date-tagging of hard copy and stored traces
- Unattended pass/fail signal monitoring

Automatic Measurements and Waveform Math

The measurement/storage module adds measurement capabilities such as:

- Amplitude, pulse overshoot and preshoot, delay, and phase angle
- 10%/90%, 20%/80%, and user-defined voltage thresholds for rise-time and fall-time measurements
- New measurement formats of percentage and phase angle
- Waveform multiplication, differentiation, and integration

Additional Trace Storage

The modules add three high-speed, non-volatile trace storage locations and 64K of trace memory to the HP 54600 scope. The modules use a data compression technique for trace memory storage, allowing you to save up to 96 additional waveforms, depending on trace complexity.

Unattended Signal Monitoring

The measurement/storage module simplifies circuit analysis and debugging by comparing your live signal to a test template you create. If the scope detects a failure, it can perform one of three tasks:

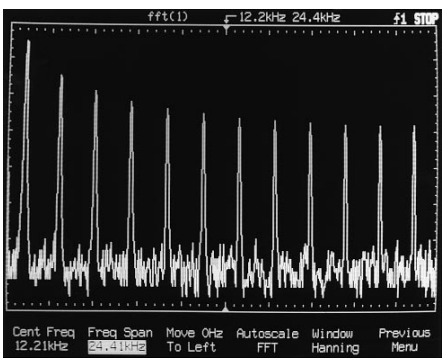
- Store the failing trace to memory, along with the time and date of the failure
- Print the trace (with time and date) on a printer
- Note the failure and maintain pass/fail statistics while continuing the test

Built-in mask generation and editing software make creating your test template simple. Once your mask and test are created, you can leave them in the module's non-volatile memory or store it to a PC with HP BenchLink software. This capability lets you easily run tests to characterize your circuits, whether for a short time or many days. You can even use the measurement/storage module in conjunction with a PC for enhanced throughput and to take advantage of the automatic measurements.

FFT—A New Measurement Dimension

The measurement/storage module now has the ability to give you frequency information for your input waveforms. Fast Fourier Transform (FFT) capability allows you to find and identify unusual waveform frequency components. FFT also allows you to check the fidelity of your signal or compare it to other similar-looking waveforms. The FFT autoscale function simplifies frequency domain set-up.

The measurement/storage module's FFT capability includes frequency and amplitude cursors (with both dBm and dBv scaling), which let you make quick, accurate measurements. Choose between Hanning, flat-top, exponential, and rectangular windows. You can even view the frequency components of a single shot event.



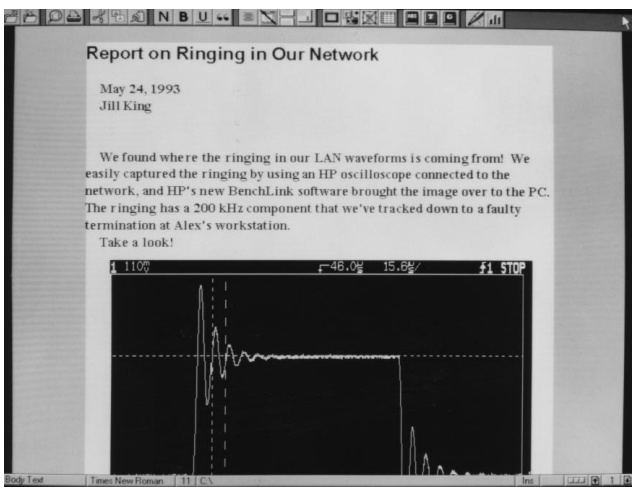
HP 54600 Series Software and Accessories

HP 34810B BenchLink Scope Windows Software (Option 106) Offers Connectivity

The HP BenchLink Scope provides a simple communications link between your PC and the HP 54600 and 54500 families of oscilloscopes. HP BenchLink Scope is a member of the HP BenchLink family of PC/basic instrument connectivity solutions, and takes full advantage of the Windows interface to easily transfer screen images, waveform data, front-panel setups, and even custom test information via HP-IB or RS-232 interfaces.

HP BenchLink Scope makes it easy to move important information from scope to PC. You'll be able to transfer:

- Screen images—you can transfer a bitmap picture of the scope screen to your PC for viewing, annotation, storage or printing. HP BenchLink Scope provides convenient annotation tools, and Windows makes it easy to cut and paste your annotated image into other applications. You can also save your image in PCX and TIF formats. You'll find documenting lab results to be fast and simple.
- Waveform data—HP BenchLink Scope transfers the actual waveforms on screen to your PC for further review and analysis. You can simultaneously capture scope and logic waveforms, and, once captured, use waveform markers in HP BenchLink Scope to review your data. HP 54645A/D users can also use pan and zoom to effectively review 1 MB spreadsheets and analysis programs, and you can save waveform data in a variety of formats.
- Instrument setups—the full front-panel setup of your scope can be saved in the PC for later use. You can store setups for several different tests or configure multiple scopes with the setup created on a master scope.



HP BenchLink/Scope makes PC connections easy

HP 54654A Operator's Training Kit (Option 103 to HP 54600 Series Instruments)

The operator's training kit consists of a training signal board and lab workbook. The signal board provides 12 signals that show various operating modes and features of an HP 54600 series oscilloscope. Nineteen logic analyzer test points are also provided to demonstrate the features of the HP 54600 series logic analyzers or mixed signal oscilloscope. After completing the labs, the user can operate the instrument and make measurements with no extra training. This kit is ideal for the educational environment and can also be an excellent tool for training new employees. The operator's training kit comes with signal board, manual, and 9 V battery, all contained in an attractive case.

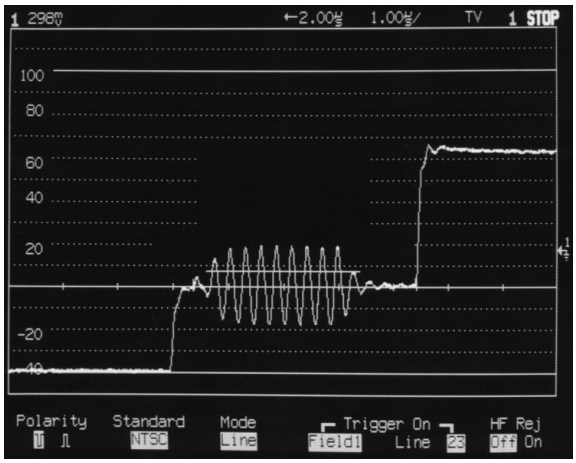
Two-Year Warranty Extension (Option W50)

Option W50 for HP 54600 series scopes extends the normal three-year warranty for an additional two years, giving you five years of worry-free operation.

Enhanced Performance for Video Applications (Option 005 to Select HP 54600 Series Scopes)

With the addition of Option 005, enhanced TV/video triggering, to the HP 54602B, HP 54610B, HP 54615B, HP 54616B/C or HP 54645A oscilloscopes, you will be able to trigger on any specified line of video in either NTSC, PAL, PAL-M, SECAM or generic video formats. With this additional triggering, you will be able to easily view signals that are often very dim or invisible on most analog scopes. Once you have the signal of interest displayed, you can measure it with digital precision.

With Option 005, a full bandwidth signal output is added to the scope's rear panel. Now you can bring additional measuring instruments to the signal at the scope's probe tip.



Live NTSC broadcast video

HP 10098A Pouch and Front Panel Cover (Option 101 to HP 54600 Series Scopes)

The pouch provides probe and accessory storage on top of the scope and is easily removable for rackmounting. The front panel cover provides sturdy protection of the front panel display and knobs when transporting the scope.

HP 1185A Carrying Case (Option 104 to HP 54600 Series Scopes)

The HP 1185A carrying case makes transporting and shipping your HP 54600 series oscilloscope safe and simple. A scope, optional module, and other accessories fit neatly inside the padded shell of hard plastic, and the case is lockable for shipment.

Product Specific Performance Characteristics

Vertical system	HP 54603B	HP 54600B	HP 54602B	HP 54610B	HP 54615B/ HP 54616B/C	HP 54645A
Bandwidth (BW) Ch. 1 and 2	dc to 60 MHz	dc to 100 MHz	dc to 150 MHz 100 MHz @ 1, 2, & 5 mV/div	dc to 500 MHz[7]	dc to 500 MHz[7]	dc to 100 MHz 75 MHz @ 1, 2 and 5 mV/div
Ch. 3 and 4	N/A	N/A	dc to 250 MHz	N/A	N/A	N/A
Rise time (calculated) Ch. 1 and 2	5.8 ns	3.5 ns	2.3 ns	700 ps	700 ps	3.5 ns
Ch. 3 and 4	N/A	N/A	1.4 ns	N/A	N/A	N/A
Input R & C	1 MΩ, ≈ 13 pf	1 MΩ, ≈ 13 pf	1 MΩ, ≈ 13 pf	1 MΩ, ≈ 9 pf	1 MΩ, ≈ 9 pf	1 MΩ, ≈ 13 pf
Dynamic range (from center screen)	± 8 divisions	± 8 divisions	± 8 divisions	± 12 divisions	± 12 divisions	± 8 divisions
Sensitivity (per division) Ch. 1 and 2	2 mV to 5 V	2 mV to 5 V	1 mV to 5 V	2 mV to 5 V	2 mV to 5 V	1 mV to 5 V
Ch. 3 and 4	N/A	N/A	0.1 V and 0.5 V	N/A	N/A	N/A
Accuracy	± 2%	± 1.5%	± 1.5%	± 2%	± 2%	± 1.5%
Vernier accuracy	± 3.5%	± 3%	± 3%	± 2%	± 2%	± 3%
Maximum input dc + peak ac	400 V	400 V	400 V	250 V or 5 V RMS in 50 Ω mode	250 V or 5 V RMS in 50 Ω mode	400 V
Selectable BW limit Ch. 1 and 2	20 MHz	20 MHz	20 MHz	30 MHz	30 MHz	20 MHz
Horizontal system						
Accuracy	± 0.01%	± 0.01%	± 0.01%	± 0.01%	± 0.005%	± 0.01%
Vernier accuracy	± 0.05%	± 0.05%	± 0.05%	± 0.05%	NA	± 0.05%
Resolution	100 ps	100 ps	100 ps	25 ps	20 ps	40 ps
Delay jitter	10 ppm	10 ppm	10 ppm	10 ppm	1 ppm	10 ppm
Sweep speed	5 s/div to 5 ns/div	5 s/div to 2 ns/div	5 s/div to 2 ns/div	5 s/div to 1 ns/div	5 s/div to 1 ns/div	50 s/div to 2 ns/div
Acquisition system						
Max. sample rate	20 MSa/s	20 MSa/s	20 MSa/s	20 MSa/s	1 GSa/s[10]/2 GSa/s	200 MSa/s[10]
Single shot BW	2 MHz	2 MHz	2 MHz	2 MHz	250 MHz/500 MHz[10]	50 MHz[10]
Peak detect (single chan.)	50 ns	50 ns	50 ns	50 ns	1 ns[10]	5 ns[10]
Record length (pts. vectors off/on)	4,000/2,000	4,000/2,000	4,000/2,000	4,000/2,000	5,000/2,000	1 Meg
Max. update rate vectors off	1.5 M pts/s	1.5 M pts/s	1.5 M pts/s	1.5 M pts/s	0.5 M pts/s	3 M pts/s
Trigger system						
Sensitivity Ch. 1 and 2	dc to 25 MHz, 0.35 div or 3.5 mV dc to 60 MHz, 1 div or 10 mV	dc to 25 MHz, 0.35 div or 3.5 mV dc to 100 MHz, 1 div or 10 mV	dc to 25 MHz,[9] 0.35 div or 3.5 mV dc to 150 MHz, 1 div or 10 mV	dc to 25 MHz, 0.35 div or 3.5 mV dc to 500 MHz, 1 div or 10 mV	dc to 100 MHz, 0.5 div or 3.5 mV dc to 500 MHz, 1 div or 7 mV	dc to 25 MHz 0.35 div or 3.5 mV dc to 100 MHz, 1 div or 10 mV
Sensitivity Ch. 3 and 4	N/A	N/A	dc to 250 MHz 1 div or 10 mV	N/A	N/A	N/A
External trigger range	± 18 V	± 18 V	N/A	± 18 V	± 2 V	± 18 V
External trigger sensitivity	dc to 25 MHz, 50 mV dc to 60 MHz, 100 mV	dc to 25 MHz, 50 mV dc to 100 MHz, 100 mV	N/A	dc to 100 MHz, 75 mV dc to 500 MHz, 150 mV	dc to 100 MHz, 75 mV dc to 500 MHz, 150 mV	dc to 25 MHz, 50 mV dc to 100 MHz 100 mV
External trigger input R&C	1 MΩ, ≈ 13pf	1 MΩ, ≈ 13pf	N/A	1 MΩ, ≈ 12pf or 50 Ω	1 MΩ, ≈ 12pf or 50 Ω	1 MΩ, ≈13pf
External trigger input maximum input	400 V (dc + peak ac)	400 V (dc + peak ac)	N/A	250 V (dc + peak ac) or 5 V rms in 50 Ω	250 V (dc + peak ac) or 5 V rms in 50 Ω	400 V (dc + peak ac)

[1] Temperature is ±10° C from calibration.
[2] Use full scale of 80 mV for 2 mV/div and 5 mV/div ranges on HP 54600B, HP 54615B, HP 54616B/C and HP 54603B. Use full scale of 40 mV for 2 mV/div range on HP 54610B. Use full scale of 56 mV for 2 mV/div range on HP 54615B, HP 54616B/C . Use full scale of 16 mV for 1 mV/div or HP 54602B.
[3] Use full scale of 50 ns for 2 ns/div.
[4] Tested to Hewlett-Packard environmental specification section 758 for Class B-1 products.
[5] Characteristic for the HP 54602B only.
[6] Characteristic for HP 54610B and HP 54615B, HP 54616B/C only.
[7] Upper BW reduces by 2 MHz per degree C above +35° C.
[8] Characteristic for HP 54603B only.
[9] 1, 2, 5 mV/div dc to 25 MHz, 1 div or 2 mV.
[10] Simultaneous on both channels.

Product Specific Performance Characteristics

Vertical System–All Models

Math Functions: Channel 1 ± Channel 2
Cursor Accuracy[1,2]/Single Cursor: Vertical accuracy ± 1.2% of full scale ± 0.5% of position value
Dual Cursor: Vertical accuracy ± 0.4% of full scale
Inversion: Channel 1 and Channel 2
CMRR: ≈20 dB at 50 MHz

Vertical System (HP 54610B, 54615B, 54616B/C)

50 Ω Protection: Protects 50 Ω load from excessive voltage
Probe Sense: Automatic readout of 1X, 0X, 20X, and 100X probes

Horizontal System–All Models

Cursory Accuracy (t and 1/t)[3]**:** ± 0.01% ± 0.2% of full scale ± 200 ps
Pre-Trigger Delay (negative time)**:** 10 div
Post-Trigger Delay (trigger to start of sweep)**:** At least 2560 div or 50 ms. Not to exceed 100 s.
Time Skew (HP 54610B, HP 54615B, 54616B/C)**:** Each channel adjustable over a range of ± 25 ns to remove effects of cabling

Delayed Sweep

Main Sweep 5 s/div to 10 ms/div: Delayed sweep; up to 200 x main
5 ms/div and Faster: Up to 2 ns/div/1 ns/div[6]/5 ns/div[8]

Trigger System

Sources
HP 54602B: Channels 1, 2, 3, 4, or line
HP 54600B, 54603B, 54610B, 54615B,54616B/C 54645A: Channels 1, 2, line, and external
Coupling: ac, dc, LF reject, HF reject, and noise reject. LF and HF: –3 db at 50 kHz.
Modes: Auto, Auto-level, Normal, Single, and TV
TV Triggering: TV line and field. Requires 0.5 div of composite sync for stable display (Channels 1 and 2).
Holdoff: Adjustable from 200 ns to 13 s from 300 ns (HP 54615B, 54616B/C)

External Trigger (HP 54600B, HP 54603B, HP 54610B, HP 54615B, HP 54616B/C, HP 54645B)

Coupling: dc, HF reject and noise reject

External Trigger (HP 54610B only)

Coupling: ac and dc
Trigger View: External trigger is viewable
Bandwidth: ≥ 350 MHz

X-Y Operation–All Models

Z-Blanking: TTL high-blanks trace (Not available on HP 54615B, HP 54616B/C)
Bandwidth: X and Y same as vertical system
Phase Difference: ± 3° at 100 kHz, ± 3° at 10 MHz (HP 54615B, HP 54616B/C), ± 1.8° at 1 MHz (HP 54645A)

Display System–All Models Except HP 54616C

Display: 7-inch raster CRT
Resolution: 255 vertical x 500 horizontal points
Controls: Front-panel intensity control
Graticule: 8 x 10 grid or frame
Auto-Store: Saves previous sweeps in half-bright display and the most recent sweep in full-bright display

Acquisition System–All Models

Resolution: 8 bits
Simultaneous Channels: Channels 1 and 2 or Channels 3 and 4 (HP 54602B)
Average: Number of averages selectable from 8, 64, 256

Advanced Functions–All Models

Automatic Measurements: Continuously updated
Voltage: V avg, V rms, V p-p, Vtop, V base, V min, and V max
Time: Frequency, period, + width, – width, duty cycle, rise time, and fall time
Cursors: Manually or automatically placed
Setup Functions Autoscale: Sets the vertical and horizontal deflection and the trigger level
Save/Recall: 15 front-panel setups; 10 front-panel setups (HP 54645A)
Trace Memory: 2 volatile pixel memories
TV Functions/Line Counting: Delay time calibrated in NTSC and PAL line numbers
All-Field Trigger (both fields selected)**:** Oscilloscope triggers on the vertical sync pulse in both fields, allowing use with fields, allowing use with noninterlaced video

General

Power Requirements
Line Voltage Range: 100 Vac to 240 Vac
Line Voltage Selection: Automatic
Line Frequency: 45 Hz to 440 Hz
Max. Power Consumption: 220 VA, 300 VA (HP 54615B, HP 54616B/C)
Environmental Characteristics: Meets the requirements of MIL-T-28800D for Type III, Class 3, Style D equipment as described later in this table
Ambient Temperature
Operating: –10° C to + 55° C
Nonoperating: –51° C to + 71° C
Humidity[4]
Operating: 95% RH at 40° C for 24 hrs.
Nonoperating: 90% RH at 65° C for 24 hrs.
Altitude
Operating: To 4,500 m (15,000 ft)
Nonoperating: To 15,000 m (50,000 ft)
EMI (Commercial) (MIL-T-28800D)**:** Meets FTZ 1046 Class B. Meets requirements in accordance with paragraph 3.8.3 EMI Type III and MIL-STD-461C as modified by Table XII.
CE01: Part 2 narrow band requirements up to 15 kHz
CE03: Part 4
CS01: Part 2
CS02: Part 2
CS06: Part 5 limited to 300 V
RE01: Parts 5 and 6 measured @ 12-inch, 15 dB relaxation to 20 kHz exceptioned from 20 kHz to 50 kHz
RE02: Part 2 (limited to 1 GHz) full limits of Class A1C and A1F with Option 002 installed. Without Option 002 installed, 10 dB relaxation, 14 kHz to 1 GHz.
RS02: Part 2, Part I and Part 2, Part II, exceptioned
RS03: Part 2, limited to 1 V/meter from 14 kHz to 1 GHz (with Option 001 installed); slight trace shift from 80 MHz to 200 MHz.
Vibration: Operating 15 min. along each of the 3 major axes; 0.025-inch peak-to-peak displacement, 10 Hz to 55 Hz in 1-min. cycles. Held for 10 min. at 55 Hz (4 g at 55 Hz).
Shock: Operating 30 g, 1/2 sine, 11-ms duration, 3 shocks/axis along major axis. Total of 18 shocks.
Size (excluding handle)**:** 322 mm W x 172 mm H x 317mm D (12.7 in x (6.8 in x 6.8 in x 12.5 in)
Weight: 6.2 kg (14 lbs)
Safety: CSA certification, IEC-348, UL-1244 listed

Product Specific Performance Characteristics

HP 54650A HP-IB Interface Module

Provides full remote control and hard copy to HP-IB printers and plotters. Programming is in accordance with IEEE-488.2. With the addition of this module, the scope's two pixel memories become non-volatile. An operating and programming manual and a programming examples disk are supplied.
Specifications: The interface capabilities of the HP 54600 series oscilloscope with this module installed are as defined by IEEE-488.1 as SH1, AH1, T5, L4, SR1, RL1, PP1, DC1, DT1, C0 and E2.
Printer/Plotter Supported: HP ThinkJet, HP QuietJet, HP PaintJet, and HP Laser-Jet; HP-GL compatible plotters.

HP 54652B RS-232/Parallel Interface Module

Provides full remote control via RS-232 and printing via parallel in one module. The RS-232 can also be configured for printing when not being used for remote control.
Specifications
Connector Type: 9 pin (m) DTE Port, works with HP 34398A RS-232 cable
Protocols: Xon/Xoff, hardwire
Data Bits: 8
Parity: None
Baud Rates: 1200, 2400, 9600, or 19200
Printer/Plotter Support: HP ThinkJet, HP QuietJet, HP PaintJet, and HP Laser-Jet; HP-GL compatible plotters
Connector Type: 25 pin (F) connector, works with HP C2950A parallel printer cable
Supported Printers: Epson FX-80 or HP PCL compatible printers

HP 54657A and 54659B Measurement/Storage Modules

With the the addition of either the HP 54657A module with HP-IB interface or the HP 54659B module with RS-232 and parallel interface, the HP 54600 series oscilloscope will provide all of the following features:

19 Automatic Measurements consisting of:

Voltage: Vamp, Vavg, Vrms, Vpp, Vpre, Vovr, Vtop, Vbase, Vmin, and Vmax
Time: Delay, Duty Cycle, Frequency, Period, Phase Angle, Rise Time, Fall Time, + width, and –width
Thresholds: User selectable among 10%/90%, 20%/80%, or absolute voltage levels
Cursor Readout: Voltage or percentage
Modes: Time or phase angle

Waveform Math Functions

Function 1: Addition, subtraction, and multiplication
Function 2: Differentiation, integration, and FFT
FFT
Windows: Exponential, flat top, Hanning and rectangular
Samples: 1024 points

Storage

Trace Memory: Up to 100 nonvolatile memories
Memories 1–3: High speed storage without compression
Memories 4–100: Storage with compression. Storage time is approximately 7 seconds. Number of traces that can be stored is a function of complexity, with the minimum being 4 highly complex traces and the maximum being 96.
Memory Labeling: An onscreen text editor is provided for creating labels up to 20 characters. Each label contains the date and time it was saved.
Real-Time Clock: 24-hour format with battery back-up. Can be set from front panel.

Unattended Waveform Monitoring

Testing Method: Comparison to waveform mask
Number of Masks: 2
Mask Generation and Operation: Automask, controlled from the front panel, generates mask from displayed wave-form with selectable tolerance. Mask editor function allows pixel-by-pixel editing and line drawing. Smoothing function performs a running average of 3 pixels.
Action on Failure:
Save failed trace to memory with date and time of the failure
Print failed trace with date and time of the failure
Count the failure and maintain pass/fail statistics while continuing the test
Hard Copy and Programmability Interface: HP 54657A: HP-IB (for HP-IB specifications, see HP 54650A)
HP 54658A: RS-232 (for RS-232 specifications, see HP 54652B)

HP 54600-Series Scope Interface and Enhancement Modules

Ordering Information Product	Description	HP-IB	RS-232	FFT and Advance Parallel	Windows MC-S	Software
1. **HP 54650A**	HP-IB Interface Module	•				
HP 54652B	RE-232 and Parallel Interface Module		•	•		
2. **HP 54657A**	HP-IB Measurement/Storage Module	•			•	
HP 54659B	RS-232 Measurement/Storage Module		•	•	•	
3. **HP E2657A**	Measurement/Connectivity Kit for HP-IB	•			•	•
HP E2659A	Measurement/Connectivity Kit for RS-232		•	•	•	•

(Note that the HP 54620A/C logic analyzers can use any of these modules, but they use the modules for I/O only.) HP 34810B BenchLink Scope software for Windows is available separately. See page 97.

1. Basic Connectivity
If all you need is a PC interface, add HP-IB with the HP 54650A or both RS-232 and parallel connections with the HP 54652B.

2. Connectivity and Advanced Measurements
For high-performance tools usually found only in much more expensive scopes–including the FFT to view signals in the frequency domain–add the HP 54657A (HP-IB) or HP 54659B (RS-232 and parallel) measurement/storage module.

This module also provides many other features to make your work easier, including unattended signal monitoring and failure detection, measurements of channel-to-channel delay and phase, user-definable voltage levels for timing measurements, and extended math functions and cursor readouts.

3. Complete Connectivity, Including Software
Get the complete package, including HP BenchLink Scope software for documenting and analyzing measurement results (see page 97 for more information on HP BenchLink).

Ordering Information

HP 54600B Two-Channel 100-MHz Oscilloscope
Includes two 1.5 m 10X probes (HP 10071A), operating and service guide, and line cord
HP 54602B Four-Channel 150-MHz Oscilloscope
Includes two 1.5 m 10X probes (HP 10071A), operating and service guide, and line cord
HP 54603B Two-Channel 60-MHz Oscilloscope
Includes two 1.5 m 10X probes (HP 10071A), operating and service guide, and line cord
HP 54610B Two-Channel 500-MHz Oscilloscope
Includes two 1.5 m 10X probes (HP 10073A), operating and service guide, and line cord
HP 54615B Two-Channel 500 MHz Oscilloscope
Includes two 1.5 m 10X probes (HP 10073A), operating and service guide, and line cord
HP 54616B Two-Channel 500 MHz Oscilloscope
Includes two 1.5m 10X probes (HP 10073A), operating and service guide, and line cord
HP 54616C Two-Channel 500 MHZ Color Oscilloscope
Includes two 1.5m 10X probes (HP 10073A), operating and service guide, and line cord
HP 54645A Two-Channel 100 MHz MegaZoom Oscilloscope
Includes two 1.5m 10X probes (HP 10074A), operating and service guide, and line cord

Accessories
HP 54650A HP-IB Interface Module
HP 54652A Parallel Interface Module
HP 54652B RS-232 and Parallel Interface Module
HP 54654A Operator's Training Kit
HP 54655A Test Automation Module with HP-IB Interface (compatible with the HP 54600B, HP 54603B, HP 54602B and HP 54610B only)
HP 54656A Test Automation Module with RS-232 Interface (compatible with the HP 54600B, HP 54603B, HP 54602B and HP 54610B only)
HP 54657A Measurement/Storage Module with HP-IB Interface
HP 54658A Measurement/Storage Module with RS-232 Interface (not recommended for 54600B series)
HP 54659B Measurement/Storage Module with RS-232 and Parallel
HP 1146A Oscilloscope AC/DC Current Probe
HP 1137A 1000:1 High Voltage Divider Probe
HP 10070A 1.5 m 1X Probe
HP 10071A 1.5 m 10X 150 MHz Probe
HP 10072A SMT Probe Tip Kit for HP 10070A family of probes
HP 10073A 1.5 m 10X 500 MHz Probe
HP 10074A 1.5 m 10X 150 MHz Probe with Probe Sense
HP 10075A 0.5 mm SMT Probe Accessory Kit for the HP 10070A family of probes
HP 34397A DC to AC Inverter
HP 85901A AC Power Source

Options

Opt 001 Display EMI Shield (HP 54600-68703)
Provides extra shielding for the CRT. For MIL standards or harsh magnetic environments (see page 99 for more details).
Opt 002 Display Filter
Provides additional reduction in radiated emissions. For MIL standards or measurement environments sensitive to radiated emissions (see page 99 for more details).
Opt 005 Enhanced Video Trigger
(not available on HP 54600B or HP 54603B)
Adds the ability to trigger on a specified line of NTSC, PAL, PAL-M,SECAM, or general format video. IRE graticule, IRE cursor readout, video autoscale, and rear-panel outputs for trigger and channel input are added with this option.
Opt 101 Accessory Pouch and Front-Panel Cover (HP 10098A)
Opt 102 Two Additional 10071A Probes (54602B only)
Opt 103 Operator's Training Kit (HP 54654A)
Consists of a training signal board and lab workbook. After completing these labs, an operator will be able to make measurements and operate the oscilloscope without any additional training.
Opt 104 Carrying Case (HP 1185)
Designed to protect the oscilloscope for shipment or for checking as airline baggage
Opt 106 BenchLink Software (HP 34810B)
Windows software that interfaces the scope (with either HP-IB or RS-232 module installed) to a PC for storage, analysis, or easy integration of waveform data into desktop publishing software
Opt 090 Delete Probes for HP 54600B, 54602B, 54603B
Opt 090 Delete Probes for HP 54610B, HP 54615B, HP 54616B/C
Opt 090 Delete Probes for HP 54645A
Opt 1CM Rackmount Kit (HP 5062-7345)
7-inch EIA standard rack
Opt W50 Additional Two-Year Warranty (for a total of five years)
HP 54600B
HP 54602B
HP 54603B
HP 54610B
HP 54615B
HP 54616B
HP 54616C
HP 54645B

For the Educators
These oscilloscopes are ideally suited for classroom use. Contact your local Hewlett-Packard sales office for details on specific education discount programs.

HP 54600 Interfacing and Hard Copy Output Information Compatibility Chart

The following table describes the devices supported by the HP 54600 series oscilloscopes:

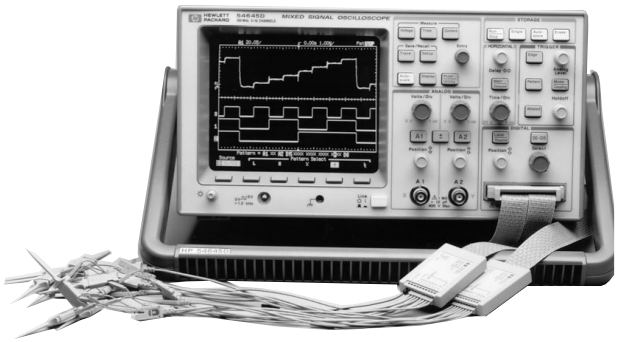
	HP-IB modules	RS-232 modules	Parallel modules
Hewlett-Packard Printers (LaserJet, DeskJet)	N/A	N/A	Yes
Epson Printers (FX-80 or Compatible)	N/A	Yes	Yes
Computers	Yes	Yes	Yes
HP-PCL Printers	Yes	Yes	Yes
HP-GL Plotters	Yes	Yes	N/A

HP-IB Cables for HP 59650A and HP 59657A
HP 10833A 1 m Cable
HP 10833B 2 m Cable
HP 10833C 4 m Cable
HP 10833D 0.5 m Cable
RS-232 Cables for HP 54652B and HP 54659B
For connection to printers and plotters:
HP 34398A 2.5 m, 9 Pin (f) to 9 Pin (f)
HP 34399A Adapter Kit
For connection to PCs:
HP 34398A 2.5 m, 9 Pin (f) to 9 Pin (f) Plus 9 Pin (m) to 25 Pin (f) Adapter
RS-232 Cables for HP 54656A and HP 54658A
For connection to printers and plotters:
HP 13242G 5 m, 25 Pin (m) to 25 Pin (m)
For connection to IBM PC/XT computers:
HP C2913A 1.5 m, 25 Pin (m) to 25 Pin (f)
For connection to PCs:
HP 24542G 3 m, 25 Pin (m) to 9 Pin (f)
Parallel Cable
HP C2950A 2 m, Parallel Printer Cable

HP 54615T
HP 54616TC
HP 54620A
HP 54620C
HP 54645D

HP has a Variety of Tools to Help You Troubleshoot and Debug Today's Mixed Signal Designs

HP 54645D Mixed Signal Oscilloscope



Key Features

- Dual-channel 100 MHz scope, 200 MSa/s sample rate
- 1 MB of memory per channel
- 16 logic-timing channels with 400 MSa/s on 8 channels and 200 MSa/s on 16 channels
- MegaZoom technology for easy-to-use and responsive deep memory
- Powerful triggering

Mixed-signal testing in one box, the HP 54645D is a new class of oscilloscope. This mixed-signal oscilloscope (MSO) will allow you to easily view the complex relationships of your circuit's analog and digital operation.

For more details about the HP 54645D, please see page 90.

HP 54620A/C Logic Analyzer

Key Features

- 16 channels of 500 MSa/s timing analysis
- 3.5 ns glitch capture at any sweep speed
- Simple scope-like controls
- Edge, pattern and advanced triggering
- Full-color display with HP 54620C

When Your Oscilloscope is Not Enough

When the HP 54620A/C is used in conjunction with your scope, you have a powerful mixed-signal debugging combination. The HP 54620A/C has 16 channels of 500 MSa/s timing analysis and powerful triggering. When used in combination with your oscilloscope, it can provide more channels to view your problem. The trigger out of the HP 54620A/C can help trigger your scope on the most complex signals.

For more details about the HP 54620A/C, please see page 93.

HP 54616TC Mixed Signal System

Key Features

- HP 54616C Oscilloscope and HP 54620C Logic Analyzer
- Reduced system price over individual purchase
- 500 MHz bandwidth oscilloscope, 500 MSa/s timing analyzer

One Powerful Combination

Take the HP 54616C, 500 MHz, 2 GSa/s, color scope and combine it with the HP 54620C 16 channel, 500 MSa/s color timing analyzer and you have the HP 54616TC.

The powerful triggering capabilities of the HP 54620C can be used in triggering the HP 54616C, enabling the capture of analog signals up to 500 MHz in bandwidth. This powerful yet compact combination can help solve some of your most difficult high frequency problems.

The HP 54615T is the HP 54615B, 500 MHz, 1 GSa/s oscilloscope combined with the HP 54620A to provide a lower cost monochrome system.

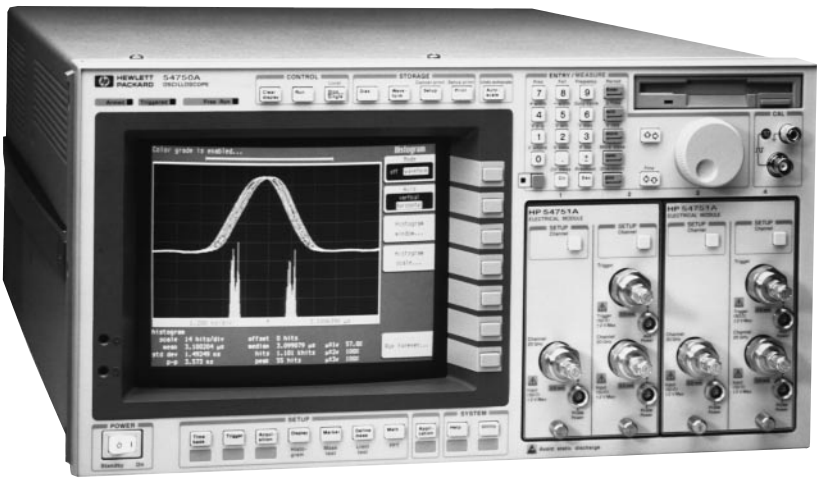
For more details about the HP 54616C, please see page 95.

Ordering Information

HP 54615T Mixed Signal Test System
Includes HP 54615B Option 101, HP 54620A Option 101, and BNC Interconnect Cable
HP 54616TC Color Mixed Signal Test System
Includes HP 54616C Option 101, HP 54620C Option 101, and BNC Interconnect Cable

HP 54750A

- 50 GHz bandwidth
- < 62.5 fs timing resolution
- 8 ps time interval accuracy
- Differential TDR
- Fast data acquisition and throughput
- Modular system design
- 2.5 GHz edge trigger
- New optional 12 GHz gated trigger



HP 54750A

HP 54750A Series High-Bandwidth Digitizing Oscilloscope

The HP 54750A provides up to four low-noise high-bandwidth channels coupled with the best measurement feature set in the industry. The exceptionally stable timebase and 2.5 GHz (or 12 GHz with Option 100) trigger circuits give highly repeatable and accurate results as needed by today's engineers for circuit or device characterization and modeling.

Key Contributions

The 54750A series oscilloscope offers:
- DC to 20 GHz bandwidth (HP 54751A), 17.5 ps rise time
- DC to 50 GHz bandwidth (HP 54752A/B)
- Single-ended TDR (HP 54753A)
- Differential and single-ended TDR (HP 54754A)
- 8 ps time interval accuracy
- 62.5 fs horizontal resolution
- 2.5 GHz or 12 GHz edge triggering
- 500 MHz to 18 GHz triggering with the HP 54118A
- 15 bits vertical resolution with averaging
- < 0.5 mVrms noise (12.4 GHz)
- 1 mV per division to 100 mV per division vertical scaling
- HP-IB programmable
- Support for both HP and Epson (Centronics) printers
- Up to 4 channels
- Modularity for future expansion
- 50 built-in automatic measurements including: FFT, Color-Graded Display, Histograms, Limit Testing, Mask Testing, full parametrics on both single and multi-valued signals
- 4K point memory depth per channel
- Test high-speed circuits remotely with the HP 11898A module extender

Signal Measurements

The HP 54750A offers a very rich feature set giving quick repeatable measurement results so engineering productivity is maximized. A broad range of measurement capability is provided with FFTs, Color-Graded Display, Histograms, Parametric Limit Testing, and Mask Template Testing. These measurements can be used independently or in concert.

An internal database stores acquired data for use with the Color-Graded Display, Histograms, and multi-valued parametric testing. Additional new measurements can be taken without re-acquiring the signal. This database can be stored to the internal MS-DOS compatible disk or internal memory for later analysis.

Data Stream Measurements

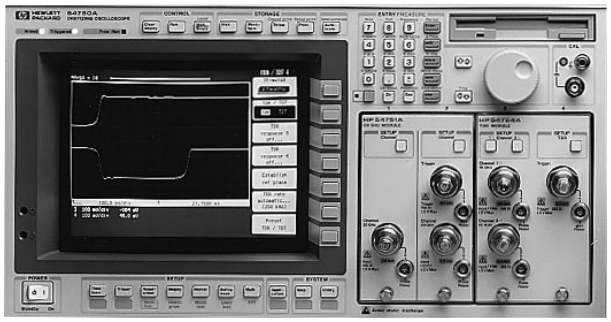
Full parametric measurements on multi-valued signals (eye diagrams), found in digital buses and memory circuits, can be taken without the need for an external controller. In addition to the normal parametric measurements such as rise time, fall time, etc., five new measurements have been added specifically to characterize digital data: Eye Height, Crossing Percent, Eye Width, RMS Jitter, and Peak-to-Peak Jitter. Characterizing and evaluating the dynamics of digital data has never been easier.

HP 83480K Digital Communications Option

The HP 83480K is an optional software package that provides the capabilities of the HP 83480A digital communications analyzer/oscilloscope. This option provides the firmware necessary to support the 8348X series of optical to electrical plug-ins. It also adds the communications measurements provided by the HP 83480A digital communications analyzer.

Ordering Information

HP 54750A Digitizing Oscilloscope Mainframe
Opt 100 1–12 GHz Gated Trigger
HP 54751A 2-Channel 20 GHz Plug-in
HP 54752A Dual-Channel 50 GHz
HP 54752B Single-Channel 50 GHz
HP 54753A 2-Channel 20 GHz w/single-ended TDR
HP 54754A 2-Channel 18 GHz w/differential TDR
HP 54755A TDR S/W for the HP 83480A
HP 83480K Communications S/W for HP 54750A
HP 11898A Module Extender



HP 54751A Plug-in

The HP 54751A plug-in offers two 20 GHz bandwidth channels. The two-wide configuration allows up to four channels in the HP 54750A mainframe. The bandwidth of each channel may be selected independently from the channel menu as either 20 GHz or 12.4 GHz. The bandwidth of the channel is altered by changing the bias on the sampling bridge.

The low-noise characteristic of the plug-in gives an RMS noise level of < 1.0 mV in the high-bandwidth mode and < 0.5 mV in the low-bandwidth mode. With exceptionally low noise and a minimum sensitivity of 1 mV/div, the HP 54751A is ideally suited for evaluation of low-level signals.

The plug-in provides a single external trigger input of 2.5 GHz or 12 GHz bandwidth. Triggering to 18 GHz is possible by using the HP 54118A.

HP 54752A/B Plug-ins

The HP 54752A has two 50 GHz bandwidth channels and the HP 54752B provides a single cost-effective channel. Both plug-ins use 2.4 mm connectors to provide the highest fidelity from the DUT.

These plug-ins also feature a dual bandwidth scheme which can be selected independently from the mainframe. The low-bandwidth mode bandlimits the signal to 26.5 GHz. The high-bandwidth mode RMS noise performance is < 1.5 mV and the low-bandwidth mode is < 0.75 mV.

HP 54753A TDR/TDT Module

The HP 54753A is a two-channel vertical plug-in with a TDR step generator built into channel one. The bandwidth of the TDR/vertical channel is 18 GHz. The bandwidth of channel two is 20 GHz.

The step generator provides a 200 mV TDR step with a system rise time of < 45 ps. The system has the ability to normalize the TDR by applying a digital filter. Normalization removes errors caused by loss or imperfect launchers or cables.

The rise time of the normalization filter may be varied to allow you to simulate the edge speeds found in your system. You may also push the rise time up to 10 ps. Unlike the HP 54120 series, the normalization filter when activated processes every acquisition so you see changes as the DUT is adjusted.

The HP 54753A provides support for external step generators, such as the PicoSecond Pulse Labs 4015B.

HP 54754A Differential TDR/TDT Module

The HP 54754A has two independent vertical channels and two step generators. The bandwidth of both channels is 18 GHz. The step generators may be operated singly, simultaneously but independently, differentially, or as common-mode stimulus. The TDR results may be viewed as common mode or differentially and displayed simultaneously. Once selected, the display mode is computed automatically, freeing the user from setting up mathematical functions.

Each step may be skewed separately in time. Coupled with the ability to skew the vertical channels, it is possible to accurately perform differential TDR when the launch cables are not the same electrical length.

HP 54750A System Specifications

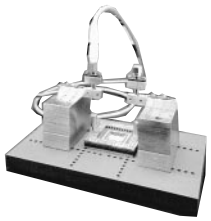
Vertical	**54751A**	**54752A/B**	**54753A**	**54754A**
DC-coupled bandwidth (–3dB)				
High bandwidth				
Channel 1	20 GHz	50 GHz	18 GHz	18 GHz
Channel 2	20 GHz	50 GHz	20 GHz	18 GHz
Low bandwidth				
Channel 1	12.4 GHz	26.5 GHz	12.4 GHz	12.4 GHz
Channel 2	12.4 GHz	26.5 GHz	12.4 GHz	12.4 GHz
Rise time (calculated)				
High bandwidth				
Channel 1	≤ 17.5 ps	≤ 7.0 ps	≤ 19.4 ps	≤ 19.4 ps
Channel 2	≤ 17.5 ps	≤ 7.0 ps	≤ 17.5 ps	≤ 19.4 ps
Low bandwidth				
Channel 1	≤ 28.2 ps	≤ 13.2 ps	≤ 28.2 ps	≤ 28.2 ps
Channel 2	≤ 28.2 ps	≤ 13.2 ps	≤ 28.2 ps	≤ 28.2 ps
Noise (RMS)				
High bw	≤ 1 mV	≤ 1.5 mV	≤ 1 mV	≤ 1 mV
Low bw	≤ 0.5 mV	≤ 0.75 mV	≤ 0.5 mV	≤ 0.5 mV
DC accuracy (single voltage marker)	0.4% of full-scale or marker reading (whichever is greater) ± 2 mV ± 1.2% of (reading-channel offset)			
Dynamic range	± 400 mV relative to channel offset			
Connectors	3.5 mm	2.4 mm	3.5 mm	3.5 mm

TDR System	**Oscilloscope/TDR performance**	**Normalized characteristics**
Rise time	≤ 45 ps	Adjustable from larger of 10 ps or 0.08 x time/div Maximum: 5 x time/div
Flatness	≤ ± 1% after 1 ns from edge; ≤ + 5%, –3% 1 ns from edge	< 0.1%
Low level	0.00 V ± 2 mV	0.00 V ± 2 mV
High level	200 mV ± 2 mV	200 mV ± 2 mV

External Trigger Input (Standard Configuration)	
Sensitivity	40 mVp-p dc to 100 MHz increasingly linearly to 200 mVp-p at 2.5 GHz
Pulse width	200 ps > 200 mV
High frequency reject	Trigger bandwidth reduced to 100 MHz
Jitter (trigger and time base combined)	≤ 2.5 ps + 5E-5 x delay setting

HP 54118A 18 GHz trigger

HP 83440C/D lightwave detector O/E converters



Inter-Continental Microwave TDR launching probes

HP 54008A 20 GHz delay line

HP 54007A RF accessory kit

PicoSecond Pluse Labs Model 4015B

HP 54118A, 500 MHz to 18 GHz Trigger

Simple, Stable Triggering at Microwave Frequencies

For applications requiring more than 2.5 GHz trigger bandwidth, use the HP 54118A 18 GHz trigger. The HP 54118A gives your HP 54750 series oscilloscope true event triggering from 500 MHz to 18 GHz, with less than 1.7 ps of rms jitter at 18 GHz. This powerful and versatile accessory extends the oscilloscope's measurement capabilities to applications in lightwave communications, pulsed RF, gigabit logic, pseudo-random bit-stream eye patterns, and other microwave signals.

HP 83440 Series Unamplified Lightwave Converters and HP 11982A Amplified Lightwave Converter

These products are wide-range optical-to-electrical converters for characterizing SONET/SDH optical waveforms. See page 429 for more information.

S1 Interconnect Analysis System

- Automated measurement, modeling, and simulation in one toolset
- Analyze PC boards, IC packages, connectors and cabling
- Familiar TDR measurement environment

High-speed design requires detailed, accurate interconnect analysis to meet tight timing budgets. The SIS/HP Interconnect Analysis System combines the features of a time-domain reflectometer, network analyzer, and SPICE simulator into an integrated 32-bit Windows 95/NT environment for interconnect evaluation. TDR waveforms are acquired, automatically processed in both time and frequency domains, then translated into SPICE models. A built-in lossy, multiconductor simulator then analyzes the models with I/O receiver/driver information to validate the model and show interconnect performance with respect to overall system specifications. Interconnect applications include PC boards, MCMs, cabling and connectors. Contact Amherst Systems Associates at (413) 596-5354.

Launching and Probing Solutions from Inter-Continental Microwave (ICM)

ICM offers both fixed- and variable-spacing 50-Ω TDR/TDT probe assemblies for launching a TDR pulse into transmission systems under test, such as in a PC board trace. These probes can be handheld or placed in a manipulator. The model A0112322 probe adjusts for spacings between 0.05-inch and 0.176-inch; the A0113734 probe adjusts between 0.14-inch and 1.0-inch. ICM also offers a universal test platform (UTP-3000) with accessories for component and package measurements. Contact Werner Schuerch at ICM, 1515 Wyatt Dr., Santa Clara, CA 95054-1524; (408)727-1596.

HP 54008A 22 ns Delay Line

Viewing the Trigger Signal

The HP 54008A delay line provides 22 ns of delay with a useable frequency response of 20 GHz. By adding this accessory to your HP 54750 oscilloscope system, you will be able to view the trigger event. The HP 54008A has enough delay to view the trigger event with the HP 54118A trigger installed in the trigger path also.

HP 54007A Accessory Kit

Low-Loss Measurements for HP 54750A Oscilloscope Systems

The HP 54007A accessory kit provides an assortment of parts with 3.5-mm connectors. This kit is highly recommended for low-loss reflection and transmission measurements. It also includes semi-rigid coax, formed for use with the HP 11667B power splitter.

Contents of the HP 54007A Accessory Kit

- 17-in (43.18 cm) cable, APC-3.5 (f-f)
- Coaxial short, APC-3.5
- 50 Ω termination, APC-3.5 (m)
- 7.5-cm "airline", APC-3.5 (m-f)
- 6-cm semi-rigid "L", SMA (m-m)
- 6 dB attenuator, APC-3.5 (m-f)
- Adapter, APC-3.5 mm (m-m)
- 17-in (43.18 cm) cable, APC-3.5 (m-f)
- Coaxial short, APC-3.5 mm (m)
- 50 Ω termination, APC-3.5 (f)
- Power splitter, APC-3.5 mm (f)
- 3-cm semi-rigid "L", SMA (m-m)
- 40 dB attenuator, APC-3.5 (m-f)

PicoSecond Pulse Labs 4015B

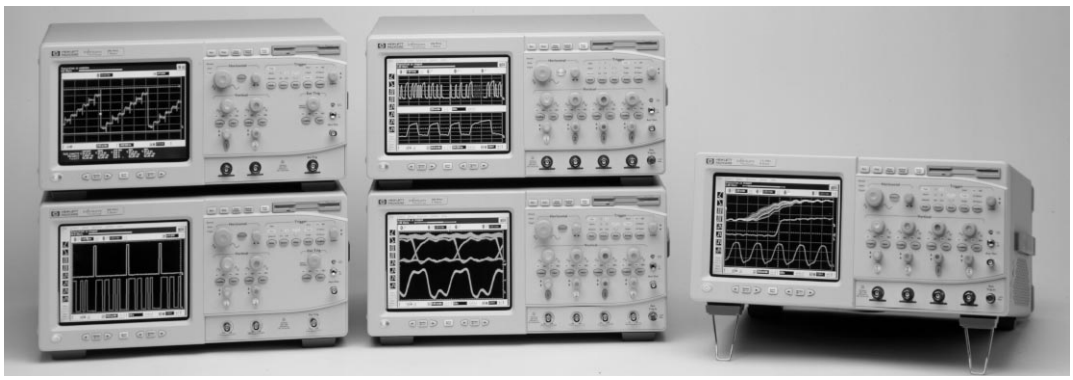
15-ps, 9 V External TDR or TDT Source

The PicoSecond Pulse Labs model 4015B pulse generator extends the TDR/TDT performance of the HP 54750 series oscilloscopes. The pulse generator produces a 15-ps fall time with an amplitude of 9 V, which can be triggered by any HP 54750 series TDR step generator. The HP 1167C power splitter is not included. Contact Dr. Jim Andrews at PSPL, P.O. Box 44, Boulder, CO 80306; (303)443-1249.

Infinium Oscilloscopes

HP 54810A
HP 54815A
HP 54820A
HP 54825A
HP 54845A

- 500-Mhz to 1.5-Ghz bandwidth
- 2- or 4-channel models
- Up to 8 Gsa/s sample rates
- Simple, analog-like front panel
- Windows® 95-based graphical user interface
- Built-in information system



Infinium models 54810A and 54820A, Infinium models 54815A and 54825A, Infinium model 54845A

Performance You Can Use

HP Infinium oscilloscopes combine a simple, analog-like front panel, the graphical user interface of a PC, and a built-in information system, to make high-performance features accessible and uncomplicated. We call it usable performance. We think you'll call it a significant improvement.

Simple Analog-like Front Panel

Infinium high-performance oscilloscopes give you the simple, uncluttered front panel of an analog scope for accessing all basic functions. Dedicated scale and position knobs for each vertical channel provide intuitive scope operation. Trigger LEDs show you trigger status at a glance. To speed up measurements, you can configure the QuickMeas key for instant access to any four measurements. The Default Setup key returns the scope to a known state with one touch—a valuable feature if you share a scope.

Standard Graphical User Interface

Infinium oscilloscopes employ a graphical user interface based on Windows® 95. Because this is a familiar and intuitive user interface, you won't have to spend a lot of time learning and relearning the scope. Pull-down menus give you easy access to advanced features. Dialog boxes display all the choices you need to make for measurement setups. And many functions can be done without accessing the menus. For instance, drag-and-drop measurements, direct manipulation of waveforms and zooming can all be done using the mouse.

Drag-and-Drop Measurements

Just drag and drop an icon from the measurement toolbar onto the portion of the waveform you want to measure and the measurement appears instantly on screen.

Direct Manipulation

Waveforms and markers can be easily moved using simple drag-and-drop mouse operations. Just click on the waveform or marker you want to move, drag it to the new location and drop it. No cumbersome selection through softkeys.

Easy Zooming

Infinium's graphical user interface gives you a new, easier way to zoom. Use the mouse to draw a box around the section of the waveform that you want to expand, then click inside the box to zoom in on the area of interest.

Built-in Information System

Infinium's built-in information system puts measurement assistance at your fingertips. You'll no longer have to look for the manual when you need help setting up scope functions or making complex measurements. A Setup Guide gives you step-by-step instructions for 24 different measurements and procedures. In addition, you'll find a thorough index of help topics and context-sensitive help available from the dialog boxes.

Extra-Large Display

Infinium's high-resolution color display has a waveform viewing area more than double that of many products in its class. Output the scope display to a VGA monitor for an even larger view of your waveforms.

New Triggering

Infinium oscilloscopes include HP violation trigger technology, based on a new trigger IC developed specifically for Infinium. In addition to standard trigger modes, such as edge, glitch, delay, logic, state and video, HP's violation trigger technology adds trigger capabilities, such as rise-time trigger, fall-time trigger, setup and hold-time trigger, and runt trigger.

Waveform Math with FFTs

Infinium oscilloscopes have 12 math functions, including Fast Fourier Transforms. Use FFTs to get a second perspective on your waveforms. This feature helps in identifying noise or other interfering signals, or in determining signal fidelity.

Internal Hard and Floppy Disk Drives

Documentation is simple with built-in disk drives. Use the internal 1.4 GByte hard drive or the 3.5-inch MS-DOS®-compatible high-density floppy disk drive to store waveforms, instrument setups, or screen images. Images can be stored as BMP, EPS, GIF, PCX, or PS files for easy import into various programs for documentation or further analysis.

Standard Interfaces

HP-IB, RS-232, and Centronics interface are standard features. Infinium oscilloscopes are fully HP-IB programmable.

Easy Probing

The AutoProbe interface is an intelligent communication and power link between compatible probes and the Infinium oscilloscope. AutoProbe completely configures the oscilloscope for the probe. It identifies the type of probe attached and sets up the proper input impedance, attenuation ratio, probe power, and offset range if needed. A whole new line of compatible passive, active, and differential probes is available. See the Infinium Probes and Accessories Product Overview for more information (5965-7001).

HP 1160 Family of Miniature Passive Probes

The HP 1160 family of miniature probes was developed as a result of intensive market research on probing. We developed a probe with a browser that won't slip off the test point being probed and short to some adjacent point. The browser uses a crown point that digs in to solder, and won't slip. These probes include a variety of ground leads, and 50 mil SMD clips, for attaching to different grounding points. Each Infinium oscilloscope ships with HP 1160 family passive probes.

HP 1152A 2.5-GHz, 0.6-pF Active Probe

Use the HP 1152A active probe with Infinium model 54845A for the most nonintrusive, faithful reproduction of signals. Even without grounding, this probe accurately reproduces high-frequency edges. HP's breakthrough technology assures minimum loading on your circuit.

Printer Support

Use any printer that has a Windows® 95 driver; that's hundreds of preloaded drivers for printers from over 40 different manufacturers. Also, new drivers can be loaded from a floppy disk.

Clip-on Trackball Option

If you don't have the bench space for a standard mouse, a clip-on trackball option is available. The trackball clips into holes on the side of the instrument.

Keyboard Option

An optional keyboard makes file naming easier if you are archiving waveforms or instrument setups.

Lab Scope Performance

Infinium models 54810A and 54815A offer 1 GSa/s on 2 and 4 channels respectively, for general-purpose lab measurements. The 54820A and 54825A offer 2 GSa/s on 2 or 4 channels for more accurate single shot measurements.

1 ns Peak Detect

With Infinium models 54810/15/20/25A you can use peak detect to improve your measurement confidence when using your scope at slower sweep speeds. Peak detect runs the sampler at a high rate, regardless of the time-per-division setting, so you can see narrow events that would otherwise be missed.

Ultimate Performance

Infinium model 54845A provides the superior bandwidth, and sample rate to accurately capture high-speed signals. 1.5-GHz bandwidth and 8-Gsa/s sampling rate assure your signal will be recorded accurately.

New A/D Technology

Based on new analog-to-digital converter technology developed by HP Labs, Infinium model 54845A interleaves four 4-GSa/s channels to achieve two 8-GSa/s channels of simultaneous, real-time acquisition, with 64-K memory depth on each channel. The Infinium 54845A offers a new level of performance in a highly usable and affordable benchtop package.

Model	Ch.	Bandwidth	Sample Rate	Memory Depth
HP 54810A	2	500 MHz	1 GSa/s	32 K
HP 54815A	4	500 MHz	1 GSa/s	32 K
HP 54820A	2	500 MHz	2 GSa/s	32 K
HP 54825A	4	500 MHz	2 GSa/s	32 K
HP 54845A	4	1.5 GHz	8 GSa/s (2 ch. mode) 4 Gsa/s (4 ch. mode)	64 K (2 ch. mode) 32 K (2 ch. mode)

HP 54810A
HP 54815A
HP 54820A
HP 54825A
HP 54845A

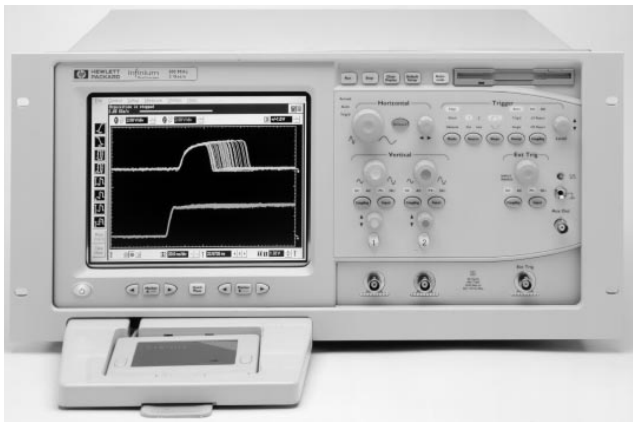
Performance Characteristics	HP 54810A, 54815A, 54820A and 54825A	HP 54845A
Acquisition		
Maximum sample rate, real time	HP 54810A/15A: 1 GSa/s on each channel HP 54820A/25A: 2 GSa/s on each channel	2 channel mode: 8 GSa/s 4 channel mode: 4 GSa/s
Maximum effective sample rate, equivalent time	100 GSa/s	500 GSa/s
Memory depth	32, 768 points/channel	2 channel mode: 65,536 points 4 channel mode: 32,768 points
Averaging	Selectable from 2 to 4096	Selectable from 2 to 4096
Vertical		
Number of channels	HP 54810A/20A: 2 (simultaneous acquisition) HP 54815A/25A: 4 (simultaneous acquisition)	4 (simultaneous acquisition)
Analog bandwidth (–3dB)*	500 MHz	50 Ω: 1.5 GHz; 1 M Ω: 500 MHz (with HP 1161A probe)
System bandwidth with: 1160A 10:1 passive probe 1161A 10:1 passive probe 1162A 1:1 passive probe 1163A 10:1, 500 Ω passive probe 1152A 2.5 GHz, .6pF active probe 1153A 200 MHz differential probe	 500 MHz — 25 MHz 500 MHz 500 MHz 200 MHz	 — 500 MHz 25 MHz 1.5 GHz 1.3 GHz 200 MHz
Real time bandwidth*	HP 54810A/15A: 250 MHz HP 54820A/25A: 500 MHz	50 Ω: 1.5 GHz (2 ch. mode), 1.0 GHz (4 ch. mode) 1 M Ω: 500 MHz
Rise time[1]	HP 54810A/15A: 700 ps (equivalent time); 1.4 ns (real time) HP 54820A/25A: 700 ps	50 Ω : 233 ps 1 M Ω: 700 ps
Sensitivity[2] 1 M Ω 50 Ω	 1 mV/div to 5 V/div 1 mV/div to 5 V/div	 2 mV/div to 2 V/div 2 mV/div to 1 V/div
Input impedance*	1 M Ω ± 1% (≈8 pF), or 50 Ω ± 1%	1 M Ω ± 1% (≈12 pF), or 50 Ω ± 1.5%
Input coupling	dc, ac (7 Hz, available in 1 M Ω only)	dc, ac (7 Hz, available in 1 M Ω only)
Maximum input voltage* 1 M Ω 50 Ω	 ± 250 V (dc + ac) [ac < 10 kHz], CAT I 5 Vrms, CAT I	 ± 100 V (dc + ac) [ac < 10 kHz], CAT I 5 Vrms, CAT I
Hardware bandwidth limit (-3 dB)	On/Off selectable, 30 MHz	N/A
Channel-to-channel isolation (with channels at equal sensitivity)	dc to 50 MHz: 50 dB 50 MHz to 500 MHz: 40 dB	dc to 100 MHz: 40 dB 100 MHz to 1 GHz: 30 dB 1 GHz to 1.5 GHz: 25 dB
Offset range	Vertical Sensitivity — Available Offset 1 mV/div to 50 mV/div — ± 2 V > 50 mV to 250 mV/div — ± 10 V > 250 mV to 1.25 V/div — ± 50 V	Vertical Sensitivity — Available Offset 1M Ω: 2 mv/div to 100 mV/div — ± 4 V > 100 mV/div to 2 V/div — ± 40 V 50 Ω: all — > ± 12 div
Dynamic range	± 12 div from center screen	± 8 div from center screen
Full resolution channel scales	All volts/division settings > = 7 mV/div	10, 20, 50, 100, 200, 500, 1000 mV/div (plus 2000 mV/div in 1 M Ω)
dc gain accuracy *[2,3]	± 1.25% of full scale at full resolution channel scale	± 1% of full scale at full resolution channel scale
Resolution[2] Real time Equivalent time	 8 bits (0.4% of full scale), 12 bits with averaging 8 bits (0.4% of full scale), 12 bits with averaging	 8 bits (0.4% of full scale), 12 bits with averaging 8 bits (0.4% of full scale), 12 bits with averaging
Horizontal		
Main time base range	500 ps/div to 5 s/div	100 ps/div to 5 s/div
Delayed sweep range	1 ps/div to current main time base setting	1 ps/div to current main time base setting
Delayed sweep delay range	Within main time base acquisition record	Within main time base acquisition record
Resolution	10 ps	2 ps
Timebase accuracy	50 ppm (.005%)	70 ppm (.007%)
Delta-t accuracy* Real time mode[4] Equivalent time mode (≥ 16 avgs.) Peak detect mode Example (equivalent time mode (≥ 16 avgs.), 9 ns signal, 1 ns/div, 1 channel)	 ±[(.005%)(delta-t)+(0.2)(sample period)] ±[(.005%)(delta-t)+(full scale/(2 * memory depth)) + 60ps] ±[(.005%)(delta-t)+(1 sample period)] Accuracy = ±[(.005%)(9 ns)+((10 ns)/(2 * 32,768)) + 60ps] = ±[(450 x 10^{-15})+(152 x 10^{-15}) (60 x 10^{-12})] = 61 ps	 ±[(.007%)(delta-t)+(0.2)(sample period)] ±[(.007%)(delta-t)+(full scale/(2 * memory depth))+ 30ps] N/A Accuracy = ±[(.007%)(9 ns)+((10 ns)/ (2 * 65,536)) + 30ps] = ±[(630 x 10^{-15})+(76 x 10^{-15}) +30 x 10^{-12})] = 31 ps

* Denotes warranted specifications, all others are typical. Specifications are valid after a 30-minute warm-up period, and ±10° C (models HP 54810A/15A/20A/25A) or ±5° C (model HP 54845A) from firmware calibration temperature.

	HP 54810A, 54815A, 54820A, and 54825A	HP 54845A
Trigger		
Sensitivity*[2]		
Internal (normal)	dc to 100 MHz: 0.5 div 100 MHz to 500 MHz 1.0 div	dc to 100 MHz: 0.5 div 100 MHz to 500 MHz: 1.0 div 500 MHz to 1 GHz: 1.5 div
Internal (noise reject)	dc to 100 MHz: 1.0 div 100 MHz to 500 MHz: 1.5 div	N/A
External (HP 54810/20A)	dc to 100 MHz: 0.0225 x (signal range) 100 MHz to 500 MHz: 0.045 x (signal range)	N/A
Auxiliary (HP 54815/25/45A)	dc to 500 MHz: 300 mVp-p	dc to 500 MHz: 300 mVp-p
Maximum input voltage*		
External (HP 54810/20A)	1 M Ω ±250 V (dc + ac) [ac<10 kHz], CAT II, 50 Ω: 5 Vrms, CAT I	N/A
Auxiliary (HP 54815/25/45A)	2.5 kΩ: ±15 V, CAT I	2.5 kΩ: ±15 V, CAT I
Min. pulse width (internal, external)	1 ns at > 1.0 div	500 ps at > 1.0 div
Level range		
Internal	± 12 div from center screen	± 8 div from center screen
External (HP 54810/20A)	± 1 V, ± 5 V, ± 25 V	N/A
Auxiliary (HP 54815/25/45A)	± 5 V	± 5 V
Sweep modes	Auto, triggered, single	
Trigger coupling	dc, ac (7Hz), low frequency reject (50 kHz), high frequency reject (50 kHz)	
Trigger holdoff range	60 ns - 320 ms	
Trigger modes	Edge, Glitch, Pattern, State, Delay by Time, Delay by Events, Violation (Runt, Setup/Hold Time, Pulse Width, Transition), Video, Line	
Display		
Display	8.4 inch diagonal color active matrix LCD module incorporating amorphous silicon TFTs	
Active display area	6.73"x 5.04" (33.92 sq. in.), 171 mm x 128 mm (21,888 sq. mm)	
Persistence	Minimum, Variable (up to 6 levels of gray scale, 100 ms to 40 s), Infinite	
Display update rate	Waveforms/sec > 300	Waveforms/sec > 800
Measurements		
Automatic parametrics	27 automatic measurements	
Statistics	On/Off selectable. Current measurement, mean and standard deviation	
Measurement toolbar	16 drag-and-drop automatic measurement icons	
QuickMeas	Activates 4 preselected automatic measurements	
Markers modes	Manual Markers, Track Waveform Data, Track Measurements	
Waveform math	4 functions f1-f4. Select from Add, Subtract, Multiply, Divide, Invert, Magnify, Vs, Min., Max., Integrate, Differentiate, FFT magnitude	
FFT		
Frequency range[5]	54820A/54825A: dc to 1 GHz (Sample rate/2) 54810A/54815A: dc to 500 MHz (Sample rate/2)	2 channel mode: dc to 4 GHz (Sample rate/2) 4 channel mode: dc to 2 GHz (Sample rate/2)
Frequency resolution	Sample rate/memory depth	
Frequency accuracy	(1/2 frequency resolution) + ($5x10^{-5}$) (signal freq.)	(1/2 frequency resolution) + ($7x10^{-5}$) (signal freq.)
Signal-to-noise ratio	70 dB at 32K memory depth. Noise floor varies with memory depth and with averaging.	
Window modes	Hanning, flattop, rectangular	
Computer System/ Storage		
CPU	AMD-K5™ PR 133 microprocessor	
Disk drives	1.4 GByte internal hard drive. Storage capacity is limited only by disk space. 3.5" MS-DOS® compatible, high-density, floppy disk drive. Store and recall setups, waveforms, and store screen images to both hard drive and floppy drive.	
File types		
Waveforms	Internal, verbose, Y values	
Images	BMP, EPS, GIF, PCX, PS (Postscript)	
Mouse	Standard mouse supplied. Supports any Microsoft® mouse-compatible pointing device, serial or PS/2.	
Waveform memories	4 nonvolatile waveform memories	
I/O		
HP-IB	Fully programmable, complies with IEEE 488.2	
RS-232	2 ports: COM1, COM2. Printer and pointing device support	
Centronics	Printer support	
Printers and plotters	Supports all printers and plotters compatible with Microsoft Windows® 95. Includes but is not limited to HP DeskJet- and LaserJet-series printers. HP-IB devices not supported.	
Video output	15 pin VGA, full color	

[1] Rise time figures are calculated from tr = 0.35/bandwidth.
[2] HP 54810A/15A/20A/25A: Magnification is used below 7 mV/div range. Below 7 mV/div, full scale is defined as 56 mV. HP 54845A: Magnification is used below 10 mV/div range and between major attenuation settings. Full scale is defined as the major attenuator setting above an intermediate setting. (Major settings 50 Ω: 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 500 mV, 1 V, 1 M Ω: all of the above plus 2 V)
[3] HP 54810A/15A/20A/25A: The dc gain accuracy decreases 0.08% of full scale per degree Celsius from the firmware calibration temperature.
[4] For bandwidth limited signals, tr >=1.4 x sample interval
[5] FFT amplitude readings are affected by input amplifier roll-off; HP 54810A/15A/20A/25A: –3 dB at 500 MHz, with amplitude decreasing as frequency increases above 500 MHz. HP 54845A: –3 dB at 1.5 GHz, with amplitude decreasing as frequency increases above 1.5 GHz.

HP E2609A
HP E2610A
HP E2611A
HP E2612A



HP E2609A Rackmount Kit

3

The rackmount kit provides a support shelf and hardware for mounting HP Infinium oscilloscopes into EIA standard 19-in (487 mm) rack cabinets. When installed, the instrument occupies 5 vertical increments [8.75 in (222 mm)]. Each kit includes a support shelf, 2 rackmounts rails, 1 TouchPad (E2612A), 2 brackets, hardware, and a user's reference.

HP E2611A Clip-on Trackball

If you don't have the bench space for a standard mouse, a clip-on track-ball is available for Infinium oscilloscopes. The trackball clips into holes on the instrument. The driver for the clip-on trackball is pre-installed in the Infinium oscilloscope.

HP E2610A Keyboard

The HP E2610A keyboard is a small keyboard for use with HP Infinium oscilloscopes. The keyboard makes file naming easier if you are archiving waveforms or instrument setups. You'll appreciate the small size of this keyboard for use on your bench or an oscilloscope cart. The cable has an AT connector.

HP E2612A Touchpad

The HP E2612A Touchpad has a touch surface that gives you complete control of your scope with just the tip of your finger. The driver for the Touchpad is pre-installed in the Infinium oscilloscope.

Ordering Information

HPE2609A Rackmount kit
HPE2610A Keyboard
HPE2611A Clip-on Trackball
HPR2612A Touchpad

Oscilloscope/Probe Compatibility

Oscilloscope	High Impedance Passive Probes	Active	Differential	High Voltage	High Impedance 1:1 Probe	Low Z, 50 Ohm
HP 54720D	10430A (10X) 1m, 10441A (10X) 2m	54701A	1141A/1142A	1137A	10438A (1X) 1m, 10439A (1X) 2m	54006A,10020A
HP 54750A	N/A	54701A	1141A/1142A[1]	N/A	N/A	54006A,10020A
HP 54600/1/2/3A/B	10071A (10X) 1.5m, 10440A (100X) 2m	N/A	1141A/1142A w/ 50 Ohm term	1137A	10070A (1X) 1.5m	N/A
HP 54610A/B/15B/16B	10073A (10X) 1.5m , 10444A (10X) 1.6m, 10431A (10X) 1m	1144A[2] 1145A[2]	1141A/1142A	1137A	10070A (1X) 1.5m	10437A (1X) 2m, 10442A (10X)
HP 54645A/D	10074A (10X) 1.5m, 10440A (100X) 2m	N/A	1141A/1142A	1137A	10070A (1X) 1.5m	N/A
HP 54501A	10432A (10X) 1m, 10433A (10X) 2m	N/A	1141A/1142A	1137A	10438A (1X) 1m, 10439A (1X) 2m	N/A
HP 54502/03/04/10A/10B/12B	10430A (10X) 1m, 10440A (100X) 2m , 10441A (10X) 2m	1144A[2] 1145A[2]	1141A/1142A	1137A	10438A (1X) 1m, 10439A (1X) 2m	10437A (1X) 2m, 10442A (10X)
HP 54520/22/40/42A/C	10441A (10X) 2m, 10430A(10X) 1m, 10440A(100X), 2m	1144A 1145A	1141A/1142A	1137A	10438A (1X) 1m, 10439A (1X) 2m	10437A (1X) 2m, 10442A (10X)
HP 54200/01A/D	10432A (10X) 1m, 10433A (10X) 2m, 10435A (10X) 1m, 10440A (100X) 2m	N/A	1141A/1142A	1137A	10438A (1X) 1m, 10439A (1X) 2m	N/A
HP 54111/112D	10431A (10X) 1m, 10440A (100X) 2m, 10441A (10X) 2m, 10444A (10X) 1.6m	1144A[2] 1145A[2]	1141A/1142A	1137A	10438A (1X) 1m, 10439A (1X) 2m	10437A (1X) 2m, 10442A (10X)
HP 1715/22/25/26/27	10432A (10X) 1m, 10435A (10X) 1m, 10440A (100X) 2m	1144A[2] 1145A[2]	1141A/1142A	1137A	10438A (1X) 1m, 10439A (1X) 2m	10437A (1X) 2m, 10442A (10X)
HP 1740/41/42/43/44/45/46A	10434A (10X) 1m, 10436A (10X) 2m	N/A	1141A/1142A w/ 50 Ohm term	1137A	10438A (1X) 1m, 10439A (1X) 2m	10437A (1X) 2m, 10442A (10X) 2m
HP 54121/22/23/24T	N/A	54701A[1]	1141A/1142A[1] w/ 50 Ohm term	N/A	N/A	54006A,10020A
HP 54810/15/20/25A	1160A (10X) 1.5m	1144A[2], 1145A[2] or 1152A	1153A	1137A	1162A	1163A (10X) 1.5m
HP 54845A	1161A (10X) 1.5m	1152A	1153A	1137A	1162A	1163A (10X) 1.5m

[1] Probe is not commensurate with scope bandwidth.
[2] 1142A probe power supply is needed for use with any scopes but HP 54520/22/40/42A/C or HP 54615B/16B.

HP 10070 Passive Divider Probe Family

The HP 10070A family are rugged, general-purpose probes designed to operate with the HP 54600 family of oscilloscopes. This family provides a range of high-quality probing solutions at a very reasonable price.

These reliable probes come with 1 retractable hook tip, 8 color identification tags, 1 ground bayonet, 1 IC Tip, 1 adjustment tool, and 1 ground lead.

See pages 114 and 115 for compatible SMT probing kit.

HP 10070A Passive Divider Probe Series

Model	Length	Division ratio	Circuit loading (1 MΩ scope input)	Typical scope bandwidth	Compensates oscilloscope input
10070A	1.5 m	1:1	1 MΩ; 70 pF	20 MHz	High Impedance
10071A	1.5 m	10:1	10 MΩ; 15 pF	150 MHz	1 MΩ; 9 to 17 pF
10073A	1.5 m	10:1	1 MΩ; 12 pF	500 MHz	1 MΩ; 6 to 15 pF
10074A[3]	1.5 m	10:1	10 MΩ; 15 pF	150 MHz	1 MΩ; 9 to 17 pF

[3] Probe ID pin

Other HP 10070 Series Probe Accessories

Accessory	HP p/n
Probe tip to BNC (m) adapter	5081-7705
Replacement parts accessory kit	5081-7690

Other Accessories

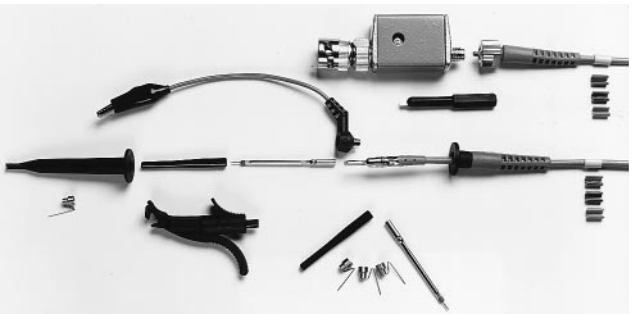
Accessory	HP p/n
BNC 50 Ω feedthrough	10100C
BNC 75 Ω feedthrough	11094B
BNC AC blocking capacitor	10240B
BNC (m) to single banana jack	1250–1263
Dual banana to BNC (m)	10110B
Dual banana to BNC (f)	1251-2277

HP 10400A Passive Divider Probe Family

The HP 10400A mini-probe family offers modular construction, superior electrical performance, and high reliability. Modular construction allows individual replacement of probe tips, cables, and chassis assemblies which reduces repair costs. Its narrow, sharp probe tip is excellent for probing surface-mount devices.

This family has a complete set of accessories that complement today's large variety of probing needs. Each HP 10400A family probe is shipped with one general-purpose retractable hook tip and one ground lead. An accessory package is also included, which contains 4 grounding spanners (for close grounds at the probe tip), 1 probe barrel insulator, 1 adjustment screwdriver, and 8 colored cable markers.

See pages 114 and 115 for compatible SMT probing kits. For complete specifications, see HP p/n 10400-90901.



HP 10400A Passive Divider Probe Series

Model	Length	Division ratio	Circuit loading (1 MΩ scope input)	Typical scope bandwidth	Compensates oscilloscope input
10430A	1 m	10:1	1 M Ω; 6.5 pF	500 MHz	1 M Ω; 6 to 9 pF
10431A[3]	1 m	10:1	1 M Ω; 6.5 pF	500 MHz	1 M Ω; 6 to 9 pF
10432A	1 m	10:1	10 M Ω; 7.5 pF	300 MHz	1 M Ω; 10 to 16 pF
10433A	2 m	10:1	10 M Ω; 10 pF	300 MHz	1 M Ω; 10 to 16 pF
10434A	1 m	10:1	10 M Ω; 8.5 pF	100 MHz	1 M Ω; 18 to 22 pF
10435A	1 m	10:1	1 M Ω; 7.5 pF	300 MHz	1 M Ω; 10 to 16 pF
10436A	2 m	10:1	10 M Ω; 11 pF	100 MHz	1 M Ω; 18 to 22 pF
10437A	2 m	1:1	50 Ω	1 GHz	50 Ω
10438A	1 m	1:1	40 pF	See note 2	High Impedance
10439A	2 m	1:1	64 pF	See note 2	High Impedance
10440A	2 m	100:1	10 M Ω; 2.5 pF	300 MHz	1 M Ω; 6 to 14 pF
10441A[1]	2 m	10:1	1 M Ω; 9.0 pF	500 MHz	1 M Ω; 6 to 9 pF
10442A	2 m	10:1	500 Ω; 1.2 pF	1 GHz	50 Ω
10444A	1.6 m	10:1	1 M Ω; 9.0 pF	500 MHz	1 M Ω; 6 to 15 pF
54006A	3 ft	10:1 or 20:1	500 Ω or 1k Ω; 0.25 pF	up to 6 GHz	50 Ω; SMA

[1] Probe ID pin
[2] These probes can be used with many different oscilloscopes, however because of the high capacitance, there will be bandwidth degradation.

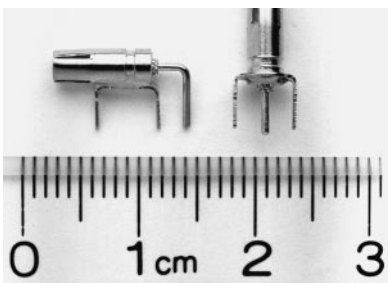
Other HP 10400 Series Probe Accessories

Accessory	HP p/n
General-purpose retractable hook tip	5061-6160
Ground lead	5061-6162
Accessory package: 4 grounding spanners, 1 probe barrel insulator, 1 adjustment tool, 8 colored wire markers	5061-6163
BNC (m) to probe tip adapter	1250-1454

HP 10400 Series Replacement Probe Tip Assemblies

Probe	HP p/n	Color
HP 10430A HP 10431A	5061-6145	white
HP 10433A	5061-6146	blue
HP 10434A	5061-6150	brown
HP 10435A	5061-6147	green
HP 10440A	5061-6148	yellow
HP 10437A HP 10438A HP 10439A	5061-6149	black
HP 10432A	5061-6151	red
HP 10436A	5061-6152	orange
HP 10441A HP 10444A	5061-6153	purple

HP 1250-2427 and HP 1250-2428 PC Board Mini-Probe Sockets

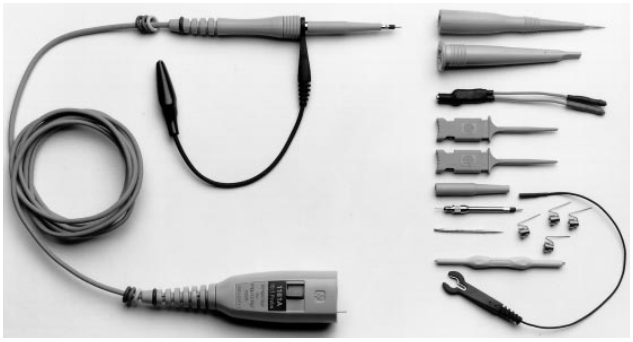


The HP PC board mini-probe sockets are ideal for reliable, stable, and convenient connection between the 10400 family probe tip and the circuit under test. The HP 1250-2427 horizontal PC board mini-probe replaces HP 1250-1737. The HP 1250-2428 vertical PC board mini-probe socket replaces HP 1250-1918.

Ordering Information

HP 1250-2427 Horizontal Mini-Probe Socket
HP 1250-2428 Vertical Mini-Probe Socket

HP 1160A Family Miniature Passive Probes NEW



The HP 1160 family of miniature probes are reliable general-purpose probes for use with Infinium Oscilloscopes (HP 54800 series). The HP 1160 family probes include a no-slip browser with a crown point that digs in to solder, and won't slip. The pogo pin allows hand movement without losing contact.

A variety of grounding accessories are included. An alligator ground lead for general-purpose probing, 4 spring grounds for high frequency measurements, a socketed ground lead and 2 SMD IC clips for probing 50 mil SMD. Also included is a dual lead adapter so that both the probe tip and ground can be connected to SMD devices. For connection to 0.5 mm–0.8 mm devices, order the 10467-68701 0.5 mm IC clips.

The HP 1160 family probes are built and tested for high reliability. The cable has a kevlar strengthener for added pull strength. The general-purpose retractable hook tip has a durable music wire hook. And probe tips are replaceable.

The miniature probe has a narrow, sharp tip that is good for probing SMD. To fully miniaturize the probe, unscrew the handle and pull it back on the cable.The HP 1160 family probes are compatible with the AutoProbe Interface, which completely configures the Infinium Oscilloscope for the probe.

Model	Type of probe	Length	Division ratio	Circuit loading	System bandwidth (scope and probe)	Oscilloscope input
HP 1160A	High Impedance, Passive	1.5 m	10:1	10 MOhm, 9pF	500 MHz[1]	1 MOhm, 6-9 pF
HP 1161A	High Impedance, Passive	1.5 m	10:1	10 MOhm, 10 pF	500 MHz[2]	1 MOhm,12-14 pF
HP 1162A	High Impedance, Passive	1.5 m	1:1	1 MOhm, 50 pF +scope input	25 MHz[3]	1 MOhm
HP 1163A	500 Ohm Resistive Divider	1.5 m	10:1	500 Ohm, 1.5 pF	1 GHz[2]	50 Ohm

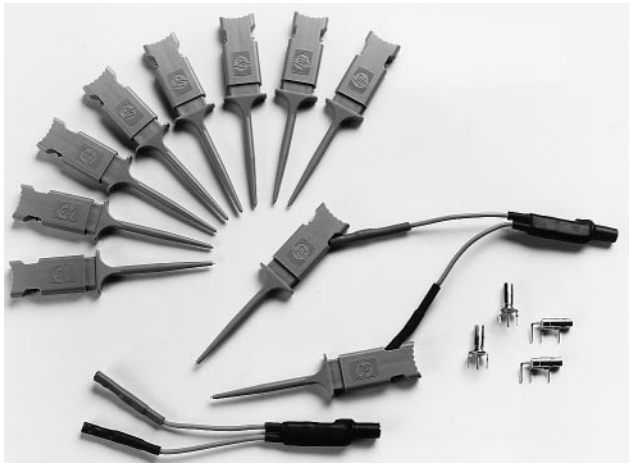
[1] System bandwidth with 54810A/15A/20A/25A
[2] System bandwidth with 54845A
[3] System bandwidth with all Infinium scopes

HP 1160 Family Replacement Parts

HP p/n	Description	Qty
5063-2115	Browser	1
5063-2120	Socketed ground lead	1
5063-2135	General-purpose retractable hook tip	2
5063-2140	Alligator ground lead	2
5063-2147	Dual lead adapter	1
5063-2149	SMD IC clips	5
01160-68701	Accessory kit: 4 spring grounds, 4 browser pogo pins, 4 barrel insulators, 1 screwdriver	1
5063-2136	HP 1160A probe tip	5
5063-2137	HP 1161A probe tip	5
5063-2138	HP 1162A probe tip	5
5063-2139	HP 1163A probe tip	5

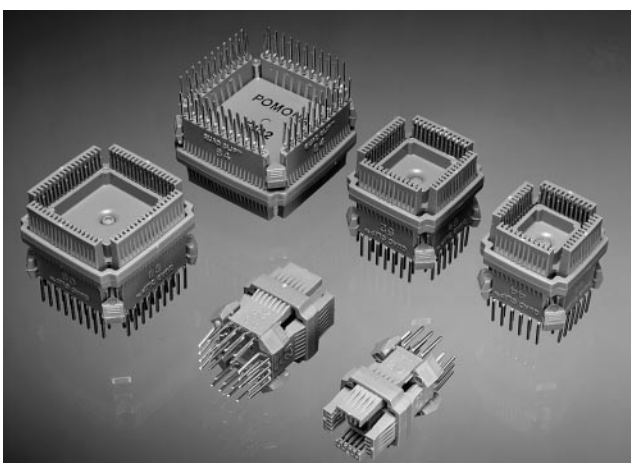
Other Accessories

HP p/n	Description	Qty
10467-68701	0.5 mm IC clips for SMT parts with lead spacings of .5 mm (.020 in) to .8 mm (.032 in)	1



HP 10450A SMT Probe Accessory Kit

Assorted accessories include 10 SMT lead IC clips that interface the HP 10400 series miniature probes to the fine-pitch circuitry.

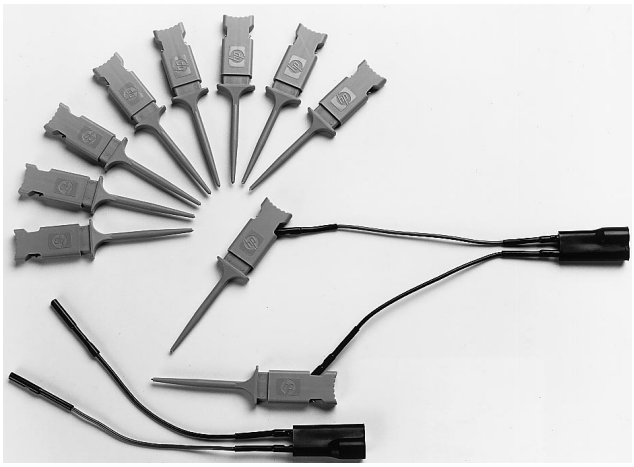


HP E2422A

HP E2422A Quad Clip® Adapter Kit

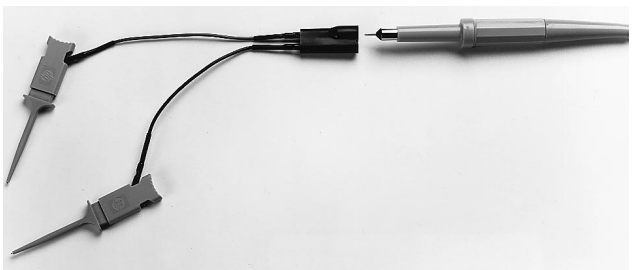
The HP E2422A contains clips for 20, 28, 44, 52, 68, and 84-pin PLCC devices. These clips quickly lock onto J-leaded PLCCs or PCCs providing easy-probing access.

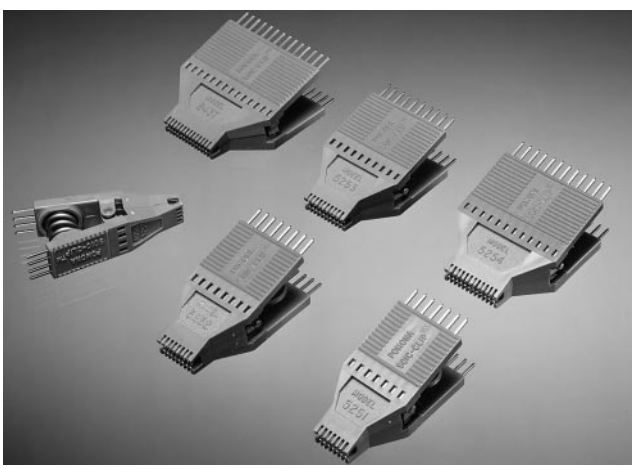
Quad Clip® is a trademark registered and owned by ITT Industries, Inc., ITT Pomona



HP 10072A SMT Probe Accessory Kit

The HP 10072A includes 10 SMT lead IC clips which adapt the 10070A family of low-cost probes to fine-pitch devices.





HP E2421A

HP E2421A SOIC Clip® Adapter Kit

The HP E2421A contains clips for 8, 14, 16, 20, 24, and 28-pin SOIC devices.

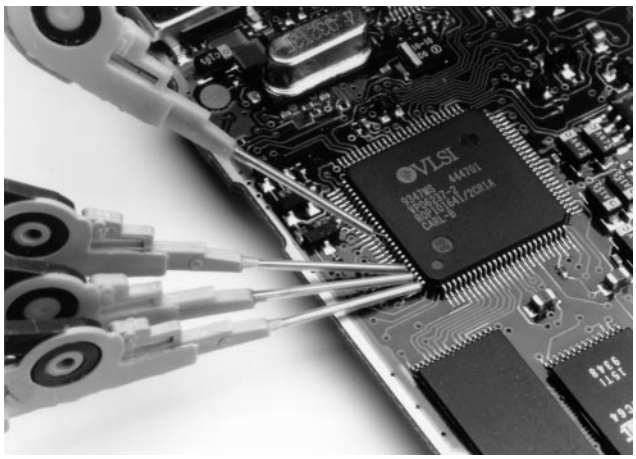
SOIC Clip® is a trademark registered and owned by ITT Industries, Inc., ITT Pomona

Ordering Information

HP 10450A SMT Probe Accessory Kit
HP 10072A SMT Probe Accessory Kit
HP E2422A Quad Clip® Adapter Kit
HP E2421A SOIC Clip® Adapter Kit

- Smallest IC clips in the industry to date
- Probe PQFP and SOIC SMT packages from .5 mm –.8 mm lead pitch
- Thin-clip body allows many PQFP clips to be mounted side by side
- Use with HP oscilloscopes, mixed-signal oscilloscopes, and logic analyzers

New 0.5 mm IC Clips



10467-68701 0.5 mm IC Clips

Use these IC clips with the HP 1144A and HP 1145A active oscilloscope probes, the HP 54645D mixed-signal oscilloscope, the HP 54620A/C logic analyzers, as well as other HP logic analyzers. Maximum-input voltage is ± 40 V (dc + peak ac).

HP 10075A 0.5 mm IC Clip Accessory Kit

HP 10467A 0.5 mm IC Clip Accessory Kit

HP 10075A 0.5 mm IC Clip Accessory Kit
This kit includes four 0.5 mm IC clips (10467-68701) and two dual-lead adapters (8710-2063) for use with the HP 10070 family probes. Plug the probe tip into one end of the adapter, and connect the IC clips to the other end.

HP 10467A 0.5 mm IC Clip Accessory Kit
This kit includes four 0.5 mm IC clips (10467-68701) and two dual-lead adapters (5081-7742) for use with the HP 10400 family probes. Plug the probe tip into one end of the adapter, and connect the IC clips to the other end.

Ordering Information

HP 10467-68701 .5 mm IC Clips
Includes: Qty 4, 0.5 mm IC Clips
HP 10075A 0.5 mm IC Clips
HP 10467A 0.5 mm IC Clips

HP 1141A Differential Probe with HP 1142A Power Supply

The HP 1141A is a 1X FET differential probe with 200 MHz bandwidth and 3000:1 CMRR (Common Mode Rejection Ratio). The probe has a high-input resistance of 1 MΩ and low-input capacitance of 7 pF to minimize circuit loading. The HP 1141A must be used with the HP 1142A probe control and power module. It is designed for use with instruments having 50 Ω inputs.

The HP 1142A probe control and power module controls input coupling modes dc, dc with variable offset, and dc reject. The offset capability allows viewing of very small signals on large dc components without attenuating the ac low-frequency components or causing sag from ac coupling. In automated test applications the coupling modes can be controlled remotely. Two attenuators, 10X and 100X, are provided to expand the linear differential input range to ±30 V.

HP 1153A 200 MHz Differential Probe

The 1153A is a 200 MHz Differential Probe for use with HP Infinium Oscilloscopes. It is a 1X FET differential probe with 200 MHz bandwidth and 3000:1 CMRR (Common Mode Rejection Ratio). The probe has high-input resistance of 1 MOhm and low-input capacitance of 7 pF to minimize circuit loading. The 1153A is compatible with the AutoProbe Interface which provides power and completely configures the Infinium Oscilloscope for the probe.

Input coupling modes include dc, dc with variable offset, and lf reject. The offset capability allows viewing of very small signals on large dc components without attenuation the ac low-frequency components or causing sag from ac coupling. Two attenuators, 10X and 100X, are provided to expand the linear differential input range to ± 30V.

Ordering Information

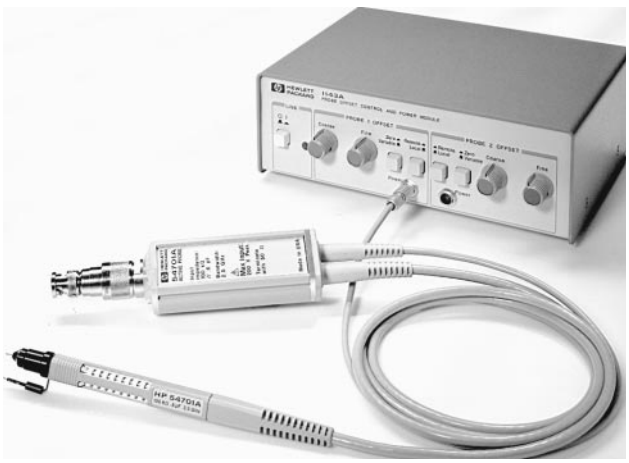
HP 1141A 200 MHz Differential Probe
HP 1142A Power Supply
HP 1153A 200 MHz Differential Probe

HP 1144A 800 MHz Active Probe

The HP 1144A features 800-MHz bandwidth, 1 MΩ input resistance, 2 pF input capacitance, 10:1 attenuation, and ±40 Vdc + peak ac maximum-input voltage. The HP 1144A can access power directly from the HP 54520 and HP 54540 series and the HP 54615B and HP 54616B oscilloscopes. These oscilloscopes provide power for two channels of active probing. If four channels of probing are needed, a special one-input, two-output adapter is available (p/n 01144-61604). Two adapters are needed for four channels of probing. If the HP 1144A is used with any scope not listed above, then the HP 1142A power supply is required. The HP 01144-61604 adapter can be used with this power supply to provide power for two channels of active probing.

HP 1145A Two-Channel, 750 MHz, Small-Geometry Active Probe for Surface-Mount Devices

The two-channel HP 1145A provides easy and reliable connection to SMDs, while delivering active probe performance down to the tip. The probe combines high bandwidth (750 MHz), high-input resistance (1 MOhm), and low-input capacitance (2 pF). This combination is superior to that of passive divider probes that have higher input capacitance because it provides minimal circuit loading. A versatile set of accessories lets you probe 0.050-inch SMD packages. Order the 10467-68701 0.5 mm IC clips for fault-free probing of SMT packages as fine as 0.5 mm lead pitch. This probe can access power directly from the HP 54520/40 series, and the HP 54615B/16B oscilloscopes. The HP 1142A power supply is required for all other instruments. This configuration requires 50 Ohm vertical inputs.



HP 1152A 2.5 GHz, 0.6 pF Active Probe NEW

The 1152A's 0.6 pF, 100 kOhm input provides ultra low loading of the device-under-test, making it an ideal companion for the HP 54845A 1.5 GHz Infinium Oscilloscope. Its 40 Vac maximum input voltage, ± 15 kV ESD tolerance, and replaceable probe tips make the HP 1152A extremely reliable. The 1152A is compatible with the AutoProbe Interface which provides power and completely configures the Infinium Oscilloscope for the probe.

HP 54701A 2.5 GHz, 0.6 pF Active Probe with 1143A Probe Offset and Power Module

The HP 54701A 2.5 GHz, 10:1 active probe provides ultra-low loading on a device-under-test because of its low 0.6 pF capacitive loading and its high 100 k Ω resistive loading. Its 200 Vac maximum-input voltage, ±15 kV ESD tolerance, and replaceable probe tips make the HP 54701A the most reliable active probe ever manufactured.

The HP 1143A probe offset and power module provides power for two HP 54701A probes with any instrument with 50 Ω input impedance. The power supply is not required if the probe is used with the HP 54700 series scopes.

Ordering Information

HP 1144A 800 MHz Active Probe
HP 01144-61604 Adapter (1144A)
HP 1145A 2 Channel, 750 MHz, Active Probe
HP 1152A 2.5 GHz, 0.6 pF Active Probe
HP 54701A 2.5 GHz, 0.6 pF Active Probe
HP 1143A Probe Offset and Power Module

HP 1137A
HP 1146A
HP 54006A
HP 1181A
HP 1182A
HP 1183A

HP 1137A High-Voltage Divider Probe

The HP 1137A 1000:1 high-voltage divider probe is designed for use with any oscilloscope having input resistance of 1 MΩ (±1%) and input capacitance between 6 and 50 pF. The HP 1137A is a 1000:1 divider probe with 5 kV maximum-input voltage. The bandwidth of the HP 1137A is 1 MHz with a rise time of approximately 350 ns. The input impedance is 500 MΩ shunted by approximately 3 pF capacitance. The maximum-input voltage is dc voltage of 5 kV, ac voltage is 5 kV rms (0 to 250 kHz), and 2.5 kV rms (250 kHz to 1 MHz). The HP 1137A has two operating modes: 1 MΩ mode for oscilloscopes with 1 MΩ ±1% input and 10 MΩ mode for oscilloscopes with 10 MΩ ±1% input.

HP 1146A Oscilloscope AC/DC Current Probe

This AC/DC current probe expands oscilloscope applications into industrial, automotive or power environments, and is ideal for analysis and measurement of distorted current waveforms and harmonics. This probe permits accurate display and measurement of currents from 100 mA to 100 A rms, dc to 100 kHz without breaking into the circuit. The 1146A uses Hall-effect technology to measure ac and dc signals. Compatible with any scope or voltage measuring instrument with BNC input, 0.2 to 0.5 V/div, and a minimum input impedance of 1 MOhm. 1 mV/100 mA Range; Output Signal: 10 mV/A ac/dc. 1mV/10mA Range; Output Signal: 100 mV/A ac/dc. Working Voltage: 660 V max., Battery: 9 V alkaline.

HP 54006A 6-GHz Passive Divider Probe

The low 0.25 pF input capacitance and sophisticated ground design of the HP 54006A probe lets you probe multi-GHz systems with minimal loading of the circuit-under-test. The small size of this probe also allows you to access very small components. The HP 54006A is supplied with 10:1, 500 Ω, and 20:1, 1 k Ω resistive dividers.

HP 1183A

HP 1181A, 1182A, and 1183A Testmobiles

The HP 1181A is for larger instruments, such as the HP 54700 series oscilloscopes and HP network and spectrum analyzers. The HP 1182A is an inexpensive testmobile designed for HP 54500 and 54200 series oscilloscopes and HP 165X series of logic analyzers. For more information, see page 568.

The HP 1183A was developed specifically for the HP 54600 family of oscilloscopes and the HP 54620A logic analyzer. The instrument attaches to the cart via a convenient locking system which avoids the usual nylon strap. The tray that holds the instrument can be tilted and locked into position with a pin and socket mechanism. The tray is designed with a convenient probe holder.

Ordering Information

HP 1137A 1000:1 High Voltage Divider Probe
HP 1146A Oscilloscope AC/DC Current Probe
HP 54006A 6-GHz Passive Divider Probe
HP 1181A Testmobile
HP 1182A Testmobile

HP LogicDart Advanced Logic Probe

HP E2310A

- Logic monitor (high, low, toggling, tristate)
- 3 ½ digit dc voltage to 35 volts
- 3 channels of 100 MSa/s timing analysis, 2048 samples per channel
- 33 MHz frequency counter
- Measure continuity and resistance
- Check diodes

First-Level Troubleshooting

The HP LogicDart (HP E2310A)

A "personal digital troubleshooting tool" for bench and field-site work—LogicDart takes logic probe capabilities to an unprecedented level of sophistication. It's an advanced logic probe that not only performs basic logic monitoring, but also tests continuity, dc voltage, frequency, and does timing analysis. Quickly check digital systems for stuck bits, tri-state conditions, proper supply voltages, clock distribution, shorts, opens, pulse width, clock symmetry, bus contention, skew, setup and hold time violations, and propagation delays. This eliminates the hassle of switching tools and keeps you focused on solving problems while doing first-level troubleshooting.

Form Enhances Function

You no longer have to fumble around hooking up different probes for different instruments. And HP LogicDart's precise probe tip allows you to confidently probe fine-pitch surface mount circuitry. LogicDart easily supports multiple locations and even hard-to-access worksites. Conveniently control display viewing distance and angle while using magnifiers and microscopes.

Three Channels of Timing

In the Analyze function, you can look at up to three channels of logic activity simultaneously. You can trigger on edge, pattern, or edge/pattern combinations. And with 100 MSa/s, you will have up to 10 ns resolution. Movable cursors and pan-and-zoom allow you to easily measure the time between different events. Logic levels are displayed as high, low, or tristate.

Logic Monitoring

Logic activity is clearly displayed by two LEDs, plus an audible beeper. You can check for high, low, and toggling. Plus, you can select several different logic families, including TTL, CMOS, and ECL. Or you can set up your own thresholds for custom logic.

DC Voltage and Frequency

Check out power supplies and clocks quickly. Both dc voltages and frequency are displayed simultaneously, without needing to switch modes. You can measure up to 35 volts with 3 ½ digits of resolution, and frequencies up to 33 MHz.

Resistance, Diode Test, and Continuity

Check for opens, shorts, and misloads using HP LogicDart. More than just continuity, you get resistance measurements, plus the ability to check diodes.

Compare Waveforms

Compare a known good waveform to a second waveform, and HP LogicDart will indicate any of the 2048 points that are different.

Save and Recall

You can store up to ten waveform displays, and later recall them for further analysis or comparison.

Optional Printer

An optional HP portable printer gives you hard copy of the waveforms you have been monitoring using HP LogicDart.

Get a free measurement demo of LogicDart at our website at (http://www.hp.com/info/LogicDart). This robust website is an experiment in state-of-the-art website design. Please experience this website and let us know if it makes the grade. Complete specifications available at the website.

Specifications

Input Characteristics (all channels): 1 MΩ, approx. 13 pF, maximum 40 V to ground

DC Voltage (3 ½ digits):
- **Accuracy:** ±(0.5% of reading + 2 counts)* at 23° C ± 5° C
- **Range:** ±35.00 V
- **Temperature Coefficient:** Accuracy x 0.1/°C (for dc voltage and resistance) (0° C to 18° C, 28° C to 55° C)

Resistance
- **Accuracy:** 0.00 kΩ to 1.19 kΩ: ± (1.5% of reading + 1 count); 1.2 kΩ to 11.9 kΩ: ± (2.0% of reading + 1 count); 12 kΩ to 120 kΩ: ± (7.9% of reading + 1 count)

Continuity
- **Threshold:** 80 Ω minimum, 140 Ω typical

Frequency
- **Accuracy:** ± (0.1% of reading + 1 count)
- **Display:** 1 Hz to 9 Hz: one digit; 10 Hz to 99 Hz: two digits; 100 Hz to 33.0 MHz: three digits

Logic Monitor
- **Sample Rate:** 100 MSa/s
- **States:** High, low and tri-state indicators**
- **Glitch Detect:** ≥ 15 ns

Timing Analyzer
- **Maximum Sample Rate:** 100 MSa/s
- **Number of Channels:** 3
- **Number of Samples:** 2048 per channel
- **Triggering Modes:** Edge, pattern, edge/pattern combination
- **Trigger Glitch Detect:** ≥ 15 ns
- **Minimum Input:** 0.50 V p-p
- **Time Base Range:** 10 ns/div to 20 s/div
- **Cursor Accuracy:** ±(1 sample period + 2 ns + 0.1% of reading)
- **Dual Threshold Range:** ±8.20 V

Dual Threshold Accuracy:

Logic Family	High Min	High Max	Low Min	Low Max
TTL, 3.3V CMOS	1.65 V	2.40 V	0.40 V	1.52 V
5 V CMOS	3.23 V	4.50 V	0.50 V	1.84 V
ECL**	–1.50 V	–1.00 V	–1.60 V	–1.11 V
USER 1, USER 2	High –e***	High	Low	Low + e***

* For USER 1 and USER 2: ±(0.5% of reading + 5 counts).
** Tri-state is not defined for the ECL logic family.
***e = 0.2 x (High – Low) + 0.43 (high and low threshold will never overlap for the same channel)

Power Supply
- **Battery:** 3 x 1.5 V AA alkaline (R6/LR6) or AA lithium batteries (FR6/15LF)
- **Battery Life:** 15 to 20 hours typical for alkaline batteries (depending on use)
- **AC Adapter:** Included

Physical
- **Dimensions:** 8.9 cm x 19.8 cm x 3.8 cm (3.5 in x 7.8 in x 1.5 in)
- **Weight:** 0.4 kg (12 oz)

Operating Environment: Full accuracy from 0° C to 55° C; Full accuracy to 80% RH (non-condensing) at 30° C
Storage Environment: –40° C to 65° C

Ordering Information

HP E2310A Advanced Logic Probe
Includes: carrying case, 3 probes, 2 browsers, 6 IC clips, 3 contact pins, user's guide, AC adapter, 3 –1.5 V AA alkaline batteries, and Certificate of Calibration
- **Opt 001** Security Lock and Cable

HP E2320A Assembled Probe w/Browser
Includes: 1 probe, 1 browser, 1 – 30.5 cm (12 in) ground lead, and 1 IC clip

HP E2321A Replacement Probe

HP E2322A Probe Accessory Kit
Includes: 1 browser, 3 – 30.5 cm (12 in) ground leads, 6 – 10.2 cm (4 in) ground leads, 4 IC clips, 6 contact pins, 6 ground extenders, and 3 browser replacement pins

HP 82240B Portable Thermal Printer

Electronic Counters

Hewlett-Packard offers the industry's broadest line of electronic counters and counter/timers. Starting with the first frequency-measurement projects in the 1940s, HP has pioneered the major technologies enabling today's electronic counters and modulation-domain analyzers.

Electronic counter/timers are used throughout most technical industries for measuring and analyzing frequency, phase, and time-interval signal characteristics. The breadth of the HP offering allows the best product to be selected for each application. An ideal functional and performance fit delivers the greatest value: the best and most cost-effective solution.

HP counter/timers offer:

- High-measurement accuracy
- Fast system throughput/HP-IB capability
- Low cost of ownership
- Ease of use
- Data reduction on many models
- Triggering simplicity

New Measurement Technology

Modulation domain products feature "continuous count" technology. Unlike traditional counters, these products do not stop between measurements to process data. Rather, they measure continuously and process results on the fly. As a result, new kinds of measurements are made possible.

Modulation domain products include:

HP 53310A: Combines affordability and ease of use

HP E1725B: Highest performance time-interval analyzer

HP E1740A: 150 MHz time-interval analyzer; high-performance analysis for VXI systems

For more information on modulation domain products, see the section starting on page 121.

Counter Products

RF Frequency Counter

The HP 53181A RF counter offers outstanding measurement performance in a low-cost, easy-to-use package.

The HP 53181A leads off Hewlett-Packard's newest line of frequency counters. The HP 53181A RF counter employs continuous measurement technology to provide superior performance at a very low price. Frequency and period measurements are provided over the range of 0.1 Hz to 225 MHz with exceptional resolution of 10 digits in one second. An optional second channel increases the frequency range to 1.5 GHz, 3 GHz, 5 GHz, or 12.4 GHz, making it easy to cover your exact RF measurement needs. Other features of the HP 53181A include HP-IB, automatic limit testing, analog display mode, single-button recall, extensive in-box statistical and math analysis, and more.

The HP 53181A RF counter is designed for systems and bench applications where high-precision frequency measurements are required in an easy-to-use, small and rugged package.

HP 53181A: The low-cost RF counter for systems and bench use

Basic and High-Performance Universal Counters

The HP 53131A universal counter offers high performance for system or bench.

The HP universal counter/timers incorporate frequency measurements, just like the HP 53181A, and additional capabilities for time-interval measurements. Specifically, these HP counters measure precise timing between two trigger events. The high-performance universal products also provide complete, automatic characterization of rise time, pulse width, and other signal parameters. Options are available (frequency extensions, high-performance time bases) to customize the products.

The current HP universal counter offering includes the low-cost portable HP 5314A, and two high-performance universal counters: the HP 53131A and HP 53132A.

The HP 53131A is designed for manufacturing test, troubleshooting, and service. This counter allows you to easily make highly reliable frequency and timing measurements. Featured are extensive in-box analysis, automatic limit testing, analog display mode, single button recall, and more. The HP 53131A's half-rack size and light weight make it well suited for both benchtop and rackmounting.

The HP 53132A is designed for high-performance ATE systems. It combines the functionality of the HP 53131A with improved frequency and time interval resolution.

HP 53131A: High-performance system and bench counter (10 digits/sec. and 500 ps LSD)

HP 53132A: Highest resolution universal counter for system applications (12 digits/sec. and 150 ps LSD)

HP 5314A: An affordable portable

Precision Time-Interval Counter

The HP 5370B universal time-interval counter is optimized for precision time-interval measurements and offers time-interval resolution of 20 ps LSD. It measures frequency and period (with increased accuracy per unit time compared to other counters) from dc to 100 MHz.

HP 5370B: High-precision time-interval mesurements

Microwave and Millimeter-Wave Frequency Counters

These products provide fundamental high-performance frequency measurements, dc to 46 GHz. Many enhancements—power measurement, battery operation, systems interface (HP-IB), and high-accuracy time bases—are available standard or as options.

Pulse counters add the capability to automatically measure and profile burst or pulsed microwave or millimeter-wave signals.

HP 5350B/5351B/5352B: CW microwave, 10 Hz to 46 GHz

HP 53150A/53151A/53152A: Portable CW microwave counters with power measurement for telecommunications service

HP 5347A/5348A: Portable CW microwave counter plus true power meter for improved power accuracy

HP 5361B: Profiles pulsed/CW microwave frequencies

High-Precision Oscillators

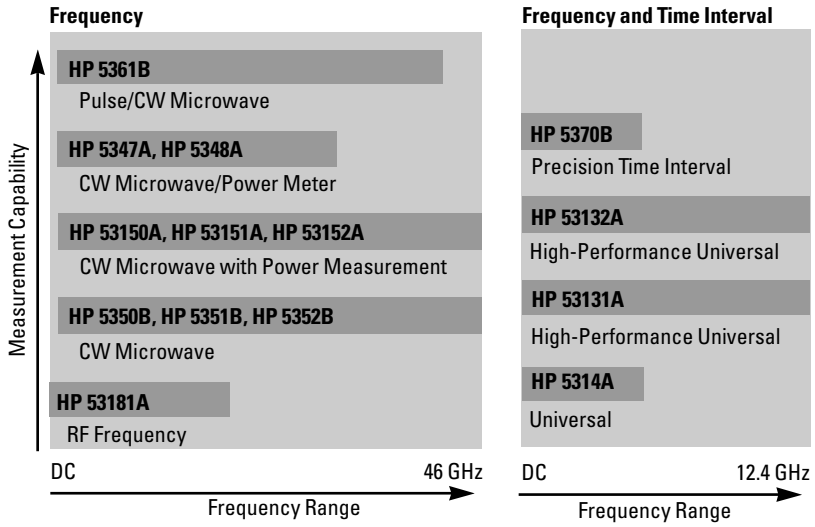
The accuracy of frequency and time-interval measurements is vitally dependent on the time base or reference element selected. HP has pioneered the field of high-precision crystal oscillators. The current counter product line benefits from HP's leadership in quality and precision oscillator technology. Three oscillator varieties are standard or optional with HP counters and counter/timers:

RTXO: Room-temperature crystal oscillators are designed for minimum frequency change over a change in temperature

TCXO: Temperature-compensated oscillators use external components to offset temperature effects. TCXO time bases have temperature characteristics which are typically five times better than an RTXO, or $<5 \times 10^{-7}$ for a 0° to 50° C change.

Oven Time Base: This alternative places the crystal and temperature-sensitive elements within a temperature-controlled environment. A heating element maintains a consistent temperature. The best stability is achieved when the operating point is 15° to 20° C above the highest temperature to which the unit will be exposed. After warm-up, the frequency remains very stable, typically $<7 \times 10^{-9}$ over a 0° to 50° C variation.

For more information, please request Application Note 200-2, "Fundamentals of Quartz Oscillators" from your local HP sales office.



Counter Selection Guide

Model	Frequency range (extension)	Freq. resolution (1 s gate time)	Best sensitivity	Time-interval res. (single-shot LSD)	Additional features	Page
Universal Counter						
HP 5314A	100 MHz	1 Hz	25 mV	100 ns	Battery optional	129
High-Performance Universal Counters						
HP 53131A	225 MHz (3, 5, 12.4 GHz)	10 digits	20 mV	500 ps	HP-IB standard, full math, statistics, limit testing, auto pulse characterization	126
HP 53132A	225 MHz (3, 5, 12.4 GHz)	12 digits	20 mV	150 ps	HP-IB standard, full math, statistics, limit testing, auto pulse characterization	126
Precision Time-Interval Counter						
HP 5370B	100 MHz	11 digits	35 mV	20 ps	HP-IB standard, statistics	130
RF Frequency Counter						
HP 53181A	225 MHz (1.5, 3, 5, 12.4 GHz)	10 digits	20 mV	—	HP-IB standard, full math, statistics, limit testing	126
CW Microwave Counters						
HP 5350B	20 GHz	1 Hz	–32 dBm	—	HP-IB standard, fast tracking mode	131
HP 5351B	26.5 GHz	1 Hz	–32 dBm	—	HP-IB standard, fast tracking mode	131
HP 5352B	40 GHz (46 GHz)	1 Hz	–25 dBm	—	HP-IB standard, fast tracking mode	131
CW Microwave Counters with Power Measurement						
HP 53150A	20 GHz	1 Hz	–30 dBm	—	HP-IB standard, battery optional, simultaneous power measurement	132
HP 53151A	26.5 GHz	1 Hz	–30 dBm	—	HP-IB standard, battery optional, simultaneous power measurement	132
HP 53152A	46 GHz	1 Hz	–30 dBm	—	HP-IB standard, battery optional, simultaneous power measurement	132
CW Microwave Counter/Power Meters						
HP 5347A	20 GHz	1 Hz	–32 dBm	—	HP-IB optional, battery optional, –70 dBm to +20 dBm true power meter	134
HP 5348A	26.5 GHz	1 Hz	–32 dBm	—	HP-IB optional, battery optional, –70 dBm to +20 dBm true power meter	134
Pulse/CW Microwave Counter						
HP 5361B	20 GHz (26.5 GHz) (40 GHz)	1 Hz	–28 dBm	—	HP-IB standard, full microwave pulse measurements, automatic pulse profiling	136

Additionally, Hewlett-Packard offers electronic counters and counter/timers in an industry standard platform: VXIbus. With VXIbus counters from Hewlett-Packard, you can rely on the same exceptional performance that you have always had from Hewlett-Packard's high-performance rack-and-stack universal counters. All B-size instruments can be adapted to fit into the C-size VXIbus mainframes. Please request the 1997 *HP System Builder's Source Book and CD*, p/n 2965-533E, for additional configuration and product ordering information. Also, see the *VXIbus Products, HP 75000 VXIbus Family* section in this catalog.

Modulation Domain Analysis: A New View of Complex Signals

As a pioneer of counter/timer technology, Hewlett-Packard recognized a need to expand traditional frequency and time measurement techniques. With modulation domain analyzers, HP offers a unique method for viewing complex signals that is both intuitive and insightful.

Oscilloscopes display amplitude (voltage) versus time: the time domain. Spectrum analyzers show amplitude versus frequency: the frequency domain. The HP 53310A, E1725B and E1740A bring a new dimension to frequency and time interval analysis with views of the modulation domain:

- Frequency versus time
- Phase versus time
- Time interval versus time

Improved Measurement Analysis

A wide range of applications benefit from modulation domain analysis. Jitter measurements in digital communication systems, disk and tape drives, and mechanical systems are dramatically improved. Identify the sources of jitter—the first step in improving system performance.

Modulation domain analyzers simplify the study of step response for voltage-controlled oscillators. They easily characterize the frequency-hopping performance of an agile transmitter. Chirp linearity and phase switching in radar systems are easily understood from displays of frequency or phase versus time.

Modulation Domain Analyzer Products

HP modulation domain analyzers provide a range of features and performance. Analysis features include views of frequency and phase versus time, with built-in statistics and histograms. HP-IB programmability lets you control these analyzers remotely, or use the front panel measurement and display options for quick on-the-spot measurements.

The HP 53310A combines modulation domain analysis in a low-cost offering. Single-button functions and automated setup and measurement capabilities make the HP 53310A the easiest to operate of the modulation domain analyzers. The HP 53310A Option 031 includes features that further simplify the analysis steps for RF mobile communications designers, and Option 305 provides software for complete phase analysis.

HP 53310A: Affordable, easy-to-use modulation domain analyzer

Time Interval Analyzer Products

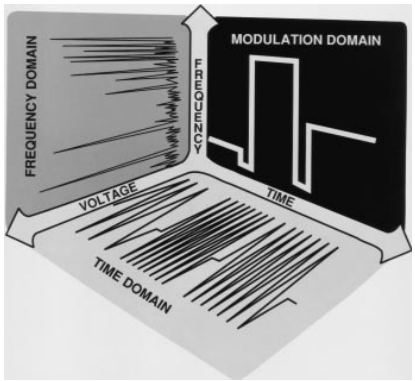
HP's expertise with modulation domain analyzer technology has resulted in a family of time interval analyzer (TIA) products tuned for specific applications. Choose from preconfigured instruments, or design your own solution using the basic TIA module and selecting from a range of software offerings.

The HP E1725B TIA is based on the HP E1740A TIA module, a VXI card that can be plugged into a VXI cardcage. The on-card functionality includes basic arming and measurement control and a large 512K memory for storing results. Histograms are also executed in hardware on the HP E1740A for accelerated analysis operations.

The HP E1725B instruments combine the HP E1740A in a VXI cardcage with an embedded IBM-compatible PC. The PC's Microsoft® Windows interface and optional HP software packages simplify measurements and offer powerful display and analysis capabilities for viewing and interpreting measurement results.

HP E1740A: Two-slot VXI module

HP E1725B: Highest performance time interval analyzer with configurable personalities



The Modulation Domain adds a third dimension of frequency vs. time

Application Solutions

With a range of add-on software packages, the HP E1725B TIAs can be tailored as complete solutions for specific applications. The current family of HP E174XA software products provide full-function and easy-to-use platforms for these complex measurement situations:

Data storage: Evaluate designs and troubleshoot problems for today's high-speed digital storage solutions.

Clock jitter: Study and solve jitter problems in clock distribution networks.

SONET/SDH networks: Evaluate existing equipment for use with new high-speed technologies.

Network synchronization: Determine compliance with today's industry standards.

Token Ring: Test IEEE inter-operability and identify general jitter problems.

HP E1741A/E1747A: Data storage test

HP E1742A: SONET/SDH tributary jitter analysis

HP E1743A: Computer clock jitter analysis

HP E1744A: Token Ring jitter analysis

HP E1746A: Network synchronization measurement

HP E1748A: Multiple channel network sychronization measurement

Modulation Domain Analyzer Selection Guide

Model	Key selection criteria	Feature highlights
HP 53310A	Low-cost, easy to use	Auto set-up RF transmitter characterization features Fast histograms
HP E1725B	Highest performance analyzer	80 MHz sample rate Microsoft® Windows user interface with custom analysis software
HP E1740A	2-slot VXI module	High performance histograms, window margin analysis, statistics 512K on-card memory

Modulation Domain Analyzer Applications

The application examples on this page and the next illustrate some of the many situations that benefit from HP modulation domain analyzers. For complete product specifications or to arrange a product demonstration, contact the HP sales office in your area.

Modulation Analysis for Mobile Communications

The HP 53310A's Option 031 "Digital RF Communications Analysis/High Resolution 2.5 GHz Input" provides automatic measurements of synthesizer settling time, Frequency Shift Keyed (FSK) center frequency, and FSK peak deviation on DECT, CT2, and CT3 radios. Features for optimizing RF designs include:

- High resolution measurements—built-in downconversion provides superior frequency resolution for RF signals.
- RF envelope trigger—simplifies measurement setup by automatically triggering on a detected TDMA burst.
- Automatic measurements—synthesizer settling time, Frequency Shift Keyed (FSK) center frequency, and FSK deviation.

Option 305 phase analysis software adds the power of phase analysis to your HP 53310A. Direct phase analysis lets you measure digital communication systems and extract data, including phase settling time, phase noise (phase spectrum), phase deviation, and phase trajectory. When used in combination, Options 031 and 305 allow direct profiles of both wide- and narrowband modulations up to a 500 KHz modulation rate and eliminate the need for external downconversion.

Data Storage Analysis

The HP E1725B Option 141 instrument is tailored for the specific requirements of data storage analysis. High-speed measurements and the large 512K on-board memory allow you to measure a full track on today's high data rate drives. Complete acquisition control allows measuring of data edges in the presence of servo or header fields. The Option 141 TIA software can be combined with the Option 147 timing pattern analysis software to provide powerful display and analysis capabilities:

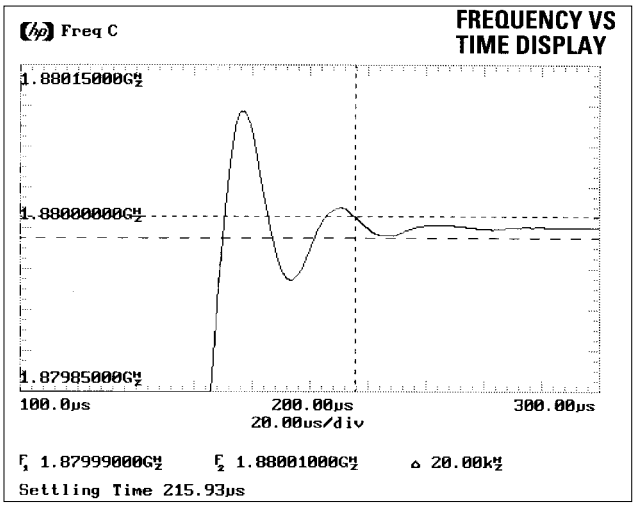
- Window margin analysis and histograms for understanding drive timing (view peak shift, jitter, worst-case data patterns).
- Flexible measurement setup for measuring the edges of your choice, specifying trigger delays and measurement duration, and pacing measurements.
- Sequential displays for characterizing PLL dynamics, viewing spindle speed variations, or verifying correctly written data patterns.
- Computed clock for measuring to an ideal reference.
- Timing pattern analysis for studying worst-case data patterns or viewing problematic data patterns and the surrounding code spacings.
- Online Help for quick answers to operation questions.
- Data export capability for transferring results to another analysis package or to spreadsheet or wordprocessor packages.

Characterization and Reduction of Clock Jitter

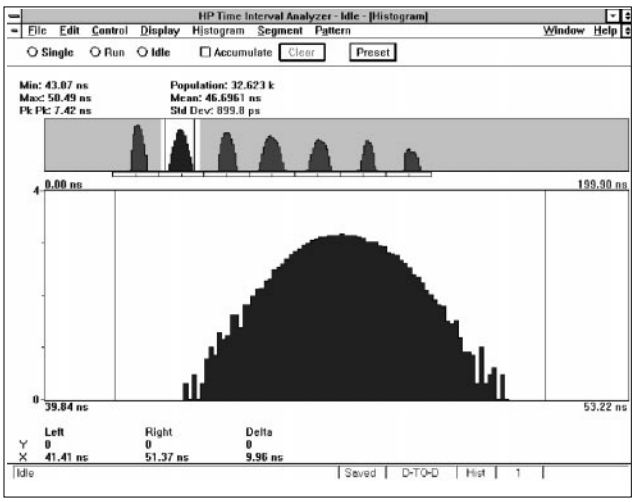
The HP E1725B Option 243 TIA and clock jitter analyzer software provides digital designers with a powerful tool for understanding and reducing clock jitter. High-speed clock distribution networks are critical for high performance digital systems. The clock buffers found in these networks—PLLs, frequency dividers, fanout and translation ICs—are also affected by jitter.

The HP E1725B Option 243 includes powerful jitter measurement and display capabilities:

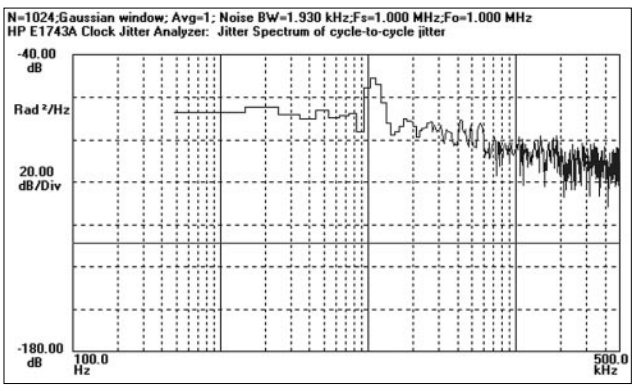
- Capture every clock cycle up to 80 MHz, continuously for a trillion cycles using fast histogram or 256K cycles using a vs. time display.
- Understand true peak-to-peak and cycle-to-cycle jitter using a complete range of statistics.
- Display jitter spectrum (using a built-in FFT) to determine the root causes of jitter.
- View the phase power spectral density display to see phase noise as noise power offset from the carrier.
- Use the Allan variance display to understand the type and level of noise (white phase, flicker phase, random walk phase, flicker FM, random walk FM, and white FM).
- Export data to another analysis package or to spreadsheet or wordprocessor packages.



Settling time is displayed automatically on this direct measurement of the synthesizer step.



The HP E1741A features extensive statistical, histogram, and window margin analysis features to simplify jitter characterization in data storage products.



The HP E1743A phase power spectrum feature allows you to examine jitter spectrum, in this case of cycle-to-cycle jitter on a clock signal. A jitter component near 10 kHz can be easily identified.

SONET/SDH Tributary Jitter Analysis

When integrating new SONET/SDH technologies with existing telecommunications equipment, network equipment designers use the HP E1725B TIA Option 242 tributary jitter analyzer software to make sure that new designs conform to evolving standards. HP's unique software clock extraction scheme and software filters provide consistent, repeatable results when measuring jitter. The display screens make it easy to examine mapping jitter, pointer-induced jitter, and waiting time jitter.

After a measurement is performed, the HP E1742A software (included in Option 242) extracts the clock signal and performs a variety of analysis functions:

- Phase deviation display shows the cumulative phase difference of a signal relative to the extracted clock.
- Jitter display uses a built-in 10 Hz high pass filter to simultaneously display peak-to-peak jitter, positive peak, negative peak, mapping jitter, and other jitter components.
- Power spectrum display shows the frequency components which contribute to the jitter and gives a better understanding of the jitter sources.
- Frequency deviation display explains the effect of a pointer hit on the desynchronizer phase lock loop inside a network element.
- Allan variance, TVAR, and FFT functions enhance further study and analysis of the tributary jitter. Each measurement can be stored for future analysis. Graphic and numeric results can be transferred to other Windows applications for inclusion in documents or spreadsheets.

Ensure Compliance with Network Synchronization Standards

Network synchronization problems can lead to slips and degrading voice, fax and video services. The HP E1746A/E1748A network synchronization measurement software packages, available as Options 246 and 248 respectively with the HP E1725B TIA, give network managers powerful tools for evaluating network synchronization and ensuring compliance with industry standards.

All measurements adhere to ITU (CCITT) 0.171, Bellcore and ANSI requirements. On an operational network, MTIE and TDEV are measured and plotted against proposed ITU, ANSI, and ETSI masks for fast reviewing of results. With these measurements, network managers can characterize SSUs and SDH switches. MTIE can be measured over long times, sampling at the ITU-specified rate of 80 samples per second. A unique software clock extraction scheme and software filters result in consistent, repeatable results. Measurement times can be extended even further utilizing concatenation available with the HP E1748A software. As industry standards evolve, the masks, sample rates, and filters used by the HP E1746A and E1748A software packages can be updated.

Jitter levels are accurately measured with the HP E1746A/E1748A and the HP E1725B TIA. Its unsurpassed timing resolution of 100 ps rms, combined with the power of its Phase Power Spectral Density plot, deliver enough detail to determine which network components are improving or degrading incoming signals.

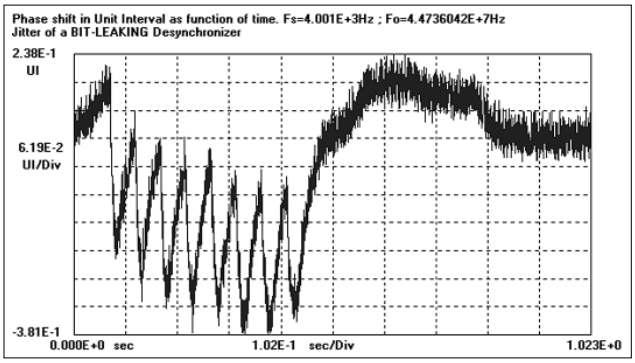
The HP E1748A multiple channel network synchronization measurement software further enhances the features of the HP E1746A software with simultaneous recording of multiple channels. Overlay displays offer quick visual comparison of data obtained from multiple MTIE or TDEV measurements.

Test Token Ring Jitter for Compliance with IEEE 802.5

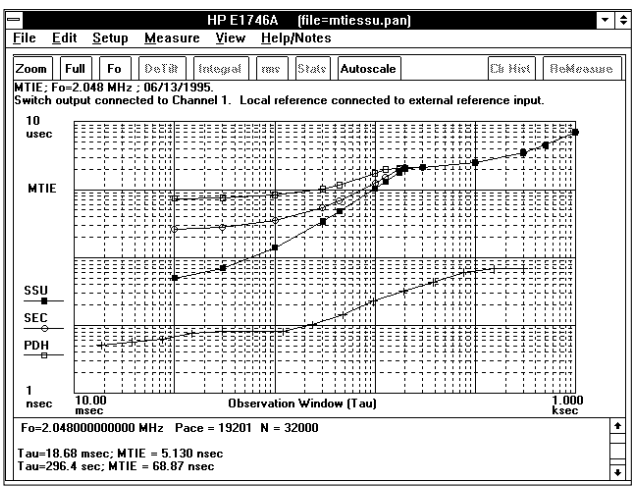
The HP E1744A Token Ring jitter analysis software, included with the HP E1725B Option 244 TIA, provides both inter-operability testing as defined by the IEEE 802.5 standard and general-purpose jitter measurements. This solution is used by the designers of products for computer networks and gives them a faster, automated alternative to tedious oscilloscope measurements.

The displays described in the previous application overview, Characterization and Reduction of Clock Jitter, are available with this version of the HP E1725B instrument. In addition, measurement of Filtered Accumulated Jitter (FAJ) and Filtered Accumulated Phase Slope (FAPS) are fully implemented by the HP E1725B Option 244—including averaging and filtering specified by the IEEE 802.5 standard. The HP instrument also measures transmitter duty cycle distortion (TDCD), Tdiff01, and Tdiffmax.

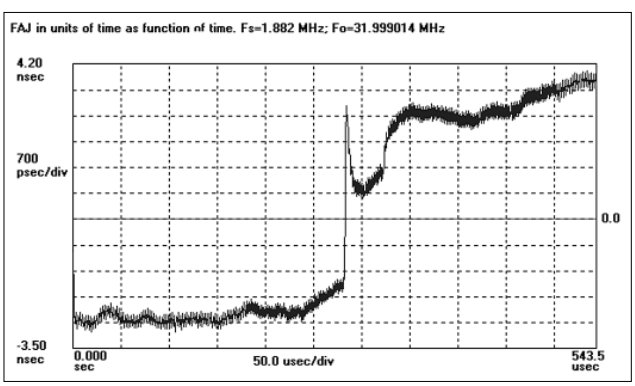
A scrolling text window below the data display automatically records every action the instrument takes and records every result. This includes marker clicks and other actions performed in order to read, examine, or interpret results. Custom notes can be intermixed in this file to record important information such as type/length of cable, number of PHYs, pass/fail, and so forth. The file can be saved and used in reports or other documents to provide a complete record of the test.



This HP E1742A display shows the peak-to-peak jitter during an 8 UI phase transient. The phase transient is being leaked out to the tributary over 0.5 seconds one bit at a time.



Typical MTIE measurements made with HP E1748A multiple channel network synchronization measurement software show sufficient margin compared to ETSI draft DE/TM 3017 masks. The four simultaneous measurements show, however, degradation from cascading timing signals.

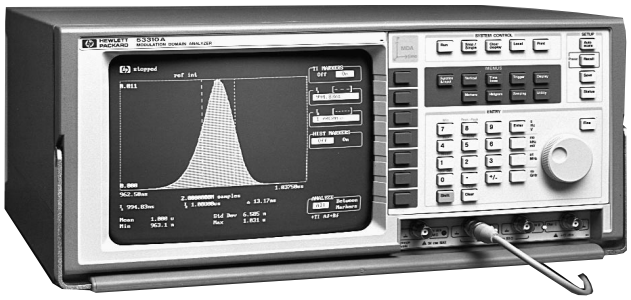


IEEE 802.5 specified jitter measurements are simplified with the HP E1744A Token Ring jitter analysis software, such as this display of Filtered Accumulated Jitter (FAJ).

Modulation Domain and Time Interval Analyzers

HP 53310A
HP E1725B
HP E1740A
HP E1741A
HP E1742A
HP E1743A
HP E1744A
HP E1746A
HP E1747A
HP E1748A

- 200 ps rms single-shot resolution, 1 ps with averaging
- DECT, CT2, CT3 mobile communications measurements
- Easy to use



HP 53310A

- Highest performance HP TIA
- Fast histograms, statistics, and window margin analysis
- Analyze data storage devices
- Study and identify clock jitter
- Analyze jitter in SONET/SDH networks
- Study jitter in Token Ring networks

HP E1725B

3

HP 53310A Modulation Domain Analyzer

Affordability and Ease of Use

The most affordable domain analyzer, the HP 53310A, includes many innovations for ease of use. Characterization of modulation and jitter is easy with built-in analysis. Parameters such as peak-to-peak deviation, carrier frequency, and modulation rate are all quickly and automatically displayed. Jitter analysis is simplified with automated mean, standard deviation, and probability functions. Key features of this frequency and time interval analysis product include:
Automated setup: A single button can set up the HP 53310A for measurement. Signals are automatically evaluated.
Single-touch measurements: Peak-to-peak deviation, carrier frequency, and modulation rate are easily and quickly measured for quantifying modulation. The Save/Recall function stores up to 10 measurement steps for fast repeat operations.
Built-in statistics: Mean, standard deviation, and probability function buttons simplify jitter analysis.
Softkey-driven menus: Measurement parameters and analysis functions are easily selected while viewing measurement data.
Large display: The expanded screen displays measurement results clearly and aids analysis.
Low cost: The HP 53310A is priced to fit budget-constrained projects and departments.

Product Features

The HP 53310A offers powerful analyzer features:
Dual timebases: Main timebase and window timebase allow data capture while viewing measurement details in the window.
Auto or triggered operation: Select auto triggering, edge triggering (rising or falling), or a unique feature: measurement value triggering (frequency or time interval). Value triggering can eliminate the need for and expense of external sync signal generation, shortening project time and lowering costs.
Display vs. time or histogram: Select appropriate views.
Fast histograms: Up to 16 million measurements per acquisition.
Automated measurements: Autoscale selects appropriate setup parameters; built-in analysis functions eliminate calculations.

Specifications and Ordering Information

See page 125 for key specifications and ordering details.

HP E1725B Time Interval Analyzer

The HP E1725B time interval analyzer (TIA) combines a fast measurement sampling rate with a large memory and advanced analysis capabilities. Optional software packages, purchased separately or as options with the HP E1725B instrument, tailor the instrument to meet a variety of demanding application areas.

Configured with the HP E1741A time interval analyzer software, the HP E1725B is tailored for the characterization of high-speed data storage devices. HP offers several options to address other applications involving jitter analysis.

Versatile Design and Operation

Tailored for benchtop use, the HP E1725B instrument integrates a high performance time interval analyzer with an embedded IBM-compatible PC based on the Intel 486™ processor. The MS® -Windows interface streamlines setup and offers complete control of measurement and analysis parameters. Measurements are carried out and stored in the instrument's 512K of memory. Built-in histograms, window margin analysis, and statistics functions speed access to many results.

For customers who desire a VXI solution, HP offers the HP E1740A time interval analyzer card. The HP E1725B benchtop instrument and HP E1740A VXI TIA card offer equivalent measurement capabilities, and the software packages that run on the HP E1725B can be purchased as add-on products for the HP E1740A.

Advanced Analysis Software

The current HP E174XA software solutions address four application areas described in the two previous pages of this catalog. These applications and corresponding software include:
- Data storage and test: HP E1741A and HP E1747A
- SONET/SDH tributary jitter analysis: HP E1742A
- Clock jitter analysis: HP E1743A
- Token Ring jitter analysis: HP E1744A
- Network synchronization measurement: HP E1746A
- Multiple channel network synchronization measurement: HP E1748A

Specifications and Ordering Information

See page 125 for key specifications and ordering details.

Modulation Domain Analyzer Specification Highlights

Model	Frequency range (extension)	Single-shot freq. res. (1s gate)	Time interval resolution (single-shot/ averaging)	Maximum continuous meas. rate (meas/s)	Memory size	Output meas/s	Analysis and display
HP 53310A	200 MHz (2.5 GHz) (18 GHz)[1]	10 digits	200 ps/1ps	2.5 M	8000 (32,000 w/Option 001)	HP-IB: to 7,500	Frequency and time vs. time; auto-scale (setup); large display; jitter analysis; simple triggering; digital RF communications (Option 031)
HP E1740A HP E 1725B	150 MHz (18 GHz)[1]	10 digits	100 ps/1ps	80 M	512K	6,500; VXI shared memory available	Frequency, time interval, time stamps, histogram, statistics, and window margin analysis. Additional analysis and display capability available using the HP E174xA software.

[1] Requires HP 5364A

Ordering Information

HP 53310A Modulation Domain Analyzer
- **Opt 001** Extended Measurement Memory (4 x)
- **Opt 010** High Stability Oven Timebase
- **Opt 030** 2.5 GHz Channel C
- **Opt 031** Digital RF Communications
- **Opt 305** Phase Analysis Software
- **Opt W30** Extended Repair Service (see page 584)
- **Opt W32** Calibration Service (see page 584)

Available Separately
HP 53305A Phase Analysis Software

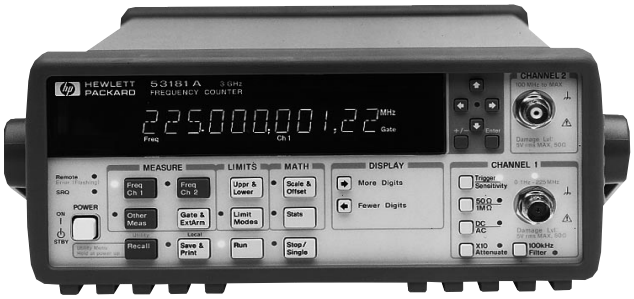
HP E1725B Time Interval Analyzer
Includes HP E1740A TIA module, MS-Windows 3.1, MS-DOS 6.22, VXI 6-slot cardcage, Radisys EPC-7 embedded computer, monitor, keyboard, mouse, mouse pad, and 4 oscilloscope probes
- **Opt 001** Delete embedded computer and accessories, add HP E1406A VXI Slot-0 controller with HP-IB interface
- **Opt 002** Replace 6-slot card cage with HP E1401A 13-slot mainframe
- **Opt 003** Delete embedded computer and accessories, add HP E1483A VXLink kit
- **Opt 141** Time Interval Analyzer Software
- **Opt 147** Timing Pattern Analysis Software
- **Opt 242** SONET/SDH Tributary Jitter Analyzer Software
- **Opt 243** Clock Jitter Analyzer Software
- **Opt 244** Token Ring Jitter Analyzer Software
- **Opt 246** Network Synchronization Measurement Software (must also order Option 001 or 003)
- **Opt 248** Multiple Channel Network Synchronization Software (must also order Option 001 or 003)

Available Separately
HP E1740A Time Interval Analyzer Module
- **Opt W32** Calibration Service (see page 584)

HP E1741A Time Interval Analyzer Software
HP E1742A SONET/SDH Tributary Jitter Analyzer Software
HP E1743A Clock Jitter Analyzer Software
HP E1744A Token Ring Jitter Analyzer Software
HP E1746A Network Synchronization Measurement Software
HP E1747A Timing Pattern Analysis Software
HP E1748A Multiple Channel Network Synchronization Software

Accessories and Other Products
HP 5364A Microwave Mixer/Detector

- High-accuracy frequency measurements to 225 MHz (optional to 1.5, 3, 5 or 12.4 GHz)
- 10-digit resolution with 1s gate time
- Intuitive user interface with shallow menu structure
- HP-IB standard with data transfer rate of 200 fully-formatted measurements/second; talk-only RS-232
- Limit test capability



- High-accuracy frequency- and time-interval measurements to 225 MHz (optional to 3, 5 or 12.4 GHz)
- HP 53131A: 10-digit/s and 500 psec resolution
- HP 53132A: 12-digit/s and 150 psec resolution

HP 53181A RF Counter

HP-IB

Optimized for RF applications, the single-channel HP 53181A gives you frequency, period, and peak-voltage measurements with up to 10 digits/sec frequency resolution. The lowest-cost counter in the HP 53100 series, the HP 53181A is ideal for benchtop and system RF and analog applications.

A digit-blanking function lets you easily eliminate unnecessary digits when you want to read measurements quickly. For higher-frequency measurements, an optional second channel provides 1.5, 3, 5 or 12.4 GHz bandwidth. A self-guided shallow menu makes this counter exceptionally easy to use.

Analog display mode uses an asterisk to represent the current measurement relative to user-defined upper and lower limits. The colon on the left represents the lower limit and the colon on the right represents the upper limit.

HP 53131A and 53132A Universal Counters

The two-channel HP 53131A counter offers 10 digits per second of frequency resolution at up to 225 MHz. Single-shot time-interval resolution is specified at 500 ps and averaging can reduce this even further. Measurements include frequency, time interval, ratio, period, phase angle, totalize, peak voltage, pulse parameters and more. For quick access to frequently used tests, a single keystroke recalls up to 20 different stored front-panel set-ups. Choose the HP 53131A for general bench or system test where you need excellent performance at an unbeatable price.

For applications requiring higher resolution, the HP 53132A offers the same features and functions as the HP 53131A with up to 12 digits/frequency resolution. Single-shot time-interval resolution is specified at 150 ps. Choose the HP 53132A when you need the very best in accuracy and resolution, or when speed in an automated system is critical. Whichever HP 53100-series counter you choose, you'll have an accurate, reliable counter that will serve you for years to come. We back that claim with a standard three-year warranty that can be extended an additional two years for added peace of mind.

A Full Family of High-Performance RF and Universal Counters

Within Budget, Without Compromise

HP 53100-series high-performance counters offer exceptional price and performance in a rugged, lightweight package. You can't find this combination of ease of use, complete measurement set, extensive analysis capability, reliability, and high measurement and data transfer speed in any other counter family.

These instruments use real-time digital signal processing technology to analyze data while simultaneously taking new readings, speeding measurement throughput. The technology, developed for HP's high-end line of modulation-domain analyzers, allows the counters to gather more data for each measurement so you get the higher-resolution measurements in a fraction of the time it takes a conventional reciprocal counter.

Powerful Analysis Capability

All HP 53100-series counters offer built-in statistics and math functions so you can scale measurements and simultaneously measure and track average, min./max. and standard deviation. Automated limit testing lets you set upper and lower limits for any measurement. When a measurement falls outside those limits, the counters log the out-of-limit conditions, notify the operator and generate an output signal to trigger external devices or stop the test. An analog display mode carries limit testing one step further, letting you see at a glance whether a measurement falls within pass/fail limits.

High-Speed Automated Test Capability

For computer-controlled systems applications, each HP 53100 series counter includes a standard HP-IB interface with a data transfer rate of more than 200 fully-formatted measurements per second. The counters use the Standard Commands for Programmable Instruments (SCPI) protocol, letting you leverage your programming investment across your measurement system. The standard RS-232 talk-only interface provides printer support or data transfer to a computer through a terminal-emulation program.

Options Increase Versatility

Extended Frequency Range

HP 53100-series two-channel universal counters can be ordered with an optional RF-input channel to provide frequency measurements up to 3 GHz (Option 030) 5 GHz (Option 050) or 12.4 GHz (Option 124). This extended bandwidth lets you use the HP 53131A in mobile communications and other RF test environments. In addition to the above options the HP 53181A also has an optional 1.5 GHz (Option 015) channel.

Increased Stability

A choice of optional timebases is available for HP 53100-series counters to increase your measurement accuracy. Option 010 provides a high-stability oven timebase with aging of less than 5×10^{-10} per day.

Optional Software Turns Your HP 53100-Series Counter Into a Single-Channel Data Acquisition System

Make your high-performance HP 53100-series counter even more valuable with HP BenchLink Meter software. This software turns your PC and counter into a powerful, easy-to-use measurement system.

HP BenchLink Meter, a member of HP's family of PC/basic instrument connectivity solutions, lets you easily configure and run tests from your Windows-based PC, making data gathering more convenient. HP BenchLink software also helps you get more information from your data by providing a variety of basic display formats and analysis tools that let you manipulate and understand your data quickly and easily. HP BenchLink Meter lets you:

- Use your PC to configure HP 53100-series counter tests, including measurement type, number of readings, measurement speed, and more
- Choose display modes from real-time strip chart, histogram, readout, and table mode
- Scale measurements data and make it look the way you want it
- Zoom in on specific data points for a closer look
- Easily copy captured data to other Windows applications for more complex analysis

HP BenchLink Meter supports the following HP-IB cards (HP 82335A/B, 82340A/B or 82341A/B/C/D) or National Instruments GPIB cards (GPIB-PCII/IIA and AT-GPIB, both standard and TNT versions). System requirements include a 386 or 486 computer with a minimum of 4 MB of RAM, Windows 3.1 or higher (including Windows 95) and at least 2 MB of available disk space.

HP 53100-Series Abridged Measurement Specifications and Characteristics

All measurements are specified over the full signal ranges of channels 1 and 2 (channel 1 only for the HP 53181A). For full specifications, please call your HP representative and request a Technical Data Sheet for HP 53100-series counters.

Channel 1 and 2 Inputs (Ch. 1 valid for HP 53181A)

Frequency Range
DC Coupled: 0.1 Hz to 225 MHz
AC Coupled: 1 MHz to 225 MHz (50 Ω); 30 mHz to 225 MHz (1 MΩ)
Voltage Range and Sensitivity (Sinusoid)
DC to 100 MHz: 20 mVrms to ±5 Vac + dc
100 MHz to 200 MHz: 30 mVrms to ±5 Vac + dc
200 MHz to 225 MHz: 40 mVrms to ±5 Vac + dc
(75 mVrms with optional rear connectors)
Trigger: Rising or falling edge; level set by percent of signal level or absolute voltage
Gating and Arming: Auto; manual (defined by gate time or digits of resolution required); external; delay
Standard Timebase:
Temperature: $<5 \times 10^{-6}$, 0° to 50° C
Aging: $<3 \times 10^{-7}$ per month

Measurements

Only measurements so marked are valid for the HP 53181A.
Frequency (Ch. 1, 3 valid for HP 53181A)
Channel 1 and 2 Range: .1 Hz to 225 MHz
Channel 3 Range: 100 MHz to 3 GHz, 200 MHz to 5 GHz, or 200 MHz to 12.4 GHz
Trigger: Defaults to 50% of the peak-to-peak signal
Period (Ch. 1 valid for HP 53181A)
Channel 1 and 2 Range: 4.4 ns to 10 s
Frequency Ratio (valid for HP 53181A w/optional second channel)
Results Range: 10^{-10} to 10^{11}
"Auto" Gate Time: 100 ms
LSD: 1/(Ch. 2 frequency x gate time)
Peak Volts Channel 1 or 2 (Ch. 1 valid for HP 53181A)
Input Signal: >100 Hz and >100 mVp-p or dc
Results Range: 100 mVp-p to ±5.1 V
Resolution: 10 mV
Accuracy: 20 mV 11% of V peak
Use of the input attenuator multiplies all voltage specs (input range, results range, resolution, and accuracy) by a factor of 10.

HP 53131A/53132A Universal Counter

In addition to frequency period, ratio, and peak voltage the universal counter can be used for the following measurements:
Time Interval 1 to 2: 1 ns to 105 s
Pulse Measurements
Pulse Width Channel 1: 5 ns to 10^5 s
Rise/Fall Time Channel 1: 5 ns to 10^5 s
LSD: 500 ps (53131A), 150 ps (53132A)
Phase 1 to 2
Results Range: –180° to +360° C
Duty Cycle 1
Results Range: 0 to 1
Totalize 1
Results Range: 0 to 10^{15}
LSD: 1 count of input signal
Resolution: ±1 count
Analysis: Limit testing, math (scaling and offset), statistics (minimum, maximum, mean, standard deviation)
Measurement Throughput (HP-IB ASCII)**:** Maximum 200 meas/s

Optional High-Stability Timebases

	Temperature 0° to 50° C	Aging per month	Turn-on within
Option 001 medium stability	$<2 \times 10^{-7}$	$<2 \times 10^{-7}$	$<2 \times 10^{-7}$ of final value in 10 min.
Option 010 high stability	$<2.5 \times 10^{-9}$	$<1.5 \times 10^{-8}$	$<1 \times 10^{-8}$ of final value in 10 min.

Optional DC Power Input (Option 002)

Power Supply Voltage: 10 to 32 Vdc, 3-pin male XLR connector
Power Requirements: 4 A inrush at 10 Vdc; 3 A max. once stabilized

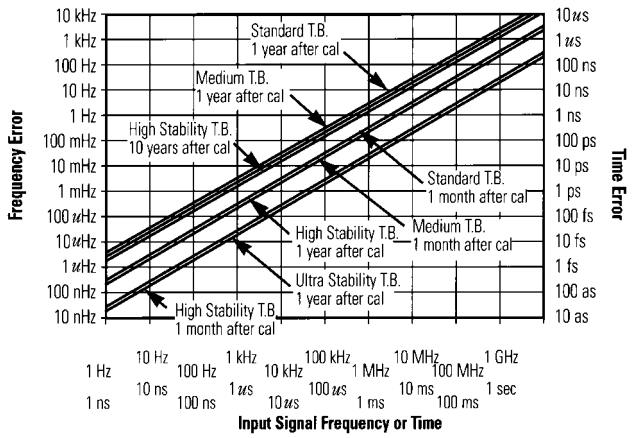
Optional High-Frequency Channels

	Frequency range	Coupling	Power range and sensitivity	Damage level
Option 015[1] 1.5 GHz channel	100 MHz to 1.5 GHz	ac	–27 dBm to +19 dBm	5 Vrms
Option 030 3.0 GHz channel	100 MHz to 3.0 GHz	ac	–27 dBm to +19 dBm (100 MHz to 2.7 GHz) –21 dBm to +13 dBm (2.7 GHz to 3 GHz)	5 Vrms
Option 050 5.0 GHz channel	200 MHz to 5.0 GHz	ac	–23 dBm to +13 dBm	25 dBm
Option 124 12.4 GHz channel	200 MHz to 12.4 GHz	ac	–23 dBm to +13 dBm	25 dBm

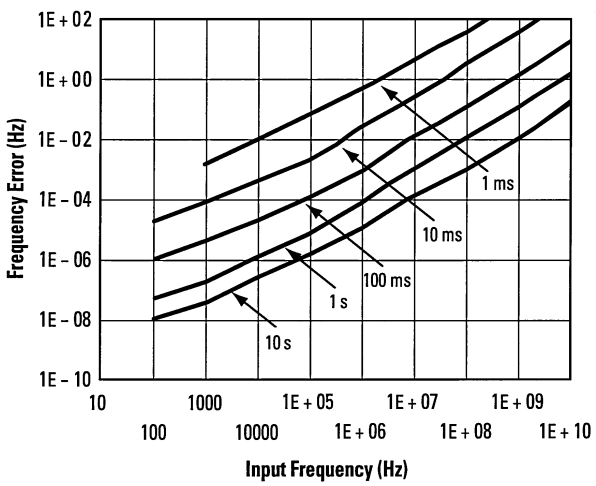
[1] Option 015 is available only for HP 53181A counters.

These graphs provide a quick way to estimate resolution for the measurement you wish to make by assuming negligible values for other error sources. Typically, frequency resolution error and timebase error are the largest components of error in a frequency or period measurement, while timebase and trigger errors are most significant in a time-interval measurement. Remember: other error factors may affect your measurement. For full specifications, please see your HP representative.

Timebase Error



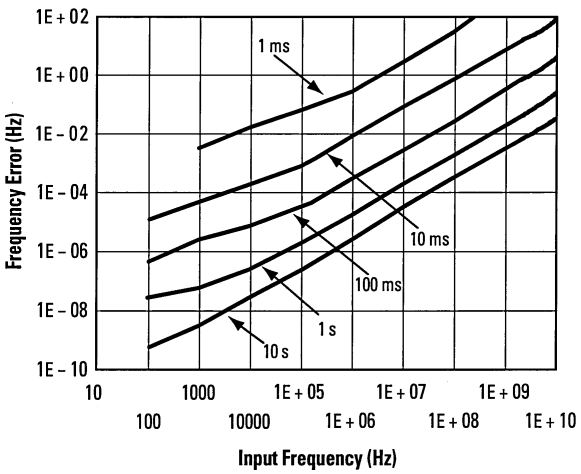
HP 53131A and 53181A – Worst Case RMS Resolution
(Time or Digits Arming)



General Information

Save and Recall: Up to 20 complete front panel setups
Size: 212.6 mm W x 88.5 mm H x 348.3 mm D (8.5 in x 4.5 in x 14.0 in)
Weight: 3.5 kg (6.5 lbs) maximum
Warranty: 3 years
Power Supply: 88 to 135 Vac or 176 to 269 Vac, automatically selected; 45 to 66 Hz
Power Requirements: 170 VA maximum; 30 W typical
Operating Environment: 0° to 55° C
Storage Environment: –40° to 71° C
Remote Interface: HP-IB (IEEE 488.1-1987, IEEE 488.2-1987)
HP-IB Interface Capabilities: SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E2
Remote Programming Lang: SCPI-1992 (Standard Commands for Programmable Instruments)

HP 53132A – Worst Case RMS Resolution
(Time or Digits Arming)

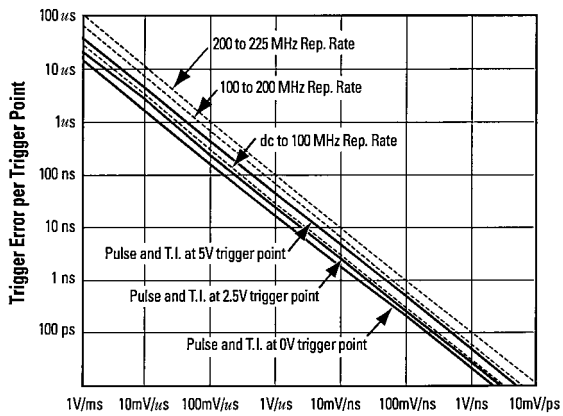


The preceding graphs do not reflect the effects of trigger error. To place an upper bound on the added effect of this error term, determine the appropriate graph and add trigger error term as follows:

Time or Digit Arming

$$\text{Frequency Error} + \left(\frac{4 \times \sqrt{2} \times \text{Trigger Error}}{\text{Gate Time} \times \text{Number of Samples}} \right) \times \text{Frequency or Period}$$

Trigger Level Timing Error
(Level Setting Error and Input Hysteresis)



Ordering Information

HP 53131A Universal Counter
HP 53132A Universal Counter
HP 53181A RF Counter
Each counter comes with standard crystal timebase, power cord, operating, programming, and service manuals
Options
Opt 001 Medium-Stability Timebase
Opt 002 DC Power Input
Opt 010 High-Stability Timebase
Opt 015 1.5 GHz Ch. w/BNC Connector (HP 53181A only)
Opt 030 3 GHz Channel with BNC Connector
Opt 050 5 GHz Channel with Type-N Connector
Opt 124 12.4 GHz Channel with Type-N Connector
Opt 060 Rear-Panel Connectors
Opt 1BP MIL-STD-45662 Calibration w/ Data
Opt 1CM Rackmount Kit
HP 34812A HP BenchLink Meter Software
HP 34161A Accessory Pouch

HP 5314A

- 100 MHz
- 100 ns time interval
- Portable

HP 5314A

HP 5314A Universal Counter

The HP 5314A universal counter combines excellent performance and traditional HP quality at a very attractive price. This counter is designed to deliver reliable, high-quality operation in such areas as production test, frequency monitoring, education, training, service, and calibration. A battery (Option 002) makes the HP 5314A especially attractive for field and portable applications.

Specifications

Input Channel Characteristics (A and B)

Range
Channel A: 10 Hz to 10 MHz direct, 1 MHz to 100 MHz prescaled
Channel B: 10 Hz to 2.5 MHz
Sensitivity
Channel A: 25 mV rms to 100 MHz, 75 mV peak-to-peak at minimum pulse width of 5 ns (100 MHz range)
Channel B: 25m V rms to 2.5 MHz, 75 mV peak-to-peak at minimum pulse width of 200 ns
Coupling: AC
Impedance: 1M Ω nominal shunted by less than 30 pF
Attenuator: x1 or x20 nominal (channel A only)
Trigger Level: Continuously variable ± 350 mV times attenuator setting around average value of signal
Slope: Independent selection of + or – slope
Channel Input: Selectable SEPARATE or COMMON A
Dynamic Range: 75 mV peak-to-peak to 4 V peak-to peak

Frequency

Range: 10 Hz to 10 MHz direct count; 1 to 100 MHz prescaled by 10
Least Significant Digit (LSD) Displayed: Direct count 0.1 Hz, 1 Hz, 10 Hz switch-selectable. Prescaled 10 Hz, 100 Hz, 1k Hz, switch-selectable
Resolution: ± LSD
Accuracy: ± LSD ± (time base error) x frequency

Period

Range: 10 Hz to 2.5 MHz
LSD Displayed: $\frac{100\text{ ns}}{N}$ for N=1 to 1000 in decade steps of N
Resolution: ± LSD ± $\frac{(1.4 \times \text{trigger error})}{N}$
Accuracy: ± LSD ± $\frac{(1.4 \times \text{trigger error})}{N}$
± (time base error) x period

Time Interval

Range: 250 ns to 1 s
LSD Displayed: 100 ns
Resolution: ± LSD ± START trigger error ± STOP trigger error
Accuracy: ± LSD ± START trigger error;
± STOP trigger error ± (time base error) x TI;
External arming required for START/STOP channels

Ratio (A to B)

Range:10 Hz to 10 MHz Channel A; 10 Hz to 2.5 MHz Channel B
LSD Displayed: 1/N in decade steps of N for N = 1 to 1000
Resolution: ± LSD ± (B trigger error x frequency A)/N
Accuracy: ± LSD ± (B trigger error x frequency A)/N

Totalize

Range: 10 Hz to 10 MHz
Resolution: ± 1 count of input
Totalize controlled by front panel switch

General

Check: Counts internal 10 MHz oscillator
Display: 7-digit amber LED display with gate and overflow indication
Max. Sample Rate: 5 readings per second
Operating Temperature: 0° to 50° C
Power Requirement: 115 V, +10%,–25%; 230 V, +9%,–17%; 48 to 66 Hz; 10 VA max
Weight: 2.0 kg (4.4 lb)
Size: 238 mm W x 98 mm H x 276 mm D (9.38 in x 3.88 in x 10.88 in)
Timebase
Frequency: 10 MHz
Aging Rate: < 3 parts in 10^7 per month
Temperature: < ± 1 part in 10^6, 0° to 50° C
Line Voltage: < ± 1 part in 10^8 for ± 10% variation

Options

Option 001: High-stability timebase (TCX0)
Frequency: 10 MHz
Aging Rate: < 1 part in 10^7 per month
Temperature: < ± 1 part in 10^6, 0° to 40° C
Line Voltage: < ± 1 part in 10^8 for ± 10% variation
Option 002: Battery
Type: Rechargeable lead-acid (sealed)
Capacity: Typically 8 hours of continuous operation at 25° C
Recharging Time: Typically 8 hours to 98% of full charge; instrument non-operating. Charging circuitry included with option. Batteries not charged during instrument operation.
Battery Voltage Sensor: Automatically shuts instrument off when low-battery condition exists
Line-Failure Protection: Instrument automatically switches to batteries in case of line failure
Weight: Option 002 typically adds 1.5 kg (3.3 lb) to weight of instrument

Definition

Trigger error: $\frac{\sqrt{(80\mu V)^2 + e_n^2}}{\text{input slew rate at trigger point } (\mu V/s)}$ (rms)

where e_n is the rms noise of the input for a 100 MHz bandwidth in Channel A and 10 MHz bandwidth in Channel B.

Ordering Information

HP 5314A 100 MHz/100 ns Universal Counter
Opt 001 High-Stability Timebase
Opt 002 Battery
Opt W30 Extended Repair Service (see page 584)
Opt W32 Calibration Service (see page 584)
All orders must include one of these line power options:
Opt 115 86 to 127 V
Opt 230 190 to 250 V

Universal Time-Interval Counter and Low-Pass Filter Kit

HP 5370B
HP 10856A

- 20 ps single-shot LSD
- 11 digits/s frequency resolution
- Up to 8000 measurements/sec.
- Built-in statistics functions
- Frequency and period to 100 MHz

HP 5370B

The HP 5370B's Precision and Measurement Speed

HP-IB

- IC tester performance verification
- Fast IC characterization
- Disk drive manufacturing
- Digital communications—jitter analysis
- Radar/laser ranging calibration
- Nuclear systems
- Calibration labs

Full Range of Measurement and Analysis Functions

Time Interval: Achieve 20 ps single-shot LSD on time intervals from 0 to 10 s, including negative time (in which the STOP channel event occurs before the START channel event).
Frequency: Measure up to 100 MHz with 11 digits of resolution in 1 s. Choose gate times down to 1 period: use 1 period with average mode and access the powerful Statistics capabilities.
Period: Measure period average from 1 to 100k samples and use statistics.
Statistics: Reduce external computations, reduce random errors, and improve measurement throughput.
Sample Size: Select 1, 10, 1k, 10k or 100k samples from the front panel, or 1 to 65,536 samples over HP-IB. For the selected sample size, you can compute:

Mean
Standard Deviation
Minimum
Maximum

Flexible Arming and Gating: + TI or ±TI with internal or external arming, with or without external hold-off.
Full HP-IB Programming and Fast Data Output:
Up to 8000 readings/s in fast binary mode—125 μs dead time
10 to 20 readings/s fully formatted—330 μs dead time

Time-Interval Measurement Characteristics

Range
±TI: –10 to +10s, including zero
+TI: 10 ns to 10s
Resolution
Measurement resolution depends on input signal noise and slew rate.
Accuracy
Time-interval measurement accuracy is influenced by internal systematic uncertainties, trigger-level timing error for each trigger edge, and timebase aging in addition to resolution or random uncertainties. Uncertainties may be reduced to less than 10 ps by calibration with the HP J06-59992A time-interval calibrator. Careful calibration and averaging will result in accuracies to ± 100 ps.

Frequency and Period Measurement Characteristics

Range
Frequency: 0.1 Hz to 100 MHz
Period: 10 ns to 10 s
Resolution
Measurement resolution depends on input signal noise as well as measurement gate time.
Accuracy
Accuracy is influenced by internal uncertainties, timebase aging, and noise on the input signal. Periodic timebase calibration minimizes uncertainty due to timebase aging. Internal uncertainties and noise effects may be reduced by selecting longer gate times, or by averaging results.

HP 10856A Low-Pass Filter Kit

The four low-pass filters of the HP 10856A filter kit are recommended for use with any HP frequency counter to reduce high-frequency noise or unwanted signals that cause frequency or period measurement errors. Further applications for the kit include reducing noise (trace fuzz) in oscilloscope and spectrum analyzer displays.

HP 10856A Specifications

Cutoff Frequency (nominal)	**5 KHz**	**50 KHz**	**500 KHz**	**15 MHz**
Input Impedance (nominal)	1 MΩ	100 kΩ	10 kΩ	50 kΩ
Signal Rejection, 100 MHz to 500 MHz	> 40 dB	> 40 dB	> 40 dB	> 20 dB

Roll-Off: 20 dB per decade
Attenuation: x 2, reduces signal voltage by a factor of 2
Output Impedance: For use with 1 M Ω input instruments

Key Literature

HP 5370B Technical Data Sheet, p/n 5952-7915
HP J06-59992A Technical Data Sheet, p/n 5952-7837
Product Note 5370B -2: *Better than 100 ps Accuracy in HP 5370B Time Interval Measurements Through Bias Error Reduction*, p/n 5952-7834
Application Note 191-7: *High-Speed Timing Acquisition and Statistical Jitter Analysis*, p/n 5952-7908

Ordering Information

HP 5370B Time-Interval Counter
Opt 913 Rack Flange Kit for Use With Supplied Front Handles
Opt 908 Rack Flange Kit, No Front Handles
Opt W30 Extended Repair Service (see page 584)
HP 10856A Low-Pass Filter Kit
HP J06-59992A Time-Interval Calibrator

- 10 Hz to 46 GHz without an external mixer
- Exceptional sensitivity to –40 dBm
- 1 GHz/s tracking speed
- 60 ms acquisition time
- 100 measurements/s (HP-IB) in automatic mode
- Three years of hardware support with Option W30

HP 5352B

HP 5350B, 5351B, 5352B Microwave Counters

The HP 5350B/5351B/5352B are automatic CW microwave frequency counters that measure to 20, 26.5, and 40 GHz (46 GHz with Option 005), respectively. One hertz resolution, exceptional sensitivity, fast tracking speed, high-measurement throughput, and wide FM tolerance are a few of the high-performance features of these counters.

Specifications

Input 1

Frequency Range: HP 5350B: 500 MHz to 20 GHz; HP 5351B: 500 MHz to 26.5 GHz; HP 5352B: 500 MHz to 40 GHz; Option 005: 500 MHz to 46 GHz
Sensitivity: See Graph 1, Sensitivity
Maximum Input: +7 dBm
Damage Level: +25 dBm; HP 5350B/5351B Option 006: +39 dBm (500 MHz to 6 GHz), +36 dBm (6 GHz to 18 GHz), +34.8 dBm (18 GHz to 26.5 GHz)
SWR (typical)**:** 500 MHz to 10 GHz: 2:1; Option 002/006, 2.5:1 10 GHz to 26.5 GHz: 3:1; Option 002/006, 3.5:1 26.5 GHz to 46 GHz: 3.5:1
Connector: Precision type-N (female) (HP 5350B); APC-3.5 (male) with collar (HP 5351B/HP 5352B); APC-2.4 (male) with collar (Option 005)
Resolution: Selectable, 1 Hz to 1 MHz
FM Tolerance
Maximum Deviation:
Auto: 20 MHz p-p (HP 5350B/51B),
12 MHz p-p (HP 5352B),
9 MHz p-p (Option 005)
Manual: 60 MHz p-p (HP 5350/51B),
55 MHz p-p (HP 5352B),
55 MHz p-p (Option 005)
Maximum FM Rate: 10 MHz
Tracking Speed
Fast-Acquisition Track: 1 GHz/s
Normal FM Rate: 1 MHz/s
Low FM Rate: 80 kHz/s
Automatic Amplitude Discrimination: Measures largest signal present, providing that signal is 6 dB (typical) above any signal within 500 MHz; >20 dB (typical) above any signal within 500 MHz to 20 (46) GHz
Acquisition Time
Automatic Mode: Fast-acquisition track: <60 ms
Normal FM rate: <125 ms
Low FM rate: <1.25 s
Manual Mode: <20 ms

	TCXO	Option 001	Option 010
Aging Rate	1×10^{-7}/month	5×10^{-10}/day	1×10^{-10}/day
Short Term	1×10^{-9}/s	2.5×10^{-10}/s	2.5×10^{-10}/s
Temperature 0° to 50° C	1×10^{-6}	7×10^{-9}	7×10^{-9}
Line 10% change	1×10^{-7}	1×10^{-10}	1×10^{-10}
Warmup to <5 10^{-9} @ 25° C	—	10 min.	10 min.

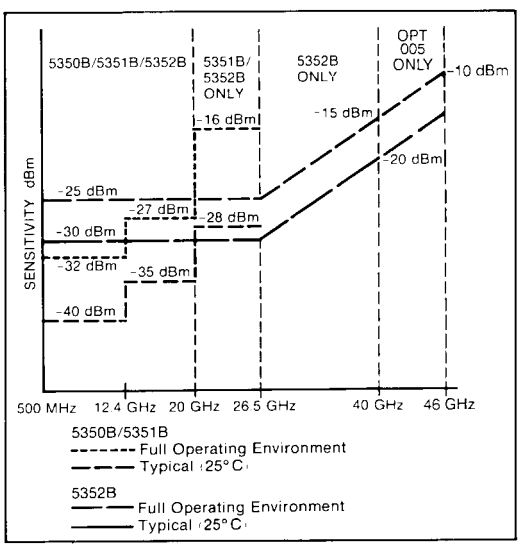
Timebase (10 MHz)

Input 2

Frequency Range: 10 Hz to 525 MHz
50 Ω: 10 MHz to 525 MHz
1 ΩM: 10 Hz to 80 MHz
Sensitivity: Full operating environment:
50 Ω: 10 MHz to 525 MHz, 25 mV rms: 15 mV typical @ 25° C
1 ΩM: 10 Hz to 80 MHz, 25 mV rms: 15 mV typical @ 25° C
Resolution: Selectable, 1 Hz to 1 MHz
High Resolution: 1 MΩ mode: 0.001 Hz for <100 kHz input;
0.01 Hz for <1 MHz input; 0.1 Hz for <10 MHz input;
1 Hz for >10 MHz input: 1-second gate

General

Data Output: Over HP-IB bus; varies with frequency and resolution
Auto Mode: >100 readings/s, 10 kHz resolution, no math functions, "DUMP" mode
Manual Mode: >120 readings/s, 10 kHz resolution, no math functions, "DUMP" mode
Math Functions: Scale, offset, smooth (exponential averaging)
Sleep Mode: Input 1 emissions reduced to < –70 dBm typical when sleep mode or Input 2 is selected
HP-IB Interface Functions: SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C0, E1 (see page xxx)
Operation Temperature: 0° to 50° C
Power Requirements: 100 VA max.
Line Select: 100 V (90 to 105 Vac rms; 47.5 to 440 Hz); 115/120 V (104/126 Vac rms; 47.5 to 440 Hz); 220 V (198 to 231 Vac rms; 47.5 to 66 Hz); 230/240 V (207 to 252 Vac rms; 47.5 to 66 Hz);
Accessories Furnished: power cord, manual



Graph 1. Sensitivity

Ordering Information

HP 5350B 20 GHz Microwave Frequency Counter
HP 5351B 26.5 GHz Microwave Frequency Counter
HP 5352B 40 GHz Microwave Frequency Counter
Options for HP 5350B/5351B/5352B:
Opt 001 Oven Timebase
Opt 002 Rear-Panel Inputs (HP 5350B/51B only)
Opt 005 Frequency Extension to 46 GHz (HP 5352B only)
Opt 006 Microwave Level Limiter (HP 5350B/51B only)
Opt 010 High-Stability Oven Timebase
Opt 908 Rackmount Kit for Use with Front Handles removed
Opt 910 Additional Operating and Service Manual
Opt 913 Rackmount Kit for Use with Supplied Front Handles
Opt 1A3 Bellcore CLEI Barcode Sticker
Opt W30 Extended Repair Service (see page 584)
Opt W32 Calibration Service (see page 584)

CW Microwave Counters with Power Measurement

HP 53150A
HP 53151A
HP 53152A

- Ultra wide range, single input (from 50 MHz up to 46 GHz)
- Simultaneous power and frequency measurement with analog peaking indicator
- Fully programmable HP-IB and RS-232 standard
- Lightweight with optional battery

HP 53152A

HP 53150A, 53151A, 53152A Microwave Counters

HP-IB

The HP 53150 series represent a total re-thinking of microwave counters: innovative designs that offer no-compromise performance and quality while attaining true portability. The HP 53150A, 53151A, and 53152A measure both frequency and power over the frequency ranges of 20 GHz, 26.5 GHz, and 46 GHz, respectively, and feature a single, extremely wideband microwave input (50 MHz up to 46 GHz).

No Compromise Performance

Utilizing a unique single board design with low phase noise PLL circuitry, the HP 53150 series offers exceptional sensitivity, excellent power measurement accuracy and repeatability as well as fast acquisition times and full programmability. Performance equals or surpasses the industry standard HP 5350 series in virtually every aspect in a package that is less than half the weight and size.

Frequency and Power Measurements with a Single Connection

The heart of the HP 53150 series is an advanced sampler design that integrates a separate zero bias Schottky diode for the accurate measurement of input power. This allows the convenient measurement of both frequency and power with a single connection with accuracies and repeatabilities that rival power meters with diode sensors. Best of all, since the frequency of the test signal is measured simultaneously, the diode's frequency response is automatically adjusted for. And like the latest in diode sensors, deviation from square law is also compensated for.

Functionality Without Clutter

The HP 53150 series offers a clean, uncluttered front panel with with a minimum of push buttons. Despite their simple appearance, these counters retain all the powerful functions one expects in precision instrumentation, with such useful functions as: measurement averaging, arbitrary as well as nulling offsets for both frequency and power, display of power in either dBm or Watts and full control of resolution, sampling rate, and HP-IB address plus extensive self-diagnostics.

Field Tough but Ready for Benchtop or ATE Applications

The HP 53150 series is as comfortable in the field as in the laboratory. The rugged case with an integrated tilting handle can tolerate the vibration and shock expected in field use. The "see anywhere" backlit LCD display ensures visibility in all environments, from dark to full sunlight. And in situations where AC is unavailable, the internal, replaceable camcorder batteries provide over 2.5 hours of continuous operation. Alternatively, the unit can be powered from an external 11-18 VDC source.

For benchtop and ATE applications, the HP 53150 series delivers full functionality and high measurement speed along with fully programmable RS-232 interface and high speed HP-IB (SCPI compliant) as standard. In addition, these counters are compatible with standard HP rackmount hardware.

HP 53150 Series Abridged Measurement Specifications and Characteristics

All measurement specifications are over the full signal ranges of channels 1 and 2. For full specifications, please call your HP representative and request a Product Overview for the HP 53150 series microwave counters.

Input Characteristics

	Input 1 (1 MΩ)	Input 2 (50 Ω)	
Frequency Range			
53150A	10 Hz to125 MHz	.05–20 GHz	
53151A	10 Hz to125 MHz	.05–26.5 GHz	
53152A	10 Hz to125 MHz	.05–46 GHz	
Sensitivity		**HP 53150/51**	**HP 53152**
<30 Hz	40 mV	—	—
to 125 MHz	25 mV	—	—
<250 MHz	—	–20 dBm	–20 dBm
to 12.4 GHz	—	–33 dBm	–33 dBm
to 18 GHz	—	–33 dBm	–30 dBm
to 20 GHz	—	–29 dBm	–27 dBm
to 26.5 GHz	—	–25 dBm (151)	–27 dBm
to 40 GHz	—	—	–23 dBm
to 46 GHz	—	—	–17 dBm
Maximum Input	2 V_{rms}	+5 dBm, < 2 GHz +13 dBm, > 2 GHz	
Damage Level	5 V_{rms}	+27 dBm	
Coupling	AC	AC	

Channel 1

Resolution: Selectable 1 Hz to 1 MHz
Connector: BNC female

Channel 2

Resolution: Selectable 1 Hz to 1 MHz
Acquisition Time: 125 ms typical at 1 MHz FM rate
Gate Time: 1/Resolution
FM Tolerance: 20 MHz p-p @ 10 MHz rate to 26.5 GHz; 12 MHz p-p @ 10 MHz rate to 46 GHz
AM Tolerance: Any depth/rate within dynamic range of input
Amplitude Discrimination (above 250 MHz)**:** 20 dB for greater than 75 MHz separation; 6 dB for less than 75 MHz separation
Connector: 3.5 mm SMA compatible (HP 53150A/53151A); 2.92 mm (HP 53152A)

Power Measurement
Range: Counter sensitivity to +7 dBm
Units: dBm or milliwatts/microwatts
Resolution: 0.01 dB

Accuracy (0 to –20 dBm)**:**

	HP 53150/51	HP 53152
< 12.4 GHz	±1.5 dB	±1.0 dB
to 20 GHz	±1.5 dB	±1.5 dB
to 26.5 GHz	±2.0 dB (151)	±1.5 dB
to 46 GHz	—	±2.0 dB

General

Display: Backlit LCD
Sample Rate: User-selectable Fast, Medium, Slow or Hold
Programming: HP-IB and RS-232C, SCPI compatible
Math Functions
Offset: Arbitrary or offset to reading for either power or frequency
Averaging: 1 to 99 measurement running average
Cable Loss Compensation: Offsets power reading via linear interpolation of user-entered frequency attenuations
Sleep Mode: Automatically activated if no input is present for 5 minutes, battery option only
Power Requirements
75 VA max.
90–252 VAC; 47.5–66 Hz
11–18 VDC; 2A max.; battery option only
Battery (option)**:**
Type: VHS camcorder, sealed lead acid
Charge Time: 8 hours
Capacity: 2.5 hours typical at 25° C
Timebase:

	TCXO (std)	Option 001
Aging Rate	1×10^{-7}/mo	5×10^{-10}/day
Short Term (1 sec. avg.)	1×10^{-9}	2×10^{-10}
Temperature	1×10^{-6}	3×10^{-9}

Accessories Furnished: Power cord and operating, programming, and service manuals
Size: 213 mm W x 88.5 mm H x 300 mm D
Weight: 4 kg battery; 6.4 kg with 2 batteries

Ordering Information

HP 53150A 20 GHz Counter
HP 53151A 26.5 GHz Counter
HP 53152A 46 GHz Counter
Options
Opt 001 Oven Timebase
Opt 002 Battery/DC Input

Microwave Counter/Power Meter

HP 5347A
HP 5348A

- Quick, easy power and frequency measurements
- Portable; battery operation
- Built-in sensor calibration tables
- Supports four HP power sensors

HP 5347A portable microwave counter/power meter (shown with Option 803, HP 8485A power sensor, and Option 070 soft carrying case)

HP 5347A and HP 5348A Microwave Counter/Power Meters

HP-IB

The HP 5347A and HP 5348A microwave counter/power meters offer the convenience of a single instrument that meets both your frequency and power measurement needs. The HP 5347A counter/power meter makes these measurements to 20GHz; the HP 5348A, to 26.5 GHz. Both counter/power meters offer the accuracy and resolution that previously required a standalone counter and separate power meter. Measurements are easy. The HP 5347A and HP 5348A are designed for ease of use; they have only five function keys. They are rugged, lightweight and battery-powered.

True Power Meter Performance

As power meters, the HP 5347A and HP 5348A offer excellent dynamic range, linearity, and accuracy. They use any one of four proven power sensors used with Hewlett-Packard's standalone power meters. Power sensors and accurate, wide-range measurements go hand in hand. Power measurements can be made from –70 dBm to +20 dBm over a 10 MHz to 26.5 GHz frequency range, depending on the sensors used. Exceptional power-meter linearity and low sensor SWR combine to give you outstanding measurement accuracy. The instrumentation accuracy is ±0.5% in linear mode or ±0.02 dB in logarithmic mode, making power-meter uncertainty a negligible part of your total measurement error.

Outstanding Frequency Measurements

The frequency counter performance rivals that of HP's highest-performance standalone CW microwave counters. The HP 5347A measures frequency from 10 Hz to 20 GHz; the HP 5348A, from 10 Hz to 26.5 GHz. You can select either 1 Hz or 10 kHz resolution while measuring signals down to –35 dBm.

Portable, Easy to Use

The HP 5347A and HP 5348A come in a rugged, lightweight and portable package. Several features have been designed in for quick and easy portable measurements. An internal-battery option, for example, provides up to two hours of cordless measurements.

Designed for Measurement Ease

How many times have you purchased test equipment only to find that you never use most of the available functionality? The excess functionality only clutters the front panel and makes measurements difficult. Hewlett-Packard recognizes the importance of quick and easy measurements to field service personnel. The HP 5347A and HP 5348A are designed for ease of use.

Five Function Keys Simplify Operation

Unnecessary functions were designed out of the HP 5347A and HP 5348A counter/power meters. Only five function keys are required to make accurate frequency and power measurements. The chance of getting an incorrect reading due to instrument set-up is almost eliminated. Little or no time is required to learn how to use these instruments. A one-page starter guide is shipped with every instrument.

No Need for Calibration Tables

An average calibration table is permanently stored in memory. You no longer need to spend time entering power-sensor calibration factors. Using average calibration tables results in only slight reduction in overall measurement accuracy. With the HP 5347A and HP 5348A, the press of a single key stores a frequency measurement for use in a power measurement. The stored frequency is then used to access the power-sensor calibration factor in the permanently stored calibration-factor-versus frequency tables.

Internal Battery for Cordless Measurements

An optional internal battery allows you to make cordless measurements for up to two hours. In the field, you do not need a power cord. Just walk right up to the output port and make your measurement.

Because at times it might be more convenient to operate the instrument from a dc supply, an external dc input is available for even greater flexibility in choosing a power source.

A Rugged Package for Tough Environments

These instruments are designed to survive the harsh transportation and operation environments common to portable applications. Their membrane front panels keep dirt and moisture from entering the instruments. An optional soft carrying case stores accessories, protects the unit during transit, and frees your hands to make measurements.

For Benchtop and ATE Systems, Too

Having frequency and true power measurements in a single portable package saves valuable bench space in a manufacturing environment. The ease-of-use features will also be greatly appreciated. A rackmount kit and HP-IB option are available for using the HP 5347A or HP 5348A in an ATE system.

Counter Specifications

Input 1

Frequency Range
- **HP 5347A:** 500 MHz to 20.0 GHz
- **HP 5348A:** 500 MHz to 26.5 GHz

Sensitivity
- **HP 5347A/48A:** 500 MHz to 12.4 GHz :–32 dBm; (–35dBm typical); 12.4 GHz to 20.0 GHz: –27dBm; (–32 dBm typical)
- **HP 5348A:** 20.0 GHz to 26.5 GHz: –20 dBm (–27 dBm typical)

Maximum Input: +7dBm
Damage Level: +25 dBm, peak
Connector: HP 5347A: N (f); HP5348A: APC 3.5 (m)
Coupling: AC
Accuracy: ± LSD ± timebase error x frequency
Accuracy specification applies from 0° to 50°C when using internal timebase, 0° to 55° C with external timebase
Resolution: 1 Hz or 10 kHz, selectable
Tracking Speed
- Resolution = 1 Hz, speed = MHz/s
- Resolution = 10 kHz, speed = 1 GHz/s

Acquisition Time
- Resolution = 1 Hz, time = < 125 ms
- Resolution = 10 kHz, time < 60 ms

Maximum Deviation: 20 MHz peak-to-peak, automatic mode
Maximum FM Rate: 10 MHz
AM Tolerance: Any modulation index, provided the minimum signal level is not less than the sensitivity specification
TCXO Timebase: See page 119 for a general description of timebases.
External Timebase: 10 MHz, 0.7 V min. to 8 V max. peak-to-peak sine wave or square wave into > 1 K Ω shunted by < 30 pF, via front-panel BNC connector

Input 2

Frequency Range: 10 Hz to 525 MHz
Sensitivity: 25 mV rms (15 mV rms typical)
Impedance: 1 MΩ nominal shunted by < 70 pF (10 Hz to 80 MHz) or 50 nominal (10 MHz to 525 MHz)
Maximum Input: + 10 dBm (50 Ω input), 1 V rms (1 M Ω input)
Connector: BNC (f)
Coupling: AC
Resolution: 1 Hz or 10 kHz, selectable

Options

Battery (Option 002)**:** 1 to 2 hours of operation (typical); 12 hours to charge (typical)
Microwave Level Limiter (Option 006)
- **Damage Level:** 500 MHz to 6 GHz: 39 dBm; 6 GHz to 18 GHz: 36 dBm; 18 GHz to 26 GHz: 34.8 dBm
- **Sensitivity reduced by:** 500 MHz to 12.4 GHz: 3 dBm; 12.4 GHz to 20 GHz: 4 dBm; 20 GHz to 26 GHz: 5 dBm
- **Oven Timebase:** Special Option

Power Meter Specifications

Frequency Range: 10 to 26.5 GHz, sensor-dependent
Power Range: –70 dBm to + 20 dBm (100 pW to 100 mW), sensor-dependent
Power Sensors: Orderable as options with the instrument
- **Option 801:** HP 8481A Power Sensor, 0.01 to 18 GHz, –30 to + 20 dBm
- **Option 802:** HP 8481D Diode Power Sensor, 0.01 to 18 GHz, –70 to –20 dBm
- **Option 803:** HP 8485A Power Sensor, 0.05 dB to 26.5 GHz, –30 to + 20 dBm

Dynamic Range: 50 dB in 10 dB steps
Display Units: Watts, dBm
Resolution: 0.01 dB in log mode, 0.1% of full scale in linear mode
Accuracy
- **Instrumentation:** ±0.02 dB or ±0.5%
- **Zero Set** (digital settability of zero)**:** ±0.5% of full scale on most sensitive range

Power Reference
- **Power Output:**1.00 mW. Factory set to ±0.7%, traceable to U.S. National Institute of Standards and Technology.
- **Accuracy:** ±1.2% worst case (±0.9% RSS) for one year

General

Diagnostics: Rear panel or HP-IB selectable, service diagnostics and user information
Data Output: Counter: varies with frequency (90 measurements/sec. with 10 kHz resol, DUMP mode): Power meter: 18 measurements/sec.
HP-IB Interface Functions: SH1, AH1, T5, L4, SR1, RL1, DC1, DT1, E1
Operating Temperature: 0° to 55°C
Power Requirements: 50 VA maximum
Line Select:
100 V (90 to 105 Vac rms; 47.5 440 Hz);
115/120 V (104 to 126 Vac rms; 47.5 to 440 Hz);
220 V (198 to 231 Vac rms; 47.5 to 66 Hz);
230/240 V (207 to 252 Vac rms; 47.5 to 66 Hz);
External dc: 14 to 26 Vdc, 40 W, binding post
Accessories Supplied: Power cord, operating/programming manual, power sensor cable (HP 11730A)
Size: 325 mm W x 144 mm H x 456 mm D (12.8 in x 5.66 in x 18.0)
Weight: 9.1 kg (20 lb); with battery, 10.4 kg (23 lb)

Ordering Information

HP 5347A 20 GHz Counter/Power Meter
HP 5348A 26.15 GHz Counter/Power Meter
Options for HP 5347A and HP 5348A
- **Opt 002** Battery Pack
- **Opt 006** Microwave Level Limiter
- **Opt 011** HP-IB Interface
- **Oven Timebase** Special Option
- **Opt 070** Soft Carrying Case
- **Opt 801** HP 8481A Power Sensor
- **Opt 802** HP 8481D Diode Power Sensor
- **Opt 803** HP 8485A Power Sensor
- **Opt 913** Rackmount Kit
- **Opt 915** Service Manual
- **Opt 916** Additional Operating/Programming Manual
- **Opt W30** (HP 5347A) Extended Repair Service (see page 584)
- **Opt W30** (HP 5348A) Extended Repair Service (see page 584)
- **Opt W32** (HP 5347A/48A) Calibration Service (see page 584)

HP Power Sensor Cables
This instrument is supplied with one HP 11730A 1.5 m (5 ft) Sensor Cable. Longer cables are available separately.
- **HP 11730B** 3.0 m (10 ft) Sensor Cable
- **HP 11730C** 6.1 m (20 ft) Sensor Cable
- **HP 11730D** 15.2 m (50 ft) Sensor Cable
- **HP 11730E** 30.5 m (100 ft) Sensor Cable
- **HP 11730F** 61.0 m (200 ft) Sensor Cable

HP 5361B

- Frequency extensions to 26.5 GHz, 40 GHz
- Measure frequency (pulsed or CW), PRI, PRF, pulse width, off-time, and frequency profiles directly

HP 5361B

HP 5361B Pulse/CW Microwave Counter

The HP 5361B offers both high-precision pulse and CW performance. With built-in frequency modulation profiling, the HP 5361B characterizes radar, EW, and communications systems or components. This counter lowers your equipment costs by eliminating the need for a separate CW counter, pulse generator, and computer.

Key features include:

Pulse measurements: Frequency, PRF, PRI, pulse width, and off-time.
Frequency profiling: Characterize frequency transients, modulation (such as chirp), and linearity using the PROFILE function. No external gate is required.
Fast track: Measure a signal that is sweeping at up to 800 MHz/s.
Low FM rate: Measure signals that vary slowly in frequency.
Simplified operation: To offload the operator, built-in automatic functions include calibration, signal assessment (pulsed or CW), signal acquisition, gate width calculation and setting, gate positioning, PRF mode, tracking of sweeping signals, pulse averaging for desired resolution and measurement display.
Scope-View: Set up externally gated measurements by viewing the downconverted pulse with a dc offset.

The HP 5361B is a cost-effective choice for manufacturing and service. High-speed throughput saves operator time and lowers cost. Periodic maintenance is limited to time-base calibration.

For radars, VCOs, and DTOs, the HP 5631B makes frequency, timing, and profiling measurements at the touch of a button. The counter makes more complex measurements for the carrier frequency of agile signals, staggered PRIs, or the frequency transients in a pulsed or CW signal. With one instrument you can characterize radar pulses or test a Stable Local Oscillator (STALO). Functions for measuring step response, post-tuning drift, and settling time facilitate accurate and easy testing of VCOs and DTOs.

Summary Specifications

Input Characteristics

	Input 1 (50 Ω)	Input 2 (1M Ω)	Input 2 (50 Ω)
Frequency range	500 MHz to 20, 26.5, 40 GHz	10 Hz to 80 MHz	10 MHz to 525 MHz
Sensitivity		25 mV rms	25 mV rms
0.5 to 12.4 GHz	–28 dBm		
12.4 to 20 GHz	–23 dBm		
0.5 to 26.5 GHz (Option 026, 040)	–20 dBm		
26.5 to 40 GHz (Option 040)	0.37 x f (in GHz) –29.8 dBm		

Frequency (Input 1)

Automatic and Manual Acquisition: 500 MHz to 20 GHz; 500 MHz to 26.5 GHz (Option 026); 500 MHz to 40 GHz (Option 040)
Least Significant Digit: 1 MHz to 1 Hz for frequency, 0.001 Hz for PRF
Pulse Frequency Measurements
- **Pulse Width** (minimum): Manual mode, 60 ns; auto mode, 100 Ns
- **Pulse Rep. Freq.:** Minimum 1 Hz; maximum 2 MHz
- **Measurement Time, Resolution, Accuracy:** See data sheet

CW Frequency Measurements
- **FM Tolerance:** 55 MHz peak-to-peak
- **Tracking Speed** (fast acquisition): 800 MHz/s
- **Acquisition Time:** Manual mode, <40 ms; automatic mode, fast acq., <100 ms
- **Gate Times** (1 Hz resolution): 200 to 1000 ms
- **Measurement Time:** ≥ 8.5 ms (in Dump Mode)

Accuracy: See data sheet

Pulse Parameters (Input 1)

	Pulse width	PRI	Offtime	PRF
Min./Max.	60 ns/10 ms	500 ns/1 s	400 ns/1 s	1 Hz/2 MHz to 0.001 Hz
LSD	(PW < 1 ms) 1 ns; (PW≥ 1 ms) 100 ns			
Accuracy (100 Avg.)	± (20 ns + timebase uncertainty x measurement ± LSD			± (20 ns) x (PRF)^2 ± LSD ± timebase uncertainty

Profile (Input 1)

Frequency Range (min./max. for Y axis): 500 MHz/40 GHz
FM Chirp Tolerance (max. span for Y axis): 50 MHz peak-to-peak
Time Range (min./max. for span x axis): 100 ns/10 ms
Time Resolution: 1 ns
Internal Gate Width: Minimum: 11 to 23 ns; typical minimum: 14 ns
External Gate Width: Minimum: manual acquisition 20 ns; auto-acquisition 60 ns
Number of Data Points: Up to 100
Profile Frequency Measurements
- **Printers Supported:** HP 2225A, HP 2227B, HP 3630A Option 002
- **Profile Phase Measurements:** See Application Note 377-4 for details. Computer required.

Frequency (Input 2)

Range: 10 Hz to 525 MHz
Accuracy: 0.001 to 1 Hz
Resolution / LSD: 0.001 to 1 Hz

Options

Option 001 Oven Timebase: Aging rate < 5 x 10^{-10} / day
Option 006, Increased Damage Level: Pulsed, + 50 dBm (100 W) peak; CW, +39 dBm (8 W)
Option 010 High-Stability Oven Timebase: Aging rate < 7 x 10^{-10} /week (Standard timebase: Aging rate < 1 x 10^{-7} /month)
Option 026: Frequency extensions for input 1 to 26.5 GHz
Option 040: Frequency extensions for input 1 to 40 GHz

Ordering Information

HP 5361B Pulsed/CW Microwave Counter
- **Opt 001** Oven Timebase
- **Opt 006** Microwave Limiter
- **Opt 010** High-Stability Timebase
- **Opt 026** 26.5 GHz Frequency Extension
- **Opt 040** 40 GHz Frequency Extension
- **Opt 908** Rackmount Kit for Use with Front Handles Removed
- **Opt 910** Additional Operating and Programming Manual
- **Opt 913** Rackmount Kit for Use With Supplied Front Handles
- **Opt 915** Service Manual
- **Opt W30** Extended Repair Service (see page 584)
- **Opt W32** Calibration Service (see page 584)

HP offers a full line of digital multimeters.

Performance and Features to Match Your Needs

The most important question with any piece of test equipment is whether it has what you need to get the job done right. From research to production to field repair, there's an HP meter with the performance you need.

If performance means resolution, HP's DMMs offer from 3½ all the way to 8½ digits. If performance means precision, the HP 3458A delivers 8 ppm basic dc volts accuracy. If performance means sensitivity, the HP 34420A nanovolt/micro-ohmeter takes you all the way down to 100 pV and 100 nΩ. And if performance means flat-out measurement speed in a data acquisition or production test system, the HP 3458A can churn out up to 100,000 readings per second—and change setups more than 340 times a second.

But a great DMM doesn't stop there. How about a "Voltmeter Complete" signal to switch channels on an external scanner without involving the host computer? Or interrupt capability to let the DMM run asynchronously so the whole system runs more efficiently? These are just two of the features you'll find on various HP DMMs that'll boost your overall test productivity.

How Many Different Ways Do You Use a Multimeter?

You probably have a long list of jobs for your multimeter, from the quick and simple to the demanding and complex. The more flexible a DMM is, naturally, the more you'll be able to do with it.

There are two ways to look at flexibility. First, how many different tasks can the DMM perform? HP's DMMs offer everything from the basics to such advanced functions as limit tests and min/max/avg read-outs. Second, will the DMM let you balance speed, resolution, and noise rejection for each test? The HP 3458A system multimeter, for instance, offers resolutions up to 8½ digits when you need precision, or speeds of up to 100,000 readings per second when throughput is paramount. Plus, you can adjust integration times to balance speed and noise rejection.

Find Your Fit in the HP Family

From a toolbox to a test rack to a VXIbus system, there's an HP DMM that's right for the job. See the table at right and the individual product pages for more detail.

HP 3458A Multimeter
Up to 8½ digits of resolution and up to 100,000 readings per second. Calibration and metrology labs worldwide rely on its accuracy and noise rejection.

HP 34420A Nanovolt/Micro-ohmeter
Raises low-level measurements to a new standard. The specified noise level is half that of other nanovolt meters, and its typical performance rivals solutions costing twice as much.

HP 34401A Multimeter
Benchtop unit delivers 12 measurement functions and 6½ digits for the price you'll pay for 5½ digits elsewhere.

HP 970 Series Handheld DMMs
Carry benchtop capabilities wherever your job takes you. Offers resolution as high as 4½ digits and a variety of useful features, from temperature to ac+dc and dB/dBm.

HP VXIbus DMMs
Five B- and C-size multimeters to choose from. Perfect for data acquisition and computer-aided test applications. Refer to the VXIbus section of this catalog for more information.

Cut your costs, now and over the long haul

HP built its reputation on products that were built to last. The warranties on our DMMs are up to three times longer than the competitions'. Plus, all-electronic calibration and built-in self-tests reduce downtime and your total cost of ownership.

HP Digital Multimeters/Digital Voltmeters

	HP 34401A	HP 34420A	HP 3458A	HP 970 series	HP E1312A HP E1412A HP VXIbus DMMs
DC voltage					
Basic 1 yr. accuracy	35 ppm	30 ppm	8 ppm (4 ppm opt.)	0.3% to 0.05%	35 ppm
Sensitivity	100 nV	0.1 nV	10 nV	100 μV to 10 μV	100 nV
Maximum reading rate	1,000 rdg/s	250 rdg/s	100,000 rdg/s	2 rdg/s	1,000 rdg/s
Maximum range	1,000 V	100 V	1,000 V	1,000 V	300 V
Resistance					
Basic 1 yr. accuracy	0.01%	0.006%	0.001%	0.5% to 0.06%	0.01%
Sensitivity	100 $\mu\Omega$	0.1 $\mu\Omega$	10 $\mu\Omega$	0.1 Ω to 0.01 Ω	100 $\mu\Omega$
AC voltage					
Basic 1 yr. accuracy	0.06%	NA	0.014%	1% to 0.5%	0.06%
Bandwidth	3 Hz to 300 kHz	NA	1 Hz to 10 MHz	up to 100 kHz	3 Hz to 300 kHz
Functions	dc and ac V dc and ac I 2- and 4-wire Ω Diode test Frequency Period Continuity Reading hold dB, dBm Null, min/max, pass/fail, ratio 512 rdg Storage HP-IB, RS-232	dc V 2-channel voltage input 2- and 4-wire Ω Offset-compensated Ω Low power Ω Voltage clamped Ω Temperature (including SPRT) Analog and digital filter Chart recorder analog output 1,024 reading storage HP-IB, RS-232	dc and ac V dc and ac I 2- and 4-wire Ω Offset-compensated Ω Frequency Period Math Ratio Internal Basic 20 KB reading memory Digitizing HP-IB	dc and ac V dc and ac I 2-wire Ω Diode test Frequency Capacitance Data hold Continuity Temperature Min/max/avg Bargraph Dual digital display Relative/percent Current shutter	dc and ac V dc and ac I 2- and 4-wire Ω Frequency Period Temperature dB, dBm Null, limit, min/max 1000 rdgs Storage
Options	**Option W50** 5-year hardware support	**Option W50** 5-year hardware support	**Option 001** Expanded reading memory to 148 KB **Option 002** High stability (4 ppm/yr.) **Option W30** 3-year hardware support	**HP E3204A** Soft carrying case **HP E2306A** Deluxe test lead kit **HP E2308A** Thermistor temperature probe **Option W50** 2-year hardware support	**Option W01** 3-year warranty conversion to 1 year on-site
Digits	6½	7½	8½	3½ to 4½	6½
More information in this catalog	page 139	page 141	page 143	page 145	page 65 VXIbus products

Need more information?

If you'd like to learn more about any of these DMMs, call your HP field engineer or one of the engineers at HP DIRECT. Our instrumentation specialists are ready to discuss your application and help you find the right DMM for your unique needs. Please see page 604 for a full directory of product and application literature available from Hewlett-Packard.

- 12 measurement functions
- 1000 V maximum input
- 15 ppm basic dV accuracy (24-hour)
- 1000 readings per second direct to HP-IB
- HP-IB and RS-232 standard
- 512-reading memory
- SCPI commands standard

HP 34401A with optional accessory pouch

HP 34401A Digital Multimeter

The HP 34401A digital multimeter establishes a new price/performance standard by offering such features as 6½ digits of resolution, 1000 readings per second, and 15 ppm basic dc accuracy at a surprisingly affordable price. The HP 34401A has been designed for superior performance while providing the flexibility to meet both your present and future needs.

Great Bench Performance

The clear, logical front panel of the HP 34401A allows you to easily select all primary measurement functions. Traditional "bench" functions, such as continuity and diode test, are included. Math functions, such as NULL, dB, dBm, limit test, and min/max/avg are easily selected. A simple menu scheme gives you access to powerful advanced features, such as the ability to store up to 512 readings in internal memory. Measurement results are displayed on a bright, high-visibility readout. A rugged case ensures survival even under the toughest conditions, and the optional accessory pouch makes it easy to pack up and go with the HP 34401A.

Superior Performance in Your System

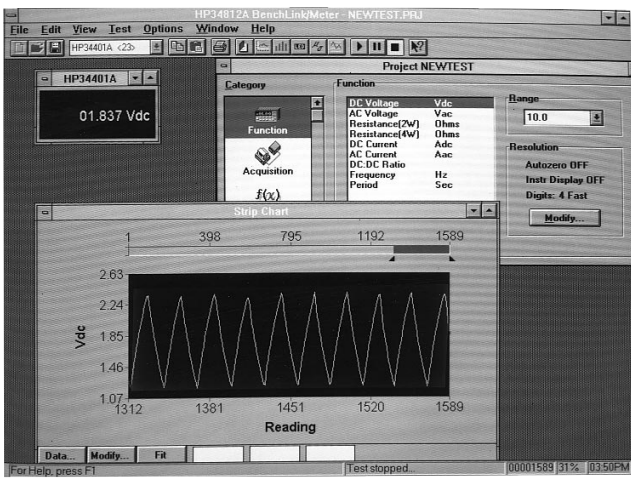
The HP 34401A can take up to 1000 readings per second, including HP-IB bus transfer in ASCII format. Both HP-IB and RS-232 are standard, letting you select the interface that best meets your needs. The HP 34401A responds to three different command languages. It accepts SCPI commands (Standard Commands for Programmable Instruments), which ensures present and future compatibility. It also responds to commands for the HP 3478A and the Fluke 8840A, thereby protecting your software investment with backward compatibility. Drivers are also available for both National Instruments Labview and Hewlett-Packard's VEE software.

Turn Your HP 34401A into a Measurement System with HP 34812A BenchLink Meter Software

The HP 34401A is an exceptional digital multimeter, and you can make it even more valuable with the HP 34812A BenchLink Meter software solution. HP BenchLink Meter turns your PC and DMM into a powerful, easy-to-use single-channel data acquisition system.

One of the HP BenchLink family of PC/basic instrument connectivity solutions, HP BenchLink Meter lets you combine your Windows-based PC and the HP 34401A DMM to easily configure, capture, and display measurement data. HP BenchLink lets you structure your entire test—measurement, acquisition parameters, time of test start, test limits, and more—from the PC, so you create the test environment you need. You'll have a variety of display and analysis formats available, including a strip chart mode, statistics, histograms, and an analysis window to let you zoom in on specific data points for a closer look. In addition, it's easy to transfer captured data to other Windows programs for more detailed analysis.

HP BenchLink Meter supports both HP-IB and RS-232 transfers, and runs on both Windows 3.1 and Windows 95.



Abbreviated Technical Specifications

DC Voltage

Input Characteristics

Range	Maximum reading (6½ digits)	Resolution in digits 6½	5½	4½	Input resistance
100 mV	120.0000	100 nV	1 μV	10 μV	10 MΩ or > 10 GΩ
1 V	1.200000	1 μV	10 μV	100 μV	10 MΩ or > 10 GΩ
10 V	12.00000	10 μV	100 μV	1 mV	10 MΩ or >10 GΩ
100 V	120.0000	100 μV	1 mV	10 mV	10 MΩ
1000 V	1050.000	1 mV	10 mV	100 mV	10 MΩ

Input Protection: >1000 V on all ranges
Measurement Accuracy: ±(% of reading + % of range)

Range	24-Hour 23° C ±1° C	90-Day 23° C ±5° C	1-Year 23° C ±5° C
100 mV	0.0030 + 0.0030	0.0040 + 0.0035	0.0050 + 0.0035
1 V	0.0020 + 0.0006	0.0030 + 0.0007	0.0040 + 0.0007
10 V	0.0015 + 0.0004	0.0020 + 0.0005	0.0035 + 0.0005
100 V	0.0020 + 0.0006	0.0035 + 0.0006	0.0045 + 0.0006
1000 V	0.0020 + 0.0006	0.0035 + 0.0010	0.0045 + 0.0010

Noise Rejection: (50 or 60 Hz, 1 kΩ unbalance in LO lead)
DC CMRR: 140 dB
AC CMRR: 70 dB
Normal mode rejection (60 Hz/50 Hz)± 0.1%:
100 PLC (1.67 s/2.00 s): 60 dB
10 PLC (167 ms/200 ms): 60 dB
1 PLC (16.7 ms/20.0 ms): 60 dB
<1 PLC (3 ms or 800 ms): 0 dB
Maximum Reading Rate: (readings/s)

Power line frequency	Resolution in digits 6½	5½	4½
60 Hz	6	300	1000
50 Hz	5	300	1000

AC Voltage (true rms)

Measurement Accuracy: ± (% of reading + % of range); 1 year, 23° C ± 5° C

Frequency	Ranges 100 mV	Ranges 1, 10, 100, 750 V
3 to 5 Hz	1.00 + 0.04	1.00 + 0.03
5 to 10 Hz	0.35 + 0.04	0.35 + 0.03
10 Hz to 20 kHz	0.06 + 0.04	0.06 + 0.03
20 to 50 kHz	0.12 + 0.04	0.12 + 0.05
50 to 100 kHz	0.60 + 0.08	0.60 + 0.08
100 to 300 kHz	4.00 + 0.50	4.00 + 0.50

Note: –3 dB frequency typically >1 MHz

Input Resistance: 1 MΩ ±2%, in parallel with 100 pF
Input Protection: >750 V rms on all ranges
Maximum Volt–Hz Product: 8×10^7
Crest Factor: Maximum of 5:1 at full scale
Maximum Reading Rate: 10 readings/s (50 readings/s with default delays defeated)

Frequency and Period
Range: 3 Hz to 300 kHz (333 ms to 3.33 μs)
1-Year Accuracy: 0.01% (40 Hz to 300 kHz); 0.05% (3 to 40 Hz)
Resolution: 10 μHz to 1 Hz
Other Measurement Functions: Continuity, Diode Test, Ratio dc:dc, Limit Test
Math Functions: NULL, Min/Max/Avg, dB, dBm, Limit Test
Memory: 512-reading internal storage
Standard Programming Languages: SCPI, HP 3478A and Fluke 8840A/42A
Computer Interface: HP-IB and RS-232C standard
Accessories Included: Test lead kit, operators manual, service manual, test report, and power cord
Warranty: 3 years standard

Resistance: (2-wire Ω, 4-wire Ω)

Input Characteristics

Range	Maximum reading (6½ digits)	Resolution in digits 6½	5½	4½
100 Ω	120.0000	100 μΩ	1 mΩ	10 mΩ
1 kΩ	1.200000	1 mΩ	10 mΩ	100 mΩ
10 kΩ	12.00000	10 mΩ	100 mΩ	1 Ω
100 kΩ	120.0000	100 mΩ	1 Ω	10 Ω
1 MΩ	1.200000	1 Ω	10 Ω	100 Ω
10 MΩ	12.00000	10 Ω	100 Ω	1 kΩ
100 MΩ	120.0000	100 Ω	1 kΩ	10 kΩ

Input Protection: >1000 V on all ranges
Measurement Accuracy: ±(% of reading + % of range)
Specs are for 4-wire Ω or 2-wire Ω using Math Null

Range	24-Hour 23° C ±1° C	90-Day 23° C ±5° C	1-Year 23° C ±5° C	Current source
100 Ω	0.0030 + 0.0030	0.008 + 0.004	0.010 + 0.004	1 mA
1 kΩ	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	1 mA
10 kΩ	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	100 μA
100 kΩ	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	10 μA
1 MΩ	0.002 + 0.001	0.008 + 0.001	0.010 + 0.001	5.0 μA
10 MΩ	0.015 + 0.001	0.020 + 0.001	0.040 + 0.001	500 nA
100 MΩ	0.300 + 0.010	0.800 + 0.010	0.800 + 0.010	500 nA*

* Measurement is computed from 10 M Ω in parallel with input.

Maximum Reading Rate: Same as dcV

DC Current

Measurement Accuracy: ±(% of reading + % of range)

Range	24-Hour 23° C ±1° C	90-Day 23° C ±5° C	1-Year 23° C ±5° C	Shunt resistance
10 mA	0.005 + 0.010	0.030 + 0.020	0.050 + 0.020	5.0 Ω
100 mA	0.010 + 0.004	0.030 + 0.005	0.050 + 0.005	5.0 Ω
1 A	0.050 + 0.006	0.080 + 0.010	0.100 + 0.010	0.1 Ω
3 A	0.100 + 0.020	0.120 + 0.020	0.120 + 0.020	0.1 Ω

Burden Voltage: <2 V for 3 A input; <0.1 V for 10 mA input
Input Protection: Externally accessible 3 A 250 V fuse; internal 7 A 500 V fuse
Maximum Reading Rate: Same as dcV

AC Current (true rms)

Measurement Accuracy: ±(% of reading + % of range); 1 year, 23° C ± 5° C

Frequency	Ranges 1 A	Ranges 3 A
3 to 5 Hz	1.00 + 0.04	1.10 + 0.06
5 to 10 Hz	0.30 + 0.04	0.35 + 0.06
10 Hz to 5 kHz	0.10 + 0.04	0.15 + 0.06

Burden Voltage: <1.5 V rms for 3 A input
Input Protection: Externally accessible 3 A 250 V fuse; internal 7 A 500 V fuse
Maximum Reading Rate: Same as acV

General Specifications

Power: 100/120/220/240V, ±10%
Power Line Frequency: 45 to 66 Hz, 360 to 440 Hz
Power Consumption: 25 VA peak (10 W average)
Operating Environment: 0° to 55° C, full accuracy to 80% RH, 40° C
Storage Environment: –40° C to 75° C
Size: 212.6 mm W x 88.5 mm H x 348.3 mm D (8.5 in x 4 in x 14 in)
Weight: Net, 3.6 kg (8.0 lb); shipping, 5.9 kg (13 lb)
Safety: Designed to UL-1244, IEC-348, CSA

Ordering Information

HP 34401A Multimeter
Opt 908 Rackmount Kit
Opt 1BP MIL-STD-45662A Certificate of Calibration with Data
HP 34130A Deluxe Test Lead Kit (unique to HP 34401A)
HP 34397A DC to AC Power Inverter
HP 34812A BenchLink/Meter Software
HP 34161A Accessory Pouch

- 1.3 nV rms noise/8 nVp-p
- 100 pV, 100 nΩ sensitivity
- Two-channel programmable voltage input; difference and ratio functions
- 7½ digit resolution
- 1 mV to 100 V ranges
- SCPI and Keithley 181 languages
- Direct SPRT, RTD, Thermistor, and thermocouple temperature measurements

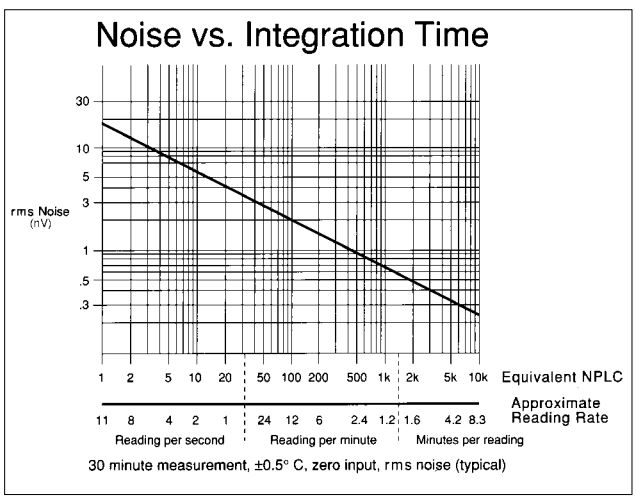
HP 34420A

HP 34420A Nanovolt/Micro-ohm Meter

The HP 34420A sets a price/performance standard in low-level measurement capability. The noise performance of the HP 34420A nanovolt/micro-ohm meter is more than an order of magnitude better than that previously available from Hewlett-Packard.

Accurate, Repeatable Low-Level Measurements

A shielded copper pin screw-down connector, a 7½-digit A/D converter, 2 ppm basic dc accuracy, and a new measurement algorithm that gives 100 dB normal mode rejection without front-end filtering result in measurement capability you can depend on to make accurate and repeatable low-level measurements. Low noise input amplifiers and a highly-tuned input protection scheme bring reading noise down to 8 nVp-p. Longer integration times improve noise performance even further.



Unprecedented Functionality

Two input channels allow voltage measurements to be made independently, or they can be mathematically combined to make difference and ratio measurements. Ohms measurements combine the low-noise input circuits with a highly-stable current source to provide outstanding low-resistance measurements. Offset compensation is employed to eliminate the effects of stray thermal EMFs that would otherwise result in measurement error. Low power ohms and a low-voltage resistance measurement capability allow repeatable measurements to be made where a low voltage (20 mV) is required to avoid oxidation punch-through. A wide range of temperature measurement capabilities are also built in, providing support for SPRT, thermocouple, RTD, and thermistor temperature sensors.

Math Functions Enhance Capabilities

Math functions such as NULL, STATS, and SCALE ease the capture of minimum and maximum readings, provide averages and standard deviation, scale your measurement results, and ultimately makes it easier for you to characterize your input signal. The HP 34420A can also store up to 1024 readings in internal memory.

Built-in Versatility

You will find that the HP 34420A will fit equally well into your bench or your system applications. Designed with the bench user in mind, operation of the HP 34420A from the front panel is straightforward and intuitive. For system applications, the HP 34420A includes both HP-IB and RS-232 interfaces standard, and uses Standard Commands for Programmable Instrumentation (SCPI). This ensures both present and future compatibility. The HP 34420A also responds to commands for the Keithley 181 nanovoltmeter.

Abbreviated Technical Specifications

Accuracy Specifications: ± (% of reading ± % of range)

DC Voltage[1] – 7½ digits resolution all ranges

Range	24-Hour 23°C ±1°C	90-Day 23°C ±5°C	1-Year 23°C ±5°C
1 mV	0.0025 + .0020	0.0040 + .0020	0.0050 + .0020
10 mV	0.0025 + .0002	0.0040 + .0002	0.0050 + .0003
100 mV	0.0015 + .0003	0.0030 + .0004	0.0040 + .0004
1 V	0.0010 + .0003	0.0025 + .0004	0.0035 + .0004
10 V	0.0002 + .0001	0.0020 + .0004	0.0030 + .0004
100 V	0.0010 + .0004	0.0025 + .0005	0.0035 + .0005

DCV1/DCV2 (ratio)**:** Ratio error in % = channel 1 accuracy in % + channel 2 accuracy in %
DCV1-2 (difference)**:** Difference error = channel 1 (% reading + % range) + channel 2 (% reading + % range)

DC Voltage Noise Specifications[2]

Range	2-Minute rms noise	2-Minute p-p noise	24-Hour p-p noise
1 mV	1.3 nV RMS	8 nV p-p	12 nV p-p
10 mV	1.5 nV RMS	10 nV p-p	14 nV p-p
100 mV	10 nV RMS	65 nV p-p	80 nV p-p
1 V	100 nV RMS	650 nV p-p	800 nV p-p
10 V	450 nV RMS	3 μV p-p	3.7μV p-p
100 V	11 μV RMS	75 μV p-p	90 μV p-p

DC Voltage
Input Resistance:
10 MΩ ±1% (100 V range)
>10 GΩ (1 mV through 10 V range)
Input Protection:
150 V peak to Channel 1 LO

Resistance[3] – 7½ digits resolution all ranges

Range	Test current	24-Hour 23°C ±1°C	90-Day 23°C ±5°C	1-Year 23°C ±5°C
1Ω	10 mA	0.0015 + .0002	0.0050 + .0002	0.0070 + .0002
10 Ω	10 mA	0.0015 + .0002	0.0040 + .0002	0.0060 + .0002
100 Ω	10 mA	0.0015 + .0002	0.0040 + .0002	0.0060 + .0002
1 kΩ	1 mA	0.0015 + .0002	0.0040 + .0002	0.0060 + .0002
10 kΩ	100 μA	0.0015 + .0002	0.0040 + .0002	0.0060 + .0002
100 kΩ	10 μA	0.0015 + .0003	0.0040 + .0004	0.0060 + .0004
1 MΩ	5 μA	0.0020 + .0003	0.0050 + .0004	0.0070 + .0004

Low Power Resistance[3]

Range	Test current	24-Hour 23°C ±1°C	90-Day 23°C ±5°C	1-Year 23°C ±5°C
1 Ω	10 mA	0.0015 + .0002	0.0050 + .0002	0.0070 + .0002
10 Ω	10 mA	0.0015 + .0002	0.0040 + .0002	0.0060 + .0002
100 Ω	1 mA	0.0015 + .0002	0.0040 + .0002	0.0060 + .0002
1 kΩ	100 μA	0.0015 + .0002	0.0040 + .0002	0.0060 + .0002
10 kΩ	10 μA	0.0015 + .0004	0.0040 + .0004	0.0060 + .0004
100 kΩ	5 μA	0.0015 + .0012	0.0040 + .0015	0.0060 + .0015
1 MΩ	5 μA	0.0020 + .0003	0.0050 + .0004	0.0070 + .0004

Voltage Limited Resistance[3]
Voltage limit selectable: 20 mV, 100 mV, or 500 mV

Range	Test current	24-Hour 23°C ±1°C	90-Day 23°C ±5°C	1-Year 23°C ±5°C
10 Ω	1 mA	0.0020 + .0002	0.0050 + .0002	0.0070 + .0002
100 Ω	100 μA	0.0025 + .0002	0.0050 + .0002	0.0070 + .0002

Temperature – 0.001°C Resolution

Probe type	Accuracy
SPRT[4]	SPRT probe accuracy + 0.003°C
RTD	RTD probe accuracy + 0.05°C
Thermistor	Thermistor probe accuracy + 0.1°C
Thermocouple[5]	Thermocouple probe accuracy + 0.2°C

Temperature
SPRT: ITS-90 calibrated temperature within the range of –190°C to +660°C
RTD: Type α =.00385 and α =.00392. R_0 from 4.9 Ω to 2.1 KΩ. ITS-90 (IEC 751) Callendar - Van Dusen conversion.
Thermistor: 5 KΩ
Thermocouple: ITS-90 conversions of type B, E, J, K, N, R, S, T

Chart Out (Analog Out)
Resolution: 16 bits
Maximum Output: ±3 V
Span and Offset: Adjustable

Filter (Analog or Digital or Both)
Analog: Low pass 2 pole @ 13 Hz, available for dcV on 1 mV, 10 mV, 100 mV ranges
Digital: Moving average filter. 10 (fast), 50 (medium) or 100 (slow) reading averages.

Math Functions
NULL (Channel 1 dcV, Channel 2 dcV, Difference, Resistance, Temperature)
STATS (Min/max/avg, peak-peak, standard deviation, number of readings)
SCALE (Allows linear scaling as Y=MX + B)
CHART NULL (Establishes zero for rear-panel output)

General Specifications

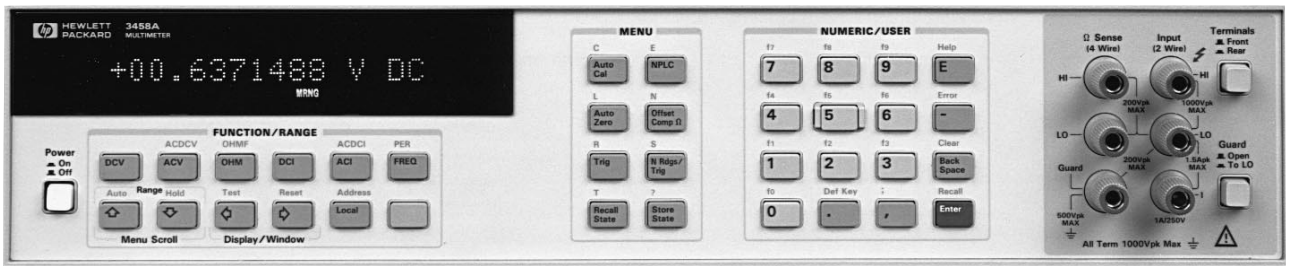
Front-Panel Connection: Shielded, low-thermal, copper contacts
Interface: HP-IB and RS-232 standard
Languages: SCPI-1994 (IEEE-488.2), Keithley 181
Warranty: 3 years standard

Ordering Information

HP 34420A Nanovolt/Micro-Ohm Meter
Includes low-thermal input cable (HP 34102A), low-thermal shorting plug (HP 34103A), operating and service manuals, quick reference guide, test report with calibration sticker, 2.3 ml bottle of contact cleaner, and power cord.
Opt 1CM Rackmount Kit

Accessories
HP 34102A Low-Thermal Input Cable (four-conductor with copper spade lugs)
HP 34103A Low-Thermal Shorting Plug
HP 34104A Low-Thermal Input Connector
HP 34161A Accessory Pouch

[1] Specifications are for channel 1 or channel 2 (100 V range on channel 1 only), after 2-hour warm-up, resolution at 7.5 digits (100 NPLC), with filters off.
[2] After a 2-hour warm-up ± 1° C, 6.5 digits (10 NPLC) with analog filter off digital filter medium (50 readings). 2 minute rms and 24-hour noise typical.
[3] All resistance specifications are for channel 1 only, after 2-hour warm-up, resolution at 7.5 digits (100 NPLC) with filters off, for 4-wire Ω or 2-wire Ω using Null.
[4] For 25 Ω SPRT with triple-point of water check within last 4 hours. With no triple-point of water check, add 0.013° C for 24-hour, 0.035° C for 90-day, and 0.055° C for 1-year specifications.
[5] For fixed reference junction. Add 0.3° C for external reference junction, add 2.0° C for internal reference junction.



HP 3458A

HP 3458A Multimeter

The HP 3458A multimeter shatters long-standing performance barriers of speed and accuracy on the production test floor, in research and development, and in the calibration lab. The HP 3458A is the fastest, most flexible, and most accurate multimeter offered by Hewlett-Packard. In your system or on the bench, the HP 3458A saves you time and money with unprecedented test-system throughput and accuracy, seven-function measurement flexibility, and low cost of ownership.

Select a rate of 100,000 reading per second for maximal test throughput. Or achieve highest levels of precision with up to 8½ digits of measurement resolution and 0.1 part per million transfer accuracy. Add to this the HP 3458A's simplicity of operation, and you have the ideal multimeter for your most demanding applications.

High-Test System Throughput

Faster Testing
- Up to 100,000 reading/s
- Internal test setups > 340/s
- Programmable integration times from 500 ns to 1 s

Greater Test Yield
- More accuracy for tighter test margins
- Up to 8½ digits resolution

Longer Uptime
- Two-source (10 V, 10 kΩ) calibration, including ac
- Self-adjusting, self-verifying auto-calibration for all functions and ranges, including ac

High-Resolution Digitizing

Greater Waveform Resolution and Accuracy
- 16 to 24-bits resolution
- 100,000 to 0.2 sample/s
- 12 MHz bandwidth
- Timing resolution to 10 ns
- Less than 100 ps time jitter
- Over 75,000 reading internal memory

Calibration Lab Precision

Superb Transfer Measurements
- 8½ digits resolution
- 0.1 ppm dc volts linearity
- 0.1 ppm dc volts transfer capability
- 0.01 ppm rms internal noise

Extraordinary Accuracy
- 0.6 ppm for 24 hours in dc volts
- 2.2 ppm for 24 hours in Ω
- 100 ppm mid-band ac volts
- 8 ppm (4 ppm optional) per year voltage reference stability

HP 3458A Multimeter Performance Features

DC Volts
- 5 ranges: 0.1 V to 1000 V
- 8½ to 4½ digits resolution
- Up to 100,000 readings/s (4½ digits)
- Maximum sensitivity: 10 nV
- 0.6 ppm 24-hour accuracy
- 8 ppm (4 ppm optional)/year voltage reference stability

Resistance
- 9 ranges: 10 Ω to 1 GΩ
- 2-wire and 4-wire Ω with offset compensation
- Up to 50,000 readings/second (5½ digits)
- Maximum sensitivity: 10 μ Ω
- 2.2 ppm 24-hour accuracy

AC Volts
- 6 ranges: 10 mV to 1000 V
- 1 Hz to 10 MHz bandwidth
- Up to 50 readings/s with all readings to specified accuracy
- Choice of sampling or analog true rms techniques
- 100 ppm best accuracy

DC Current
- 8 ranges: 100 nA to 1 A
- Up to 1,350 readings/s (5½ digits)
- Maximum sensitivity: 1 pA
- 14 ppm 24-hour accuracy

AC Current
- 5 ranges: 100 μA to 1 A
- 10 Hz to 100 kHz bandwidth
- Up to 50 readings/second
- 500 ppm 24-hour accuracy

Frequency and Period
- Voltage or current ranges
- Frequency: 1 Hz to 10 MHz
- Period: 100 ns to 1 second
- 0.01% accuracy
- AC or dc coupled

Throughput

Maximum Reading Rates
- 100,000 readings/s at 4½ digits (16 bits)
- 50,000 readings/s at 5½ digits
- 6,000 readings/s at 6½ digits
- 60 readings/s at 7½ digits
- 6 readings/s at 8½ digits

Measurement System Speed
- 100,000 readings/s over HP-IB or with internal memory
- 110 autoranges/s
- 340 function or range changes/s
- Postprocessed math from internal memory

Digital Multimeters/Digital Voltmeters

8½ Digit Multimeter (cont'd)

Abbreviated Technical Specifications

DC Voltage

Range	Full scale	Maximum resolution	1-Year* accuracy	Transfer accuracy 10 min., tref ±0.5° C	Input impedance
			ppm of reading + ppm of range		
100 mV	120.00000	10 nV	9(5) + 3	0.5 + 0.5	>10 GΩ
1 V	1.20000000	10 nV	8(4) + 0.3	0.3 + 0.1	>10 GΩ
10 V	12.0000000	100 nV	8(4) + 0.05	0.05 + 0.05	>10 GΩ
100 V	120.000000	1 μV	10(6) + 0.3	0.5 + 0.1	10 MΩ ±1%
1000 V	1050.00000	10 μV	10(6) + 0.1	1.5 + 0.05	10 MΩ ±1%

One-year specifications for NPLC 100 within 24 hours and ±1° C of last ACAL, Tcal ±5° C, MATH NULL, fixed range. Add 2 ppm of reading additional error for HP factory traceability of 10 V dc to US NIST. Traceability error is the absolute error relative to National Standards associated with the source of last external calibration. Transfer specifications for NPLC 100, following 4-hour warm-up. Full scale to 10% of full scale. Measurements on the 1000 V range are within 5% of the initial measurement value and following measurement settling. Tref is the starting ambient temperature. Measurements are made on a fixed range using accepted metrology practices.
*High stability (Option 002) ppm of reading in parentheses.

3

Noise Rejection (dB)[1]

	AC NMR[2]	AC ECMR	DC ECMR
NPLC < 1	0	90	140
NPLC ≥ 1	60	150	140
NPLC ≥ 10	60	150	140
NPLC ≥ 100	60	160	140
NPLC = 1000	75	170	140

[1] Applies for 1 kΩ unbalance in the LO lead and ±0.1% of the line frequency currently set for LFREQ.
[2] For line frequency ±1%, ACNMR is 40 dB for NPLC ≥ 1, or 55 dB for NPLC ≥ 100. For line frequency ±5%, ACNMR is 30 dB for NPLC ≥ 100.

Maximum Input

	Rated input	Nondestructive
HI to LO	±1000 V pk	±1200 V pk
LO to guard	±200 V pk	±350 V pk
Guard to earth	±500 V pk	±1000 V pk

True rms AC Voltage

(Synchronous Subsampled Mode)

Range	Full scale	Maximum resolution	Accuracy* 24 hour–2 year 40 Hz to 1 kHz % of reading + % of range	Input impedance
10 mV	12.00000	10 nV	0.02 + 0.011	1 MΩ ±15% with <140 pf
100 mV	120.00000	10 nV	0.007 + 0.002	1 MΩ ±15% with <140 pf
1 V	1.2000000	100 nV	0.007 + 0.002	1 MΩ ±15% with <140 pf
10 V	12.000000	1 μV	0.007 + 0.002	1 MΩ ±2% with <140 pf
100 V	120.00000	10 μV	0.02 + 0.002	1 MΩ ±2% with <140 pf
1000 V	700.0000	100 μV	0.04 + 0.002	1 MΩ ±2% with <140 pf

*Specifications apply for full scale to 10% of full scale, dc <10% of ac, sine-wave input, crest factor of 1.4. Within 24 hours and ± 1° C of last ACAL. Peak (ac+dc) input limited to 5 x full scale for all ranges. Add 2 ppm of reading additional error for HP factory traceability of 10 Vdc to US NIST.

Maximum Input

	Rated input	Nondestructive
HI to LO	±1000 V pk	±1200 V pk
LO to guard	±200 V pk	±350 V pk
Guard to earth	±500 V pk	±1000 V pk
Volt-Hz product	1 x 10[8]	—

Resistance

Range	Full scale	Maximum resolution	Current through unknown	1-Year Accuracy* (4-wire Ω) ppm of rdg+ppm of range
10 Ω	12.00000	10 μΩ	10 mA	15 + 5
100 Ω	120.00000	10 μΩ	1 mA	12 + 5
1 kΩ	1.2000000	100 μΩ	1 mA	10 + 0.5
10 kΩ	12.000000	1 mΩ	100 μA	10 + 0.5
100 kΩ	120.00000	10 m Ω	50 μA	10 + 0.5
1 MΩ	1.2000000	100 m Ω	5 μA	15 + 2
10 MΩ	12.000000	1 Ω	500 nA	50 + 10
100 MΩ	120.00000	10 Ω	500 nA	500 + 10
1 GΩ	1.2000000	100 Ω	500 nA	0.5% + 10

*Specifications for 100 NPLC, offset compensation on, within 24 hours and ± 1° C of last ACAL, Tcal ±5° C. Add 3 ppm of reading additional error for HP factory traceability of 10 kΩ to US NIST.

Memory

	Standard Readings	Bytes	Option 001 Readings	Bytes
Reading storage (16 bit)	10,240	20 k	+65,536	+128 k
Non-volatile, for subprograms and/or state storage	—	14 k	—	—

Math Functions

The HP 3458A performs the following math functions on measurements: NULL, SCALE, OFFSET, RMS FILTER, SINGLE POLE FILTER, THERMISTOR LINEARIZATION, DB, DBM, % ERROR, PASS/FAIL LIMIT TESTING, and STATISTICS. Two math functions may be used at one time.

General Specifications

Operating Temperature: 0° to 55° C
Warmup Time: Four hours to all specifications except where noted
Humidity Range: 95% RH, 0° to 40° C
Storage Temperature: –40° to +75° C
Power: 100/120 V, 220/240 V ± 10%, 48 to 66 Hz, 360 to 420 Hz automatically sensed. Fused at 1.5 A @ 115 V or 0.5 A @ 230 V. <30 W, < 80 VA (peak).
Size: 425.5 mm W x 88.9 mm H x 502.9 mm D (16.75 in x 3.5 in x 19.8 in)
Weight: Net, 12 kg (26.5 lb); shipping, 14.8 kg (32.5 lb)

Ordering Information

HP 3458A Multimeter (with HP-IB, 20 KB reading memory, and 8 ppm stability)
Opt 001 Extended Reading Memory (expands total to 148 KB)
Opt 002 High-Stability (4 ppm/year) Reference
Opt 1BP MIL-STD-45662A Certificate of Calibration with Data
Opt W30 Two Additional Years Return-to-HP Hardware Support
Opt W32 Three-year Customer Return Calibration Coverage
Opt 907 Front-handle Kit
Opt 908 Rack Flange Kit
Opt 909 Rack Flange Kit (with handles)

- Sophisticated math functions
- 3½, 4½ digits
- Temperature
- Safety shutter
- Dual display

Handheld Multimeters

These handheld multimeters are ideal for portable measurements requiring basic accuracy from 0.7% to 0.05%, 3½ digits, or 4½ digits.

HP E2373A

This basic multimeter measures dc and ac voltage/current, resistance, diode test and audible continuity. It provides a large 0.85 inch (22 mm) high display as well as an analog bar graph in a compact size.

HP 970 Series Features

These meters come with sophisticated math functions that allow relative (difference) or percent readings for checking tolerances, min./max. with time stamp to monitor all types of measurements including temperature, and Hold and Auto Hold for saving a reading manually or automatically and average to quiet noisy measurements. Auto-diode reverses the leads for you to check semiconductor junctions, a secondary digital display shows the range of the function or elapsed time in min./max. and autopower off turns off the meter after 30 minutes of inactivity, or defeat it for extended measurements. The innovative terminal shutter prevents inadvertent use of the current terminals by requiring two operations by the user to connect the terminals.

Description

All meters come with ac/dc volts, ac/dc current, ohms, continuity, diode test, auto-diode test, frequency volts, and °F and °C high-resolution temperature (using optional temperature probe).

HP 971A
The sophisticated math functions and the extra rugged and bright yellow design make this an ideal meter for general-purpose measurements.

HP 972A
40 mV ac/dc range, 20 kHz bandwidth, capacitance and a dual display distinguishes this meter. The dual display allows the simultaneous reading of voltage and frequency.

HP 973A
For demanding applications this meter has basic dc accuracy of 0.1%, 20 kHz true rms, ac+dc, and dB/dBm for ac. This meter has features and functions for maximum flexibility. You get a dual digital display, frequency, current, capacitance, and thermocouple temperature as added features.

HP 974A
When extra precision is required, so is the HP 974A. 4½ digits, dc accuracy of 0.05%, 100 kHz BW true rms, ac+dc, and dB/dBm with 0.01 dB resolution make this the best value for high precision.

	E2373A	971A	972A	973A	974A
Display count	3200	4000	4000	4000	49999
Basic accuracy					
dc volts	0.7%	0.3%	0.2%	0.1%	0.05%
ac volts	1.2%	1%	0.5%	0.7%	0.5%
ohms	0.7%	0.5%	0.2%	0.2%	0.06%
capacitance	—	—	1.2%	1.2%	—
Frequency response					
ac volts	500 Hz	1 kHz	20 kHz	20 kHz	100 kHz
Resolution/ maximum reading					
dcV	100 µV 1000 V	100 µV 1000 V	10 µV 1000 V	10 µV 1000 V	10 µV 1000 V
acV	1 mV 750 V	100 µV 1000 V	10 µV 1000 V	10µV 1000 V	10µV 750 V
ohms	0.1 Ω 30 MΩ	0.1 Ω 40 MΩ	0.1 Ω 40 MΩ	0.1 Ω 40 MΩ	0.01 Ω 50 MΩ
current	10 µA 10 A	100 nA 10 A	100 nA 10 A	100 nA 10 A	10 nA 10 A
elapsed time	—	1 min. 1999 min.	1 min. 1999 min.	1 min. 1999 min.	1 sec 9999 min.
frequency	—	1 Hz 100 kHz	0.01 Hz 200 kHz	0.01 Hz 200 kHz	0.01 Hz 200 kHz
Battery life (typical hours)	2,500	1000	600	600	120
Current shutter		•	•	•	•
Bargraph	•	•	•	•	
Thermistor temperature		•	•	•	•
Thermocouple temperature				•	
Dual digital display			•	•	
True rms ac response				•	•
AC+DC				•	•
dBm/dB				•	•
Warranty (years)	3	3	3	3	3

HP E2373A
Standard accessories include pair of test leads, installed batteries, spare fuse and manual.
Size: 76 mm W x 164 mm H x 33 mm D (3 in x 6.5 in x 1.3 in)
Weight: 240 g (.53 lb)

970 Series
Standard accessories include a pair of test leads, manual, certificate of calibration, spare fuse, rubber boot, and two installed AA batteries.
Size: 87 mm W x 190 mm H x 39 mm D (3.4 in x 7.5 in x 1.5 in)
Weight: 440 mg (1 lb) approx.

Digital Multimeter Accessory Compatibility Chart and Products

Accessory	HP 34401A	HP 3457A	HP 3458A	HP E2373/ HP 970 series	HP34420A[1]
34130A Deluxe Test Lead Set	Yes	No	No	Yes	No
11059A Kelvin Probe Set	Yes	Yes	Yes	No	No
11062A Kelvin Clip Set	Yes	Yes	Yes	No	Yes
11060A Surface-Mount Device Probe	Yes	Yes	Yes	Yes	No
11053A Lug-Lug Jumper Set	No	Yes	Yes	No	No
11174A Lug-Banana Jumper Set	Yes	Yes	Yes	Yes	No
11058A Banana-Banana Jumper Set	Yes	Yes	Yes	Yes	No
E2306A Deluxe Test Lead Kit	No	No	No	Yes	No
E2305A Spare Test Leads	No	No	No	Yes	No
34118B Deluxe Test Lead Kit	Yes	Yes	Yes	Yes	No
E2301A Surface Type-K Thermocouple Probe **E2303A** SMP-Dual Banana Adapter	Yes[2]	No[3]	No[3]	973A	No
E2307A Type-K Thermocouple Bead Temperature Probe	Yes[2]	No[3]	No[3]	973A	No
E2308A Thermistor Temp Probe	Yes[2]	Yes	Yes	Yes, except E2373	No
40653B Thermistor Surface Sensor Assembly	Yes[2]	Yes	Yes	Yes, except E2373	No
34302A Clamp-on ac/dc Current Probe	Yes	Yes	Yes	Yes	No
34330A 30 A Current Shunt	Yes	Yes	Yes	Yes	No
34119A 5 kV ac/dc High-Voltage probe	Yes	Yes	Yes	Yes	No
34300A 40 kV ac/dc High-Voltage Probe	Yes	Yes	Yes	Yes	No
34301A 700 MHz RF Detector Probe	Yes	Yes	Yes	Yes	No
34397A 12 Vdc to 115V ac inverter	Yes	Yes	Yes	N/A	Yes
34131A Basic Instrument Transit Case	Yes	No	No	No	Yes
34161A Accessory Pouch	Yes	No	No	No	Yes
E2304A Handheld Multimeter Carrying Case	No	No	No	Yes	No

[1] Many accessories are listed as incompatible with HP 34420A because of the specialized termination. Many of these accessories may be rewired onto the low thermal input connector 34104A.

[2] Need HP 34812A BenchLink Meter or an external program to do temperature measurements.

[3] Compatible with voltmeter inputs, however an external program would be needed for temperature calculations.

HP 34397A

HP 34161A

HP 34131A

HP E2304A

HP 34397A 12 Vdc to 115 Vac Inverter

Hit the road and power your instruments from a cigarette lighter with this dc-to-ac inverter. Accepts inputs from 10.5 to 15 V and provides 100 W max. power at 115 Vac. Optional 230 Vac output is available as Option OE3230 Vac output.

HP 34161A Accessory Pouch

Cordura pouch fits on top of the HP 34401A and HP 34420A voltmeters as well as the HP 54131/32/81A counter and the HP 33120A function/arb generator.

HP 34131A Basic Instrument Transit Case

Heavy-duty hard-cover carrying case is constructed from rugged A.B.S. and has rubber-grip steel handles and steel latches. The case can be padlocked. For use with HP 34401A and HP 34420A voltmeters as well as the HP 53131/32/81A counter and the HP 33120A function/arb generator.

HP E2304A Handheld Multimeter Carrying Case

Padded case with dual zipper and snap-on belt strap. For use with HP 970 series handhelds.


HP 11060A


HP 11174A


HP 34130A


HP 11059A


HP E2306A


HP 34118B


HP 11062A

Test Leads

HP 11060A Surface-Mount Device Probe

Designed for SMD testing. Tweezer design provides an easy method to access and measure SMD resistive networks. Not to be used over 42 V peak. Length: 1.2 m. Max. current: 3 A. Max. voltage: 42 V peak. Contact tip is gold-plated beryllium-copper.

HP 11053A Low Thermal Lug-Lug Jumper Set

Used to minimize error in low voltage measurements. Length: 1.2 m (48 in.). Includes: 2 test leads, 1 black, 1 red.

HP 11174A Low Thermal Lug-Banana Jumper Set

Used to minimize error in low voltage measurements. Length: 1.2 m (48 in.). Includes: 2 test leads, 1 black, 1 red.

HP 11058A Low Thermal Banana-Banana Jumper Set

Used to minimize error in low voltage measurements. Length 1.2 m (48 in.). Includes: 2 test leads, 1 black, 1 red.

HP E2306A Deluxe Test Lead Kit

Test leads have right-angle shrouded banana plug inputs. Length: 1.2 m (48 in.). Includes 2 test leads, 2 alligator clips, 2 pin probes, 2 hook grabbers, and 2 spade lugs. Kit comes in Velcro-sealed pouch.

HP E2305A Spare Test Leads

Test leads have right-angle shrouded banana plug inputs. 4 test leads, 2 black and 2 red, are included. Length: 1.1 m (45 in.). Compatible with HP 34401A and HP handheld multimeters.

HP 34118B Deluxe Test Lead Kit

Retractable test leads with four sets of attachable probes: alligator clips, spade lugs, spring-loaded hook tips, and probes. Includes Velcro-sealed nylon pouch compatible with HP 3457A, 3458A, and 34401A.

HP 34130A Deluxe Test Lead Set

Test leads are 1.2 m (48 in.) long with straight-shrouded banana plug inputs. Included: 2 test leads, 2 pin probes, 2 alligator clips, 2 hook grabbers, and 2 spade lugs. Kit comes in Velcro-sealed pouch.

HP 11059A Kelvin Probe Set

Gold-plated flat tweezers ensure precise contact to the components being measured. Maximum input voltage: 42 V. An alligator clip and lead are provided for either grounding or guarding. Instrument connection is through banana plugs. Not to be used over 42 V peak. Works with any DMM with 4-wire ohm function.

HP 11062A Kelvin Clip Set

Silver-plated flat tweezer clips for constructing your own Kelvin probe set for 4-wire ohm measurements. One jaw provides the current path for the source, and the other provides the current path for the sense. Use with any voltmeter that makes 4-wire ohm measurements. Wires are attached to the tweezers by slotted screws. Maximum jaw opening: 7.9 mm (.31 in.). Maximum wire size: #18 AWG, maximum current: 10 A, maximum working voltage: 30 VAC or 60 VDC.

Ordering Information

HP 11060A Surface-Mount Device Probe
HP 11053A Low Thermal Lug-Lug Jumper Set
HP 11174A Low Thermal Lug-Banana Jumper Set
HP 11058A Low Thermal Banana-Banana Jumper Set
HP E2306A Deluxe Test Lead Kit
HP E2305A Spare Test Leads
HP 34118B Deluxe Test Lead Kit
HP 34130A Deluxe Test Lead Set
HP 11059A Kelvin Probe Set
HP 11062A Kelvin Clip Set

HP 34302A

HP 34330A

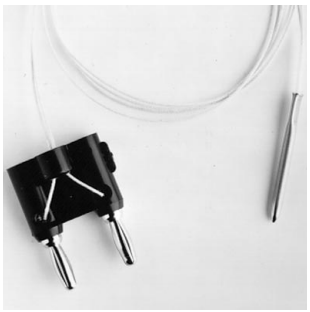
HP E2301A with HP E2303A

HP E2307A

HP E34119A

HP 34300A

HP 34301A



HP E2308A

HP 40653B

Current Measurement, High Voltage Measurement, High Frequency Measurement

HP 34302A Clamp-on ac/dc Current Probe

A clamp-on probe used for measuring ground currents, power supply ripple, or current distribution in systems. This probe measures ac, dc and ac+dc currents without breaking the circuit. Ranges: ±10 A and ±100 A. Frequency response: dc to 1 kHz. Recommended load: ≥3.0 kOhm. Rated output: ±1.0 Vdc at 10 A, ±1.0 Vdc at 100 A. Aperture size: 19 mm. Accuracy: ±2% of rated output.

HP 34330A 30A Current Shunt

This current shunt can be used to extend the current measurement range. Precision .001 ohm resistor. Output is 1 mV per amp of current passing through the shunt. 15 A continuous; 30 A for 15 minutes maximum.

HP 34119A 5kV ac/dc High-Voltage Probe

5 kV dc and ac (to 1 MHz). Can be used with any DMM with an input resistance of 10 MOhm, 1000:1 division. Accuracy: dc–100 kHz ±1.5%, 100 kHz–1 MHz ±2.5%. Length: 1.5 m (5 ft). Compensation range 20–100 pF.

HP 34300A 40kV ac/dc High-Voltage Probe

This high-voltage probe can be used with any DMM having an input resistance of 10 MOhm. Maximum input : 40 kV (dc + peak ac). Voltage division ratio: 1000:1. Bandwidth: dc to 150 Hz. Input resistance: 1 GOhm. Division ratio accuracy: ±2% (dc, 1000:1, 10 MOhm termination). Length: 2m. Includes: probe, alligator clip, and 2 tips, domed and hook.

HP 34301A 700 MHz RF Detector Probe

For high-frequency voltage measurement. Bandwidth: 100 kHz to 750 MHz bandwidth. Voltage range: .25 Vrms to 40 Vrms. Input capacitance: approx. 5 pF. Maximum ac input: 50 Vrms. Transfer ratio: 1 Vdc output for 1 Vrms input. For use with any DMM with 10 MOhm input resistance.

Temperature Measurement

HP E2301A Surface Type-K Thermocouple Probe/ HP E2303A SMP-to-Dual Banana Plug Adapter

This probe is especially suitable for measuring surface temperature on PC boards. Accuracy ±2.2° C or ±.75%, whichever is greater. Tip is 0.25-in. diameter. Temperature range: –130° C (–200° F) to 260° C (500° F). Less than 2 second response time. Thermocouple: Chromel-Alumel. Must use with E2303A thermocouple probe adapter, uncompensated.

HP E2307A Type-K Thermocouple Bead Temperature Probe

General-purpose thermocouple temperature probe. Accuracy: –260° C to –110° C (–436° F to –200° F) ±2% of reading. –110° C to 260° C (–200° F to 500° F) ±2.2° C (4° F). Length: 0.9 m (36 in.), terminated in dual banana plug.

HP E2308A Thermistor Temperature Probe

General-purpose thermistor temperature probe. 5 kOhm @ 25° C encapsulated in a stainless steel case. Temperature range: –80° C (–112° F) to 150° C (302° F). Accuracy: 0 to 70° C (32° to-158° F) ±.2° C (±.4° F). Time constant: 3 seconds typical.

HP 40653B Thermistor Surface Sensor Assembly

10,000 Ohm thermistor with fast response gives real-time temperature measurements. Temperature range: –10° C to 100° C. Accuracy: ±1° C. Termination: bare wire.

Ordering Information

HP 34302A Clamp-on ac/dc Current Probe
HP 34330A 30A Current Shunt
HP 34119A 5 kV ac/dc High-Voltage Probe
HP 34300A 40 kV ac/dc High-Voltage Probe
HP 34301A 700 MHz RF Detector Probe
HP E2301A Surface Type-K Thermocouple Probe
HP E2303A SMP-to-Dual Banana Plug Adapter
HP E2307A Type-K Thermocouple Bead Temperature Probe
HP E2308A Thermistor Temperature Probe
HP 40653B Thermistor Surface Assembly

- 3-slot data acquisition and switching mainframe
- 6½-digit (22 bit) internal DMM
- 11 built-in measurement functions
- 8 switch and control plug-in modules
- HP BenchLink data logger software included

HP 34970A (Front Panel)

HP 34970A (Back Panel)

HP 34970A Data Acquisition/Switch Unit

The HP 34970A is a high performance, low-cost data acquisition and switching mainframe ideal for data logging, data acquisition, and general-purpose switching and control applications. It consists of a half-rack mainframe with an internal 6½-digit (22 bit) digital multimeter. Three module slots are built into the rear of the unit to accept a combination of switch and control modules. Whether you need a few channels of simple data logging or a hundred channels of ATE performance, the HP 34970A meets your data acquisition needs at a price that meets your budget.

Measurements You Can Trust

The HP 34970A incorporates the measurement engine from our best-selling benchtop digital multimeter (DMM). You get the benefit of proven HP performance, universal inputs with built-in signal conditioning, and modular flexibility, all in a low-cost, compact data acquisition package. The HP 34970A features 6½ digits (22 bits) of resolution, 0.004% basic dcV accuracy, and ultra-low reading noise. Combine that with scan rates of up to 250 channels/sec, and you've got the speed and accuracy you need to get the job done.

Powerful Flexibility

The HP 34970A's unique design allows per-channel configurability for maximum flexibility and quick, easy setup. The internal autoranging DMM measures 11 different functions directly, eliminating the need for expensive external signal conditioning. Temperature conversion routines are built-in to display raw thermocouple, RTD, or thermistor inputs in degrees C, F, or Kelvin. Use Mx+B scaling to convert linear transducer outputs directly into engineering units. You can even set high/low alarm limits to warn you of out-of-tolerance conditions.

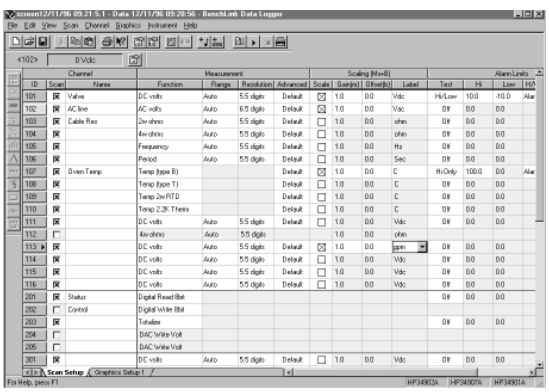
Custom Configurations That Grow With You

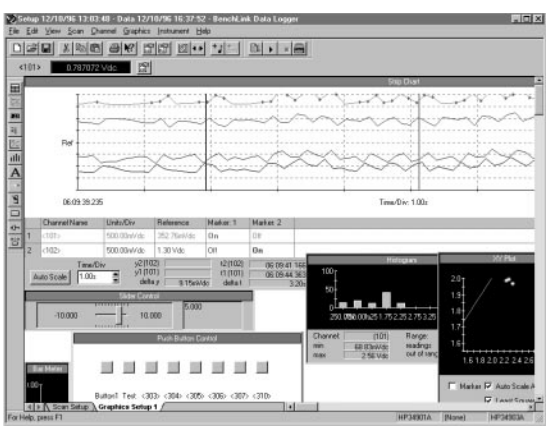
Three module slots and eight switch and control modules allow you to customize the HP 34970A to meet your unique requirements. Buy only what you need, and add more modules later as your application grows. Measure up to 120 inputs with a single half-rack unit.

Free HP BenchLink Software Simplifies Your Data Gathering

If you want PC-based data logging capabilities, but don't want to spend hours programming, HP BenchLink Data Logger is the answer. Use it to set up your test, acquire and archive measurement data, and perform real-time display and analysis of the incoming measurements.

A familiar spreadsheet environment makes it easy to configure and control your tests. A rich set of colorful graphics provides many options for displaying your data—all with point-and-click ease. Set up multiple graphics using strip charts, histograms, X-Y scatter charts, alarm lights and more. Also use HP BenchLink Data Logger to easily move data to other applications for further analysis, or for inclusion in your presentations and reports.





Free HP BenchLink Data Logger makes PC-based setup and analysis easy.

Applications

Data Logging

Configured with the HP 34901A 20-channel relay multiplexer, the HP 34970A becomes a rugged, low-cost data logger that's ideal for quick tests in the lab or in the field. An intuitive front panel with self-guiding menus and a bright, easy-to-read vacuum flourescent display make standalone set-up fast and easy. All readings are automatically time stamped and stored in a 50,000 reading memory — enough memory to hold a week's worth of data (20 channels scanned every five minutes). The non-volatile memory holds your data even after power is removed, so you can use the HP 34970A to collect data at a remote location for later uploading to a PC. The system configuration is also held in non-volatile memory, so in the event of a power failure the unit automatically resumes scanning when power is returned. And for PC-based testing, HP BenchLink Data Logger software is included to simplify your test configurations, data analysis and data managament.

Automated Testing

For automated test and benchtop automation applications, the HP 34970A's three slots and choice of eight plug-in switch and control modules allow easy customization. The 6½-digit internal DMM brings you the power and performance of a world-class standalone DMM, but in a fraction of the space and at a fraction of the cost. Software drivers that support HP VEE and National Instruments LabVIEW are available to make an easy integration of the HP 34970A into your test sytem. Standard RS-232 and HP-IB interfaces and SCPI programming language make integration even easier. A three-year warranty is also standard, as is our proprietary relay maintenance system which automatically counts and stores every individual switch closure to help you predict relay end-of-life and avoid costly production line downtime.

Switching

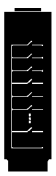
For test applications that don't require the built-in measurements of the HP 34970A, the unit can be ordered without the internal DMM. This provides an ultra low-cost solution for routing test signals to and from your device-under-test and assorted instruments, including external DMMs, scopes, counters and power supplies. Plus, you can add the DMM later if your needs change.

Module Overview

Up to three modules, in any combination, can be inserted into a single mainframe. The HP 34970A's internal DMM connections are accessible only through the HP 34901A, HP 34902A, and HP 34908A multiplexers. The HP 34970A accuracy specifications already include the switching offset and reference junction errors shown in the table below; these errors are listed separately for determining system error with external measurement devices.

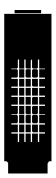
The **HP 34901A** 20-channel multiplexer is the most versatile module for general-purpose scanning. It combines dense, multifunction switching with 60 channel/second scan rates to address a broad spectrum of data acquisition applications.

The **HP 34902A** 16-channel high-speed multiplexer employs reed relays to achieve scan rates of up to 250 channels-per-second. This module is ideal for high-throughput automated test applications, as well as high-speed data logging and monitoring tasks.



Use the **HP 34908A** 40-channel single-ended multiplexer for the greatest density in common-low applications, such as battery test, component characterization, and benchtop testing.

Use the **HP 34903A** 20-channel general-purpose switch module to cycle power to products-under-test, control indicator and status lights, actuate external relays requiring large drive signals, and to build custom switch configurations.



The **HP 34904A** is a two-wire, 4x8 full cross-point matrix that gives you the most flexible connection path between your device-under-test and your test equipment, allowing different instruments to be connected to multiple points on your DUT at the same time.

The **HP 34905A** and **HP 34906A** RF multiplexers offer broadband switching capabilities for high-frequency and pulsed signals to 2 GHz. Use them to route test signals between your device-under-test and your signal generator, oscilloscope, spectrum analyzer, video amplifier, or receiver.

The **HP 34907A** multifunction module allows great flexibility for a variety of sense and control applications. It combines two 8-bit ports of digital input and output, a 100 kHz gated totalizer, and two ±12 V analog outputs—all on a single module.

Module Specifications

Module Description	Type	Connects to internal DMM	Speed (ch./sec.)	Maximum Input Voltage	Current	Power	Offset Voltage	Bandwidth	Comments
HP 34901A 20-ch. Multiplexer	2-wire armature (4-wire selectable)	yes	60	300 V	1 A	50 W	< 3 µV	10 MHz	2 current channels (22 ch. total) Built-in cold junction reference
HP 34902A 16-ch. Multiplexer	2-wire reed (4-wire selectable)	yes	250	300 V	50 mA	2 W	< 6 µV	10 MHz	Built-in cold junction reference
HP 34903A 20-ch. Actuator/GP Switch	SPDT / form C	no	120	300 V	1 A	50 W	< 3 µV	10 MHz	—
HP 34904A 4 x 8 Matrix	2-wire armature	no	120	300 V	1 A	50 W	< 3 µV	10 MHz	Full crosspoint
HP 34905A Dual 1: 4 RF Mux, 50 Ω	Common Low (unterminated)	no	60	42 V	0.7 A	20 W	< 6 µV	2 GHz	1 GHz through provided BNC-to-SMB adapter cables
HP 34906A Dual 1: 4 RF Mux, 75 Ω	Common Low (unterminated)	no	60	42 V	0.7 A	20 W	< 6 µV	2 GHz	1 GHz through provided BNC-to-SMB adapter cables
HP 34907A Multifunction Module	Two 8-bit digital I/O ports 26-bit Event Counter Two Analog Outputs	no no no	— — —	42 V 42 V ± 12 V	400 mA — 10 mA	— — —	— — —	— 100 kHz dc	Open drain Gated; selectable input threshold 16-bit, earth referenced
HP 34908A 40-ch. single-ended Mux	1-wire armature (common low)	yes	60	300 V	1 A	50 W	< 3 µV	10 MHz	No 4-wire measurements Built-in cold junction reference

These are abbreviated specifications. For more detailed information on the HP 34970A, refer to HP publication number 5965-5290.

Accuracy Specifications ± (% of reading + % of range)[1]

Includes measurement error, switching error and transducer conversion error

Function	Range[2]	Frequency, etc.	1 Year 23° C ±5° C
DC Voltage	100.0000 mV		0.0050 + 0.0040
	1.000000 V		0.0040 + 0.0007
	10.00000 V		0.0035 + 0.0005
	100.0000 V		0.0045 + 0.0006
	300.000 V		0.0045 + 0.0030
True RMS AC Voltage[3]	100.0000 mV to 100.0000 V	3 Hz–5 Hz	1.00 + 0.04
		5 Hz–10 Hz	0.35 + 0.04
		10 Hz–20 kHz	0.06 + 0.04
		20 kHz–50 kHz	0.12 + 0.05
		50 kHz–100 kHz	0.60 + 0.08
		100 kHz–300 kHz[4]	4.00 + 0.50
	300.0000 V	3 Hz–5 Hz	1.00 + 0.08
		5 Hz–10 Hz	0.35 + 0.08
		10 Hz–20 kHz	0.06 + 0.08
		20 kHz–50 kHz	0.12 + 0.12
		50 kHz–100 kHz	0.60 + 0.20
		100 kHz–300 kHz[4]	4.00 + 1.25
Resistance[5]	100.0000 Ω	1 mA current source	0.010 + 0.004
	1.000000 kΩ	1 mA	0.010 + 0.001
	10.00000 kΩ	100 μA	0.010 + 0.001
	100.0000 kΩ	10 μA	0.010 + 0.001
	1.000000 MΩ	5.0 μA	0.010 + 0.001
	10.00000 MΩ	500 nA	0.040 + 0.001
	100.0000 MΩ	500 nA//10 MΩ	0.800 + 0.010
Frequency and Period[6]	100 mV to 300 V	3 Hz–5 Hz	0.10
		5 Hz–10 Hz	0.05
		10 Hz–40 Hz	0.03
		40 Hz–300 kHz	0.01
DC Current (HP 34901A only)	10.00000 mA	<0.1 V burden	0.050 + 0.020
	100.0000 mA	<0.6 V	0.050 + 0.005
	1.000000 A	<2 V	0.100 + 0.010
True RMS AC Current (HP 34901A only)	10.00000 mA and[3] 1.00000 A	3 Hz–5 Hz	1.00 + 0.04
		5 Hz–10 Hz	0.30 + 0.04
		10 Hz–5 kHz	0.10 + 0.04
	100.0000 mA[7]	3 Hz–5 Hz	1.00 + 0.5
		5 Hz–10 Hz	0.30 + 0.5
		10 Hz–5 kHz	0.10 + 0.5

Temperature	Type	Best Range Accuracy[8]	
Thermocouple	B	1100° C to 1820° C	1.2° C
	E	–150° C to 1000° C	1.0° C
	J	–150° C to 1200° C	1.0° C
	K	–100° C to 1200° C	1.0° C
	N	–100° C to 1300° C	1.0° C
	R	300° C to 1760° C	1.2° C
	S	400° C to 1760° C	1.2° C
	T	–100° C o 400° C	1.0° C
RTD	R_0 from 49 Ω to 2.1 kΩ	–200° C to 600° C	0.06° C
Thermistor	2.2 k, 5 k and 10 k	–80° C to 150° C	0.08° C

Measurement Characteristics[9]

DC Voltage	
Measurement Method	Continuously integrating multi-slope III A–D Converter
A–D Linearity	0.0002% of reading + 0.0001% of range
Input Resistance	
100 mV, 1 V, 10 V ranges	Selectable 10 MΩ or > 10,000 MΩ
100 V, 300 V ranges	10 MΩ ± 1%
Input Bias Current	< 30 pA at 25° C
Input Protection	300 V all ranges
True RMS AC Voltage	
Measurement Method	AC coupled True RMS—measures the AC component of the input with up to 300 Vdc of bias on any range
Crest Factor	Maximum of 5:1 at full scale
Additional Crest Factor Errors (non-sinewave)	Crest Factor 1–2 0.05 % of reading Crest Factor 2–3 0.15 % of reading Crest Factor 3–4 0.30 % of reading Crest Factor 4–5 0.40 % of reading
Input Impedance	1 MΩ ± 2% in parallel with 150 pF
Input Protection	300 Vrms all ranges
Resistance	
Measurement Method	Selectable 4-wire or 2-wire Ohms. Current source referenced to LO input.
Offset Compensation	Selectable on 100 Ω, 1k Ω, 10k Ω ranges
Maximum Lead Resistance	10% of range per lead for 100 Ω and 1 k Ω ranges. 1 kΩ on all other ranges.
Input Protection	300 V on all ranges
Frequency and Period	
Measurement Method	Reciprocal counting technique
Voltage Ranges	Same as AC voltage function
Gate Time	1s, 100 ms, or 10 ms
Measurement Timeout	Selectable 3 Hz, 20 Hz, 200 Hz LF limit
DC Current	
Shunt Resistance	5 Ω for 10 mA, 100 mA; 0.1 Ω for 1 A
Input Protection	1A 250 V fuse on HP 34901A module
True RMS AC Current	
Measurement Method	Direct coupled to the fuse and shunt. AC coupled True RMS measurement (measures the ac component only).
Shunt Resistance	5 Ω for 10 mA; 0.1 Ω for 100 mA, 1 A
Input Protection	1A 250 V fuse on HP 34901A module
Thermocouple	
Conversion Conformity	ITS-90 based software routines
Reference Junction Type	Internal, Fixed, or External
Open Thermocouple Check	Selectable per channel. Open >5k Ω.
RTD	Type α = .00385 (DIN) and α = .00392
Thermistor	44004, 44007, 44006 series
Measurement Noise Rejection 60 (50) Hz[10]	
dc CMRR	140 dB
ac CMRR	70 dB
Integration Time	**Normal Mode Rejection**[11]
200 plc / 3.33s (4s)	110 dB[12]
100 plc / 1.67s (2s)	105 dB[12]
20 plc / 334 ms (400 ms)	100 dB[12]
10 plc / 167 ms (200 ms)	95 dB
2 plc / 33.3 ms (40 ms)	90 dB
1 plc / 16.7 ms (20 ms)	60 dB
< 1 plc	0 dB

[1] Specifications are for 1-hour warm-up and 6½ digits, slow ac filter
[2] 20% over range on all ranges except 300 Vdc and ac ranges and 1 A dc and ac current ranges
[3] For sinewave input > 5% of range. For inputs from 1% to 5% of range and < 50 kHz, add 0.1% of range additional error.
[4] Typically 30% of reading error at 1 MHz, limited to 1 x 108 V Hz
[5] Specifications are for 4-wire ohms function or 2-wire ohms using scaling to remove the offset. Without scaling, add 1 Ω additional error in 2-wire ohms function.
[6] Input > 100 mV. For 10 mV inputs, multipy % of reading error x 10.
[7] Specified only for inputs >10 mA
[8] 1 year accuracy. For total measurement accuracy, add temperature probe error.
[9] 300 Vdc, ac rms isolation voltage (ch-ch, ch-Earth)
[10] For 1 KΩ unbalance in LO lead
[11] For power line frequency ±0.1%
[12] For power line frequency ±1%, use 40 dB or ±3% use 30 dB

Specifications

Operating Characteristics[1]

Single Channel Measurement Rates[2]

Function	Resolution	Reading/s
dcV, 2-wire resistance	6½ digits (10 plc) 5½ digits (1 plc) 4½ digits (0.02 plc)	6 (5) 57 (47) 600
Thermocouple	0.1° C (1 plc) (0.02 plc)	57 (47) 220
RTD, Thermistor	0.01° C (10 plc) 0.1° C (1 plc) 1° C (0.02 plc)	6 (5) 57 (47) 220
acV	6½ Slow (3 Hz) 6½ Med (20 Hz) 6½ Fast (200 Hz) 6½[3]	0.14 1 8 100
Frequency, Period	6½ digits (1s gate) 5½ digits (100 ms) 4½ digits (10 ms)	1 9 70

System Speeds[4]	Channel/s
INTO Memory	
Single channel dcV	600
34902A scanning dcV	250
34907A scanning digital in	250
34902A scanning dcV with scaling and 1 alarm fail	220
34907A scanning totalize	170
34902A scanning temperature	160
34902A scanning acV[3]	100
34902A scanning dcV/Ohms on alternate channels	90
34901A/34908A scanning dcV	60
INTO and OUT of memory to HP-IB or RS-232 (init/fetch)	
34902A scanning dcV	180
34902A scanning dcV with timestamp	150
OUT of memory to HP-IB	
Readings	800
Readings with timestamp	450
Readings with all format options ON	310
OUT of memory to RS-232	
Readings	600
Readings with timestamp	320
Readings with all format options ON	230
DIRECT to HP-IB or RS-232	
Single channel dcV	440
34902A scanning dcV	200
Single channel MEAS DCV10/MEAS DCV 1	25
Single channel MEAS DCV/ MEAS OHMS	12
HP BenchLink Performance	
Scan and save to disk with 2 strip-charts displayed	100

System Characteristics

Scanning Inputs	
Analog	HP 34901A, 34902A, and 34908A multiplexer channels
Digital	HP 34907A digital in and totalize
Scan list	Scans channels in ascending order
Triggering	
Source	Interval, external, button press, software, or on monitor channel alarm
Scan count	1 to 50,000 or continuous
Scan interval	0 to 99 hours; 1 ms step size
Channel delay	0 to 60 seconds per channel; 1 ms step size
External trig delay	< 2 ms. With monitor on < 200 ms.
External trig jitter	< 2 ms
Alarms	
Analog inputs	Hi, Lo, or Hi + Lo evaluated each scan
Digital inputs	34907A digital in: maskable pattern match or state change 34907A totalize: Hi limit only
Monitor channel	Alarm evaluated each reading
Alarm outputs	4 TTL compatible; selectable TTL logic Hi or Lo on fail
Latency	5 ms (typical)

Memory (Battery backed, 4 year typical life[5])	
Readings	50,000 with timestamp Readable during scan
States	5 instrument states with user label
Alarm queue	Up to 20 events with channel number, reading, and timestamp
System Features	
Per-channel math	Individual Mx + B scaling and Min/Max/Average calculated real time
Power fail recovery	Resumes scanning automatically
Relay maintenance	Counts each relay closure and stores on module. User resettable.
Real time clock	Battery-backed, 4 year typical life[5]

HP BenchLink Data Logger software (not included with Option 001)	
System Requirements[6]	
PC Hardware	486, 66 MHz, 16 MB RAM, 12 MB disk space
Operating Systems	Windows 3.1, Windows 95, Windows NT 4.0
Computer Interfaces[7]	
HP-IB	HP 82335B, 82340A/B/C, 82341A/B/C/D National Instruments AT-GPIB/TNT, PCI-GPIB
LAN -to- HP-IB	HP E2050A (Windows 95 and NT only)
RS-232 (Serial Port)	PC COM 1-4

[1] Reading speeds for 60 Hz and (50 Hz) operation
[2] For fixed range and function, readings to memory, scaling and alarms off, autozero off
[3] Maximum limit with default settling delays defeated
[4] Speeds are for 4½ digits, delay 0, display off, autozero off. Using 115 kB RS-232 setting.
[5] Storage at temperatures above 40° C will decrease battery life
[6] Software provided on CD-ROM and includes utility to create floppy disks for installation
[7] Interface and driver must be purchased separately

General

Power Supply: 100 V/120 V/220 V/240 V ±10%
Power Line Frequency: 45 Hz to 66 Hz automatically sensed
Power Consumption: 12 W (25 VA peak)
Operating Environment:
Full accuracy for 0° C to 55° C
Full accuracy to 80% R.H. at 40° C
Storage Environment: –40° C to 70° C
Weight: Net: 3.6 kg (8.0 lbs)
Safety: Conforms to CSA, UL-1244, IEC 1010 Cat I
RFI and ESD: CISPR 11, IEC 801/2/3/4
Warranty: 3 years

Ordering Information

HP 34970A Data Acquisition/Switch Unit
Includes internal 6½ digit DMM, operating and service manuals, test report, power cord, and Quick Start package (includes HP Benchlink Data Logger software, RS-232 cable, thermocouple, and screwdriver).
Opt 001 Delete Internal DMM
Same as above but deletes DMM and quick start package. Order 34970-80010 to retrofit DMM at a later time.
Opt 1CM Rackmount Kit
Opt 0B0 Delete Manual Set
HP 34901A 20-Channel Armature Multiplexer
HP 34902A 16-Channel Reed Multiplexer
HP 34903A 20-Channel Actuator/General Purpose Switch
HP 34904A 4 x 8 Two-Wire Matrix Switch
HP 34905A Dual 4-Channel RF Multiplexer, 50 Ohms
Includes (10) SMB-to-BNC(f) 50 Ω adapter cables
HP 34906A Dual 4-Channel RF Multiplexer, 75 Ohms
Includes (10) SMB-to-BNC(f) 75 Ω adapter cables
HP 34907A Multifunction Module
HP 34908A 40-Channel Single-Ended Multiplexer
Accessories
HP 34161A Accessory Pouch
HP 34131A Hard Carrying Case
HP 34397A dc-to-ac Inverter
HP E2050A LAN/HP-IB Gateway
34970-80010 DMM Field Installation Kit
Fully calibrated with Test Report and Quick Start Kit

For more information on high-performance data acquisition products from Hewlett-Packard, refer to the Data Acquisition Systems section of this catalog starting on page 554.

Function and Arbitrary Waveform Generators

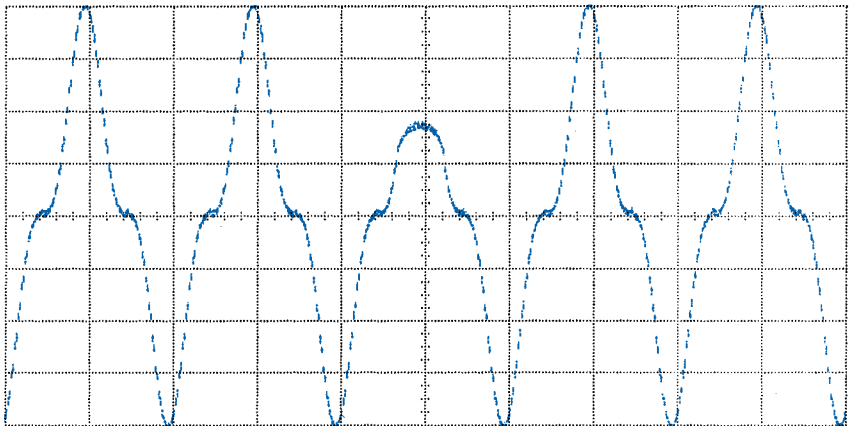
Functionality

Hewlett-Packard's function generators offer standard functions like sine, square and triangle waveforms. In addition they address needs such as multichannel signals, arbitrary waveforms, or even a mix of arbitrary and digital signals.

These products are summarized in the table below. For quick reference, representative instruments are described briefly on the next page. More detailed information is available on the page referenced in the table.

Accuracy

For tests needing higher-frequency stability and more accurate signal amplitudes, please refer to the table of synthesized function generators on the next page. In addition to performance, these products also offer functionality and (see HP 3324A) multiphase capability through master-slaving.



Function and Arbitrary Waveform Generator Specifications

	HP 8904A	HP 3245A	HP 33120A
Sine wave			
Min. frequency	dc	dc	dc
Max. frequency	600 kHz	1 MHz	15 MHz
Waveforms			
Square	0.1 Hz to 50 kHz	0 Hz to 1 MHz	100 μHz to 15 MHz
Triangle	0.1 Hz to 50 kHz	0 Hz to 100 kHz	100 μHz to 100 kHz
Ramp	0.1 Hz to 50 kHz	0 Hz to 100 kHz	100 μHz to 100 kHz
Arbitrary	—	2048 points	16,000 points
Modes	Creates		
Trigger	signals from	int./ext.	int./ext.
Gate	six basic	int./ext.	int./ext.
Counted burst	waveforms	int. subroutine	1 to 50,000 or infinite
Modulation			
AM	int.	int. subroutine	int./ext., and Arbitrary
FM	int.	int. subroutine	int., including Arbitrary
PM	int.	—	—
Sweep			
Lin.	int.	int.	int.
Log.	none	int.	int.
VCO	int.	int. subroutine	—
Output (into 50 Ω)			
Amplitude (p-p)	10 V	10 V	10 V
DC offset (±)	5 V	5 V	5 V
Output Impedance Ω	50	0/50	50
Programmability	HP-IB	HP-IB	HP-IB and RS-232
Notes	4 internal channels; one is modulated or sequenced	2 independent channels, also ac current and 6-digit precision dc voltage or current	12 bit, 40 MSa/s ARB, also has FSK, SCPI commands, 3-year warranty
Catalog page	156	158	160

Functionality Plus DDS Precision

The HP 33120A uses the latest direct digital synthesis techniques to bring you a full-featured 15 MHz function generator that also has arbitrary waveform capability built in. The HP 33120A offers both linear and log sweep, internal AM, FM, FSK, and burst modulation, and a 12-bit, 40 MSa/s, 16,000 point deep arb generator. Fully programmable, the HP 33120A includes both HP-IB and RS-232 interfaces standard. An optional software package, the HP 34811A BenchLink/arb, facilitates creating, modifying, and downloading arbitrary waveforms to the HP 33120A.

Synthesized Arbitrary Waveforms

The HP 8770A, in conjunction with the WGL toolbox software, is a complete system for generating complex arbitrary waveforms with synthesizer accuracy in both the time and frequency domains.

Multi-Function Synthesized Waveforms

The HP 8904A creates complex signals from six simple waveforms. The instrument offers standard functions, dc, and noise. Option 001 adds three modulation channels, and Option 002 adds a second independent synthesizer output. Modulation capabilities include AM, FM, PM, DSB, and pulse. These features address VOR, FM, communications signalling, and stereo applications.

Functions with Synthesizer Stability

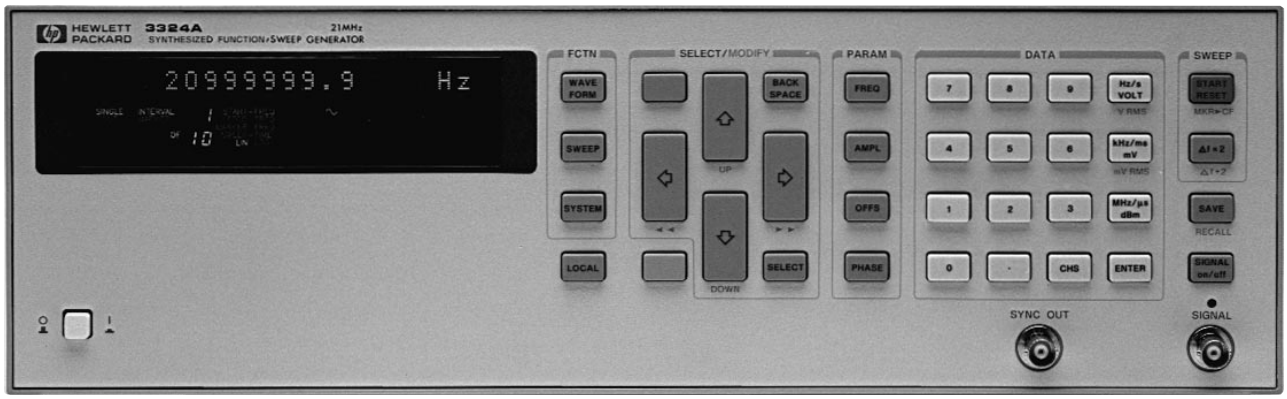
The HP 3324A and HP 3325B provide standard functions with synthesizer stability. In addition to the usual sweep modes, they also offer sequences so that, for example, acceleration profiles can be modeled. Any number of channels can be set up by master-slaving, and options for the HP 3324A allow multi-phase signals to be set up with 0.1 degree resolution automatically, deskewed at the device.

HP 33120A's functions and arbitrary waveforms are accurate and convenient to set up. Also, available software makes it easy to download modeled or captured waveforms.

Synthesized Function Generator Specifications

	HP 3324A	HP 3325B
Sine wave		
Min. frequency	1 mHz	1 μHz
Max. frequency	21 MHz	21 MHz
Frequency		
Stability	10^{-7}/month	4 10^{-7}/month
Resolution	1 mHz	1 μHz
Waveforms		
Square	1 mHz to 11 MHz	1 μHz to 11 MHz
Triangle	1 mHz to 11 kHz	1 μHz to 11 kHz
Ramp	1 mHz to 11 kHz	1 μHz to 11 kHz
Modulation		
AM	—	int./ext.
FM	—	—
PM	—	int./ext.
PWM	—	—
Sweep		
Lin.	int.	int.
Log.	int.	int.
Discrete	int.	int.
Level		
Range (50 Ω)	10 Vp-p	10 Vp-p
Resolution	4 digits	4 digits
Accuracy (±dB)	0.9	0.1
DC offset (50 Ω)	±5 V	±5 V
Output impedance (Ω)	50	50
Spurious	–55 dBc	–70 dBc
Phase noise	–50 dBc	–60 dBc
Notes	60 MHz TTL clock, multi-interval and multi-marker sweep	Modulation source can be used separately
Catalog page	155	154

- Multi-interval sweep
- Master/slave capability
- ±719.9° variable phase
- Additional 60 MHz output
- Outputs and HP-IB isolated
- HP 3325B software-compatible



HP 3324A

HP 3324A Synthesized Function/Sweep Generator[1]

HP-IB

The HP 3324A provides synthesizer performance and multi-segment sweep at a moderate price for applications such as speed sensors. Additionally, multi-phase signals can be set up because variable-phase and master/slave capabilities can be used together.

Brief Specifications (50 Ω load, 0° to 55°C)

For detailed specifications, please request Data Sheet 5952-9678 and Product Information Sheets *HP 3324A Sweep Parameters* and *HP 3324A Multi-Channel Setups.*

Frequency and Waveforms
1 mHz to: 11 kHz (triangle, ramps), 11 MHz (square), 21 MHz (sine), 60 MHz (auxiliary 0 dBm output)
Accuracy: 5 ppm
Stability: 5 ppm, Option 001; 0.1 ppm
Resolution: 1 mHz (0.1 Hz above 1 MHz)

Main Output (50 Ω source)
Amplitude: 1 mV to 10 V in eight 1-3-10 sequence ranges
Offset: 5 V; voltages double into open
Accuracy: 0.2 dB/2% typical
Resolution: 4 digits
Phase: 719.9° relative to start phase; 0.1° resolution

Sine Wave Characteristics
Phase Noise: – 50 dB
Spurious: – 55 dB
Harmonics: – 60 dBc (<200 kHz), – 40 dBc (<2 MHz); –30 dBc (<15 MHz), – 25 dBc (< 20 MHz)

Square Wave Characteristics
Transitions: <20 ns
Overshoot/Ringing: <5%
Duty Cycle: 50% fixed

Triangle/Ramp Characteristics
Linearity: 0.05%

Sweep Capabilities
Cycling: Single or continuous
Modes: Multi-interval, multi-marker
Sweeps: Linear (up, down, constant, tone), log up
Intervals: 50, sequence length 100 (in multi-interval mode)
Markers: One per interval (9 in multi-marker mode)
Sweep Time: Programmable up to 100.00 s

[1] Also in VXI form
Refer to HP E1440A in HP 75000 VXI Source Book

Auxiliary Outputs
Sync: 50 Ω source, 1.2 Vp-p square wave, same phase as main output
Auxiliary 0 dBm Output: 50 Ω source, square wave
Z-Axis Drive Output: Sweep-time ramp, 10 Vp-p, 10 kΩ source
Z-Axis Output: TTL blanking signal during sweep return, 10 mA sink
Sweep Marker Ouput: TTL pulse at selected marker frequency
1 MHz Reference Output: 0 dBm, 50 Ω source

Reference Input
For phase-locking the HP 3324A to an external frequency reference, signal 0 dBm to 20 dBm into 50 Ω.

Option 002, High Voltage Output

Amplitude: 4 mVp-p to 40 Vp-p into 500 Ω
Frequency: 1 mHz to 1 MHz

Options 003 and 004, Automatic Phase Calibration

Calibration: Refers slave phase to master. Interconnect cables are supplied. If there are two or more slaves, a VHF switch HP 59307A is required. Master/slaving does not apply to sweep mode.

General Specifications

Power: 100/120/220/240 V, 48 to 66 Hz, max. 100 VA
Size: 425.5 mm W x 132.6 mm H x 497.8 mm D (16.75 in x 5.25 in x 19.625 in)
Weight: Net, 11 kg; shipping, 16.5 kg

For more information, visit our website: (http: www.hp.com/go/dvt).

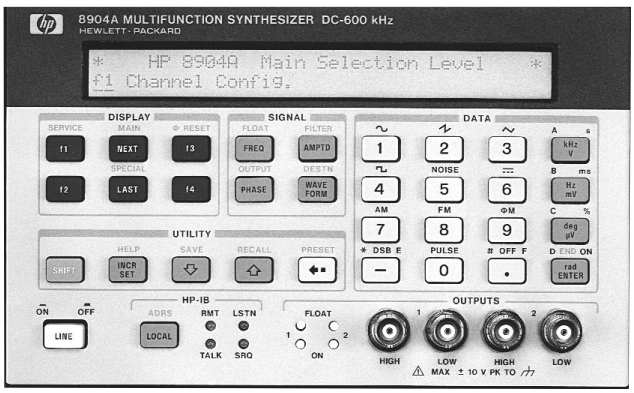
Ordering Information

HP 3324A Synthesized Function/Sweep Generator
Opt 001 High Stability Frequency Reference
Opt 002 High Voltage Output
Opt 003 Automatic Phase Calibration, Slave
Opt 004 Automatic Phase Calibration, Master
Opt 907 Front Handle Kit (5062-3989)
Opt 908 Rack Flange Kit (5062-3977)
Opt 909 Rack Flange and Handle Combination Kit (5062-3983)
Extended warranty options (see page 584) available on request
Opt 1 BP MIL-STD-45622A Calibration

Multi-Function Synthesizer

HP 8904A

- Sine to 600 kHz, square, ramp, triangle to 50 kHz
- 12-bit direct digital synthesis
- Tone, DTMF, digital, Hop Ram sequence modes
- One or two outputs
- One to four internal channels
- AM, FM, ØM, DSBSC, and pulse modulation
- Unit-to-unit phase synchronization
- Optional 600 Ω high power, balanced output



HP 8940A

HP 8904A Function Synthesizer

The standard HP 8904A multi-function synthesizer generates accurate sine waves from 0 Hz to 600 kHz with 0.1 Hz resolution. The HP 8904A also has five other standard functions: square, triangle, ramp, from 0 Hz to 50 kHz plus dc, and Gaussian white noise. All waveform values in the HP 8904A are digitally calculated in real time by Hewlett-Packard's Digital Waveform Synthesis IC yielding 12-bit digital accuracy. Full HP-IB programmability is also included standard on the HP 8904A.

Two Outputs

Option 002 adds a second, identical synthesizer and floating 50 Ω output section to the HP 8904A. Frequency, amplitude, waveform, and phase can be independently set for the two sources. Either synthesizer can be precisely varied in phase relative to each other from 0 degrees to 359.9 degrees with a resolution of 0.1 degree.

Complex Signal Generation

Option 001 adds internal synthesizers (for a total of four) which can modulate channel A or be summed to give complex waveform generating capabilities to the HP 8904A. All four synthesizers are independent with precise phase offset capabilities. These synthesizers can be digitally summed before being output. In addition to summing, Option 001 allows channels B, C, and D to modulate channel A with AM, FM, ØM, DSBSC, or pulse modulation.

FM Stereo Composite Mode

Option 001 also includes a mode for generating FM stereo composite signals. Test signals in this mode include Left = Right, Left = – Right, Left Only, and Right Only. Single keystrokes select test-tone frequency, composite level, test signal mode, and pilot tone level. Stereo separation is typically greater than 65 dB.

Communication Signaling

Option 001 also adds four sequence modes to the HP 8904A: tone, DTMF, digital, and Hop Ram sequence modes. These modes make the HP 8904A a powerful tool for use in communications signaling. Tone and DTMF modes allow creation of single or dual tone sequences up to 750 states in length. Digital sequence mode can generate bit streams up to 3000 bits in length with 100 µs resolution. Hop Ram sequence mode allows sequencing of 16 tones, each with an associated amplitude, frequency, and phase value.

Fast Hop

Option 003 adds the ability to externally hop channel A in frequency, phase, or amplitude. Up to 16 frequency/phase/amplitude states can be entered into the Hop Ram memory. To hop, an external device must address the four-bit wide, TTL-level address bus provided on the rear panel. Phase continuous switching can be done in as little as 20 µs.

Unit-to-Unit Phase Synchronization

With Option 005, multiple HP 8904As can be phase synchronized to provide more than two phase-related outputs. In the synchronous mode, one unit is specified to be the master clock unit and all others are designated slaves. Two signals are then routed from the clock master unit to all slave units through external low-loss power splitters. To synchronize the units, a phase reset command is given to the master HP 8904A via HP-IB or from the front panel. The total phase error between units will be the larger of ± 0.1 degree or 60 ns for frequencies from 0.1 Hz to 100 kHz. Up to eight HP 8904As may be synchronized.

600 Ω Balanced Output

Option 006 changes output 1 from a 50 Ω electronically-floating output to a transformer-coupled, 600 Ω -balanced output. Option 006 provides high power, balanced signals into 600 Ω loads. Maximum output is 10 volts rms into 600 Ω. The Option 006 output restricts the frequency range of output 1 to 30 Hz to 100 kHz. In addition, complex wave forms such as square, ramp, and triangle waveforms are degraded and dc cannot be passed through the Option 006 output. In many applications, however, the HP 8904A Option 006 is a direct replacement for the HP 200CD wide range oscillator.

HP 8904A Specifications (for 50 Ω output only)

Frequency
Range: Sine wave: 0 Hz to 600 kHz
Square, triangle, ramp: 0 Hz to 50 kHz
Resolution: 0.1 Hz
Accuracy (internal 10 MHz timebase)**:** 50 ppm

AC Amplitude (sine wave only)
Range: 0 to 10 V p-p into a 50 Ω load
Accuracy (> 40 mV p-p into 50 Ω)**:**
1%, 0.1 Hz to 100 kHz; 3%, 100 kHz to 600 kHz
Flatness (> 630 mV p-p into 50 Ω)**:**
± 0.1% (± 0.009 dB), 0.1 Hz to 100 kHz

DC Amplitude
Range: 0 to ±10 V p-p open circuit
Accuracy: Larger of ± 20 mV or ± 2.1%

Spectral Purity (sine wave only)
THD + N (including spurs, amplitude > 50 mV rms into 50 Ω)**:**
– 63 dBc rms (0.07%), 20 Hz to 7.5 kHz, 30 kHz BW
– 63 dBc rms (0.07%), 7.5 kHz to 20 kHz, 80 kHz BW

Gaussian Noise
Spectral Characteristic: Equal energy per unit bandwidth ("white")
Time-Domain Characteristic: Gaussian distribution
Flatness (>100 mV p-p)**:** Typically ±0.5 dB, 0.1 Hz to 100 kHz

Option 001 Specifications

Modulation is for channel A only, and specified for sine-wave carrier and modulation. External modulation is NOT possible.

Modulation

Amplitude
- **Rate:** 0 to 600 kHz
- **Depth Range:** 0% to 100 % of carrier amplitude

Frequency
- **Rate:** 0 to 600 kHz
- **Deviation Range:** 0 to 600 kHz

Phase
- **Rate:** 0 to 600 kHz
- **Deviation Range:** 0˚ to 179.9˚/channel

Pulse or DSBSC
- **Rate:** 0 Hz to 50 kHz (up to 600 kHz for DSBSC)

Summation

Two, three, or four channels may be summed.
Channel to Channel Phase Accuracy (equal amplitude sine waves): Larger of ± 0.1˚ or 30 ns, 0.1 Hz to 100 kHz

Modes

FM Stereo Composite
- **Test Modes:** Left = Right, Left = –Right, Left Only, Right Only
- **Composite Signal Level:** Up to 10 V_{p-p} into 50 Ω
- **Pre-Emphasis Modes:** Off, 25 μs, 50 μs, and 75 μs
- **Channel Separation:** Typically > 65 dB, 20 Hz to 15 kHz rates

Tone Sequence
- **Number of Frequencies:** 16 tones each with user-definable frequency, on-time and off-time
- **On/Off Time Duration Range:** 0 ms, 0.80 ms to 655.35 ms
- **Timing Accuracy:** ± 0.02 ms (± 20 μs)
- **Sequence Length:** 750 steps, user-definable

DTMF Sequence
- **Number of Tone Pairs:** 16 standard DTMF tone pairs (0-9, A-D, #, *) with user-definable on-time and off-time
- **On/Off Time Duration Range:** 0 ms, 1.00 ms to 655.35 ms
- **Timing Accuracy:** ± 0.02 ms (± 20 μs)
- **Sequence Length:** 750 steps, user-definable

Digital Sequence
- **User Definable:** On level, off level, and bit period
- **Bit Period Duration Range:** 0.10 ms to 655.35 ms
- **Timing Accuracy:** ± 0.02 ms (± 20 μs)
- **Sequence Length:** Up to 3000 bits, user-definable

Hop Ram Sequence
- **Number of Frequencies:** 16 tones each with user-definable frequency, phase, and amplitude
- **Sequence Clock Frequency Range:** 0.1 Hz to 10 kHz
- **Sequence Length:** 750 steps (all 16 tones used) or 3000 steps (tones 0 and 1 used), user-definable

Option 002 Specifications (50 Ω outputs)

Output 1 to Output 2 Phase Accuracy (sine waves at the same frequency): ± 0.1˚ or 30 ns, 0.1 Hz to 100 kHz, whichever is greater

Option 003 Specifications (Fast Hop)

Direct Hopping of Channel A: 16 phase-frequency-amplitude states may be addressed with four TTL-compatible inputs
Switching Speed (via digital port): Typically < 20 μs

Option 005 Specifications (50 Ω outputs)

Unit-to-Unit Phase Accuracy (sine waves only): Larger of ± 0.1˚ or 60 ns, 0.1 Hz to 100 kHz
Maximum Number of Synchronized Units: 8 units

Option 006 Specifications (sine wave)

All specifications for the standard 50 Ω output HP 8904A are degraded by the accuracy, flatness, and distortion specifications of the Option 006, 600 Ω transformer coupled output.

Output Type: Fully floating/balanced transformer-coupled output
Usable Frequency Range: Typically 30 Hz to 200 kHz
AC Amplitude Range: 0 to 10 Vrms into 600 Ω
AC Amplitude Accuracy (> 40 mVrms into a balanced 600 Ω load): 6% (0.5 dB), 30 Hz to 20 kHz; 12% (1.0 dB), 30 Hz to 100 kHz
Flatness (> 40 mVrms into a balanced 600 Ω load): + 0.15 dB, – 0.75 dB, 30 Hz to 100 kHz
THD + Noise (including spurs, > 140 mVrms into a balanced 600 Ω load): – 63 dB (0.07%), 7.5 kHz to 20 kHz, 80 kHz BW

General

Store Recall: 35 non-volatile registers
Output Type (standard unit): 50 Ω electronic floating or grounded output, HP-IB programmable
Maximum Float Voltage (50 Ω output, signal + float): 10 V peak maximum from high or low output to chassis ground
External Timebase Input: 10 MHz accepted at a nominal level of 0.1 to 5 V peak, automatic switching
Operating Temperature Range: 0˚ to 50˚ C
Storage Temperature Range: – 20˚ to 70˚ C
Remote Operation: HP-IB
Size: 213 mm W x 133 mm H x 513 mm D (8.36 in x 5.25 in x 20.2 in)
Weight: Net, 5.9 kg (12.8 lb); shipping, 13 kg (28.6 lb)

Ordering Information

HP 8904A Multifunction Synthesizer[1]
- **Opt 001** Adds three (two when ordered with Option 002) internal channels, Channel A modulation, summation, FM stereo mode, and sequence capability
- **Opt 002** Adds second internal synthesizer and output
- **Opt 003** Adds fast hop and digital modulation
- **Opt 004** Connectors on rear panel only (not available with Option 005 or 006)
- **Opt 005** Adds unit-to-unit phase synchronization
- **Opt 006** Changes output 1 from a 50 Ω output to a transformer-coupled, 600 Ω balanced output
- **Opt 910** Provides an additional operation and calibration manual (08904-90007) and two service manuals (08904-90008)
- **Opt 915** Adds Service Manual (08904-90008)
- **Opt W30** Extended Repair Service
- **Opt W32** Calibration Service
- **08904-61024** Rackmount Kit for a single HP 8904A
- **08904-6102**5 Rackmount Kit for mounting two HP 8904A's side by side

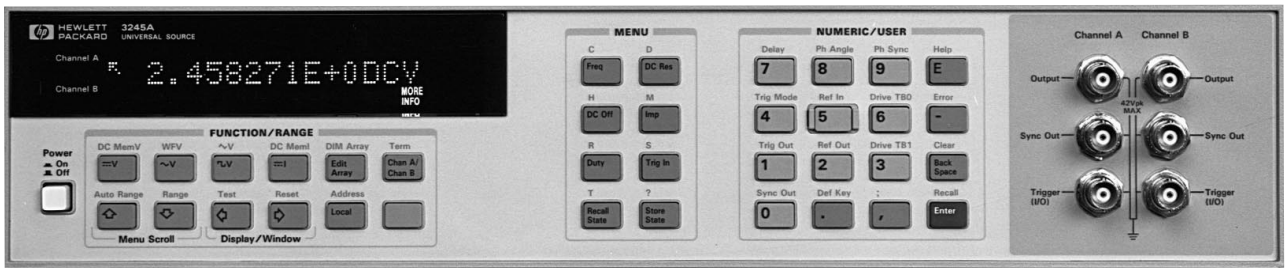
HP 8904A Retrofit Kits (customer retrofittable)
HP 11816A Retrofit Kit for Option 001
HP 11817A Retrofit Kit for Option 002
HP 11818A Retrofit Kit for Option 003
HP 11827A Retrofit Kit for Option 005[2]
HP 11837A Retrofit Kit for Option 006[2]

[1] HP-IB cables not included.
[2] Not available for units with serial prefix less than 2948A.

Universal Source

HP 3245A

- Precision dc outputs with 6½ digits of resolution
- Synthesized ac with 0.4% amplitude accuracy
- Sine, square, triangle, and Arb to 1 MHz
- Floating outputs
- 100-volt option
- Non-volatile storage of up to 14 setups
- Second-channel output available
- Phase-continuous frequency changes
- Downloadable sub-routines



HP 3245A

HP 3245A Universal Source

The HP 3245A universal source combines precision dc capabilities with versatile ac performance, including arbitrary waveform generation. This creates versatility on the bench, where the HP 3245A may be all the source you ever need. The HP 3245A can also fit into your computer-aided test system, providing the capabilities of ac, dc, Arb, and second-channel options in a single 3½-inch tall instrument.

Precision DC

The HP 3245A provides precision dc outputs of both voltage and current. In the high-resolution mode, you get 24-bit resolution with 60-ppm, 90-day accuracy. The low-resolution mode provides 12-bit resolution with 100 μs settling times. This type of precision means you can use the HP 3245A to test A/D converters, Voltage to Frequency converters, VCOs, transducers, and other equipment needing highly-accurate dc voltage or current. There are two output ranges in the high-resolution mode: ± 1 volt and ± 10 volts. In the low-resolution mode, there are seven ranges. In current, there are four ranges of output, from 0.1 mA to 100 mA. Output impedance is selectable as either zero Ω or 50 Ω.

Accurate AC

The HP 3245A can generate ac voltage outputs, including sine, triangle, and square waves, at frequencies of up to 1 MHz. Variable duty-cycle pulse and ramp outputs can be generated at up to 100 kHz. In the ac mode, the HP 3245A can make phase-continuous frequency changes "on-the-fly." All ac waveforms are synthesized and have 0.001-Hz resolution and 50-ppm frequency accuracy. Ninety-day amplitude accuracy for sine, ramp, and Arb is 0.29% of output + 0.36% of range.

Arbitrary Waveform

The HP 3245A offers arbitrary waveform operation at a full 1-MHz bandwidth. This is accomplished by a sampling technique in which the values loaded into RAM are sampled at approximately 4.3 MHz and then run through a 1.25-MHz 5-pole low-pass filter. This allows full 1-MHz repetition rate while maintaining 0.001-Hz resolution at any frequency. The HP 3245A can also store multiple arrays that can be accessed for arbitrary waveform generation. Array depth is 2048 bytes.

Second Channel Option

The addition of a second channel allows you to generate two waveforms, either independent or phase-related to each other. The second channel output can be phase-synchronized to the first channel or to an external input. Such capabilities are especially useful if you are doing modem testing, tone-sequence generation, DTMF generation, FSK generation, or other operations where two outputs are required.

Option 002 High-Voltage Output

Option 002 is a precision voltage amplifier that increases the output voltage 10-fold. Maximum voltage is now ±100 volts, or 200 volts peak-to-peak in ac mode. The second channel slot is used for the high-voltage option. It is not possible to have both second channel and high-voltage options in the same instrument.

System Operation

The HP 3245A includes features that make it especially powerful in system applications. Because it contains many BASIC-like constructs, such as IF..THEN and FOR..NEXT, the HP 3245A can do much of the work that normally falls to the host computer. Now, sub-routines can be downloaded to the HP 3245A and run standalone, minimizing host interaction. Built-in math capabilities add to the power of the HP 3245A. Electronic calibration is both easy and accurate and does not require the instrument to be removed from a rack or opened to perform a calibration.

All these features combine to make the HP 3245A a universal source, combining precision dc outputs, accurate ac waveforms, and arbitrary waveform capabilities in a single instrument.

Abbreviated Technical Specifications

DC Volts Output

High-resolution (24-bit) Mode

Range	0 Ω Mode resolution	50 Ω Mode resolution
1 V	1 μV	0.5 μV
10 V	10 μV	5 μV

Low-resolution (12-bit) Mode

Range	0 Ω Mode resolution	50 Ω Mode resolution
0.078125 V	—	40 μV
0.15625 V	79 μV	79 μV
0.3125 V	157 μV	157 μV
0.625 V	313 μV	313 μV
1.25 V	625 μV	625 μV
2.5 V	1250 μV	1250 μV
5 V	2.5 mV	2.5 mV
10 V	5.0 mV	—

Current Compliance: 100 mA on all ranges
Settling Time (Delay 0)**:**
High-resolution Mode:
0.1% of Step: 20 ms
0.001% of Step: 40 ms
(1 s if function changed)
Low-resolution Mode:
0.1% of Step
(0 Ω Mode): 100 μs
(50 Ω Mode): 25 μs
0.5% of Step (50 Ω Mode): 5 μs
Overshoot:
High-resolution Mode: < 5% of step + 0.15% of range
Low-resolution Mode: < 30% of step + 2% of range

DC Volts Accuracy

(<10 Hz noise): ± (% of programmed output + volts), 0 Ω impedance mode, >1 M Ω load. T_{cal} is the temperature of calibration from 18° C to 28° C. One hour warm-up.

24 Hour: T_{cal} ± 1° C

High-resolution mode Range	Accuracy	Low-resolution mode
10 V	0.0007% + 85 μV	0.09% of output + 0.2% of range
1 V	0.0008% + 15 μV	(for all ranges)

90 Day: T_{cal} ± 5° C

High-resolution mode Range	Accuracy	Low-resolution mode Range	Accuracy
10 V	0.0038% + 180 μV	10 V	0.17% + 37 mV
1 V	0.0042% + 31 μV	5 V	0.17% + 19 mV
		2.5 V	0.17% + 9.2 mV
		1.25 V	0.17% + 4.6 mV
		0.625 V	0.17% + 2.5 mV
		0.3125 V	0.17% + 1.3 mV
		0.15625 V	0.17% + 0.73 mV

DC Volts Accuracy with Option 002: Ninety-day accuracy in the low-resolution mode is ± (0.12% of output + 200 mV) for 10-volt range. (10x amplifier; 100 volts output)

DC Current Output

Resolution

Range	High resolution	Low resolution
0.1 mA	0.1 nA	50 nA
1 mA	1 nA	500 nA
10 mA	10 nA	5 μA
100 mA	100 nA	50 μA

DC Current Accuracy

90 Day: T_{cal} ± 5° C. After one hour warm-up.

High-resolution mode Range	Accuracy	Low-resolution mode Range	Accuracy
100 mA	0.0202% + 3.3 μA	100 mA	0.32% + 400 μA
10 mA	0.0074% + 220 nA	10 mA	0.30% + 52 μA
1 mA	0.0052% + 20 nA	1 mA	0.25% + 3.8 μA
0.1 mA	0.0052% + 3.3 nA	0.1 mA	0.25% + 0.38 μA

AC Volts Output Characteristics (sine, square, ramp, arbitrary)

Frequency Range:
0 to 1 MHz for sine, arbitrary, and square (at 50% duty cycle)
0 to 100 kHz for ramp
0 to 100 kHz for square w/duty cycle not equal to 50%

Amplitude and/or Offset Resolution

Range (peak-peak)	50 Ω Mode resolution	0 Ω Mode resolution
.15625 V	79 μV	—
.3125 V	157 μV	157 μV
.625 V	313 μV	313 μV
1.25 V	625 μV	625 μV
2.5 V	1250 μV	1250 μV
5 V	2.5 mV	2.5 mV
10 V	5.0 mV	5.0 mV
20 V	—	10.0 mV

Amplitude can be set from 10% to 100% of range.

AC Amplitude Accuracy (sine, ramp, arbitrary)**:**
24 hour: T_{cal} ± 1° C 0.16% of output + .25% of range
90 day: T_{cal} ± 5° C 0.29% of output + .36% of range
AC Amplitude Accuracy with Option 002:
Ninety-day accuracy is ± (0.32% of output ± 3.6% of range) for 10-volt range. (10x amplifier; 100 volts output)

Sine-wave Characteristics (50 Ω mode)

Frequency	Harmonic and spurious levels (ampl ≥ 50% of range)*	THD (ampl ≥ 50% of range)	Flatness in reference to 1 kHz
< 3 kHz	<– 62 dB	<– 56 dB	.07 dB
to 10 kHz	<– 62 dB	<– 50 dB	.07 dB
to 30 kHz	<– 55 dB	<– 48 dB	.07 dB
to 100 kHz	<– 46 dB	<– 46 dB	.20 dB
to 300 kHz	<– 40 dB	—	.60 dB
to 1 MHz	<– 40 dB	—	2.0 dB

*Additional fixed spurious response > 4 MHz: 500 μVrms.

Squarewave Characteristics (50 Ω mode)**:**
Rise Time: < 250 ns, 10% to 90%
Settling Time: < 1 μs to 1% of amplitude
Overshoot: < 5% of peak-to-peak amplitude
Duty-Cycle Range: 5% to 95%, 0 to 100 kHz; fixed at 50% above 100 kHz
Duty-Cycle Accuracy: ± (0.8% of period + 120 ns)
Frequency Resolution: 0.001 Hz
Frequency Accuracy: ± 50 ppm, 18° to 28° C
Frequency Temperature Coefficient: ±1 ppm/° C
Phase Offset:
Range: –360° to + 360°
Resolution: < 0.001°
Ramp Linearity to 1 kHz (50 Ω Mode)**:** 0.3% of peak-to-peak value measured @ 50% duty cycle from 10% to 90% point
Ramp Duty-Cycle Range: 5% to 95% with < 0.1% resolution

Ordering Information

HP 3245A Universal Source
Opt 001 Second Channel Output
Opt 002 High-Voltage Amplifier
Opt 907 Front Handle Kit
Opt 908 Rack Flange Kit
Opt 909 Rack Flange and Handle Combination Kit
Opt W30 Extended Warranty

Function/Arbitrary Waveform Generator

HP 33120A

- 15 MHz sine- and square-wave outputs
- Sine, triangle, square, ramp, noise, and more
- 12-bit, 40 MSa/s, 16,000 point deep arbitrary waveforms
- Direct digital synthesis for excellent stability
- Linear and log sweeps built-in
- AM, FM, FSK, and burst modulation built-in
- HP-IB and RS-232 interfaces both standard
- Optional BenchLink Arb software

HP 33120A

HP 33120A Function/Arbitrary Waveform Generator

The HP 33120A is a high-performance, full-function 15 MHz synthesized function generator. It features sine, triangle, square, ramp, and noise waveforms, a 12-bit, 40 MSa/s, 16,000 point deep arbitrary waveform generator, and both internal sweep and modulation capabilities. The HP 33120A is ideal for both bench and system applications. Both HP-IB and RS-232 interfaces are standard, as is a full three-year warranty. All this is available for a surprisingly affordable price.

Unprecedented Functionality

The HP 33120A will fill all your basic signal source needs by giving you a full complement of standard functions. But this source goes beyond the basics. You get both linear and log sweeps to 15 MHz, plus full-modulation capabilities. AM, FM, FSK, and burst modulation are just a button push away. You can internally modulate with any of the standard waveforms, including Arb. You can even use an external source for AM, FSK, and burst modulation, if desired. Finally, you get near-infinite custom waveform capability with the inclusion of a 12-bit, 40 MSa/s, 16,000 point deep arbitrary waveform generator.

Superb Performance

The performance of the HP 33120A was designed in, not left out. This means that you get clean, low-distortion sine waves, fast rise- and fall-time squarewaves, and linear triangle and ramp waveforms. Further, due to the latest direct digital synthesis techniques utilized in the HP 33120A, you can get down to 10 μHz frequency resolution.

Built-In Versatility

You will find that the HP 33120A will fit equally well into your bench or your system applications. Designed with the bench user in mind, operation of the HP 33120A from the front panel is straightforward and intuitive. The inclusion of a knob makes adjusting frequency, amplitude, and offset extremely convenient. Or enter these values directly. You can even enter amplitude values directly in V peak-to-peak, V rms, or dBm. For system applications, the HP 33120A includes both HP-IB and RS-232 interfaces standard, and uses commands that are in total compliance with the Standard Commands for Programmable Instrumentation (SCPI).

Quality and Reliability

Not only does the HP 33120A offer you performance and features unheard of at this price, you also get the advantages of owning Hewlett-Packard. A full three-year warranty is standard with the HP 33120A. The rugged construction and conservative design of the HP 33120A ensures many years of trouble-free operation. Just as price was designed out of the HP 33120A, quality and reliability were designed in.

Option 001 Phase Lock Loop

Option 001 adds a high-stability timebase, the ability to lock to an external timebase, and the ability to phase lock two or more HP 33120As together. This option is especially useful if your application requires higher-frequency stability and accuracy, if you need to lock to an external-frequency standard, or if you need two or more phase-locked outputs.

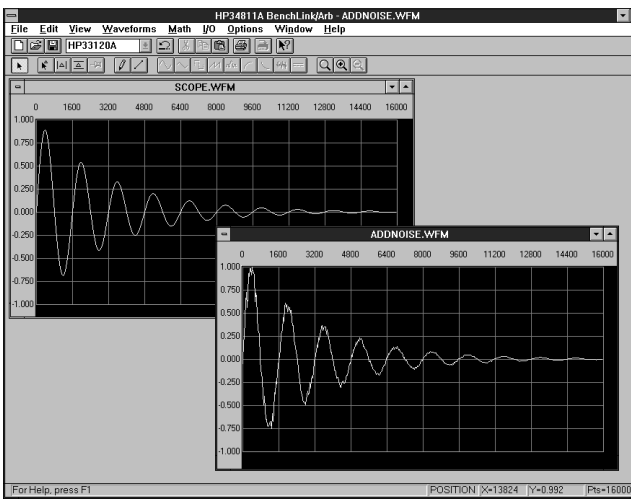
HP BenchLink Arb Software Helps the 33120A Work for You

HP BenchLink Arb lets you use your Windows-based PC (3.1 or 95) to easily create and edit arbitrary waveforms for output on the HP 33120A.

HP BenchLink Arb software application lets you create waveforms in a variety of ways:

- Select and edit a standard waveform from the HP BenchLink Arb library, and change its amplitude and frequency characteristics as desired.
- Use HP BenchLink Arb's drawing tools to draw and edit your own custom waveform.
- Bring in and edit a waveform captured or created elsewhere.

HP BenchLink Arb accepts time/voltage pairs in ASCII format, or you can use waveforms captured with HP BenchLink Scope and an HP oscilloscope. Once your waveform is ready, downloading to the HP 33120A generator is simple. Make your arbitrary waveforms quickly and easily with HP BenchLink Arb.



HP 34811A BenchLink Arb lets you take control of arbitrary waveforms on the HP 33120A function/arbitrary waveform generator.

Abbreviated Technical Specifications

Waveforms
Standard: Sine, square, triangle, ramp, noise, sin(x)/x, exponential rise, exponential fall, heartbeat, dc volts
Arbitrary
- **Waveform Length:** 8 to 16,000 points
- **Amplitude Resolution:** 12 bits (including sign)
- **Sample Rate:** 40 MSa/s
- **Non-Volatile Memory:** Four (4) 16,000 waveforms

Frequency Characteristics
Sine: 100 μHz to 15 MHz
Square: 100 μHz to 15 MHz
Triangle: 100 μHz to 100 kHz
Ramp: 100 μHz to 100 kHz
Noise (Gaussian)**:** 10 MHz bandwidth
Resolution: 10 μHz or 10 digits
Accuracy: 10 ppm in 90 days, 20 ppm in 1 year, 18° C to 28° C
- **Temp. Co-eff.:** 2 ppm/ °C
- **Aging:** 10 ppm/yr.

Sine-wave Spectral Purity
Harmonic Distortion:
DC to 20 kHz: – 70 dBc
20 kHz to 100 kHz: – 60 dBc
1000 kHz to 1 MHz: – 45 dBc
1 MHz to 15 MHz: – 35 dBc
Spurious (non-harmonic)**:**
DC to 1 MHz: < – 65 dBc
1 MHz to 15 MHz: < – 65 dBc + 6 dB/octave
Total Harmonic Distortion: < 0.04% (dc to 20 kHz)
Phase Noise: < – 55 dBc in a 30 kHz band

Signal Characteristics
Squarewave
- **Rise/Fall Time:** < 20 ns
- **Overshoot:** < 4%
- **Asymmetry:** <1% + 5 ns
- **Duty Cycle:** 20% to 80% (to 5 MHz)
  40% to 60% (to 15 MHz)

Triangle, Ramp, Arb
- **Rise/Fall Time:** 40 ns (typical)
- **Linearity:** <0.1% of peak output
- **Settling Time:** < 250 ns to 0.5% of final value

Jitter: < 25 ns

Output Characteristics
Amplitude (into 50 Ω): 50 mV p-p to 10 V p-p
- **Accuracy** (at 1 kHz)**:** 1% of specified output

Flatness	(sine wave relative to 1 kHz)
<100 kHz	±1% (0.1 dB)
100 kHz to 1 MHz	±1.5% (0.15 dB)
1 MHz to 15 MHz	±2% (0.2 dB) Ampl ≥3 Vrms
	±3.5% (0.3 dB) Ampl <3 Vrms

Output Impedance: 50 Ω (fixed)
Offset (into 50 Ω): ± 5 Vpk ac + dc
- **Accuracy:** ± 2% of setting + 2 mV

Resolution: 3 digits, amplitude and offset
Units: V p-p, V rms, dBm
Isolation: 42 Vpk maximum to earth
Protection: Short circuit protected, ±15 Vpk overdrive <1 minute

HP 33120A Option 001

Modulation
AM
- **Carrier 3dB freq.:** 10 MHz (typical)
- **Modulation:** Any internal waveform including Arb
- **Frequency:** 10 mHz to 20 kHz
- **Depth:** 0% to 120%
- **Source:** Internal/external

FM
- **Modulation:** Any internal waveform including Arb
- **Frequency:** 10 mHz to 10 kHz
- **Peak Deviation:** 10 mHz to 15 MHz
- **Source:** Internal only

FSK
- **Internal Rate:** 10 mHz to 50 kHz
- **Frequency Range:** 10 mHz to 15 MHz
- **Source:** Internal or external (1 MHz max)

Burst
- **Carrier Freq.:** 5 MHz max.
- **Count:** 1 to 50,000 cycles or infinite
- **Start Phase:** –360° to + 360°
- **Internal Rate:** 10 mHz to 50 kHz ±1%
- **Gate Source:** Internal or external gate
- **Trigger Source:** Single, external, or internal rate

Sweep
Type: Linear or logarithmic
Direction: Up or down
Start F/Stop F: 10 mHz to 15 MHz
Speed: 1 ms to 500 s ± 0.1%
Trigger: Internal, external, single

Rear Panel Inputs
Ext. AM Modulation: ± 5 Vpk =100% modulation, 5 kΩ input resistance
External Trigger/FSK/Burst Gate: TTL low true

General Specifications

State Storage Memory: Power off state automatically saved.
3 user-configurable stored states.
Interface: IEEE-488 and RS-232 standard
Language: SCPI–1991
Warranty: 3 years standard

Option 001 Phase Lock/TCXO Timebase

Stability: ±1 ppm, 0° to 50°C
Aging: < 2 ppm in first 30 days (continuous operation);
0.1 ppm/month (after first 30 days)
Ext. Reference Input Lock Range: 10 MHz ± 50 Hz
Int. Reference Output Frequency: 10 MHz
Phase Offset: –360° to + 360°, 0.001° resolution

Ordering Information

HP 33120A Function Generator
- **Opt 001** Phase Lock Loop
- **Opt 106** BenchLink/Arb Software
- **Opt 1CM** Rackmount Kit

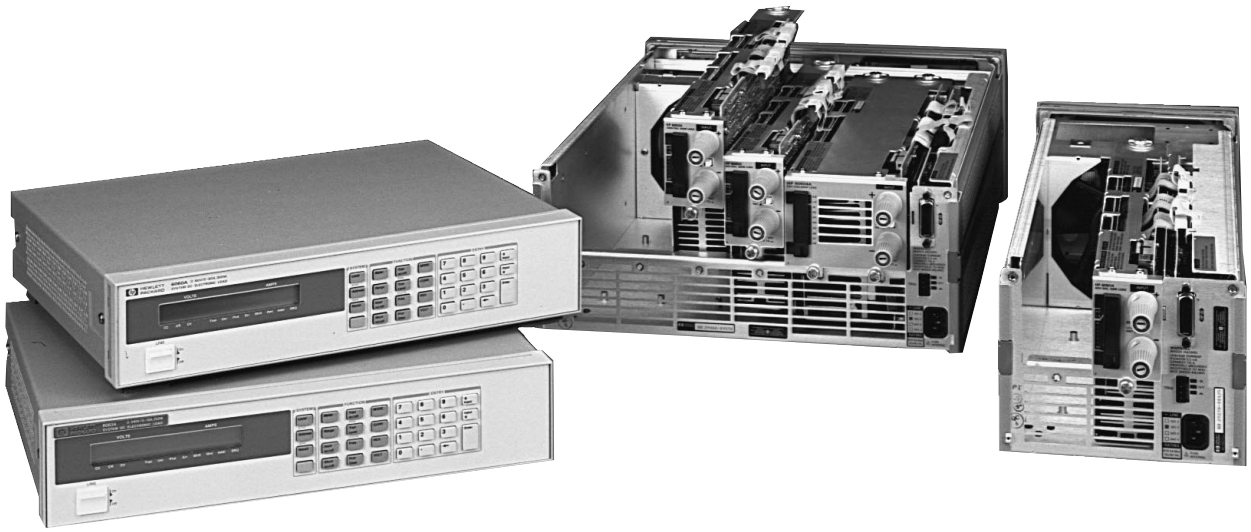
HP 34811A BenchLink/Arb Software
HP 34161A Accessory Pouch
HP 34397A DC to AC Power Inverter

DC Electronic Loads

Electronic Load Family

HP 6050A
to 6063B
HP 60501B
to 60507B

- HP-IB control of current, voltage, and resistance
- HP-IB readback of current, voltage, and power
- Built-in pulse waveform generation with programmable amplitude, frequency, duty cycle, and slew rate
- Continuous and pulse modes
- Full protection from over-current, over-voltage, over-power, over-temperature, and reverse polarity
- Electronic calibration
- Trigger for external synchronization
- Analog voltage control in constant current mode
- Parallel units in constant voltage mode
- Parallel units in constant current mode for higher power
- Remote voltage sense in constant voltage mode
- Loads available for up to 240 V



HP 6060B and 6063B

HP 6050A with
HP 60500 Series Modules

HP 6051A with
HP 60500 Series Module

HP DC Electronic Loads

HP dc electronic loads are ideal for the test and evaluation of dc power sources and power components and are well-suited for applications in areas such as research and development, production, and incoming inspection.

The Hewlett-Packard One-Box Solution

HP single-input loads and load mainframes are equipped with standard HP-IB interfaces. This built-in IEEE-488 interface allows complete control of all load functions as well as readback of input voltage, current, power, and detailed operating status. Each HP standalone load or load module also includes programming inputs that allow control of load current via an analog voltage. Other system features contributing to the one-box solution concept are internal voltage and current monitors and an internal transient generator with programmable amplitudes, frequency, duty cycle, and slew rate. The HP one-box solution saves space, cost, and time while making HP dc electronic loads easy to integrate into automated test systems.

HP dc electronic loads are optimized to address a broad range of dynamic loading applications. They are specifically designed for stability in applications where fast transients are applied to the load inputs, such as during dc power supply startup characterization or transient response testing. Dynamic load performance can be further tailored to specific application needs with the programmable slew rate feature.

Fully-Compatible Operation

All HP dc electronic loads respond to instructions from the industry-standard SCPI command set. Moreover, the features of all HP dc electronic loads are fully compatible with one another. For example, test programs developed for an HP 6060B 300 W single-input electronic load or an HP 60502B 300 W single-input load module are interchangeable.

The HP dc electronic load family is also fully compatible with the HP 59510A relay accessory (see page 180). The HP 59510A provides physical isolation of the HP dc electronic load from the device under test or any other test instrument by switching power and sense leads. Capable of switching up to 60 A and 200 Vdc, the HP 59510A can be controlled by rear-panel signals on the HP electronic load.

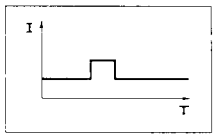
Battery Testing

The HP 6050A Option J10, HP 6051A Option J10 and HP 6060B Option J10 electronic loads are modified for battery testing. These products provide tri-level pulse loading, to simulate accurate conditions on batteries. They also feature a programmable minimum battery voltage threshold. If the voltage of the battery under test falls below this threshold, the load will automatically turn off.

Constant Current

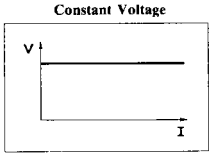
- Power Supply Load Regulation Testing
- Battery Capacity Testing
- Capacitor Discharging

Pulse and Dynamic Loading



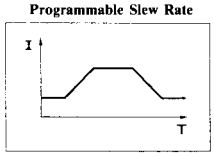
- Power Supply Load Transient Response
- Power Component Testing
- Pulse Electroplating

Constant Voltage



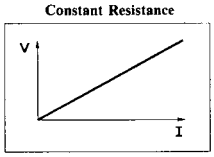
- Current Source Testing
- Current Limit Testing
- Shunt Regulator

Programmable Slew Rate



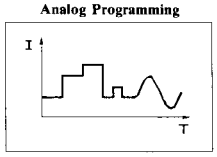
- Power Supply Testing
- Power Component Testing
- Power Supply Load Transient Response

Constant Resistance



- Characterizing Power Supply Crossover
- Power Supply Start-Up Delay
- Power Resistor Emulation

Analog Programming



- Battery Capacity Testing
- "Real-life" Load Simulation

DC Electronic Load Applications

System or Manual Applications

HP dc electronic loads are equally suitable for manual use on the bench. The front-panel LCD meters indicate voltage, current, and power readings. The full-function front-panel keypad allows easy, repeatable, and reliable control of the load when it is used manually. Six volatile user-definable states allow you to easily save settings for later recall. An additional user-definable power-up state allows you to define settings that are remembered when the unit is switched off and then recalled when it is switched on again.

Specifying System Performance

Because Hewlett-Packard electronic loads feature an integrated HP-IB programmer, pulse generator, current shunt, DMM, and cabling, their performance is specified as a system. Specifications cover all the integrated functions as one unit, which eliminates the need to calculate the actual performance of the automated test system based on each component's specification. The HP one-box solution makes the integration and documentation of your test system fast and easy.

Single-Input Products

The HP 6060B and HP 6063B are single-input loads with standard rear-panel inputs. They are also available with optional front-panel inputs in addition to the rear-panel inputs. Front-panel inputs (Option 020) make input connections to the HP electronic load convenient for bench applications. These front-panel terminals are capable of handling the entire current rating of the load and can accept wire gauges up to AWG#4 (22 mm^2). They require no tools to tighten, making the connections quick and easy.

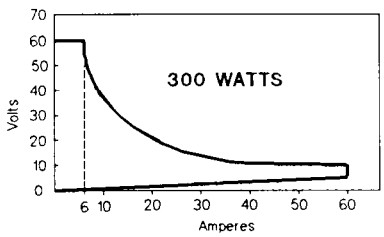
Mainframe Products

The HP 6050A 1,800-W and HP 6051A 600-W electronic load mainframes accept the user-installable HP load modules for easy system configuration and future reconfiguration, if desired. The HP 6050A holds up to six HP 60501B, 60502B, and 60503B load modules, or three HP 60504B and HP 60507B load modules, allowing up to 1,800 W of total maximum power. The HP 6051A holds up to two HP 60501B, 60502B, 60503B modules, or one HP 60504B or HP 60507B module allowing up to 600 W of total maximum power. One HP-IB address is all you need for complete control and readback of all load modules within a single mainframe.

Operating HP Loads Below the Minimum Input Voltage Specification

HP electronic loads meet all specifications when operated above 3.0 V; however, the dc operating characteristics also extend below this minimum-input voltage for static tests. Because of the FET technology used in the power input circuits, HP electronic loads have a low minimum input resistance allowing them to sink high currents even at low voltages.

The figure below shows the operating range of a typical HP dc electronic load. Notice that low-voltage operation, down to zero volts, is possible at correspondingly-reduced current levels, depending on the minimum resistance of the load. HP electronic loads, therefore, can be used in many applications that previously required zero-volt loads.



HP 60502B Input Characteristics

Why Not Make Your Own Load?

Many load users have resorted to building their loads in-house when a commercially-available electronic load with the right combination of features, power rating, performance, and purchase price could not be found. By making these loads in-house, users incur many hidden costs that can easily be overlooked. There are cost components associated with product development, parts procurement, manufacturing, product documentation, training, and product failure, maintenance, or replacement. In addition, the cost components increase as the design complexity changes from simply using resistors and relays to more sophisticated designs addressing application needs for HP-IB programming, readback, and triggering schemes for measurement synchronization.

Equipment buyers with electronic load needs have realized that the purchase price of commercially-available electronic loads can be relatively insignificant when compared to the overall cost of designing, manufacturing, and maintaining them in-house.

The HP electronic load family reduces your total cost of ownership by providing superior performance, features, reliability, and complete product documentation at a reasonable purchase price. These loads allow you to use fewer resources for your electronic load test system development, and more resources to remain successful and competitive in your particular industry. The standard three-year warranty can further reduce your maintenance costs.

The quality, performance, price, and Hewlett-Packard support will help you make an intelligent and economical purchase decision.

Special Modifications

HP offers a special modification service that entails modifying standard models. Special models available are:
HP 6050A J05 (disables the short key)
HP 6060B J08 (increases the input voltage to 70 V)
HP 6050A J10 Tri-Level Transient Mode

If you don't find a model that fits your exact needs, contact HP about its modification service.

Specifications

Hewlett-Packard Model	HP 6060B, 60502B	HP 6063B, 60503B	HP 60501B	HP 60504B	HP 60507B
Amperes	0 to 60 A	0 to 10 A	0 to 30 A	0 to 120 A	0 to 60 A
Volts	3 to 60 V	3 to 240 V	3 to 60 V	3 to 60 V	3 to 150 V
Maximum power (at 40° C)	300 W	250 W	150 W	600 W	500 W
Constant current mode					
Ranges	0 to 6 A, 0 to 60 A	0 to 1 A, 0 to 10 A	0 to 3 A, 0 to 30 A	0 to 12 A, 0 to 120 A	0 to 6 A, 0 to 60 A
Accuracy	0.1% ±75 mA	0.15% ±10 mA	0.1% ±40 mA	0.12% ±130 mA	0.1% ±80 mA
Regulation	10 mA	8 mA	10 mA	10 mA	10 mA (w/ ≥3 V at the point)
Constant voltage mode					
Accuracy	0.1% ±50 mV	0.12% ±120 mV	0.1% ±50 mV	0.1% ±50 mV	0.1% ±125 mV
Regulation (w/remote sense)	10 mV	10 mV	5 mV	20 mV	10 mV
Constant resistance mode	0.033 to 1.0 Ω	0.20 to 24.0 Ω	0.067 to 2 Ω	0.017 to 0.5 Ω	0.033 to 2.5 Ω
Ranges	1 to 1,000 Ω	24 to 10,000 Ω	2 to 2,000 Ω	0.5 to 500 Ω	2.5 to 2,500 Ω
	10 to 10,000 Ω	240 to 50,000 Ω	20 to 10,000 Ω	5 to 5,000 Ω	25 to 10,000 Ω
Accuracy	1 Ω: 0.8% ±8 mΩ (with ≥6 A at input) 1 KΩ: 0.3% ±8 mS (with ≥6 V at input) 10 KΩ: 0.3% ±8 mS (with ≥6 V at input)	24 Ω: 0.8% ±200 mΩ (with ≥1 A at input) 10 KΩ: 0.3% ±0.3 mS (with ≥24 V at input) 50 KΩ: 0.3% ±0.3 mS (with ≥24 V at input)	2 Ω: 0.8%, ±16 mΩ (with ≥3 A at input) 2 KΩ: 0.3% ±5 mS (with ≥6 V at input) 10 KΩ: 0.3% ±5 mS (with ≥6 V at input)	0.5 Ω: 0.8% ±5 mΩ (with ≥12 A at input) 500 Ω: 0.3% ±18 mS (with ≥6 V at input) 5 KΩ: 0.3% ±18 mS (with ≥6 V at input)	2.5 Ω: 0.8% ±16 mΩ (with ≥6 A at input) 2.5 KΩ: 0.3% ±5 mS (with ≥15 V at input) 10 KΩ: 0.3% ±5 mS (with ≥15 V at input)
Transient generator					
Frequency range	0.25 Hz to 10 kHz	0.25 Hz to 10 kHz	0.25 Hz to 10 kHz	0.25 Hz to 10 kHz	0.25 Hz to 10 kHz
Accuracy	3%	3%	3%	3%	3%
Duty cycle range	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)
Accuracy	6% of setting ±2%	6% of setting ±2%	6% of setting ±2%	6% of setting ±2%	6% of setting ±2%
Current level high range	60-A range:	10-A range:	30-A range:	120-A range:	60-A range:
Accuracy	0.1% ±350 mA	0.18% ±50 mA	0.1% ±200 mA	0.15% ±700 mA	0.1% ±350 mA
Current level low range	6-A range:	1-A range:	3-A range:	12-A range:	6-A range:
Accuracy	0.1% ±80 mA	0.18% ±13 mA	0.1% ±40 mA	0.15% ±160 mA	0.1% ±85 mA
Voltage level	3 to 60 V	3 to 240 V	3 to 60 V	3 to 60 V	3 to 150 V
Voltage level accuracy	0.1% ±300 mV	0.15% ±1.1 V	0.1% ±300 mV	0.15% ±300 mV	0.15% ±750 mV
Readback specifications					
Current readback accuracy	± (0.05% ±65 mA)	± (0.12% ±10 mA)	± (0.06% ±40 mA)	± (0.1% ±110 mA)	± (0.1% ±65 mA)
Voltage readback accuracy	± (0.05% +45 mV)	± (0.05% +150 mV)	± (0.05% +45 mV)	± (0.05% +45 mV)	± (0.05% +90 mV)
Power readback accuracy	± (0.2% +4 W)	± (0.2% +3 W)	± (0.2 +2 W)	± (0.2 +8 W)	± (0.2% +8 W)
Resolution					
Front panel/HP-IB	20 mV/17 mV	100 mV/67 mV	20 mV/17 mV	20 mV/17 mV	100 mV/40 mV
Ripple and noise (20-Hz to 10-MHz noise)	4 mA rms	1 mA rms	2 mA rms	6 mA rms	4 mA rms
Current	40 mA peak-to-peak	10 mA peak-to-peak	20 mA peak-to-peak	60 mA peak-to-peak	40 mA peak-to-peak
Voltage	6 mV rms	6 mV rms	5 mV rms	8 mV rms	10 mV rms

Supplemental Characteristics Non-warranted characteristics determined by design that are useful in applying the product

Hewlett-Packard Model	HP 6060B, 6050B	HP 6063B, 60503B	HP 60501B	HP 60504B	HP 60507B
Constant current mode	60-A range: 16 mA	10-A range: 2.6 mA	30-A range: 8 mA	120-A range: 32 mA	60-A range: 16 mA
Resolution	6-A range: 1.6 mA	1-A range: 0.26 mA	3-A range: 0.8 mA	12-A range: 3.2 mA	6-A range: 1.6 mA
Temperature coefficient	100 ppm/°C ±5 mA/°C	150 ppm/°C ±1 mA/°C	100 ppm/°C ±3 mA/°C	120 ppm/°C ±8 mA/°C	120 ppm/°C ±5 mA/°C
Constant voltage mode					
Resolution	16 mV	64 mV	16 mV	16 mV	40 mV
Temperature coefficient	100 ppm/°C ±5 mV/°C	120 ppm/°C ±10 mV/°C	100 ppm/°C ±5 mV/°C	100 ppm/°C ±5 mV/°C	100 ppm/°C ±5 mV/°C
Constant resistance mode	1 Ω: 0.27 mΩ	24 Ω: 6 mΩ	2 Ω: 0.54 mΩ	5 Ω: 0.14 mΩ	2.5 Ω: 0.67 mΩ
Resolution	1 KΩ: 0.27 mS	10 KΩ: 0.011 mS	2 KΩ: 0.14 mS	500 Ω: 0.54 mS	2.5 KΩ: 0.10 mS
	10 KΩ: 0.027 mS	50 KΩ: 0.001 mS	10 KΩ: 0.014 mS	5 KΩ: 0.054 mS	10 KΩ: 0.01 mS
Temperature coefficient	1 Ω: 800 ppm/°C ±0.4 mΩ/°C 1 KΩ: 300 ppm/°C ±0.6 mS/°C 10 KΩ: 300 ppm/°C ±0.6 mS/°C	24 Ω: 800 ppm/°C ±10 mΩ/°C 10 KΩ: 300 ppm/°C ±0.03 mS/°C 50 KΩ: 300 ppm/°C ±0.03 mS/°C	2 Ω: 800 ppm/°C ±0.8 mΩ/°C 2 KΩ: 300 ppm/°C ±0.5 mS/°C 10 KΩ: 300 ppm/°C ±0.5 mS/°C	0.5 Ω: 800 ppm/°C ±0.2 mΩ/°C 500 Ω: 300 ppm/°C ±1.2 mS/°C 5 KΩ: 300 ppm/°C ±1.2 mS/°C	2.5 Ω: 800 ppm/°C ±0.8 mΩ/°C 2.5 KΩ: 300 ppm/°C ±0.3 mS/°C 10 KΩ: 300 ppm/°C ±0.3 mS/°C
Transient generator					
Frequency range	0.25 Hz to 10 kHz	0.25 Hz to 10 kHz	0.25 Hz to 10 kHz	0.25 Hz to 10 kHz	0.25 Hz to 10 kHz
Resolution	4% or less	4% or less	4% or less	4% or less	4% or less
Duty cycle range	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)
Resolution	4%	4%	4%	4%	4%
Current level high range	60-A range:	10-A range:	30-A range:	120-A range:	60-A range:
Resolution	260 mA	43 mA	130 mA	520 mA	260 mA
Current level low range	6-A range:	1-A range:	3-A range:	12-A range:	6-A range:
Resolution	26 mA	4 mA	13 mA	52 mA	26 mA
Current temperature coefficient	100 ppm/°C ±7 mA/°C	180 ppm/°C ±1.2 mA/°C	100 ppm/°C ±5 mA/°C	150 ppm/°C ±10 mA/°C	150 ppm/°C ±5 mA/°C
Voltage level resolution	260 mV	64 mV	260 mV	260 mV	650 mV
Voltage temperature coefficient	150 ppm/°C ±5 mV/°C	120 ppm/°C ±10 mV/°C	150 ppm/°C ±5 mV/°C	150 ppm/°C ±5 mV/°C	150 ppm/°C ±5 mV/°C
Rise/fall time	12 μs to 8 ms	16 μs to 8 ms	12 μs to 8 ms	12 μs to 8 ms	18 μs to 8 ms

Supplemental Characteristics (cont'd)

Hewlett-Packard Model	HP 6060B, 6052B	HP 6063B, 60503B	HP 60501B	HP 60504B	HP 60507B
Analog programming bandwidth	10 kHz (–3 dB frequency)	10 kHz (–3 dB frequency)	10 kHz (–3 dB frequency)	10 kHz (–3 dB frequency)	10 kHz (–3 dB frequency)
Analog programming accuracy					
Current (low range)	4.5% ±75 mA	3% ±8 mA	4.5% ±40 mA	4% ±200 mA	4.5% ±75 mA
Current (high range)	4.5% ±250 mA	3% ±20 mA	4.5% ±130 mA	4% ±400 mA	4.5% ±200 mA
Temperature coefficient	100 ppm/°C ±6 mA/°C	150 ppm/°C ±1 mA/°C	100 ppm/°C ±3 mA/°C	100 ppm/°C ±12 mA/°C	150 ppm/°C ±6 mA/°C
Voltage	0.8% ±200 mV	0.5% ±150 mV	0.8% ±200 mV	0.8% ±200 mV	0.8% ±375 mV
Temperature coefficient	100 ppm/°C ±1 mV/°C	120 ppm/°C ±10 mV/°C	100 ppm/°C ±1 mV/°C	100 ppm/°C ±1 mV/°C	120 ppm/°C ±12.5 mV/°C
Analog programming voltage	0 to 10 V	0 to 10 V	0 to 10 V	0 to 10 V	0 to 10 V
Readback specifications					
Current readback resolution	17 mA (via HP-IB) 20 mA (front panel)	2.7 mA (via HP-IB) 10 mA (front panel)	9 mA (via HP-IB) 10 mA (front panel)	34 mA (via HP-IB) 100 mA (front panel)	17 mA (via HP-IB) 20 mA (front panel)
Temperature coefficient	50 ppm/°C ±5 mA/°C	100 ppm/°C ±1 mA/°C	65 ppm/°C ±3 mA/°C	100 ppm/°C ±8 mA/°C	100 ppm/°C ±5 mA/°C
Voltage readback resolution	17 mV (via HP-IB) 20 mV (front panel)	67 mV (via HP-IB) 100 mV (front panel)	17 mV (via HP-IB) 20 mV (front panel)	20 mV (via HP-IB) 20 mV (front panel)	40 mV (via HP-IB) 100 mV (front panel)
Voltage readback accuracy	0.05% ±45 mV	0.1% ±150 mV	0.05% ±45 mV	0.1% ±45 mV	0.1% ±90 mV
Temperature coefficient	50 ppm/°C ±1.2 mV/°C	100 ppm/°C ±8 mV/°C	50 ppm/°C ±1.2 mV/°C	100 ppm/°C ±2 mV/°C	100 ppm/°C ±5 mV/°C
Analog monitor accuracy					
Current monitor (0 to 10 V out)	4% ±85 mA	3% ±10 mA	4% ±40 mA	4% ±170 mA	3% ±85 mA
Temperature coefficient	50 ppm/°C ±6 mA/°C	100 ppm/°C ±1 mA/°C	60 ppm/°C ±3 mA/°C	100 ppm/°C ±10 mA/°C	100 ppm/°C ±6 mA/°C
Voltage monitor (0 to 10 V out)	0.25% ±40 mV	0.4% ±240 mV	0.25% ±40 mV	0.4% ±60 mV	0.4% ±120 mV
Temperature coefficient	50 ppm/°C ±0.2 mV/°C	70 ppm/°C ±1.2 mV/°C	50 ppm/°C ±0.2 mV/°C	100 ppm/°C ±2 mV/°C	100 ppm/°C ±5 mV/°C
Remote sensing	5-Vdc maximum between se	se and load input			
Minimum operating voltage	2 volts (1.2 V typical)	2 volts (1.2 V typical)	2 volts (1.2 V typical)	2 volts (1.4 V typical)	2 volts (1.4 V typical)
Programmable short	0.033 Ω (0.020 Ω typical)	0.20 Ω (0.10 Ω typical)	0.066 Ω (0.040 Ω typical)	0.017 Ω (0.012 Ω typical)	0.033 Ω (0.025 Ω typical)
Programmable open (typical)	20 kΩ	80 kΩ	20 kΩ	20 kΩ	20 kΩ
Drift (over 8-hour interval)					
Current	0.03% ±10 mA	0.03% ±15 mA	0.03% ±5 mA	0.03% ±20 mA	0.03% ±10 mA
Voltage	0.01% ±10 mV	0.01% ±20 mV	0.01% ±10 mV	0.01% ±10 mV	0.01% ±25 mV
dc isolation voltage	±240 Vdc, between any input and chassis ground				
Digital inputs	V_{IL} = 0.9 V max at I_{IL} = 1 mA / V_{IH} = 3.15 V min (pull-up resistor on input)				
Digital outputs	V_{OL} = 0.72 V max at I_{OL} = 1 mA / V_{OH} = 4.4 V min at I_{OH} = –20 μA				
Net weight (approx.)	6060B: 6.12 kg (13.5 lb) 60502B: 3.2 kg (7 lb)	6063B: 6.12 kg (13.5 lb) 60503B: 3.2 kg (7 lb)	3.2 kg (7 lb)	5.4 kg (13 lb)	5.4 kg (13 lb)
Shipping weight	6060B: 8.16 kg (18 lb) 60502B: 4.5 kg (10 lb)	6063B: 8.16 kg (18 lb) 60503B: 4.5 kg (10 lb)	4.5 kg (10 lb)	7.3 kg (16 lb)	7.3 kg (16 lb)

Notes:
1. Operating temperature range is 0° to 55° C. All specifications apply for 25° C ±5° C, except as noted.
2. Maximum continuous power available is derated linearly from 40° C to 75% of maximum at 55° C.
3. DC current accuracy specifications apply 30 seconds after input is applied.

HP 6050A, 6051A
Weight
Net Weight: HP 6050A: 9.5 kg (21 lb); HP 6051A: 5.5 kg (12 lb)
Shipping Weight: HP 6050A: 13.6 kg (30 lb); HP 6051A: 7.5 kg (17 lb)
Size
HP 6050A: 425.5 mm W x 177 mm H x 624.7 mm D
(16.75 in W x 7 in H x 24.6 in D)
HP 6051A: 213 mm W x 177 mm H x 624.7 mm D
(8.4 in W x 7 in H x 24.6 in D)
HP 6060B, 6063B: 425.5 mm W x 88.1 mm H x 396 mm D
(16.75 in W x 3.5 in H x 13.7 in D)

Ordering Information

	Options							
		AC input			Rackmount Kit			
HP model	Front-panel inputs	100 Vac Japan only	220 Vac	240 Vac			With handles	Extra manuals
	020	100	220	240	800	908	909	910
6050A	—				—			
6051A	—						—	
6060B					—			
6063B					—			
60501B	—	—	—	—	—	—	—	
60502B	—	—	—	—	—	—	—	
60503B	—	—	—	—	—	—	—	
60504B	—	—	—	—	—	—	—	
60507B	—	—	—	—	—	—	—	

†Options 908 and 909 for the HP 6050A, and Options 800 and 908 for the HP 6051A, require either the slide kit (p/n 1494-0059) or slide rails to support the weight of the load mainframe. Slide kits can be purchased using the above part number.
*This feature is available as an option.
—This feature is not available.

HP-IB Interface Capabilities

The following HP-IB functions are implemented: SH1, AH1, L4, SR1, DC1, DT1, and RL1
Regulatory Compliance: Listed to UL-1244; certified to CSA 556B; conform to IEC 348; standalone models carry the CE mark
RFI Suppression: Standalone models comply with CISPR-11, Group 1, Class B

Option Descriptions

Opt 020 Front-Panel Inputs (for HP 6060B and 6063B only)
Opt 100 87 to 106 Vac, 47 to 66 Hz (for Japan only)
Opt 220 191 to 233 Vac, 47 to 66 Hz
Opt 240 209 to 250 Vac, 47 to 66 Hz
Opt 800 Rackmount Kit for two units (for HP 6051A) mounted side-by-side (HP p/n 5061-9694 and 5062-3978)
Opt 908 Rackmount Kit (HP p/n 5062-3978 with an HP 6050A, HP p/n 5062-3960 with HP 6051A, and HP p/n 5062-3974 with an HP 6060B and 6063B)
Opt 909 Rackmount Kit with Handles (HP p/n 5062-3984 when mounting an HP 6050A and HP p/n 5062-3975 when mounting an HP 6060B and 6063B)
Opt 910 Extra manual set, including one each of the operating manual, programming reference manual, and service manual. The programming manual is available with the mainframe, and therefore not with individual modules (Standard unit is shipped with operating and programming manuals only).

Key Literature

1997/98 *HP Power Products Catalog,* p/n 5965-5284E

HP-IB System Power Supplies

Single Output

Max. volts (dc)	Max. amps (dc)	Max. watts	Output Operating Boundary	HP Model Number	Page
5	8	80	Rectangular	6631B	173
5	875	4400	Rectangular	6680A	177
6.7	30	200	Autoranging	6033A	178
7	120	1000	Autoranging	6031A	178
8	20	160	Rectangular	6641A	174
8	50	400	Rectangular	6651A	175
8	220	1760	Rectangular	6671A	176
8	580	4600	Rectangular	6681A	177
8	5	40	Rectangular	6611C	171
20	2	40	Rectangular	6612C	171
20	2	40	Rectangular	66312A	170
20	5	100	Rectangular	6632B	173
20	5	100	Rectangular	66332A	170
20	10	200	Autoranging	6033A	178
20	10	200	Autoranging	6038A	178
20	10	200	Rectangular	6642A	174
20	25	500	Rectangular	6652A	175
20	50	1000	Autoranging	6031A	178
20	50	1200	Autoranging	6032A	178
20	100	2000	Rectangular	6672A	176
21	240	5000	Rectangular	6682A	177
32	160	5100	Rectangular	6683A	177
35	6	210	Rectangular	6643A	174
35	15	525	Rectangular	6653A	175
35	60	2100	Rectangular	6673A	176
40	128	5100	Rectangular	6684A	177
50	1	50	Rectangular	6613C	171
50	2	100	Rectangular	6633B	173
60	3.3	200	Autoranging	6038A	178
60	3.5	210	Rectangular	6644A	174
60	9	540	Rectangular	6654A	175
60	17	1200	Autoranging	6030A	178
60	17.5	1200	Autoranging	6032A	178
60	35	2100	Rectangular	6674A	176
100	0.5	50	Rectangular	6614C	171
100	1	100	Rectangular	6634B	173
120	1.5	180	Rectangular	6645A	174
120	4	540	Rectangular	6655A	175
120	18	2160	Rectangular	6675A	176
200	5	1000	Autoranging	6035A	178
200	5	1200	Autoranging	6030A	178
500	2	1000	Autoranging	6035A	178

Available on Special Order

Single Output 100 to 5000 watts per output

Max. volts (dc)	Max. amps (dc)	Max. watts	Output Operating Boundary	HP Model Number
3.3/4	1000/950	3300	Rectangular	6680A-J03
5	250	1250	Rectangular	6671A-J14
6	60	360	Rectangular	6651A-J03
10	50	500	Rectangular	6651A-J01
14	150	2100	Rectangular	6671A-J03
24	85	2000	Rectangular	6672A-J04
36	55	1980	Rectangular	6673A-J04
40	12.5	500	Rectangular	6653A-J04
40	50	2000	Rectangular	6673A-J08
50	10	500	Rectangular	6654A-J05
50	100	5000	Rectangular	6684A-V50
55	38	2090	Rectangular	6674A-J03
70	3	210	Rectangular	6644A-J09
70	7.5	525	Rectangular	6654A-J04
70/80	30/26	2000	Rectangular	6674A-J05
80	6	480	Rectangular	6654A-J12
100	22	2200	Rectangular	6675A-J08
110	20	2200	Rectangular	6675A-J09
135	16	2160	Rectangular	6675A-J06
150	1.2	180	Rectangular	6645A-J05
150	3.2	480	Rectangular	6655A-J05
150	15	2175	Rectangular	6675A-J11
160	13	2080	Rectangular	6675A-J04
200	11	2200	Rectangular	6675A-J07

Key Literature

1997/98 *HP Power Products Catalog*, p/n 5965-5284E

Multiple Output

Range 1		Range 2			Outputs for each HP model number									
Max. volts (dc)	Max. amps (dc)	Max. volts (dc)	Max. amps (dc)	Max. watts per output	6621A page 172	6622A page 172	6623A page 172	6624A page 172	6625A page 172	6626A page 172	6627A page 172	6628A page 172	6629A page 172	E3631A page 181
6	5			30	—	—	—	—	—		—	—	—	Outputs 3
7	0.015	50	0.5	25	—	—	—	—	Output 1	Outputs 1 & 2	—	—	—	—
7	5	20	2	40	—	—	Output 1	Outputs 1 & 2	—	—	—	—	—	—
7	10	20	4	80	Outputs 1 & 2	—	Output 3	—	—	—	—	—	—	—
16	0.2	16	2	50	—	—	—	—	Output 2	Outputs 3 & 4	—	Outputs 1 & 2	Outputs 1-4	—
16	0.2	50	1	50	—	—	—	—	Output 2	Outputs 3 & 4	—	Outputs 1 & 2	Outputs 1-4	—
20	2	50	0.8	40	—	—	Output 2	Outputs 3 & 4	—	—	Outputs 1-4	—	—	—
20	4	50	2	100	—	Outputs 1 & 2	—	—	—	—	—	—	—	—
±25	1			25	—	—	—	—	—	—	—	—	—	Outputs 1 & 2
Output Operating Boundary					Rectangular									

Modules for HP 66000 Modular Power System

Up to 8 per mainframe

Max. volts (dc)	Max. amps (dc)	Max. watts	HP Model Number	Page
8	16	128	66101A	168
20	7.5	150	66102A	168
35	4.5	150	66103A	168
60	2.5	150	66104A	168
120	1.25	150	66105A	168
200	0.75	150	66106A	168

Max. volts (dc)	Max. amps (dc)	Max. watts	HP Model Number
5.7	20	114	66101A-J03
15	10	150	66102A-J05
37	4	148	66103A-J01

Manually-Controlled and Analog-Programmable Power Supplies

Single Output

Max. volts (dc)	Max. amps (dc)	Max. watts	Type	Manually controlled analog-prog	HP Model Number	Page
6.7	30	200	Autoranging	MC/AP	6023A	178
7	120	840	Autoranging	MC/AP	6011A	178
8	3	24	Dual-range	MC	E3610A	183
8	6	48	Rectangular	MC/AP	E3614A	183
8	20	160	Rectangular	MC/AP	6541A	174
8	50	400	Rectangular	MC/AP	6551A	175
8	220	1760	Rectangular	MC/AP	6571A	176
15	2	30	Dual-range	MC	E3610A	183
20	1.5	30	Dual-range	MC	E3611A	183
20	3	60	Rectangular	MC/AP	E3615A	183
20	10	200	Autoranging	MC/AP	6023A	178
20	10	200	Autoranging	MC/AP	6024A	178
20	10	200	Rectangular	MC/AP	6542A	174
20	25	500	Rectangular	MC/AP	6552A	175
20	50	1000	Autoranging	MC/AP	6011A	178
20	50	1000	Autoranging	MC/AP	6012B	178
20	100	2000	Rectangular	MC/AP	6572A	176
35	0.85	30	Dual-range	MC	E3611A	183
35	1.7	60	Rectangular	MC/AP	E3616A	183
35	6	210	Rectangular	MC/AP	6543A	174
35	15	525	Rectangular	MC/AP	6553A	175
35	60	2100	Rectangular	MC/AP	6573A	176
40	5.7	228	Autoranging	MC/AP	6024A	178
40	30	1200	Autoranging	MC/AP	6012B	178
60	0.5	30	Dual-range	MC	E3612A	183
60	1	60	Rectangular	MC/AP	E3617A	183
60	3.5	210	Rectangular	MC/AP	6544A	174
60	9	540	Rectangular	MC/AP	6554A	175
60	17	1020	Autoranging	MC/AP	6010A	178
60	17.5	1050	Autoranging	MC/AP	6012B	178
60	35	2100	Rectangular	MC/AP	6574A	176
120	0.25	30	Dual-range	MC	E3612A	183
120	1.5	180	Rectangular	MC/AP	6545A	174
120	4.5	540	Rectangular	MC/AP	6555A	175
120	18	2160	Rectangular	MC/AP	6575A	176
200	5	1000	Autoranging	MC/AP	6010A	178
200	5	1000	Autoranging	MC/AP	6015A	178
500	2	1000	Autoranging	MC/AP	6015A	178

Multiple Output

Range 1		Range 2		Outputs for each HP model number		
Max. volts (dc)	Max. amps (dc)	Max. volts (dc)	Max. amps (dc)	Max. watts per output	E3620A MC page 182	E3630A MC page 182
6	2.5	—	—	15	—	Output 1
20	0.5	—	—	10	—	Outputs 1 & 2
Output Operating Boundary		Rectangular				

*MC=Manually controlled. AP=Analog programmable.

DC Power Test Systems

Functional Testing of Power Supplies and DC-to-DC Converters

The Hewlett-Packard Power Test System, Z6150A, is a custom-configured, cost-effective, highly-flexible power supply test system that can be designed to meet the specified requirement of the R&D, Quality Control and Manufacturing power supply test engineer. HP factory experts integrate HP industry standard equipment, third party devices, and HP power supply test and custom software to develop a power supply test system that insures accurate and reliable tests. For detailed information, a quotation or related inquiries, please contact your HP sales representative.

Power Supplies

Modular Power System

HP 66000A
HP 66001A
HP 66101A
to 66106A

- High density: eight slots in 7 inches of rack space
- Output sequencing
- Low ripple and noise
- High-accuracy read-back of voltage and current over HP-IB
- SCPI (Standard Commands for Programmable Instruments)
- Optional keyboard and display unit
- Serial link to connect two mainframes at one HP-IB address
- Optional isolation and polarity-reversal relays
- Built-in self-test

HP 66000 Modular Power System

The Hewlett-Packard 66000 modular power system simplifies test-system assembly, cabling, programming, debugging and operation. It is ideal for ATE and production test environments, where it can supply bias power and stimulus to subassemblies and final products. The HP modular power system saves rack space, as the 7-inch-high (4-EIA units) mainframe can accommodate up to eight dc power modules.

Specifications at 0° to 55° C unless otherwise noted

		HP 66101A	HP 66102A	HP 66103A	HP 66104A	HP 66105A	HP 66106A
Output ratings (at 40° C)	Output Voltage	0 to 8 V	0 to 20 V	0 to 35 V	0 to 60 V	0 to 120 V	0 to 200 V
	Output Current	0 to 16 A	0 to 7.5 A	0 to 4.5 A	0 to 2.5 A	0 to 1.25 A	0 to 0.75 A
	Output Power	128 W	150 W	150 W	150 W	150 W	150 W
Programming accuracy (at 25° C ±5° C)	Voltage 0.03%+	3 mV	8 mV	13 mV	27 mV	54 mV	90 mV
	Current 0.03%+	6 mA	3 mA	2 mA	1.2 mA	0.6 mA	0.4 mA
Readback accuracy (via HP-IB or keyboard display at 25° C ±5° C)	Voltage 0.02%+	2 mV	5 mV	8 mV	16 mV	32 mV	54 mV
	Current 0.02%+	6 mA	3 mA	2 mA	1 mA	0.6 mA	0.3 mA
Ripple and noise (20 Hz to 20 MHz)	Constant voltage rms	2 mV	3 mV	5 mV	9 mV	18 mV	30 mV
	peak to peak	5 mV	7 mV	10 mV	15 mV	25 mV	50 mV
	Constant current rms	8 mA	4 mA	2 mA	1 mA	1 mA	1 mA
Line Regulation	Voltage	0.5 mV	0.5 mV	1 mV	2 mV	3 mV	5 mV
	Current	0.75 mA	0.5 mA	0.3 mA	0.1 mA	50 μA	30 μA
Load Regulation	Voltage	1 mV	1 mV	1 mV	2 mV	4 mV	7 mV
	Current	0.2 mA	0.2 mA	0.2 mA	0.1 mA	50 μA	30 μA

Transient Response Time: Less than 1 ms for the output voltage to recover within 100 mV of its previous level following any step change in load current up to 10 percent of rated current

Supplemental Characteristics Non-warranted characteristics determined by design that are useful in applying the product

		HP 66101A	HP 66102A	HP 66103A	HP 66104A	HP 66105A	HP 66106A
Average resolution	Voltage	2.4 mV	5.9 mV	10.4 mV	18.0 mV	36.0 mV	60.0 mV
	Current	4.6 mA	2.3 mA	1.4 mA	0.75 mA	0.39 mA	0.23 mA
	Output voltage programming (OVP)	50 mV	120 mV	200 mV	375 mV	750 mV	1.25 mV
OVP accuracy		250 mV	500 mV	800 mV	1 V	1.5 V	2.5 V

dc Floating Voltage: Output terminals can be floated up to ±240 Vdc from chassis ground
Remote Sensing: Up to half the rated output voltage can be dropped across each load lead. Add 2 mV to the voltage load regulation specification for each 1–V change in the negative output lead caused by a load current change.
Command Processing Time: The average time for the output voltage to change after getting an HP-IB command is 20 ms
Output Programming Response Time (with full resistive load): The rise and fall time (10/90% and 90/10%) of the output voltage is less than 20 ms. The output voltage change settles within 1 LSB (0.025% x rated voltage) of the final value in less than 120 ms.
Down Programming: An active down-programmer sinks approximately 10% of the rated output current
Calibration Interval: One year

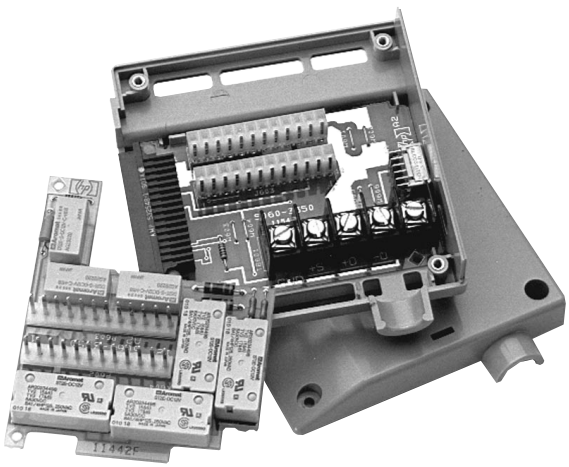
ac Input of System Mainframe

Voltage	100 Vac	120 Vac	200 Vac	220 Vac	230 Vac	240 Vac
Maximum current	29 A	25 A	16 A	16 A	15 A	15 A

Input Power of System Mainframe: 3200 VA (max.), 1800 W (max.), 1600 W (typ.)
HP-IB Capabilities: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, E1, and C0, and a command set compatible with IEEE-488.2 and SCPI
Regulatory Compliance: Listed to UL-1244; certified to CSA 22.2 No. 231; conforms to IEC 1010, carries the CE mark
RFI Suppression: Complies with CISPR-11, Group 1, Class A
Weight:
Net: HP 66000A, 15 kg (33 lb); HP 66001A, 1.05 kg (2.3 lb); HP 66101–66106A, 2.8 kg (6 lb).
Shipping: HP 66000A, 19 kg (42 lb); HP 66001A, 1.34 kg (2.95 lb); HP 66101–66106A, 4.1 kg (9 lb).
Size: HP 66000A: 425.7 mm W x 184.94 mm H x 677.93 mm D (16.76 in x 7.28 in x 26.69 in), including feet and rear connectors
Warranty Period: Three years

Key Literature

1997/98 *HP Power Products Catalog*, p/n 5965-5284E



Isolation and polarity reversal relays are available as an option to the modules. The relay assembly fits into the module connector and can be fully controlled and sensed over the HP-IB.

Key Features

- HP-IB-programmable voltage and current
- Series and parallel operation
- Programmable over-voltage and over-current protection
- Self-test initiated at power-up or from HP-IB command
- Electronic calibration over HP-IB or from keyboard
- Over-temperature protection
- Discrete fault indicator/remote inhibit (DFI/RI)
- Five nonvolatile store-recall states per output
- User-defineable power-on state

Multiple Mainframes at One HP-IB Address

The HP serial link feature will allow you to control up to 16 outputs at one HP-IB address by connecting an auxiliary mainframe. The serial link cable comes standard with the HP 66000 MPS mainframe. For applications with a broader range of power requirements, one HP 66000 mainframe can be connected with up to eight of the HP 6640, HP 6650, HP 6670, HP 6680, or HP 6030 series of system power supplies. This solution provides power ranges from 150 watts to 5,000 watts at one primary HP-IB address.

Output Connections

System assembly is simplified thanks to a quick-disconnect connector assembly on each module. Once your wires are connected to the load, the connector design permits the modules to be removed from the front of the mainframe without disconnecting cabling or removing the mainframe from the rack. One connector assembly is shipped with each module.

Output Sequencing

Increase test throughput by using the output sequencing feature of the HP 66000 MPS. This powerful feature allows you to download up to 20 voltage, current, and dwell-time parameter sets per output. This sequence can be paced by the programmed dwell times. As an alternative, triggers can be used to step through the output list. The output sequences can be executed without controller intervention, thereby increasing overall test system throughput. More detailed information on the triggering and output sequencing capabilities can be obtained by ordering the HP 66000 Modular Power System Product Note (p/n 5091-2497E) described below.

HP 66000 Modular Power System Product Note (5091-2497E)

This product note provides information on how you can use the advanced programming features of the HP 66000 modular power system to address a variety of applications. Although your exact application may not be described, the product capabilities covered in this product note can be generalized and applied to your specific needs. Programming examples are also included in HP BASIC and in several languages available on DOS-based computers. The applications described are:

- Sequencing Multiple Modules During Power-Up
- Sequencing Multiple Modules to Power-Down on Event
- Controlling Output Voltage Ramp Up at Turn-On
- Providing Time-Varying Voltages
- Providing Time-Varying Current Limiting
- Output Sequencing Paced by the Computer
- Output Sequencing Without Computer Intervention

Ordering Information

HP 66000A MPS Mainframe
Opt 908 Rackmount Kit (HP p/n 5062-3978)
Opt 909 Rackmount Kit with Handles (HP p/n 5062-3984)
Note: Options 908 and 909 require cabinet rails or a slide kit (HP p/n 1494-0059) to support the loaded mainframe's weight.
Opt 910 Extra Manual Set (Standard unit is shipped with Installation Guide only.)
HP 66001A MPS Keyboard includes 2m (6 ft) cables (Order HP 34551A to rackmount)
HP 34551A (Rack Kit for HP 66001A keyboard)
Module Options
HP 66101A dc Power Module 8 V, 16 A
HP 66102A dc Power Module 20 V, 7.5 A
HP 66103A dc Power Module 35 V, 4.5 A
HP 66104A dc Power Module 60 V, 2.5 A
HP 66105A dc Power Module 120 V, 1.25 A
HP 66106A dc Power Module 200 V, 0.75 A
Opt 760 Open/Close and Polarity Reversal Relays
Opt 910 Extra Manual Set: User's Guide, Programming Guide and Service Manual (Standard unit is shipped with Installation Guide only.)
Accessories
HP p/n 5060-3351 Field-Installable Relay Kit
HP p/n 5060-3386 Standard Connector Assembly
HP p/n 5060-3387 Standard Connector Assembly with installed relays (Option 760)
HP p/n 66000-90001 Mainframe Installation Guide
HP p/n 5959-3360 dc Power Module User's Guide
HP p/n 5959-3362 dc Power Module Programming Guide
HP p/n 66000-90003 Mainframe Service Manual
HP p/n 5959-3364 dc Power Module Service Manual
HP p/n 1252-1488 4-Pin FLT/Inhibit Connector
Line Cord Options
A line cord option must be specified. For details, refer to page 180.
Available Modifications
66101A-J03: 5.7 V, 20 A, 114 W
66102A-J05: 15 V, 10 A, 150 W
66103A-J01: 37 V, 4 A, 148 W

Dynamic Measurement Single-Output System, 40 W and 100 W

HP 66312A
HP 66332A

- Ideal for wireless/portable product test
- Dynamic pulse measurement
- Precision low current measurement
- Low-output noise
- High-speed programming
- SCPI (Standard Commands for Programmable Instruments)
- HP-IB and RS-232 interface
- HP VXI *plug&play* drivers

HP 66312A, top; HP 66332A, bottom

Specifications at 0° C to 55° C unless otherwise specified

			HP 66312A	HP 66332A
Output ratings	Voltage/Current		0 to 20 V/0 to 2 A	0 to 20 V/0 to 5 A
Programming accuracy at 25° C ±5° C	Voltage/+Current	0.05%+	10 mV/1mA	10 mV/2 mA
Ripple and noise (20 Hz to 20 MHz, with outputs ungrounded or with either terminal grounded)	Voltage normal mode Voltage fast mode Current	(rms/p-p) (rms/p-p) (rms)	0.5 mV/3 mV NA 1 mA	0.3 mV/3 mV 1 mV/10 mV 2 mA
DC measurement accuracy via HP-IB or front-panel meters with respect to actual output at 25°C ± 5°C	Voltage Low current range –20 mA to +20 mA High current range +20 mA to + rated I –20 mA to – rated I	0.03% + 0.1% + 0.2% + 0.2% +	3 mV 2.5 μA 0.25 mA 0.85 mA	3 mV 2.5 μA 0.5 mA 1.1 mA
Load regulation	Voltage/Current		2 mV/0.5 mA	2 mV/1 mA
Line regulation	Voltage/Current		0.5 mV/0.5 mA	0.5 mV/1 mA

Transient Response Time: Less than 100 μs (50 μs in the fast mode) for the output voltage to recover to its previous level (within 0.1% of the voltage rating of the supply), following any step change in load current of up to 50% of the output current rating of the supply

Supplemental Characteristics Non-warranted characteristics determined by design and useful in applying the product

Average programming resolution	Voltage/Current		5 mV/0.5 mA	5 mV/1.25 mA
OVP accuracy		2.4% +	240 mV	240 mV
Sink current*	—		1 A	5 A

*For the HP 66332A, the sink current tracks the programmed current to within 2 mA for programmed currents greater than 5 mA. Below 5 mA, the sink current remains at 5 mA. The sink current does not track the programmed current for the 66312A.

Dynamic Measurements: Accuracy of the instantaneous voltage measurement is 0.03% +5 mV. Accuracy of the instantaneous current measurement is 0.6% +1 mA (2 mA for HP 66332A). The dc, rms, maximum, minimum, high-level and low-level voltage and current measurements are calculated from the instantaneous voltage and current readings. Up to 4096 data points can be acquired. The sampling interval can be varied from 15.6 μs to 31000 sec. The instantaneous data points can also be read back from the storage buffer. Dynamic measurements on current waveforms can only be made in the high range.
dc Floating Voltage: Output terminals can be floated up to ±240 Vdc maximum from chassis ground (50 volts for HP 66312A)
Remote Sensing: Up to two volts dropped in each load lead. Add 2 mV to the voltage load regulation specification for each one volt change in the negative output lead (positive output lead for the HP 66312A) due to load current change.
Command-Processing Time: Average time required for the output voltage to begin to change following receipt of digital data is 4 ms for the power supplies connected directly to the HP-IB. (Display disabled.)
Output-Programming Response Time: The rise and fall time (10/90% and 90/10%) of the output voltage is less than 2 ms (400 μs for the HP 66332A in the fast mode). The output voltage change settles within 1 LSB (0.025% x rated voltage) of final value in less than 6 ms (2 ms in the fast mode).
Measurement Time: Average time to process query, calculate measurement parameter and return data is 20 ms. The buffer data aquisition time which is user-programmable must be added. For the default condition (2048 data points and 15.6 μs sampling interval), this time is 32 ms.
HP-IB Interface Capabilities: IEEE-488.2, SCPI command set, and 6630x Series programming capability.
Input Power (full load): HP 66312A: 160 VA, 100 W;
HP 66332A: 350 VA, 250 W

Regulatory Compliance: Listing pending to UL-3111-1; certified to CSA 22.2. No. 1010-1, conforms to IEC 1010-1, complies with EMC directive 89/336/EEC (ISM Group 1, Class B)
Warranty Period: Three years
Size: HP 66312A: 212.8 mm W x 88.1 mm H x 425.8 mm D (8.4 in x 3.5 in x 16.8 in);
HP 66332A: 425.5 mm W x 88.1 mm H x 364.4 mm D (16.75 in x 3.5 in x 14.3 in)
Weight: HP 66312A: 8.85 kg (19.5 lb) net; 11.1 kg (24.5 lb) shipping;
HP 66332A: 12.7 kg (28 lb) net, 15.0 kg (33 lb) shipping

Ordering Information

Standard: 104 to 127 Vac, 47 to 63 Hz
Opt 100 87 to 106 Vac, 47 to 63 Hz
Opt 220 191 to 233 Vac, 47 to 63 Hz
Opt 230 207 to 253 Vac, 47 to 63 Hz
Opt 020 Front-panel Binding Posts (HP 66332A only)
Opt 760 Isolation and Reversal Relays
Opt 1CM Rackmount Kit,
HP 66312A: HP p/n 5060-3972
HP 66332A: HP p/n 5062-3974
Opt 1CP Rackmount Kit with Handles,
HP p/n 5062-3975 (HP 66332A only)
Opt AXS Rackmount Kit for side-by-side mounting (66312A only), Locking Kit HP p/n 5061-9464;
Flange Kit HP p/n 5062-3974
Opt 0BN Service Manual and extra Operating Guide (Standard unit is shipped with operating guide and programming guide only.)
Accessories
HP p/n 1494-0060 Rack Slide Kit (HP 66332A only)

HP 6611C
HP 6612C
HP 6613C
HP 6614C

- Precision low current measurement
- Low-output noise
- High-speed programming
- HP-IB and RS-232 interface
- SCPI (Standard Commands for Programmable Instruments)

NEW HP-IB UID

Specifications at 0° C to 55° C unless otherwise specified

			HP 6611C	HP 6612C	HP 6613C	HP 6614C
Output ratings	Voltage/Current		0 to 8 V/0 to 5 A	0 to 20 V/0 to 2 A	0 to 50 V/0 to 1 A	0 to 100 V/0 to 0.5 A
Programming accuracy at 25° C ±5° C	Voltage/+ Current	0.05% +	5 mV/2 mA	10 mV/1 mA	20 mV/0.5 mA	50 mV/0.25 mA
Ripple and noise (20 Hz to 20 MHz, with outputs ungrounded or with either terminal grounded)	Voltage Normal mode	rms/p-p	0.5 mV/3 mV	0.5 mV/3 mV	0.5 mV/4 mV	0.5 mV/6 mV
	Current	rms	2 mA	1 mA	1 mA	1 mA
DC measurement accuracy: via HP-IB or front-panel meters with respect to actual output at 25° C ±5° C	Voltage	0.3% +	3 mV	3 mV	6 mV	12 mV
	Low current range –20 mA to +20 mA	0.1% +	2.5 μA	2.5 μA	2.5 μA	2.5 μA
	High current range +20 mA to + rated I	0.2% +	1 mA	0.25 mA	0.2 mA	0.1 mA
	–20 mA to –rated I	0.2% +	1.6 mA	0.85 mA	0.8 mA	0.7 mA
Load regulation	Voltage/Current		2 mV/1 mA	2 mV/0.5 mA	4 mV/0.5 mA	5 mV/0.5 mA
Line regulation	Voltage/Current		0.5 mV/0.5 mA	0.5 mV/0.5 mA	1 mV/0.25 mA	1 mV/0.25 mA

Transient Response Time: Less than 100 μs for the output voltage to recover to its previous level (within 0.1% of the voltage rating of the supply or 20 mV, whichever is greater) following any step change in load current of up to 50% of the output current rating of the supply

Supplemental Characteristics Non-warranted characteristics determined by design and useful in applying the product

Average programming resolution	Voltage/Current	2 mV/1.25 mA	5 mV/0.5 mA	12.5 mV/0.2 mA	25 mV/0.1 mA
Sink current		3 A	1.2 A	0.6 A	0.3 A

dc Floating Voltage: Output terminals can be floated up to ±240 Vdc maximum from chassis ground
Remote Sensing: Up to two volts dropped in each load lead. Add 2 mV to the voltage load regulation specification for each one volt change in the positive output lead due to load current change.
Command-Processing Time: Average time required for the output voltage to begin to change following receipt of digital data is 4 ms for the power supplies connected directly to the HP-IB. (Display disabled.)
Output-Programming Response Time: The rise and fall time (10/90% and 90/10%) of the output voltage is less than 2 ms. The output voltage change settles within 1 LSB (0.025% x rated voltage) of final value in less than 6 ms.
HP-IB Interface Capabilities: IEEE-488.2, SCPI command set, and 6630A Series programming compatability
Instrument Time: Average time to make a voltage or current measurement is 50 ms.
Input Power (full load)**:** 160 VA, 100 W
Regulatory Compliance: Listing pending to UL 3111-1; certified to CSA 22.2 No. 1010.1; conforms to IEC 1010-1; complies with EMC directive 89/336/EEC (ISM Group 1, Class B)
Warranty Period: Three years
Size: 212.8 mm W x 88.1 mm H x 348.3 mm D (8.4 in x 3.5 in x 13.7 in)
Weight: 8.85 kg (19.5 lb) net; 11.1 kg (24.5 lb) shipping

Ordering Information

Standard: 104 to 127 Vac, 47 to 63 Hz
Opt 100 87 to 106 Vac, 47 to 63 Hz
Opt 220 191 to 233 Vac, 47 to 63 Hz
Opt 230 207 to 253 Vac, 47 to 63 Hz
Opt 760 Isolation and Reversal Relays
Opt ICM Rackmount Kit, HP p/n 5062-3972
Opt AXS Rackmount Kit for side-by-side mounting, Lock-link Kit HP p/n 5061-9694; Flange Kit HP p/n 5062-3974 (6612B only)
Opt AXU Rackmount and slide for side-by-side mounting of 2 different depth instruments (HP p/n 5062-3996 and 1494-0015)
Opt AXV Rackmount, slide and support shelf for mounting 1 HP 6610 Series instrument (HP p/n 1494-0015, 5062-3996 and 5062-4022)
Opt 0BN Service Manual and extra Operating Guide (Standard unit is shipped with operating guide and programming guide only.)

Key Literature

1997/98 *HP Power Products Catalog,* p/n 5965-5284E

Multiple-Output System Power Supplies, 25 W to 80 W

HP 6621A
HP 6622A
HP 6623A
HP 6624A
HP 6625A
HP 6626A
HP 6627A
HP 6628A
HP 6629A

- 2, 3, or 4 independent isolated outputs
- Dual-range linear outputs
- Low ripple and noise
- Fast up- and down-programming
- 14-bit programming and readback of voltage and current (HP 6625A,6626A, 6628A, 6629A)

Specifications at 0° to 55° C unless otherwise indicated

		25-watt output	40-watt output	40-watt output	50-watt output	80-watt output	80-watt output
Output Power	Low-range volts, amps High range volts, amps	0 to 7 V, 0 to 15 mA 0 to 50 V, 0 to 500 mA	0 to 7 V, 0 to 5 A 0 to 20 V, 0 to 2 A	0 to 20 V, 0 to 2 A 0 to 50 V, 0 to 0.8 A	0 to 16 V, 0 to 200 mA 0 to 50 V, 0 to 1 A or 0 to 16 V, 0 to 2 A	0 to 7 V, 0 to 10 A 0 to 20 V, 0 to 4 A	0 to 20 V, 0 to 4 A 0 to 50 V, 0 to 2 A
Output combinations for each HP model (total number of outputs)	HP 6621A (2)	—	—	—	—	2	—
	HP 6622A (2)	—	—	—	—	—	2
	HP 6623A (3)	—	1	1	—	1	—
	HP 6624A (4)	—	2	2	—	—	—
	HP 6625A (2) Precision	1	—	—	1	—	—
	HP 6626A (4) Precision	2	—	—	2	—	—
	HP 6627A (4)	—	—	4	—	—	—
	HP 6628A (2) Precision	—	—	—	2	—	—
	HP 6629A (4) Precision	—	—	—	4	—	—
Programming accuracy (at 25° C ±5° C)	Voltage	1.5 mV + 0.016% (low) 10 mV + 0.016% (high)	19 mV + 0.06%	50 mV + 0.06%	3 mV + 0.016% (low) 10 mV + 0.016% (high)	19 mV + 0.06%	50 mV + 0.06%
	Current	15 μA + 0.04% (low) 100 μA + 0.04% (high)	50 mA + 0.16%	20 mA + 0.16%	185 μA + 0.04% (low) 500 μA + 0.04% (high)	100 mA + 0.16%	40 mA + 0.16%
Ripple and noise (peak-to-peak, 20 Hz to 20 MHz; rms, 20 Hz to 10 MHz)	Constant voltage rms	500 μV	500 μV	500 μV	500 μV	500 μV	500 μV
	peak-to-peak	3 mV	3 mV	3 mV	3 mV	3 mV	3 mV
	Constant current rms	0.1 mA	1 mA	1 mA	0.1 mA	1 mA	1 mA
Load regulation	Voltage	0.5 mV	2 mV	2 mV	0.5 mV	2 mV	2 mV
	Current	0.005 mA	1 mA	0.5 mA	0.01 mA	2 mA	1 mA
Load cross regulation	Voltage	0.25 mV	1 mV	2.5 mV	0.25 mV	1 mV	2.5 mV
	Current	0.005 mA	1 mA	0.5 mA	0.01 mA	2 mA	1 mA
Line regulation	Voltage	0.5 mV	0.01% + 1 mV	0.01% + 1 mV	0.5 mV	0.01% + 1 mV	0.01% + 1 mV
	Current	0.005 mA	0.06% + 1 mA	0.06% + 1 mA	0.01 mA	0.06% + 1 mA	0.06% + 1 mA

Transient Response Time: Less than 75 μs for the output to recover to within 75 mV of nominal value following a load change within specfications

Supplemental Characteristics Non-warranted characteristics determined by design and useful in applying the product

		25-watt output	40-watt output	40-watt output	50-watt output	80-watt output	80-watt output
Average programming resolution	Voltage	460 μV (low)/ 3.2 mV (high)	6 mV	15 mV	1 mV (low)/ 3.2 mV (high)	6 mV	15 mV
	Current	1 μA (low)/ 33 μA (high)	25 mA	10 mA	13 μA (low)/ 131 μA (high)	50 mA	20 mA
	OVP	230 mV	100 mV	250 mV	230 mV	100 mV	250 mV
Output programming response time time to settle within 0.1% of full scale output, after Vset command has been processed		6 ms	2 ms	6 ms	6 ms	2 ms	6 ms

dc Floating Voltage: All outputs can be floated up to ±240 Vdc from chassis ground
Remote Sensing: Up to 1 V (HP 6621–24A, 6627A); up to 10 V (HP 6625A, 6626A, 6628A, 6629A) drop per load lead. The drop in the load leads is subtracted from the voltage available for the load.
Command Processing Time: 7 ms typical with front-panel display disabled
Down Programming: Current sink limits are fixed approximately 10% higher than source limits for a given operating voltage above 2.5 V (HP 6621A, 6622A, 6623A, 6624A, 6627A)
Input Power: 550 W max., 720 VA max.
HP-IB Interface Capabilities: SH1, AH1, T6, L4, SR1, RL1, PP1, DC1, DT0. (C0, E1 for HP 6625A, 6626A, 6628A, 6629A only)
Regulatory Compliance: Listed to UL-1244; certified to CSA 556B; conforms to IEC 348; carries the CE mark
RFI Suppression: Complies with CISPR-11, Group 1, Class B
Size: 425.5 mm W x 132.6 mm H x 497.8 mm D (16.75 in x 5.22 in x 19.6 in)
Weight:
HP 6621A–24A, 6626A, 6627A, 6629A
Net: 17.4 kg (38 lb); Shipping: 22.7 kg (50 lb)
HP 6625A, 6628A
Net: 15.5 kg (34 lb); Shipping: 20.8 kg (46 lb)
Warranty Period: Three years

Ordering Information

HP 6621A Dual-Output System Power Supply
HP 6622A Dual-Output System Power Supply
HP 6623A Triple-Output System Power Supply
HP 6624A Quad-Output System Power Supply
HP 6625A Precision Dual-Output System Power Supply
HP 6626A Precision Quad-Output System Power Supply
HP 6627A Quad-Output System Power Supply
HP 6628A Precision Dual-Output System Power Supply
HP 6629A Precision Quad-Output System Power Supply
Standard: 104 to 127 Vac, 47 to 66 Hz, 5.4 A
Opt 100 87 to 106 Vac, 47 to 66 Hz Input, 6.3 A (Japan only)
Opt 220 191 to 233 Vac, 47 to 66 Hz, 3.0 A
Opt 240 209 to 250 Vac, 47 to 66 Hz, 3.0 A
Opt 750 Relay Control and DFI/RI
Opt 908 Rackmount Kit (HP p/n 5062-3977)
Opt 909 Rackmount Kit w/Handles (HP p/n 5062-3983)
Opt 910 Service Manual and extra Operating Guide (Standard unit is shipped with operating guide only.)
Accessories
Rack Slide Kit (HP p/n 1494-0059)
14852A Bias Cable to connect either the HP 6626A or 6629A to a 3-terminal device test fixture

HP 6631B
HP 6632B
HP 6633B
HP 6634B

- Precision low current measurement
- Low-output noise
- High-speed programming
- HP-IB and RS-232 interface
- SCPI (Standard Commands for Programmable Instruments)

HP 6632B

NEW HP-IB UID

Specifications at 0° C to 55° C unless otherwise specified

			HP 6631B	HP 6632B	HP 6633B	HP 6634B
Output ratings	Voltage/Current		0 to 8 V/0 to 10 A	0 to 20 V/0 to 5 A	0 to 50 V/0 to 2 A	0 to 100 V/0 to 1 A
Programming accuracy at 25° C ±5° C	Voltage/+ Current	0.05% +	5 mV/4 mA	10 mV/2 mA	20 mV/1 mA	50 mV/0.5 mA
Ripple and noise (20 Hz to 20 MHz, with outputs ungrounded or with either terminal grounded)	Voltage Normal mode	rms/p-p	0.3 mV/3 mV	0.3 mV/3 mV	0.5 mV/3 mV	0.5 mV/3 mV
	Voltage Fast mode	rms/p-p	1 mV/5 mV	1 mV/10 mV	1 mV/15 mV	2 mV/25 mV
	Current	rms	5 mA	2 mA	2 mA	2 mA
DC measurement accuracy: via HP-IB or front-panel meters with respect to actual output at 25° C ±5° C	Voltage	0.3% +	2 mV	3 mV	6 mV	12 mV
	Low current range –20 mA to +20 mA	0.1% +	2.5 μA	2.5 μA	2.5 μA	2.5 μA
	High current range +20 mA to + rated I	0.2% +	2 mA	0.5 mA	0.25 mA	0.25 mA
	–20 mA to –rated I	0.2% +	2.6 mA	1.1 mA	0.85 mA	0.85 mA
Load regulation	Voltage/Current		2 mV/2 mA	2 mV/1 mA	4 mV/1 mA	5 mV/1 mA
Line regulation	Voltage/Current		0.5 mV/1 mA	0.5 mV/0.5 mA	1 mV/0.25 mA	1 mV/0.25 mA

Transient Response Time: Less than 100 μs (50 μs in the fast mode) for the output voltage to recover to its previous level (within 0.1% of the voltage rating of the supply) following any step change in load current of up to 50% of the output current rating of the supply

Supplemental Characteristics Non-warranted characteristics determined by design and useful in applying the product

		HP 6631B	HP 6632B	HP 6633B	HP 6634B
Average programming resolution	Voltage/Current	2 mV/2.5 mA	5 mV/1.25 mA	12.5 mV/0.5 mA	25 mV/0.25 mA
Sink current*		10 A	5 A	2 A	1 A
Minimum current in constant current mode**		40 mA	20 mA	8 mA	4 mA

* For the HP 6631B–6634B, the sink current tracks the programmed current to within 2 mA for programmed currents greater than 5 mA. Below 5 mA, the sink current remains at 5 mA. When programming in the HP 6630A Series language compatibility mode, the sink current for the HP 6631B–6634B tracks the programmed current with a negative 500 mA, 250 mA, 100mA and 50 mA respectively.
**When programming in the HP 6630A Series language compatibility mode.

dc Floating Voltage: Output terminals can be floated up to ±240 Vdc maximum from chassis ground
Remote Sensing: Up to two volts dropped in each load lead. Add 2 mV to the voltage load regulation specification for each one volt change in the negative output lead due to load current change.
Command-Processing Time: Average time required for the output voltage to begin to change following receipt of digital data is 4 ms for the power supplies connected directly to the HP-IB. (Display disabled.)
Output-Programming Response Time: The rise and fall time (10/90% and 90/10%) of the output voltage is less than 2 ms. The output voltage change settles within 1 LSB (0.025% x rated voltage) of final value in less than 6 ms (2 ms in the fast mode).
HP-IB Interface Capabilities: IEEE-488.2, SCPI command set, and 6630A Series programming compatability
Instrument Time: Average time to make a voltage or current measurement is 50 ms.
Input Power 350 VA, 250 W
Regulatory Compliance: Listing pending to UL-3111-1; certified to CSA 22.2 No. 1010.1; conforms to IEC 1010-1; complies with EMC directive 89/336/EEC (ISM Group 1, Class B)
Warranty Period: Three years
Size: 425.5 mm W x 88.1 mm H x 364.4 mm D (16.8 in x 3.5 in x 14.3 in)
Weight: 12.7 kg (28 lb) net; 15.0 kg (33 lb) shipping

Ordering Information

Standard: 104 to 127 Vac, 47 to 63 Hz
Opt 100 87 to 106 Vac, 47 to 63 Hz
Opt 220 191 to 233 Vac, 47 to 63 Hz
Opt 230 207 to 253 Vac, 47 to 63 Hz
Opt 020 Front-panel Binding Posts
Opt 760 Isolation and Reversal Relays (HP 6632B-6634B only)
Opt ICM Rackmount Kit, HP p/n 5062-3974
Opt 1CP Rackmount Kit with Handles, HP p/n 5062-3975
Opt 0BN Service Manual and extra Operating Guide (Standard unit is shipped with operating guide and programming guide only.)
Accessories
HP p/n 1494-0060 Rack Slide Kit

Key Literature

1997/98 *HP Power Products Catalog,* p/n 5965-5284E

Power Supplies

Single-Output System and General Purpose Power Supplies: 200 W

HP 6541A
HP 6542A
HP 6543A
HP 6544A
HP 6545A
HP 6641A
HP 6642A
HP 6643A
HP 6644A
HP 6645A

- Linear output regulation
- Fast up- and down-programming
- SCPI (Standard Commands for Programmable Instruments)
- Complete front-panel control calibration and display
- Remote programming and sensing
- Fan-speed control to minimizes acoustic noise
- Low ripple and noise
- Over-voltage and over-current protection

Specifications at 0° C to 55° C unless otherwise specified

System Power Supplies (HP-IB)			HP 6641A	HP 6642A	HP 6643A	HP 6644A	HP 6645A
General Purpose Power Supplies (w/o HP-IB)			**HP 6541A**	**HP 6542A**	**HP 6543A**	**HP 6544A**	**HP 6545A**
Output ratings	Output voltage Output current (40° C) Maximum current (50° C/55° C)		0 to 8V 0 to 20 A 18 A/17 A	0 to 20 V 0 to 10 A 9A/8.5 A	0 to 35 V 0 to 6 A 5.4 A/5.1 A	0 to 60 V 0 to 3.5 A 3.2 A/3 A	0 to 120 V 0 to 1.5 A 1.4 A/1.3 A
Programming accuracy (at 25° C ±5° C)	Voltage Current	0.06% + 0.14% +	5 mV 26 mA	10 mV 13 mA	15 mV 6.7 mA	26 mV 4.1 mA	51 mV 1.7 mA
Ripple and noise (from 20 Hz to 20 MHz)	Voltage Current	rms peak-peak rms	300 µV 3 mV 10 mA	300 µV 3 mV 5 mA	400 µV 4 mV 3 mA	500 µV 5 mV 1.5 mA	700 µV 7 mV 1 mA
Readback accuracy at 25° C ±5° C (percent of reading plus fixed) System models only	Voltage +Current –Current	0.07% + 0.10% + 0.35% +	6 mV 18 mA 40 mA	15 mV 9.1 mA 20 mA	25 mV 5 mA 12 mA	40 mV 3 mA 6.8 mA	80 mV 1.3 mA 2.9 mA
Load regulation	Voltage Current		1 mV 1 mA	2 mV 0.5 mA	3 mV 0.25 mA	4 mV 0.25 mA	5 mV 0.25 mA
Line regulation	Voltage Current		0.5 mV 1 mA	0.5 mV 0.5 mA	1 mV 0.25 mA	1 mV 0.25 mA	2 mV 0.25 mA

Transient Response Time: Less than 100 µs for the output voltage to recover to its previous level (within 0.1% of the voltage rating of the supply, or 20 mV, whichever is greater) following any step change in load current of up to 50% of rated current

Supplemental Characteristics Non-warranted characteristics determined by design and useful in applying the product

Average resolution	Voltage Current OVP	2 mV 6 mA 13 mV	5 mV 3 mA 30 mV	10 mV 2 mA 54 mV	15 mV 2.5 mA/1.0 mA 93 mV	30 mV 0.5 mA 190 mV
OVP accuracy		160 mV	400 mV	700 mV	1.2 V	2.4 V
	System Power Supplies General Purpose	HP 6641A/ HP 6541A/	HP 6642A/ HP 6542A/	HP 6643A/ HP 6543A/	HP 6644A/ HP 6544A/	HP 6645A/ HP 6545A/

dc Floating Voltage: Output terminals can be floated up to ±240 Vdc from chassis ground
Remote Sensing: Up to half the rated output voltage can be dropped in each load lead. The drop in the load leads subtracts from the voltage available for the load.
Command Processing Time (HP 6641A, 6642A, 6643A, 6644A, 6645A only)**:** Average time required for the output voltage to begin to change following receipt of digital data is 20 ms for the power supplies connected directly to the HP-IB
Output Programming Response Time: The rise and fall time (10/90% and 90/10%) of the output voltage is less than 15 ms. The output voltage change settles within 1 LSB (0.025% x rated voltage) of final value in less than 60 ms.
Down Programming: An active down programmer sinks approximately 20% of the rated output current
Modulation: (Analog programming of output voltage and current)
Input Signal: 0 to –5V
Input Impedance: 10 k Ohm nominal
ac Input: (ac input frequency 47 to 63 Hz)

Voltage	100 Vac	120 Vac	220 Vac	240 Vac
Current	4.4 A	3.8 A	2.2 A	2.0 A

Input Power: 480 VA, 400 W at full load; 60 W at no load
HP-IB Interface Capabilities (HP 6641A, 6642A, 6643A, 6644A, 6645A only)**:** SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, E1, and C0. IEEE-488.2 and SCPI-compatible command set.
Regulatory Compliance: Conforms to UL-1244 and IEC 1010; certified to CSA 22.2 No. 231; carries the CE mark
RFI Suppression: Complies with CISPR-11, Group 1, Class B
Size: 425.5 mm W x 88.1 mm H x 439 mm D (16.75 in x 3.5 in x 17.3 in)
Weight: Net, 14.2 kg (31.4 lb); shipping, 16.3 kg (36 lb)
Warranty Period: Three years

Ordering Information

Standard: 104 to 127 Vac, 47 to 63 Hz
Opt 100 87 to 106 Vac, 47 to 63 Hz
Opt 220 191 to 233 Vac, 47 to 63 Hz
Opt 240 209 to 250 Vac, 47 to 63 Hz
Opt 908 Rackmount Kit (HP p/n 5062-3974)
Opt 909 Rackmount Kit w/Handles (HP p/n 5062-3975)
Opt 910 Service Manual and extra Operating Guide (Standard unit is shipped with operating guide and programming guide only.)
Accessories
HP p/n 1494-0060 Accessory Slide Kit
The following accessories for HP 6641A, 6642A, 6643A, 6644A and 6645A only:
HP p/n 1252-3698 7-pin Analog Plug
HP p/n 1252-1488 4-pin Digital Plug
HP p/n 5080-2148 Serial Link Cable 2 m (6.6 ft)
Available Modifications
6644A-J09: 70 V, 3 A, 210 W
6645A-J05: 150 V, 1.2 A, 180 W

Key Literature

1997/98 *HP Power Products Catalog*, p/n 5965-5284E

HP 6551A
HP 6552A
HP 6553A
HP 6554A
HP 6555A
HP 6651A
HP 6652A
HP 6653A
HP 6654A
HP 6655A

- Complete front-panel control, calibration and display
- Remote programming and sensing
- Fan-speed control to minimize acoustic noise
- Low ripple and noise
- Over-voltage and over-current protection
- Linear output regulation
- Fast up- and down-programming
- SCPI (Standard Commands for Programmable Instruments)

Specifications at 0° C to 55° C unless otherwise specified

System Power Supplies (HP-IB)			HP 6651A	HP 6652A	HP 6653A	HP 6654A	HP 6655A
General Purpose Power Supplies (w/o HP-IB)			**HP 6551A**	**HP 6552A**	**HP 6553A**	**HP 6554A**	**HP 6555A**
Output ratings	Output voltage Output current (40° C) Maximum current (50° C/55° C)		0 to 8 V 0 to 50 A 45 A/42.5 A	0 to 20 V 0 to 25 A 22.5 A/21.3 A	0 to 35 V 0 to 15A 13.5 A/12.8 A	0 to 60 V 0 to 9 A 8.1 A/7.7 A	0 to 120 V 0 to 4 A 3.6 A/3.4 A
Programming accuracy (at 25° C ±5° C)	Voltage Current	0.06% + 0.15% +	5 mV 60 mA	10 mV 25 mA	15 mV 13 mA	26 mV 8 mA	51 mV 4 mA
Ripple and noise (from 20 Hz to 20 MHz)	Voltage Current	rms peak-peak rms	300 μV 3 mV 25 mA	300 μV 3 mV 10 mA	400 μV 4 mV 5 mA	500 μV 5 mV 3 mA	700 μV 7 mV 2 mA
Readback accuracy at 25° C ±5° C (percent of reading plus fixed) System models only	Voltage +Current –Current	0.07% + 0.15% + 0.35% +	6 mV 67 mA 100 mA	15 mV 26 mA 44 mA	25 mV 15 mA 24 mA	40 mV 7 mA 15 mA	80 mV 3 mA 7 mA
Load regulation	Voltage Current		1 mV 2 mA	2 mV 1 mA	3 mV 0.5 mA	4 mV 0.5 mA	5 mV 0.5 mA
Line regulation	Voltage Current		0.5 mV 2 mA	0.5 mV 1 mA	1 mV 0.75 mA	1mV 0.5 mA	2 mV 0.5 mA

Transient Response Time: Less than 100 μs for the output voltage to recover to its previous level (within 0.1% of the voltage rating of the supply, or 20 mV, whichever is greater) following any step change in load current of up to 50% of rated current

Supplemental Characteristics Non-warranted characteristics determined by design and useful in applying the product

Average resolution	Voltage Current OVP		2 mV 15 mA 12 mV	5 mV 7 mA 30 mV	10 mV 4 mA 54 mV	15 mV 2.5 mA 93 mV	30 mV 1.25 mA 190 mV
OVP accuracy			160 mV	400 mV	700 mV	1.2 V	2.4 V
	System Power Supplies General Purpose		HP 6651A/ HP 6551A/	HP 6652A/ HP 6552A/	HP 6653A/ HP 6553A/	HP 6654A/ HP 6554A/	HP 6655A/ HP 6555A/

dc Floating Voltage: Output terminals can be floated up to ±240 Vdc from chassis ground
Remote Sensing: Up to half the rated output voltage can be dropped in each load lead. The drop in the load leads subtracts from the voltage available for the load.
Command Processing Time (HP 6651A, 6652A, 6653A, 6654A, 6655A only): Average time required for the output voltage to begin to change following receipt of digital data is 20 ms for the power supplies connected directly to the HP-IB
Output Programming Response Time: The rise and fall time (10/90% and 90/10%) of the output voltage is less than 15 ms. The output voltage change settles within 1 LSB (0.025% x rated voltage) of final value in less than 60 ms.
Down Programming: An active down programmer sinks approximately 20% of the rated output current
Modulation: (Analog programming of output voltage and current)
Input signal: 0 to –5 V
Input impedance: 10 k Ohm nominal
ac Input: (ac input frequency 47 to 63 Hz)

Voltage	100 Vac	120 Vac	220 Vac	240 Vac
Current	4.4 A	3.8 A	2.2 A	2.0 A

Input Power: 1,380 VA, 1,100 W at full load; 120 W at no load
HP-IB Interface Capabilities (HP 6651A, 6652A, 6653A, 6654A, 6655A only): SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, E1, and C0. IEEE-488.2 and SCPI-compatible command set.
Regulatory Compliance: Listed to UL-1244; certified to CSA 556B; conforms to IEC 348; carries the CE mark
RFI Suppression: Complies with CISPR-11, Group 1, Class B
Size: 425.5 mm W x 132.6 mm H x 497.8 mm D (16.75 in x 5.22 in x 19.6 in)
Weight: Net, 25 kg (54 lb); shipping, 28 kg (61 lb)
Warranty Period: Three years

Ordering Information

Standard: 104 to 127 Vac, 47 to 63 Hz
Opt 100 87 to 106 Vac, 47 to 63 Hz
Opt 220 191 to 233 Vac, 47 to 63 Hz
Opt 240 209 to 250 Vac, 47 to 63 Hz
Opt 908 Rackmount Kit (HP p/n 5062-3977)
Opt 909 Rackmount Kit w/ Handles (HP p/n 5062-3983)
Opt 910 Service Manual and extra Operating Guide (Standard unit is shipped with operating guide and programming guide.)
Accessories
Rack Slide Kit (HP p/n 1494-0059)
The following accessories for HP 6651A, 6652A, 6653A, 6654A and 6655A only:
HP p/n 1252-3698 7-pin Analog Plug
HP p/n 1252-1488 4-pin Digital Plug
HP p/n 5080-2148 Serial Link Cable 2 m (6.6 ft)
Available Modifications
6651A-J03: 6 V, 60 A, 360 W
6653A-J04: 40 V, 12.5 A, 500 W
6654A-J05: 50 V, 10 A, 500 W
6654A-J04: 70 V, 7.5 A, 525 W
6654A-J12: 80 V, 6 A, 480 W

Key Literature

1997/98 *HP Power Products Catalog*, p/n 5965-5284E

Power Supplies

Single-Output System: 2000 W

HP 6571A
HP 6572A
HP 6573A
HP 6574A
HP 6575A
HP 6671A
HP 6672A
HP 6673A
HP 6674A
HP 6675A

- Low ripple and noise
- Fast up- and down-programming
- SCPI (Standard Commands for Programmbale Instruments)
- Complete front-panel control, calibration and display
- Remote programming and sensing
- Fan-speed control to minimize acoustic noise
- Low ripple and noise
- Over-voltage and over-current protection

Specifications at 0° C to 55° C unless otherwise specified

System Power Supplies (HP-IB)			HP 6671A	HP 6672A	HP 6673A	HP 6674A	HP 6675A
General Purpose Power Supplies (w/o HB-IB)			**HP 6571A**	**HP 6572A**	**HP 6573A**	**HP 6574A**	**HP 6575A**
Output ratings	Output voltage Output current	0 to 8V (40° C)	0 to 20 V 0 to 220 A	0 to 35 V 0 to 100 A	0 to 60 V 0 to 60A	0 to 120 V 0 to 35 A	 0 to 18 A
Programming accuracy (at 25° C ±5° C)	Voltage Current	0.04% + 0.1% +	8 mV 125 mA	20 mV 60 mA	35 mV 40 mA	60 mV 25 mA	120 mV 12 mA
Ripple and noise (from 20 Hz to 20 MHz)	Voltage Current	rms peak-peak rms	650 µV 7 mV 200 mA	750 µV 9 mV 100 mA	800 µV 9 mV 40 mA	1.25 mV 11 mV 25 mA	1.9 mV 16 mV 12 mA
Readback accuracy at 25° C ±5° C (percent of reading plus fixed) System models only	Voltage ±Current	0.05% + 0.1% +	12 mV 150 mA	30 mV 100 mA	50 mV 60 mA	90 mV 35 mA	180 mV 18 mA
Load and line regulation	Voltage Current	0.002%+ 0.005%+	300 µV 10 mA	650 µV 7 mA	1.2 mV 4 mA	2 mV 2 mA	4 mV 1 mA

Transient Response Time: Less than 900 µs for the output voltage to recover 100 mV following a change in load from 100% to 50%, or 50% to 100% of the output current rating of the supply

Supplemental Characteristics Non-warranted characteristics determined by design and useful in applying the product

Average resolution	Voltage Current OVP	2 mV 55 mA 15 mV	5 mV 25 mA 35 mV	9 mV 15 mA 65 mV	15 mV 8.75 mA 100 mV	30 mV 4.5 mA 215 mV
Output voltage programming response time* (excluding command processing time) System models only		30 ms	60 ms	130 ms	130 ms	195 ms
	System Power Supplies General Purpose	HP 6671A/ HP 6571A/	HP 6672A/ HP 6572A/	HP 6673A/ HP 6573A/	HP 6674A/ HP 6574A/	HP 6675A/ HP 6575A/

* Full load programming rise/fall time (10% to 90% or 90% to 10%) with full resistive load equal to rated output voltage/rated output current.

dc Floating Voltage: Output terminals can be floated up to ±240 Vdc from chassis ground
Output Common-Mode Noise Current: (to signal ground binding post) 500 µA rms, 4 mA peak-to-peak
Remote Sensing: Up to half the rated output voltage can be dropped in each load lead. The drop in the load leads subtracts from the voltage available for the load.
Command Processing Time (HP 6671A, 6672A, 6673A, 6674A, 6675A only)**:** Average time required for the output voltage to begin to change following receipt of digital data is 20 ms for the power supplies connected directly to the HP-IB
Output Programming Response Time: The rise and fall time (10/90% and 90/10%) of the output voltage is less than 15 ms. The output voltage change settles within 1 LSB (0.025% x rated voltage) of final value in less than 60 ms.
Modulation: (Analog programming of output voltage and current)
Input Signal: 0 to –4V for voltage, 0 to 7 V for current
Input Impedance: 30 k Ohm or greater
Input Power: 3,800 VA, 2,600 W at full load; 170 W at no load
HP-IB Interface Capabilities (HP 6671A, 6672A, 6673A, 6674A, 6675A only)**:** SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, E1, and C0. IEEE-488.2 and SCPI-compatible command set.
Regulatory Compliance: Listed to UL-1244; certified to CSA 556B; conforms to IEC 348; carries the CE mark
RFI Suppression: Complies with CISPR-11, Group 1, Class B
Size: 425.5 mm W x 132.6 mm H x 640 mm D (16.75 in x 5.22 in x 25.2 in)
Weight: Net, 28.2 kg (62 lb); shipping, 31.8 kg (70 lb)
Warranty Period: Three years

Key Literature

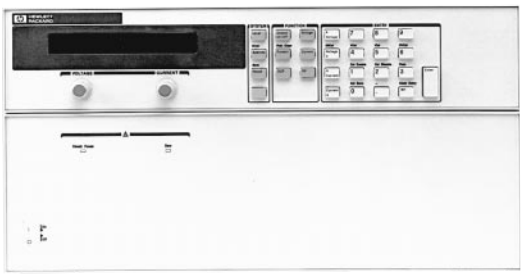
1997/98 *HP Power Products Catalog,* p/n 5965-5284E

Ordering Information

Standard: 191 to 250 Vac, 47 to 63 Hz
Opt 200 174 to 220 Vac, 47 to 63 Hz (Japan only)
Opt 908 Rackmount Kit (HP p/n 5062-3977)
Opt 909 Rackmount Kit w/ Handles (HP p/n 5062-3983)
Opt 910 Service Manual and extra Operating Guide (Standard unit is shipped with operating guide and programming guide only.)
A line cord option must be specified. See page 180 for ordering information.
Accessories
Rack Slide Kit (HP p/n 1494-0059)
The following accessories for HP 6671A, 6672A, 6673A, 6674A and 6675A only:
HP p/n 1252-3698 7-pin Analog Plug
HP p/n 1252-1488 4-pin Digital Plug
HP p/n 5080-2148 Serial Link Cable 2 m (6.6 ft)
Available Modifications
6671A-J14: 5 V, 250 A, 1,250 W
6671A-J03: 14 V, 150 A, 2,100 W
6672A-J04: 25 V, 85 A, 2,000 W
6673A-J04: 36 V, 55 A, 1,980 W
6673A-J08: 40 V, 50 A, 2,000 W
6674A-J03: 55 V, 38 A, 2,090 W
6674A-J05: 80 V/26 A; 70 V, 30 A, 2,000 W
6675A-J08: 100 V, 22 A, 2,200 W
6675A-J09: 110 V, 20 A, 2,200 W
6675A-J06: 135 V, 16 A, 2,160 W
6675A-J11: 150 V, 15 A, 2,175 W
6675A-J04: 160 V, 13 A, 2,080 W
6675A-J07: 200 V, 11 A, 2,200 W

HP 6680A
HP 6681A
HP 6682A
HP 6683A
HP 6684A

- "One-Box" solution: includes V and I read-back
- Low ripple and noise
- Fast up- and down-programming
- High-accuracy current programming and read back
- SCPI (Standard Commands for Programmable Instruments)
- Selectable compensation for inductive loads



Specifications at 0° to 55° C unless otherwise specified

			HP 6680A	HP 6681A	HP 6682A	HP 6683A	HP 6684A
Output ratings	Voltage Current (derated linearly 1%/° C from 40° to 55° C)		0 to 5 V 0 to 875 A	0 to 8 V 0 to 580 A	0 to 21 V 0 to 240 A	0 to 32 V 0 to 160 A	0 to 40 V 0 to 128 A
Programming accuracy (at 25° C ±5° C)	Voltage Current	0.04% + 0.1% +	5 mV 450 mA	8 mV 300 mA	21 mV 125 mA	32 mV 85 mA	40 mV 65 mA
Ripple and noise (from 20 Hz to 20 MHz)	Constant voltage Constant current	rms peak-to-peak rms	1.5 mV 10 mV 290 mA	1.5 mV 10 mV 190 mA	1.0 mV 10 mV 40 mA	1.0 mV 10 mV 28 mA	1.0 mV 10 mV 23 mA
Readback accuracy at 25° C ±5° C (percent of reading plus fixed)	Voltage Current	0.05% + 0.1% +	7.5 mV 600 mA	12 mV 400 mA	32 mV 165 mA	48 mV 110 mA	60 mV 90 mA
Load and line regulation	Voltage Current	0.002% + 0.005% +	190 μV 65 mA	300 μV 40 mA	650 μV 17 mA	1.1 mV 12 mA	1.5 mV 9 mA

Transient Response Time: Less than 900 μs for the output voltage to recover within 150 mV following a change in load from 100% to 50%, or 50% to 100% of the output current rating of the supply

Supplemental Characteristics Non-warranted characteristics determined by design that are useful in applying this product

Average programming resolution	Voltage Current OVP		1.35 mV 235 mA 30 mV	2.15 mV 155 mA 45 mV	5.7 mV 64 mA 120 mV	8.6 mV 43 mA 180 mV	10.8 mV 34 mA 225 mV
Output voltage programming response time (excludes command-processing time)	Full-load programming rise or fall time (10/90% or 90/10%, resistive load)		9 ms	12 ms	45 ms	60 ms	60 ms
Output common-mode noise current (to signal-ground binding post)		rms peak-to-peak	1.5 mA 10 mA	1.5 mA 10 mA	3 mA 20 mA	3 mA 20 mA	3 mA 20 mA

dc Floating Voltage: Output terminals can be floated up to ±60 Vdc maximum from chassis ground
Remote Sensing: Up to half the rated output voltage can be dropped in each load lead. The drop in the load leads subtracts from the voltage available for the load.
Command Processing Time: Average time required for the output voltage to begin to change following receipt of digital data is 20 ms for power supplies connected directly to the HP-IB
Modulation (analog programming of output voltage and current)
Input Signal: 0 to –5 V for voltage, 0 to +5 V for current
Input Impedance: 30 k Ohm or greater
ac Input (47 to 63 Hz)**:** 180 to 235 Vac (line-to-line, 3 phase), 27.7 A rms maximum; 360 to 440 Vac, 14.3 A rms maximum (maximum line current includes 5% unbalanced phase voltage condition.) Output voltage derated up to 95% at 50 Hz and below 200 Vac.
Input Power: 7350 VA and 6000 W maximum; 160 W at no load
HP-IB Interface Capabilities: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, E1, and C0. IEEE-488.2 and SCPI-compatible command set.
Regulatory Compliance: Listed to UL-1244; certified to CSA 22.2 No. 231; conforms to IEC 1010; carries the CE mark
RFI Suppression: Complies with CISPR-11, Group 1, Class A
Size: 425.5 mm W x 220 mm H x 675.6 mm D (16.75 in x 8.75 in x 26.6 in)
Weight: Net, 51.3 kg (113 lb); shipping, 63.6 kg (140 lb)
Warranty Period: Three years

Ordering Information

Opt 400 360 to 440 Vac, 3 phase, 47 to 63 Hz
Opt 601 Output Connector Kit (required for bench applications) includes bus-bar spacer, connector bolts, and output cover (HP p/n 5060-3515)
Opt 602 Two Bus-Bar Spacers for paralleling power supplies (HP p/n 5060-3514)
Opt 908 Rackmount Kit (HP p/n 5062-3977 and p/n 5062-3974)
Opt 909 Rackmount Kit with Handles (HP p/n 5062-3983 and p/n 5062-3974). Support rails required for Option 908 and 909 HP Rack: E3663A, Rack Slides p/n 1494-0058, third party rack: E3664A
Opt 910 Service Manual (HP p/n 5960-5590) and extra Operating Guide (Standard unit is shipped with operating guide only.)

Accessories
HP p/n 5060-3513 Three 30-A Replacement Fuses for 180 to 235 Vac line
HP p/n 5060-3512 Three 16-A Replacement Fuses for 360 to 440 Vac line

Available Modifications
6680A-J03 3.3 V@1000 A, AV @ 950 A
6684A-V50 50 V, 100 A, 5,000 W

Key Literature

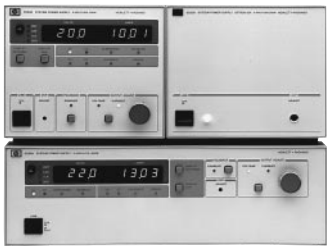
1997/98 *HP Power Products Catalog,* p/n 5965-5284E

Power Supplies

Single-Output Power Supplies, 200 W to 1000 W Autoranging

HP 6023A, HP 6028A

HP 6010A, 6011A, 6012A and 6015A



HP 6033A and HP 6038A

HP 6033A and HP 6038A with Option 001 (on right)

Specifications at 0° C to 50° C unless otherwise noted

System Autorangers			HP 6030A	HP 6031A	HP 6032A	HP 6033A	HP 6035A	HP 6038A
Autorangers			**HP 6010A**	**HP 6011A**	**HP 6012B**	**HP 6023A**	**HP 6015A**	**HP 6028A**
Output ratings	Voltage Current		0 to 200 V 0 to 17 A	0 to 20 V 0 to 120 A	0 to 60 V 0 to 50 A	0 to 20 V 0 to 30 A	0 to 500 V 0 to 5 A	0 to 60 V 0 to 10 A
Maximum power	Watts		1,200 W	1,064 W	1,200 W	242 W	1,050 W	240 W
Autoranging output	V1, P1 V2, P2 V3, P3		200 V, 5 A 120 V, 10 A 60 V, 17 A	20 V, 50 A 14 V, 76 A 7 V, 120 A	60 V, 17.5 A 40 V, 30 A 20 V, 50 A	20 V, 10 A 14 V, 17.2 A 6.7 V, 30 A	500 V, 2 A 350 V, 3 A 200 V, 5 A	60 V, 3.3 A 40 V, 6 A 20 V, 10 A
Programming accuracy (at 25° C ±5° C) System models only	Voltage Current		0.035% +145 mV 0.2% +25 mA	0.035% +15 mV 0.25% +250 mA	0.035% +40 mV 0.2% +85 mA	0.035% +9 mV 0.15% +20 mA	0.25% +400 mV 0.3% +63 mA	0.035% +40 mV 0.09% +10 mA
Ripple and noise, (20 Hz to 20 MHz)	Voltage Current	rms p-p rms	22 mV 50 mV 15 mA	8 mV 50 mV 120 mA	8 mV 40 mV 25 mA	3 mV 30 mV 15 mA	50 mV 160 mV 50 mA	3 mV 30 mV 5 mA
Readback accuracy (at 25° C ±5° C) System models only	Voltage Current		0.08% + 80 mV 0.36% +15 mA	0.08% +7 mV 0.4% +100 mA	0.08% +20 mV 0.36% +35 mA	0.07% +6 mV 0.3% +25 mA	0.5% +300 mV 0.5% +50 mA	0.07% +50 mV 0.2% +11 mA
Load regulation	Voltage Current	0.01%+ 0.01%+	5 mV 10 mA	3 mV 15 mA	5 mV 10 mA	2 mV 9 mA	40 mV/13 mV 35 mA/34 mA	3 mV 5 mA
Line regulation System models only	Voltage Current	0.01%+ 0.01%+	5 mV 5 mA	2 mV 25 mA	3 mV 10 mA	1 mV 6 mA	13 mV 18 mA	2 mV 2 mA
Transient response time 10% step change	Time Level		2 ms 150 mV	2 ms 100 mV	2 ms 100 mV	1 ms 50 mV	5 ms 200 mV	1 ms 75 mV

Supplemental Characteristics Non-warranted characteristics determined by design that are useful in applying the product

dc floating voltage (either terminal can be grounded or floated from chassis ground)		±550 V	±240 V	±240 V	±240 V	±550 V	±240 V
ac input current	100 Vac (system only) 120 Vac 220 Vac 240 Vac	24 A 24 A 15 A 14 A	24 A 24 A 15 A 14 A	24 A 24 A 15 A 14 A	6 A 6.5 A 3.8 A 3.6 A	24 A 24 A 15 A 14 A	6 A 6.5 A 3.8 A 3.6 A
Weight System models	Net Shipping	16.3 kg (36 lb) 21.8 kg (48 lb)	17.2 kg (38 lb) 22.7 kg (50 lb)	16.3 kg (36 lb) 21.8 kg (48 lb)	9.6 kg (21 lb) 11.4 kg (25 lb)	16.3 kg (36 lb) 21.8 kg (48 lb)	9.6 kg (21 lb) 11.4 kg (25 lb)
Weight Standard models	Net Shipping	16.3 kg (36 lb) 21.8 kg (48 lb)	17.2 kg (38 lb) 22.7 kg (50 lb)	16.3 kg (36 lb) 21.8 kg (48 lb)	9.6 kg (21 lb) 11.4 kg (25 lb)	16.3 kg (36 lb) 21.8 kg (48 lb)	9.6 kg (21 lb) 11.4 kg (25 lb)
	System Autorangers Autorangers	HP 6030A/ HP 6010A/	HP 6031A/ HP 6011A/	HP 6032A/ HP 6012B/	HP 6033A/ HP 6023A/	HP 6035A/ HP 6015A/	HP 6038A/ HP 6028A/

Remote Sensing: Up to 2 V drop in each lead. Voltage regulation specification met with up to 0.5 V drop, but degrades for greater drops.
Modulation: (analog programming of output voltage and current)
Input signal: 0 to 5 V or 0 to 4 k Ohms
Regulatory Compliance: Listed to UL-1244; certified to CSA 556B; conforms to IEC 348, carries the CE mark
RFI Suppression: Complies with CISPR-11, Group 1, Class B
Inductive Load: HP 6023A, 6028A are stable in CC mode for loads up to 1 H. HP 6010A–6012B, 6015A are stable in CC mode for loads up to 100 mH.
Size:
HP 6030A–32A, 6035A: 425.5 mm W x 132.6 mm H x 503.7 mm D (16.75 in x 5.25 in x 19.83 in).
HP 6033A, 6038A, 6023A, 6028A: 212.3 mm W x 177.0 mm H x 516.4 mm D (8.36 in x 6.97 in x 17.87 in).
HP 6010A–12B, 6015A: 425.5 mm W x 132.6 mm H x 516.4 mm D (16.75 in x 5.25 in x 20.33 in).

Ordering Information

Standard: 104 to 127 VAC, 48 to 63 Hz
Opt 001 Front panel has only line switch, line indicator, and OVP adjust (HP 6030A–33A and 6038A only)
Opt 002 Provides extra programming and monitoring capabilities (HP 6010A–12B, 6023A, 6028A only)
Opt 100 87 to 106 Vac, 48 to 63 Hz (power supply output is derated to 75%) HP 6030A–33A, 6035A, 6038A only
Opt 220 191 to 233 Vac, 48 to 63 Hz
Opt 240 209 to 250 Vac, 48 to 63 Hz
Opt 800 Rackmount Kit for Two Half-rack Units Side by Side. HP p/n 5061-9694 and 5062-3978
Opt 908 Rackmount Kit for a Single Half-rack Unit
HP Models 6023A, 6028A, 6033A and 6038A (with blank filler panel); HP p/n 5062-3960
HP Models 6010A–12B, 6015A, 6030A–32A and 6035A; HP p/n 5062-3977
Opt 909 Rackmount Kit with Handles. For HP 6010A–12B, 6015A, 6030A–32A, 6035A; HP p/n 5062-3983
Opt 910 Service Manual and extra Operating Guide (Standard unit is shipped with operating guide only.)
For HP Models 6010A–12B, 6015A, 6023A, 6028A
For HP Models 6030A–33A, 6035A, 6038A
A line cord option must be specified for HP 6010A–12B, 6015A, 6030A–32A, 6035A. See page 180 for ordering information.

Accessories
HP 5080-2148 Serial Link Cable, 2 m (6.6 ft) for HP 6030A, 6031A, 6032A, 6033A, 6035A, and 6038A
HP 1494-0060 Rack Slide Kit

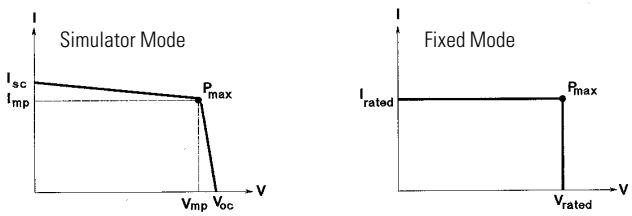
The E4350B/E4351B simulates the output characteristic of a satellite's solar panels as it moves from darkness to light.

HP Solar Array Simulator

The HP one-box Solar Array Simulator (SAS) is a dc power source that simulates the output characteristics of a solar array. The HP SAS is primarily a current source with very low output capacitance and is capable of simulating the I-V curve of different arrays under different conditions (i.e., temperature, age, etc.). The I-V curve is programmable over the IEEE-488.2 bus and is conveniently generated within the HP SAS.

The HP SAS provides three current operating modes:

1. Simulator Mode: An internal algorithm is used to approximate a SAS I-V curve. Four input parameters: Voc (open circuit voltage), Isc (short circuit current), Imp and Vmp (current and voltage at the peak power point on the curve) are needed to establish a curve in this mode.



2. Table Mode: For a fast and accurate I-V simulation, the HP SAS provides a table mode. The I-V curve is set by a user-defined table of points. A table can have any length up to 4000 points (a point corresponds to a specific value of I and V). As many as 30 tables may be stored in the HP SAS built-in volatile and non-volatile memory.

Non-volatile memory can store a maximum of 3500 points. The tables (I-V curves) are easily stored and recalled with an IEEE-488.2 command. The table(s) stored in this memory will be retained when the power is turned off.

Volatile memory greatly increases the flexibility by saving up to 30,000 points. Multiple tables are easily accessed with IEEE-488.2 command. These tables will be erased after power is removed.

In Table Mode, current and voltage offsets can be applied to the selected table to simulate a change in the operating conditions of the solar array.

3. Fixed Mode: This is the default mode when the unit is powered on. The unit has the rectangular I-V characteristics of a standard power supply, when an output capacitor is added in this mode.

Specifications

	HP E4350B	HP E4351B NEW
For simulator and table modes		
Max. Power	480 W	480 W
Voc, Max.*	65 V	130 V
Isc, Max.*	8 A	4 A
For mixed mode		
Max. Power	480 W	480 W
V rated*	0–60 V	0–120 V
I rated*	0–8 A	0–4 A

*Other voltage/current combinations may be configured to meet your unique requirements.

Programming Accuracy: at 25°C + 5°C (SAS and Table Mode)
Voltage: 0.06% + 0.07% of rated voltage
Current: 0.15% + 0.15% of rated current
Ripple and Noise: (20 Hz to 20 MHz) with outputs ungrounded or with either terminal grounded
Voltage: rms 0.035% of rated voltage; p-p 0.35% of rated voltage
Current: rms 0.2% of rated current
Load Switching Recovery Time: < 5μs for I > 10% of rated current to within 10% of programmed value when switched from short circuit to variable load.
Load/Line Regulation: Change in output voltage or current for any load or line change within ratings
Voltage: 0.01% of rated voltage
Current: 0.25 mA + 0.005% of rated current

ac Input: 104 to 127 Vac

Voltage	100 Vac	120 Vac	220 Vac	240 Vac
Current	12 A	10 A	5.7 A	5.3 A

Supplemental Characteristics

Supplemental characteristics are intended to provide information useful in applying the HP SAS by describing nonwarranted performance that has been determined by design or type testing.

Remote Sensing: Up to 5% of the rated output voltage can be dropped in each load lead. The drop in the load leads subtracts from the voltage available for the load. Add 3 mV to the voltage load regulation specification for each 1 volt change in the positive output lead due to load current change.
Analog Programming of Output Voltage and Current
Input Signal: 0 to –5.0 V
Input Impedance: 20 k Ohms nominal
Shunt Regulation: Switching frequency up to 50 kHz
Series Regulation: Switching frequency up to 3 kHz
OVP and OCP: Overvoltage and overcurrent protection triggers in <100 μs
Capacitive Load: In fixed mode, the maximum load capacitance (without causing instability) is 2000μF. In simulator and table mode, it is unconditionally stable at all capacitive loads.
Inductive Load: The maximum load capacitance (without causing instability) is 500μH
HP-IB Interface Capabilities: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, E1, and C0. IEEE-488.2 and SCPI command set
Size: 425.5 mm W x 132.6 mm H x 497.8 mm D (16.75 in x 5.25 in x 19.6 in)
Weight: Net, 25 kg (54 lb): shipping, 28 kg (61 lb)
Warranty: Three years

Ordering Information

Simulators can be ordered as individual modules or as a fully customized system.
Opt 0BN Service Manual and extra Operating Guide
Opt 100 87 to 106 Vac, 47 to 63 Hz
Opt 220 191 to 233 Vac, 47 to 63 Hz
Opt 240 209 to 250 Vac, 47 to 63 Hz
Opt 908 Rackmount Kit, HP p/n 5062-3977
Opt 909 Rackmount Kit with Handles, HP p/n 5062-3983
Accessories
HP p/n 1252-3698 7-pin Analog Plug
HP p/n 1252-1488 4-pin Digital Plug
HP p/n 5080-2148 Serial Link Cable 2 m (6.6 ft)
HP p/n 1494-0059 Accessory Slide Kit

Power Supply Relay Devices and AC Line Cord Options

HP 59510A
HP 59511A

- Relay accessories to isolate load from dc output
- Switch and sequence power and sense leads
- DC output polarity reversal (HP 59511A only)

HP 59511A

HP 59510A and HP 59511A Relay Devices

The HP 59510A and 59511A are designed for control from 66XXA and 603XA series power supplies. These can be configured to switch dc power in multiple test fixtures or provide extra protection when a fault condition requires an emergency shutdown. Each unit switches one power supply output and can be used with any dc power supply within the voltage and current limits. The HP 59511A has all of the features of the HP 59510A, plus relays for reversing polarity. Using the PEM fasteners provided, both models can be mounted to a flat surface on any of the three sides.

Specifications

Operating Ranges: 200 V at 20 A, 120 V at 30 A, or 48 V at 60 A
dc Floating Voltage: Input to output, 200 Vdc; input or output to ground, 500 Vdc; TTL control to ground, 240 Vdc
Settling Time (TTL control)**:** Connect, 440 ms; disconnect, 160 ms; polarity reversal, 600 ms
dc Voltage Drop (at 60 A)**:** 0.5 V maximum on each relay
ac Input: Can be set for 100, 120, 220, or 240 Vac (–13%, +6%) at 48 to 63 Hz
Weight:
HP 59510A: Net, 2.3 kg (5 lb); shipping, 3.6 kg (8 lb); shipping with Option 850, 4.1 kg (9 lb)
HP 59511A: Net, 3.6 kg (8 lb); shipping, 5.0 kg (11 lb); shipping with Option 850, 5.5 kg (12 lb)
Mounting Orientation: Within ±10° from vertical
Size: 185.4 mm W x 130.6 mm H x 198.6 mm D (7.26 in x 5.14 in x 7.81 in)

Key Literature

1997/98 *HP Power Products Catalog,* p/n 5965-5284E

Ordering Information

HP 59510A Output Isolation Relay Accessory
HP 59511A Output Isolation, Polarity Reversal Accessory
Opt 850 Rackmount Kit (side-by-side mounting of two units requires two kits)
Opt 910 Extra Operating and Service Manual, HP p/n 5957-6382

Power-Supply AC Line Cord Options

Power distribution regulations and techniques vary greatly among geographic regions. For this reason, line cord type must be specified for high-power (1000- to 5000-W) dc power supplies at the time of ordering. The HP 66000A modular power system mainframe is included because one line cord might supply ac power for up to eight 150-W modules. If no line cord option is specified for these models, an unterminated cable will be shipped with the unit.

Option Descriptions

Order the correct option according to local electrical codes. All the cords listed are 2.5 m (about 8.2 ft) long.

Unterminated Line Cords (user supplies plug)

Option 831: 12 AWG; UL-listed, CSA-certified; unterminated. Suggested for use in North and South America. Note for HP 6670 and 6570 Series: intended for use on a dedicated branch circuit and not intended for use in Canada. Note for HP 6030 and 66000 Series: intended for connection to 200- to 240-Vac service.
Option 832: 4-mm² wire size; harmonized cordage; unterminated. Suggested for use in Europe and other areas not listed.
Option 833: 1.5-mm² wire size; harmonized cordage; unterminated. For use in Europe and other areas not listed. Note for HP 6030 and 66000 Series: intended for connection to 200- to 240-Vac service.
Option 834: 10 AWG; UL-listed, CSA-certified; unterminated. Suggested for use in North and South America. Note for HP 6030 and 66000 Series: intended for connection to 100- to 120-Vac service.

Options Available

Options	6010A Series 6030A Series (1000 W)	6570A Series	6670A Series	66000A Mainframe
831	•	•	•	•
832	—	•	•	—
833	•	—	—	•
834	•	•	•	•
841	•	•	•	•
842	—	•	•	—
844	—	•	•	—
845	•	—	—	•
846	•	—	—	•
847	•	—	—	•
848	•	—	—	•

Terminated Line Cords Line cords with plugs

Option 846
10 AWG; UL-listed, CSA-certified; with NEMA L5-30P, 30-A, 120-V locking plug. Suggested for use in North America. HP p/n 8120-5565

Option 841
12 AWG; UL-listed, CSA-certified; with NEMA 6-20P, 20-A, 250-V plug. Suggested for use in North and South America and Japan. Note for HP 6670 and 6570 Series: not intended for use in Canada. Intended for use on a dedicated branch circuit. HP p/n 8120-5572

Option 844
10 AWG; UL-listed, CSA-certified; with NEMA L6-30P, 30-A, 250-V locking plug. Suggested for use in North and South America. HP p/n 8120-5546

Option 847
1.5-mm² wire size; harmonized cordage with CEE 7/7, 16-A, 220-V plug. Suggested for use in continental Europe. HP p/n 8120-5567

Option 842
4-mm² wire size; harmonized cordage with IEC 309, 32-A, 220-V plug. Suggested for use in Europe and other areas not listed. HP p/n 8120-5489

Option 845
1.5-mm² wire size; harmonized cordage with IEC 309, 16-A, 220-V plug. Suggested for use in Denmark, Switzerland, Austria, China, and other countries not listed. HP p/n 8120-5570

Option 848
1.5-mm² wire size; harmonized cordage with BS 546, 15-A, 240-V plug. Suggested for use in India and South Africa. HP p/n 8120-5569

HP E3631A Features
- 80 watts of power
- Triple outputs
- HP-IB/RS-232 standard
- Dual voltage and current meters
- SCPI (Standard Commands for Programmable Instruments)

HP E3632A Features
- 15 V, 7 A/30 V, 4 A single output dual range
- Low noise/excellent regulation
- HP-IB/RS-232 standard
- Two digital meters
- Remote sense, OVP and OCP capability
- 16-bit programming resolution and high accuracy

HP E3631A Triple-Output/ HP E3632A Single-Output

The HP E3631A is a triple-output programmable dc power supply designed to meet the most exacting engineering requirements with traditional HP quality and reliability designed in.

The HP E3631A comes with both HP-IB and RS-232. This power supply lets you program both voltage and current. You can monitor the output terminals for voltage and current, and query command lets you read the programmed voltage and current. All programming is done in easy-to-use SCPI.

The HP E3632A is a 120 watt single-output dual range programmable dc power supply designed to meet the most exacting engineering requirements with traditional HP quality and reliability designed in.

Low Noise/Excellent Regulation

0.01% load and line regulation keep the output steady. The linear supply specifies both normal-mode voltage noise and common-mode current noise. The low normal-mode specification assures clean power for precision circuitry and the low common-mode current provides isolation from power line current injection.

Remote Interface

Both supplies come with HP-IB and RS-232. These supplies let you program both voltage and current. You can monitor the output terminals for voltage and current, and a query command lets you read the programmed voltage and current. All programming is done in easy-to-use SCPI. Visa driver is available.

Front Panel Operation

Both voltage and current can be monitored simultaneously for output from the front panel on an easy-to-read vacuum fluorescent display. A knob allows you to set the output at the resolution you need for the most exacting adjustments, quickly and easily. Store and recall key enables you to save and recall up to three frequently-used states. The output on/off button disables the output.

Isolated

All the outputs are isolated from the chassis ground and from the remote interface. In the E3631A, 6 V supply is isolated from the ±25 V supply to minimize any interference between circuits-under-test.

Specifications at 0° to 55° unless otherwise specified

		HP E3631A			HP E3632A Low Range/High Range
dc outputs	**Voltage/Current**	**0 to +25 V/0 to 1 A**	**0 to –25 V/0 to 1 A**	**0 to 6 V/0 to 5 A**	**0 to 15 V, 7 A/0 to 30 V, 4 A**
Load regulation	Voltage Current	<0.01% + 2 mV <0.01% + 250 μA	<0.01% + 2 mV <0.01% + 250 μA	<0.01% + 2 mV <0.01% + 250 μA	<0.01% + 2 mV <0.01% + 250 μA
Line regulation	Voltage Current	<0.01% + 2 mV <0.01% + 250 μA	<0.01% + 2 mV <0.01% + 250 μA	<0.01% + 2 mV <0.01% + 250 μA	<0.01% + 2 mV <0.01% + 250 μA
Ripple and noise	Normal-mode voltage Normal-mode current Common-mode current	<350 μV rms/2 mV p-p <500 μA rms <1.5 μA rms	<350 μV rms/2 mV p-p <500 μA rms <1.5 μA rms	<350 μV rms/2 mV p-p <2 mA rms <1.5 μA rms	<350 μVrms/2mVpp <2 mA rms <1.5 μA rms
Programming accuracy (25° C ±5° C)	Voltage Current	0.05% + 20 mV 0.15% + 4 mA	0.05% + 20 mV 0.15% + 4 mA	0.1% + 5 mV 0.2% + 10 mA	0.05% + 10 mV 0.2% +10 mA
Readback accuracy (25° C ±5° C)	Voltage Current	0.05% + 10 mV 0.15% + 4 mA	0.05% + 10 mV 0.15% + 4 mA	0.1% + 5 mV 0.2% + 10 mA	0.05% + 5 mV 0.15% + 5 mA
Resolution	Program/readback Meter	1.5 mV/0.1 mA 10 mV/1 mA	1.5 mV/0.1 mA 10 mV/1 mA	0.5 mV/0.5 mA 1 mV/1 mA	1 mV/0.5 mA/0.5 mV/0.1 m A 1 mV/1 mA

Transient Response Time: 50 μsec for output to recover to within 15 mV following a change in output current from full load to half load or vice versa

Supplemental Characteristics

ac Input:
110 Vac ± 10%, 47 to 63 Hz (Option OE9)
115 Vac ± 10%, 47 to 63 Hz (Standard)
230 Vac ± 10%, 47 to 63 Hz (Option OE3)
Product Regulation: Designed to comply with UL-1244, IEC 1010-1; certified with CSA 22.2; meets requirements for CE regulation

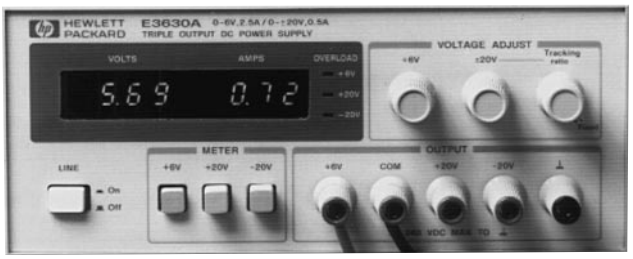
Warranty: Three years
Size: **E3631A** 13 mm W x 132 mm H x 360 mm D (8.4 in x 5.2 in. x 14.2 in)
E3632A 13 mm W x 132 mm H x 348 mm D (8.4 in x 5.2 in. x 13.7 in)
Weight:
E3631A 6.9 kg (15 lbs)
E3632A 9.5 kg (21 lbs)

Laboratory: Multiple Output 35 W to 50 W

HP E3620A
HP E3630A

HP E3620A Features
- Low noise, excellent regulation
- Two isolated power supplies
- Two digital meters
- Linear power supply

HP E3630A Features
- Triple output
- Low noise, excellent regulation
- Auto-tracking
- Two digital meters



HP E3620A, E3630A

These multiple-output power supplies have 0.01% load and line regulation which keeps the outputs steady with changes of the power line and load. These supplies specify both normal-mode voltage noise and common-mode current noise. The low normal-mode noise specification of 350 μV rms assures clean power for precision circuitry, and the low common-mode current specification of 1 μA rms minimizes line frequency current injection.

Both power supplies have separate digital panel meters to monitor both the voltage and current of any output simultaneously. An LED indicator for each output lets the user know when any supply is overloaded. All the outputs on these models are protected against overload and short-circuit damage. Protection circuits prevent output voltage overshoot when supply is turned on and off. The +6 V output of E3630A employs current foldback; all others are current limited.

3

HP E3630A

This general-purpose power supply provides three outputs, one 0 to 6 V output to power logic or other circuitry and one 0 to +20 V and 0 to –20 V to power linear circuits. The 0 to +20 V and 0 to –20 V outputs track to within 1%. The 0 to –20 V output can be set to any value less than the 0 to +20 V output. One voltage control may be used to vary both simultaneously.

The HP E3630A is 213 mm W x 88 mm H x 213 mm D (8.4 in x 3.6 in x 12.6 in) and weighs 3.8 kg (8.4 lbs).

HP E3620A

This general-purpose power supply provides two separate, independent and isolated power supplies in one small package. Each output has a ten-turn potentiometer for fine adjustment. Convenient meter selections allows the user to read voltage and current of either output. Each output can deliver up to 25 watts.

The HP E3620A is 213 mm W x 88 mm H x 400 mm D (8.4 in x 3.6 in x 15.8 in) and weighs 5.5 kg (12.1 lbs).

Specifications at 0° to 55° C unless otherwise specified

		E3620A	E3630A
Number of outputs		2	3
Number of output ranges		1	1
Output ratings	Output 1 Output 2 Output 3 Power (max.)	0 to 25 V, 0 to 1 A 0 to 25 V, 0 to 1A 50 W	0 to 6 V, 0 to 2.5 A* 0 to +20 V, 0 to 0.5 A 0 to –20 V, 0 to 0.5 A 35 W
Load regulation		0.01% +2 mV	0.01% +2 mV
Ripple and noise	rms peak-to-peak	350 μV 1.5 mV	350 μV 1.5 mV
Control mode		CV/CL	CV/CL
Resolution (minimum change using front-panel controls)	Voltage Current	10 mV 1 mA	10 mV 1 mA
Input power		115 Vac ±10% 47 to 63 Hz	115 Vac ±10% 47 to 63 Hz
Options available		OE3, OE9	OE3, OE9

* Derate max., output current from 2.5 A at 0 V, to 1A at 0 V.

Key Literature

1997/98 *HP Power Products Catalog,* p/n 5965-5284E
HP Basic Instrument Catalog, p/n 5965-7748 LE, EN/EUS

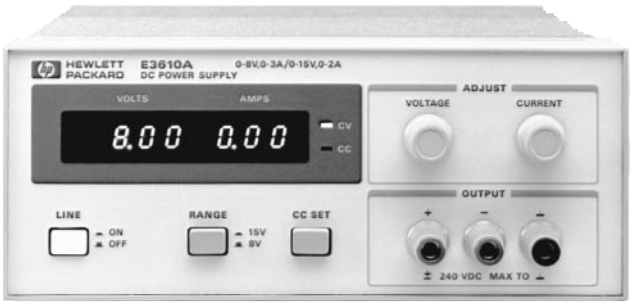
Ordering Information

(See tables for which options are available on specific models)

Opt 0E3 230 Vac ±10%, 47 to 63 Hz Input
Opt 0E9 100 Vac ±10%, 47 to 63 Hz Input
For use in Japan

HP E3610A, E3611A, and E3612A Features
- Dual ranges
- Digital voltage and current meters
- 10-turn potentiometer
- Linear power supply

HP E3614A, E3615A, E3616A, and E3617A Features
- Digital voltage and current meters
- Over-voltage protection
- Remote sensing
- Remote analog programming
- Linear power supply



HP E3610A–E3617A

HP E3610A, E3611A, E3612A

These popular low-cost CV/CC bench supplies are designed for general laboratory use. The constant-voltage, constant-current output allows operation as either a voltage source or current source. The changeover occurs automatically, based on the load. This feature also provides an adjustable current limit, allowing you to set the safest current limit level for a particular DUT. Also, a CC-set button lets you set the current limit without your having to short the output.

Each model has two ranges, allowing more current at a lower voltage. For a higher-output voltage, supplies can be connected in series. Either the positive or negative terminal can be connected to ground, providing a positive or negative voltage output. Either terminal can also be floated up to 240 V from ground.

Dual digital meters monitor current and voltage simultaneously. Adjustments are made with the 10-turn voltage control and the 10-turn current control. Each power supply is 212 mm W x 88 mm H x 318 mm D (8.4 in x 3.5 in x 12.5 in) and weighs 3.8 kg (8.4 lb).

HP E3614A, E3615A, E3616A, E3617A

These flexible single range CV/CC power supplies can be used as either voltage sources or current sources. The CC-set button allows you to quickly set the current limit when operating in the CV mode, without shorting the output. 10-turn controls allow accurate adjustment of voltage and current output settings. The output voltage and current can also be controlled with external 0 to 10 volt analog signals.

Output connections can be made on either the front or rear panel. Remote sensing is available to eliminate the errors in voltage regulation due to voltage drops in the load leads. Either the positive or negative output terminal may be connected to ground to provide positive or negative output voltage. Either terminal can also be floated to a maximum of 240 volts. Multiple units can be combined in auto-parallel, auto-series and auto-tracking configurations to obtain more voltage or current output.

The load is protected with the over-voltage protection feature, which is easily monitored and adjusted from the front panel. The digital voltage and current meters provide continuous and accurate readings of the output levels. The HP E3614A–E3617A are 212 mm W x 88 mm H x 373 mm D (8.5 in x 3.5 in x 14.7 in).

Key Literature

1997/98 *HP Power Products Catalog,* p/n 5965-5284E
HP Basic Instrument Catalog, p/n 5965-7748 LE, EN/EUS

Specifications at 0° to 55° C unless otherwise specified

Single-output models		HP E3610A	HP E3611A	HP E3612A	HP E3614A	HP E3615A	HP E3616A	HP E3617A
Number of output ranges		2	2	2	1	1	1	1
Output ratings[1]	Range 1	0 to 8 V, 0 to 3 A[1]	0 to 20 V, 0 to 1.5 A[1]	0 to 60 V, 0 to 0.5 A[1]	0 to 8 V, 0 to 6 A	0 to 20 V, 0 to 3 A	0 to 35 V, 0 to 1.7 A	0 to 60 V, 0 to 1 A
	Range 2	0 to 15 V, 0 to 2 A[1]	0 to 35 V, 0 to 0.85 A[1]	0 to 120 V, 0 to 0.25 A[1]	—	—	—	—
	Power (max.)	30 W	30 W	30 W	48 W	60 W	60 W	60 W
Load and line regulation		0.01%+2 mV	0.01%+2 mV	0.01%+2 mV	0.01%+2 mV	0.01%+2 mV	0.01%+2 mV	0.01%+2 mV
Ripple and noise	rms	200 μV	200 μV	200 μV	200 μV	200 μV	200 μV	200 μV
	peak-to-peak	2 mV	2 mV	2 mV	1 mV	1 mV	1 mV	1 mV

Supplemental Characteristics Non-warranted characteristics determined by design and useful in applying the product

Control mode		CV/CC	CV/CC	CV/CC	CV/CC	CV/CC	CV/CC	CV/CC
Resolution (minimum change using front-panel controls)	Voltage	10 mV	10 mV	100 mV	10 mV	10 mV	10 mV	100 mV
	Current	5 mA	5 mA	2 mA	10 mA	5 mA	5 mA	5 mA
Power (115 Vac ±10%)		47 to 63 Hz	47 to 63 Hz	47 to 63 Hz	47 to 63 Hz	47 to 63 Hz	47 to 63 Hz	47 to 63 Hz
Options available		0E3, 0E9	0E3, 0E9	0E3, 0E9	0E3, 0E9	0E3, 0E9	0E3, 0E9	0E3, 0E9

[1] Maximum current is derated 1% per °C between 40° to 55° C.

Harmonic/Flicker Test Systems

HP 6840 Series Harmonic/Flicker Test Systems

HP 6841A
HP 6842A
HP 6843A

- One-box solution tests products for compliance to EN 60555-2, EN-60555-3, EN 61000-3-2, and EN 61000-3-3
- Full 1-phase coverage at 230 Vrms and 16 Arms
- Measurement and generation implementation compliant with IEC 868, IEC 1000-7-4, and IEC 725
- Compliant-level harmonic current measurements for the fundamental through the 40th harmonic
- Windows™ software for IEC/EN testing capability
- Real-time and off-line test data review and analysis
- Test report generation
- Advanced diagnostic capabilities for failure analysis
- Standard ac source operating mode (normal mode)
- Standard three-year warranty

HP 6841A, 6842A, top right HP 6843A, bottom right

HP Harmonic/Flicker Test Systems

The HP 6840 Series Harmonic/Flicker Test Systems are specifically designed for testing products for compliance to the low-frequency emissions regulations for quasi-stationary current harmonics, fluctuating current harmonics, and voltage fluctuations and flicker. Three models provide full power coverage of the single phase regulatory standard requirements:
HP 6841A 230 Vrms, 3.3 Arms, 750 VA (compliance testing);
300 Vrms, 6.5 Arms, 750 VA (maximum ratings); panel height: 5.25 inch
HP 6842A 230 Vrms, 7.6 Arms, 1750 VA (compliance testing);
300 Vrms, 13 Arms, 1750 VA (maximum ratings); panel height: 5.25 inch
HP 6843A 230 Vrms, 16 Arms, 4800 VA (compliance testing);
300 Vrms, 16 Arms, 4800 VA (maximum ratings); panel height: 10.5 inch

Reduce Cost and Integration Time with the HP One-Box Test System

The HP 6840 series eliminates the time and cost required to research, specify, and integrate individual instruments, and offers a more cost-effective solution than multiple-box test systems. These fully-integrated test systems combine all of the generation and measurement functionality required for full compliance-level testing in one compact unit.

Each one-box test system contains the capabilities of a standalone ac source, power analyzer, flicker meter, and line impedance network. All regulatory testing functionality is available via the HP-IB and test system software.

High Performance Ensures Compliance-Level Testing Capability

Low distortion power generation, low- and programmable-output impedance, and an accurate measurement system assure compliance-level performance. The HP 6841A, 6842A, and 6843A were designed according to the normative references for voltage and current harmonic measurement techniques (IEC 1000-4-7), flicker measurements (IEC 868), and reference impedance requirements (IEC 725).

Unlike multiple-box ac source and measurement configurations, the power generation and measurement of the HP 6840 series are controlled by a common internal timebase and are truly synchronized. This allows precise measurement of harmonics since they will fall directly within the center of the FFT bins with a synchronization accuracy better than 1 ppm.

Easy-to-Use Windows™ Graphical User Interface

Each HP 6840 series test system is shipped with the HP Harmonic/Flicker Test System for Windows™ software, providing a fast and easy way to access the IEC/EN testing capabilities. The software provides the following capabilities:

- Test set-up and execution
- Full control of EUT ac mains power during testing
- Pre-test for EUT class determination (current harmonics)
- Data archiving of all parameters
- Real-time test data display (graphical and tabular)
- On-line/off-line test data review with user-specified search criteria
- Test termination under user-defined conditions
- Pass/Fail indication
- Diagnosis of test results via advanced features
- Report generation

Recommended PC Configuration

- 486DX4 100 MHz or Pentium
- 16 MB of RAM
- 1.2 GB IDE PCI hard disk (13 ms access time)[1,2]
- Windows 3.1, or Windows for Work Groups 3.11, Windows 95 and Windows NT
- Networking disabled

Notes:
[1]HP HFTS software requires ~4 MB of hard disk space for installation.
[2]The recommended hard disk space accommodates data storage for the maximum possible test length (7 days). Less disk space is required for shorter test lengths.

Supported GPIB Interfaces

HP 82335B, 82340B and HP 2341C, HP-IB Interface and the National Instruments AT-GPIB/TNT Interface

Key Literature

1997/1998 *Power Products Catalog*, p/n 5965-5284E
Regulatory Testing Application Note 1273, p/n 5964-1917

Specifications

Specifications are warranted over the ambient temperature range of 0° to 40°C. For specifications pertaining to standard ac source operation and ac input requirements, see the HP 6800 AC Power Source/Analyzer Specifications and Supplemental Characteristics.

	HP 6841A	HP 6842A	HP 6843A
Number of phases	1	1	1
Output ratings			
Power (VA)	750 VA	1750 VA	4800 VA
Maximum rms voltage	300 V	300 V	300 V range
Maximum rms current	6.5 A	13 A	32 A
Output frequency range	50 Hz/60 Hz	50 Hz/60 Hz	50 Hz/60 Hz
Reference impedance accuracy	3% (at 0.4 Ω and 796 μH)/ 1% (at 0.4 Ω and 796 μH at 25°C)		
Constant voltage ripple and noise (20 kHz to 10 MHz)			
rms relative to full scale	–60 dB	–60 dB	–60 dB
rms	300 mV	300 mV	300 mV
Load regulation	0.5% of full scale	0.5% of full scale	0.5% of full scale
Line regulation	0.1% of full scale	0.1% of full scale	0.3% of full scale
Maximum total harmonic distortion	0.25%	0.25%	1%
Output voltage harmonic content[1]	Compliant with IEC 868 and IEC 1000-3-2		
Programming accuracy (25°C ± 5°C)			
Voltage (rms)	0.15% +0.3 V	0.15% +0.3 V	0.15% +0.3 V
Frequency	0.01% +10 mHz	0.01% +10 mHz	0.01% +10 mHz
Measurement accuracy (25°C ± 5°C)			
Current magnitude (low range)			
Fundamental	0.03% + 1.5 mA	0.03% + 1.5 mA	0.03% + 3 mA
Harmonics 2-49	0.03% + 1 mA + 0.2%/kHz	0.03% + 1 mA + 0.2%/kHz	0.03% + 2 mA + 0.2%/kHz
Current magnitude (low range)			
Fundamental	0.05% + 5 mA	0.05% + 5 mA	0.05% + 6 mA
Harmonics 2-49	0.05% + 3 mA + 0.2%/kHz	0.05% + 3 mA + 0.2%/kHz	0.05% + 3 mA + 0.2%/kHz
Flicker	Compliant with IEC 868	Compliant with IEC 868	Compliant with IEC 868
Flicker perceptibility (pst)	Compliant with IEC 868	Compliant with IEC 868	Compliant with IEC 868
Synchronization accuracy	< 1 ppm	< 1 ppm	< 1 ppm
Current shunt burden	0 volts	0 volts	0 volts
Current harmonic smoothing filter time constant	1.5 seconds	1.5 seconds	1.5 seconds
Pst integration time	1, 5, 10 or 15 minutes	1, 5, 10 or 15 minutes	1, 5, 10 or 15 minutes

[1] Output voltage harmonic content specification is limited for the HP 6843A for half-wave rectified/Class C loads. Compliance will be tested, verified and reported by the HP HFTS software for all DUTs.

IEC Mode Measurement System Characteristics for the HP 6841A, 6842A, and 6843A

	Sample rate	Window width	Acquisition overlap
50 Hz Operation			
Rectangular measurement window	12.8 kHz	16 cycles	None
Hanning measurement window	8.533 kHz	24 cycles	50%
60 Hz Operation			
Rectangular measurement window	15.360 kHz	16 cycles	None
Hanning measurement window	7.680 kHz	32 cycles	50%

Ordering Information

HP 6841A Harmonic/Flicker Test System
- **Opt OBN** Extra Documentation
- **Opt ICM** Rackmount Kit
- **Opt ICP** Rackmount Kit with Handles (HP p/n 5062-3983)
- **Opt 100** 87 to 106 Vac, 48 to 63 Hz (Japan only)
- **Opt 230** 191 to 254 Vac, 48 to 63 Hz
- **Opt 831** 12 AWG, 200 to 240 Vac, unterminated
- **Opt 833** 1.5 mm 2 wire size, 200 to 240 Vac, unterminated
- **Opt 834** 10 AWG, 100 to 120 Vac, unterminated
- **Opt 841** Line Cord with NEMA 6-20P; 20 A, 250 V Plug
- **Opt 845** Line Cord with IEC 309; 16 A, 220 V Plug
- **Opt 846** Line Cord with NEMA L5-30P; 30 A, 120 V Plug
- **Opt 847** Line Cord with CEE 7/7; 16 A, 220 V Plug
- **Opt 848** Line Cord with BS 546; 15 A, 240 V Plug

HP 6842A Harmonic/Flicker Test System
- **Opt OBN** Extra Documentation
- **Opt ICM** Rackmount Kit

Support rails required when rackmounting the HP 6841A and 6842A with Option 1CM.
- **Opt ICP** Rackmount Kit with Handles (HP p/n 5062-3983)
- **Opt 200** 174 to 220 Vac, 48 to 663 Hz. If Option 200 is not ordered, this unit will be configured to operate at 191 to 254 Vac, 47 to 63 Hz
- **Opt 831** 12 AWG, 200 to 240 Vac, unterminated
- **Opt 832** 4 mm 2 wire size, 200 to 240 Vac, unterminated
- **Opt 841** Line Cord with NEMA 6-20P; 20 A, 250 V Plug
- **Opt 842** Line Cord with IEC 309, 32 A, 220 V Plug
- **Opt 844** Line Cord with NEMA L6-30P; 30 A, 250 V Locking Plug

HP 6843A Harmonic/Flicker Test System
- **Opt OBN** Extra Documentation
- **Opt ICM** Rackmount Kit
- **Opt 400** 360 to 440 Vac L-L, 48 to 63 Hz operation (required for Europe)

HP E3664A cabinet rails must be ordered with Option 1CM for rackmounting the HP 6843A.

HP p/n 5063-2310 Heavy duty rack slide kit

AC Power Source/Analyzers

HP 6800 Series
HP 6811A
HP 6812A
HP 6813A
HP 6814B
HP 6834B

- Cost effective 375 VA solution (6811A)
- ac and dc output capability
- Compact 1Φ and 3Φ "one-box" solutions
- Power line disturbance simulation
- Arbitrary waveform generation
- High accuracy readback
- Built-in harmonic analysis capability
- dc output capability (HP 6811A, 6812A, 6813A)
- Built-in HP-IB and RS-232 interface with SCPI programming
- CE mark
- Compliance testing to IEC 1000-3-2 quasi-stationary harmonic current limits (HP 6812A-6814B, 6834B)
- Full IEC 1000-3-2/3 compliance testing with the 6840 series Harmonic/Flicker Test Systems (see pages xxx and xxx)
- Two current measurement ranges. Low range increases sensitivity 10:1 (HP 6811A, 6812A, and 6813A)
- Maximum output freqency of 5 KHz (HP 6814B and 6834B)
- Programmable 1Φ/3Φ mode switch (HP 6834B only)
- Elgar PIP 9012 Code built into mainframe

HP 6811A, 6812A, 6813A, top; HP 6814B, 6834B, bottom

3

HP 6800 Series AC Power Source/ Analyzers

HP 6811A 300 V_{rms}, 375 VA
Single phase model
Panel height: 5.25 inch

HP 6812A 300 V_{rms}, 750 VA
Single phase model
Panel height: 5.25 inch

HP 6813A 300 V_{rms}, 1750 VA
Single phase model
Panel height: 5.25 inch

HP 6814B 300 V_{rms}, 3000 VA
Single phase model
Panel height: 10.5 inch

HP 6834B 300 V_{rms}, 4500 VA_{total}
One/three phase models
Panel height: 10.5 inch

Hewlett-Packard ac power source/analyzers are designed for applications which require precise control, accurate measurement, and analysis of single- and three-phase ac power. The feature set and performance levels of this product family provide the flexibility necessary to power and test a wide variety of devices. These products are ideal for applications such as power supply testing, UPS testing, avionics ATE, the testing of power-factor-corrected equipment and devices, and compliance testing to regulatory standards.

The HP 6800 series utilizes a low noise switching topology, which delivers high performance and reduced size. These products can output dc (HP 6811A 6812A, 6813A), ac, complex, and user-defined waveforms for exceptional application flexibility over the bus or via an easy-to-use front panel.

Key Features

- Sine, square, and up to 12 user-defined waveforms
- Programmable voltage, current limit, frequency, phase, and distortion (clipped sinewave)
- Programmable dc output (HP 6811A, 6812A, 6813A)
- Programmable output impedance (HP 6811A, 6812A, 6813A)
- Voltage and frequency slew control
- Power line disturbance simulation (sag, surge, dropout, clipping, and event programming)
- Independent phase control (HP 6834B)
- Measurement of rms voltage, rms current, peak current, neutral current (HP 6834B), frequency, phase, real power, reactive power, apparent power, total 3Φ power (HP 6834B), and power factor
- Harmonic analysis of voltage and current with magnitude and phase results up to the 50th harmonic
- THD measurement of voltage and current
- Over-current, over-voltage, over-power, over-temperature, and RI/DFI protection
- Built-in output isolation relays
- Sixteen non-volatile store and recall states
- User-definable power-on state
- Self-test at power-up
- HP VEE support
- Electronic calibration via the bus or front panel

Performance and Features to Meet Critical Testing Needs

Powerful Direct Digital Synthesis (DDS) Waveform Generation

The HP 6800 series offers the ultimate in waveform generation versatility. For testing products under ac line distortion conditions, clipped sine waves can be generated with 0% to 43% distortion. Up to twelve user-defined arbitrary waveforms can be defined and stored in non-volatile memory. These waveforms can be used to generate steadystate out-puts or can be combined for more complex transient generation schemes. Testing for compliance to ac line harmonic immunity standards can easily be achieved. Sine waves with harmonic content specified by this standard can be downloaded into non-volatile memory and generated as needed.

For testing that requires dc output capability, dc transients or waveforms with a dc offset, the output of the HP 6811A, 6812A, and 6813A can be configured in ac or dc mode.

Flexible Transient Generation

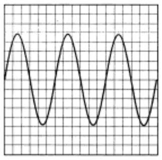
When testing requires precise synchronization between waveform generation and measurement of the device under test, the HP 6800 series transient generation capability provides a powerful tool. The Step and Pulse modes offer an easy and convenient method of executing single-step and continuous-output changes. The output voltage amplitude, frequency, phase, waveform shape, voltage slew rate, and frequency slew rate can be controlled in response to an input trigger generated from an internal or external event. The List transient mode further extends this capability for more complex waveform generation needs. Up to 100 sequences of output settings can be precisely executed in response to a trigger or paced by programmed dwell times without computer intervention.

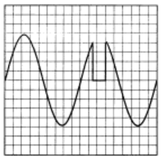
Extensive Measurement and Analysis

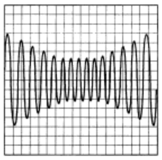
The HP 6800 series has measurement functionality equivalent to commercially available high-accuracy power analyzers. This eliminates the need for this standalone instrument for most applications, and lowers systems cost, increases available rack space, and simplifies cabling. All measurements are made with 16-bit resolution, suitable for even the most demanding applications.

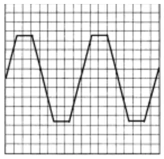
The HP 6800 series has built-in voltage and current waveform digitization combined with harmonic analysis capability. Amplitude, phase, and total harmonic distortion results up to the 50th harmonic are provided for output frequencies equal to or less than 250 Hz. This measurement feature, accessible via the front panel or over the bus, provides a sophisticated solution for testing during product development.

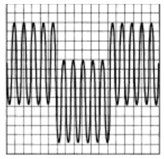
HP 6800 Series Waveform Examples with a Resistive Load

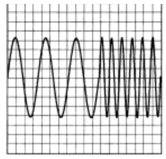

Low distortion sinewave

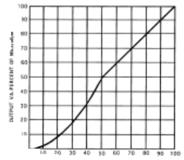

Phase referenced cycle dropout


Voltage amplitude change


Programmable distortion with programmable slew rate


Waveform with a dc offset (clipped sinewave)


Frequency change


VA Capabilities for the 6814B, 6834B, 6843A

Specifications

Per phase for a sine wave with a resistive load at 0° to 40° C, within an output frequency range of 45 Hz to 1000 Hz, and in ac coupled mode unless otherwise noted[1]

	HP 6811A	HP 6812A	HP 6813A	HP 6814B	HP 6834B
Number of phases	1	1	1	1	1/3
Output frequency range	dc; 45 Hz to 1 kHz	dc; 45 Hz to 1 kHz	dc; 45 Hz to 1 kHz	45 Hz to 5 kHz	45 Hz to 5 kHz
Output ratings					
Power	375 VA	750 VA	1750 VA	3000 VA	4500 VA
Maximum rms voltage	300 V	300 V	300 V	300 V_{1-n} (high range) 150 V_{1-n} (low range)	300 V_{1-n} (high range) 150 V_{1-n} (low range)
DC voltage range	±425 V	±425 V	±425 V	N/A	N/A
Maximum rms current	3.25 A	6.2 A (real-time mode)	13 A (real-time mode)	[2]10 A (300 V range) [2]20 A (150 V range)	[2]15 A/5 A (300 V range) [2]30 A/10 A (150 V range)
Maximum dc current	2.5 A	5 A	10 A	N/A	N/A
Maximum repetitive and nonrepetitive peak current	40 A	40 A	80 A 80 A (low range)	40 A (300 V range) 120 A/40 A (150 V range	60 A/20 A (300 V range) 96 A/150 V (range)
Crest factor	12	6	6	4	4
Constant voltage ripple and noise (20 kHz to 10 MHz)	–60 dB (relative to full scale)	–60 dB (relative to full scale)	–60 dB (relative to full scale)	–60 dB (relative to full scale)	–60 dB (relative to full scale)
Line regulation	0.1%	0.1%	0.1%	0.1%	0.1%
Load regulation	0.5%	0.5%	0.5%	0.5%	0.5%
Maximum total harmonic distortion	0.25% at 50 Hz/60 Hz 1% worst case 45 Hz to 1 kHz	0.25% at 50 Hz/60 Hz 1% worst case 45 Hz to 1 kHz	0.25% at 50 Hz/60 Hz 1% wort case 45 Hz to 1KHz	1% (45–1000 Hz) 1% + 1% kHz (>1 kHz – 5 kHz)	1% (45–1000 Hz) 1% + 1% kHz (>1 kHz – 5 kHz)
Programming accuracy (25° C ±5° C)					
rms voltage	0.15% + 0.3V (45 to 100 Hz) 0.5% + 0.3V (>100 to 500 Hz) 1% + 0.3V (>500 to 1000 Hz)	0.15% + 0.3V (45 to 100 Hz) 0.5% + 0.3V (>100 to 500 Hz) 1% + 0.3V (>500 to 1000 Hz)	0.15% + 0.3V (45 to 100 Hz) 0.5% + 0.3V (>100 to 500 Hz) 1% + 0.3V (>500 to 1000 Hz)	0.15% + 0.3V (45 to 100 Hz) 0.5% + 0.3V (>100 to 500 Hz) 1% + 0.3V (>500 to 1000 Hz)	0.15% + 0.3V (45 to 100 Hz) 0.5% + 0.3V (>100 to 500 Hz) 1% + 0.3V (>500 to 1000 Hz)
DC voltage	0.1% + 0.5V	0.1% + 0.5V	0.5% + 0.3V	N/A	N/A
Frequency	0.01% + 10 μHz	0.01% + 10 μHz	0.01% + 10 μHz	0.01% + 10 μHz	0.01% + 10 μHz
(HP 6834B in 3Φ mode)					
Phase	N/A	N/A	N/A	N/A	0.1° (45–100 Hz) 1° (>100–1 kHz) 1% + 1%/ 1 kHz (>1 kHz–5 kHz)
Measurement accuracy (25° ± 5° C)					
rms voltage (45–100 Hz)	0.03% + 100 mV[3] + 250 mV	0.03% + 100 mV[3]	0.03% + 100 mV[3]	0.05% + 250 mV (45 Hz–1kHz) 0.05% + 0.05%/ kHz + 250 mV	0.05% + 250 mV (45 Hz–1kHz) 0.05% + 0.05%/ kHz + 250 mV
DC voltage	0.03% + 150 mV[3]	0.03% + 150 mV[3]	0.03% + 150 mV[3]	N/A	N/A
rms current[4] (45–100 Hz)	0.05% + 8 mA[3]	0.05% + 15 mA[3]	0.05% + 15 mA[3]	0.1% + 50 mA	0.1% + 25 mA 0.1% + 50 mA[5]
Frequency	0.01% + 0.01 Hz[3]	0.01% + 0.01 Hz[3]	0.01% + 0.01 Hz[3]	0.01% + 0.01 Hz	0.01% + 0.01 Hz
Power (VA)[4] (45–100 Hz)	0.1% + 3.5 VA[3]	0.1% + 3.5 VA[3]	0.1% + 3.5 VA[3]	0.15% + 5 VA	0.15% + 5VA 0.15% + 3 VA
Power (watts)[4] (45–100 Hz)	0.1% + 0.3 W + 9.4 mW/V[3]	0.1% + 0.3 W + 12.7 mW/V[3]	0.1% + 0.3 W + 12.7 mW/V[3]	0.15% + 5 W	0.15% + 5 W 0.15% + 0.3W[5]
Power factor[4]	0.01	0.01	0.01	0.01	0.01
Isolation to ground	300 Vrms	300 Vrms	300 Vrms	300 Vrms	300 Vrms

30-minute warm-up period
Specifications subject to change without notice

[1] It is possible to program the output frequency of HP 6812A and 6813A from dc to 45 Hz (see note 3).
[2] Full current is available at voltages between 50% and 100% of the output voltage range.
[3] Product may be operated between dc and 45 Hz subject to the following conditions: measurements may be extended to 4.5 Hz at full accuracy only by selecting a digitization rate of 250 μseconds per point; frequency content of the measured signal must be limited to 4 kHz or less to avoid aliasing effects.
[4] High current measurement range shown
[5] Single-phase operation

Supplemental Characteristics Non-warranted characteristics determined by design that are useful in applying the product

	HP 6811A	HP 6812A	HP 6813A	HP 6814B	HP 6834B
Average programming accuracy					
rms current	1.2% + 50 mA	1.2% + 50 mA	1.2% + 50 mA	0.2% + 80 mA	0.2% + 80 mA/ 0.2% + 40 mA
Average programming resolution					
rms voltage	125 mV	125 mV	125 mV	80 mV	80 mV
DC voltage	250 mV	250 mV	250 mV	N/A	N/A
Overvoltage programming (OVP)	2 V	2 V	2 V	2 V	2 V
rms current	2 mA	4 mA	4 mA	5 mA	7.5 mA/2.5 mA
Peak current	12.5 mA	12.5 mA	25 mA	N/A	N/A
Output frequency	10 mHz	10 μHz	10 μHz	10 μHz	10 μHz
Phase	N/A	N/A	N/A	N/A	0.001° (45 Hz to 5 kHz)
Average measurement resolution					
rms voltage	10 mV	10 mV	10 mV	10 mV	10 mV
rms current	2 mA	2 mA	2 mA	3 mA	2 mA/6 mA
Net weight	28.2 kg (62 lb)	28.2 kg (62 lb)	32.7 kg (72 lb)	79.5 kg (175 lb)	87.7 kg (193 lb)
Shipping weight	31.8 kg (70 lb)	31.8 kg (70 lb)	36.4 kg (80 lb)	119.1 kg (262 lb)	127.3 kg (280 lb)

3

Remote Sensing: Up to 10 Vrms can be dropped across each load lead.
Command Processing Time: The average time for the output rms voltage to start to change after receiving an HP-IB command is 10 milliseconds.
Calibration Interval: One year
HP-IB Capabilities: SH1, AH1, T6 L4, SR1, RL1 PPO, DC1, DT1, E1, and CO, and a command set compatible with IEEE-488.2 and SCPI

Regulatory Compliance: Listed to UL-1244; certified to CSA 22.2 No. 231; conforms to IEC 1010
RFI Suppression: Complies with CISPR-11, Group 1, Class A
Warranty Period: Three years

AC Input Ratings *Input power configuration for the standard unit

	HP 6811A	HP 6812A	HP 6813A	HP 6814B	HP 6834B
Voltage range (Vac)	87 to 106 Vac *104 to 127 Vac 174 to 220 Vac 191 to 254 Vac	87 to 106 Vac *104 to 127 Vac 174 to 220 Vac 191 to 254 Vac	174 to 212 Vac *191 to 254 Vac	*180 to 254 L-L (3Φ) 342 to 456 L-L (3Φ)	*180 to 254 L-L (3Φ) 342 to 456 L-L (3Φ)
Maximum input Current (rms)[1]	12 A (at 100 Vac) 10 A (at 120 Vac) 7.5 A (at 200/208 Vac) 6.5 A (at 230 V)	24 A (at 100, 120 Vac) 28 A (at 100 Vac) 13 A (at 200, 208 Vac) 13 A (230 Vac)	22 A (at 200/208 Vac) 20 A (at 220/230/240 Vac)	18 A 10 A	25 A 15 A
Input power (max)[2]	100 VA/ 700 W	2500 VA/1400 W	3800 VA/2600 W	5800 VA/4100 W	8900 VA/5900 W
Input frequency	47 to 63 Hz	47 to 63 Hz	47 to 63 Hz	47 to 63 Hz	47 to 63 Hz

[1] Measured at low line
[2] Measured at high line

Ordering Information

Opt 0BN Extra Documentation
Opt 1CM Rackmount Kit (p/n 5062-3977)
Opt ICP Rackmount Kit with Handles, HP 6811A, 6812A, 6813A only (p/n 5062-3983)
Opt 100 87 to 106 Vac, 48 to 63 Hz (Japan only), HP 6811A, 6812A
Opt 200 174 to 220 Vac, 47 to 63 Hz. If Option 200 is not ordered, the ac source will be configured to operate at 191 to 254 Vac, 47 to 63 Hz. (HP 6811A)
Opt 230 191 to 254 Vac, 48 to 63 Hz (HP 6811A, 6812A)
Opt 831 12 AWG, 200 to 240 Vac, unterminated (HP 6811A, 6812A, 6813A)
Opt 833 1.5 mm^2 wire size, 200 to 240 Vac, unterminated (HP 6811A, 6812A)
Opt 834 10 AWG, 100 to 120 Vac, unterminated (HP 6811A, 6812A)
Opt 841 Line Cord with NEMA 6-20P; 20 A, 250 V Plug (HP 6811A, 6812A, 6813A)
Opt 845 Line Cord with IEC 309; 16A, 220 V Plug (HP 6811A, 6812A)
Opt 846 Line Cord with NEMA L5-30P; 30 A, 120 V Plug (HP 6811A, 6812A)
Opt 847 Line Cord with CEE 7/7; 16 A, 220 V Plug (HP 6811A, 6812A)
Opt 848 Line Cord with BS 546; 15 A, 240 V Plug (HP 6811A, 6812A)
Opt 832 4 mm^2 wire size, unterminated (HP 6813A)
Opt 841 Line Cord with NEMA 6-20P; 20 A, 250 V Plug (HP 6813A)
Opt 842 Line Cord with IEC 309, 32 A, 220 V Plug (HP 6813A)
Opt 844 Line Cord with NEMA L6-30P, 30 A, 250 V Locking Plug (HP 6813A)
Support rails (p/n 1494-0059) required when rackmounting the HP 6812A and 6813A Opt 1CM and Opt 1CP
Opt 400 360 to 440 Vac, 3-phase, 47 to 63 Hz operation (HP 6814B, 6834B)
HP E3664A cabinet rails must be ordered with Opt 1CM for rackmounting the HP 6814B and 6834B

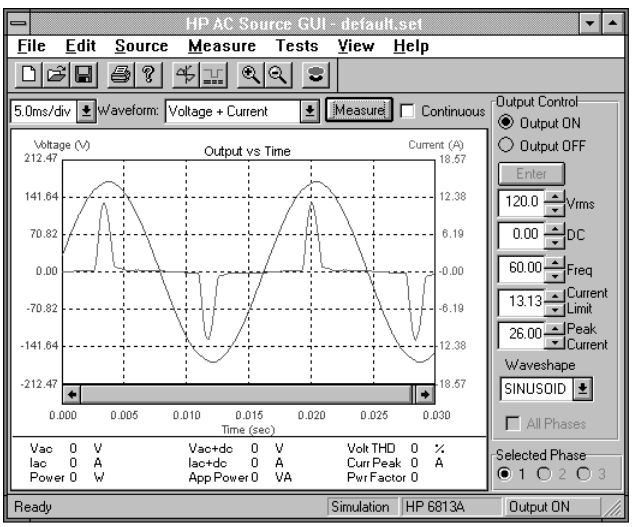
Accessories

HP p/n 5060-3513 Three 30-A replacement fuses for 180 to 235 Vac line (HP 6814B, 6834B)
HP p/n 5060-3512 Three 16-A replacement fuses for 360 to 440 Vac line (HP 6814B, 6834B)
HP p/n 5063-2310 Heavy-duty rack slide kit (HP 6814B, 6834B)

Key Literature

1997/98 *Power Products Catalog,* 5965-5284
Product Note, p/n 5963-7044E

- Fast and easy ac source setup
- Easy-to-use table for transient generation
- "Click and drag" graphical creation of transients
- "Oscilloscope" view of dynamic and static voltage and current measurements shown in a single window
- Quickly develop, view, and download harmonic and arbitrary waveforms
- Command view window shows all SCPI commands being sent to the ac source and parameters received from the ac source
- Configure and save ac source states, arbitrary waveforms and transient generation files for convenient recall
- Continuous logging and filing of measurement data
- On-line product manual and Help
- Use with the HP 6800 series Harmonic/Flicker Test Systems in normal (standard ac source) mode
- Runs on Windows 95 and Windows NT 4.0
- Automatic setup of inrush, dropout, surge and say



Graphical User Interface

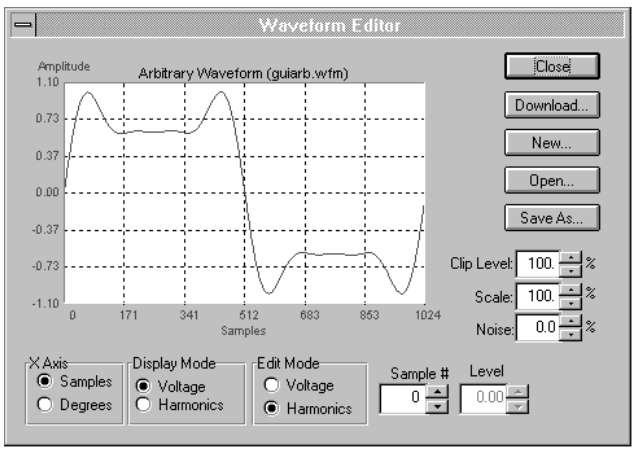
Increase Your Testing Productivity at No Cost

Simplify your ac power testing with the new ac source graphical user interface. This new product provides easy access to the capabilities of the HP ac source products, and allows you to get up and running quickly in your application. The HP ac source graphical user interface is shipped with every HP 6800 series ac source and HP 6840 Harmonic/Flicker Test System on 3.5-inch floppy disk media.

Access the Powerful Capabilities of the HP 6800 and 6840 Series Products

The graphical user interface allows you to easily perform key tests such as inrush characterization with the built-in data acquisition capability of HP's ac source and harmonic/flicker test system products.

Graphical and numeric test results can be saved for future analysis or reporting. Create arbitrary waveforms that can be easily downloaded to the HP 6800 and 6840 products' non-volatile memory—without writing a line of software code. These waveforms can be saved in PC-based files so that you can accumulate a customer library of waveforms specifically tailored to your applications. These waveforms can be later recalled and downloaded to the HP 6800 or 6840 products at your convenience.



Minimum PC Configuration
486DX33 or faster
8 MB of Ram
2 MB of hard disk space

Supported Interfaces
HP 82335B, HP 82340B, HP 82341C,
HP 82341D, National AT-GPIB/TNT, RS-232

Oscilloscopes

HP Basic Instruments Catalog
5966-0703EN
HP 54600-Series 60 to 500 MHz Oscilloscope Data Sheet
5964-9339EN
HP 54645A 1 Meg Memory Oscilloscope Data Sheet
5964-9630EN
HP 54645D Mixed Signal Oscilloscope Data Sheet
5964-9634EN
HP 54500-Series 500 MHz Oscilloscopes Brochure
5963-7246E
Data Sheet
5963-7245E
HP 54700-Series Modular Oscilloscope Brochure
5091-6979 E
Data Sheet
5091-9256E
HP 54750 Modular Oscilloscope Data Sheet
5962-0097E
HP Infinium Oscilloscopes: 54810A, 54815A, 54820A, 54845A Data Sheet
5965-7002EN

(PN 54600-3) HP 54600 Series Oscilloscopes—FFT Lab Experiments Notebook
5091-7568E
(PN 54600-4) Using the Fast Fourier Transform in HP 54600 Series Oscilloscopes
5091-7227E
(PN 54720A-1) Bandwidth and Sampling Rate in Digitizing Oscilloscopes
5091-3757E
(PN 54720A-2) Measuring Time Intervals Accurately and Precisely with the HP 54720A
5091-3756E
(PN 54720A-3) Selecting Oscilloscope Probes for High-Speed Digital Circuit Measurements
5091-3758E
(PN 54720A-4) Triggering an Oscilloscope
5091-3755E

Oscilloscope Probes & Accessories

HP Basic Instruments Catalog
5966-0703EN
Oscilloscope Probes and Accessories
5091-6195E
HP 1141A 200 MHz Differential Probe Data Sheet
5952-3291D
HP 1144A 800 MHz Active Probe Data Sheet
5091-7935E
HP 1145A 750 MHz Active Probe Data Sheet
5962-8537E
HP 54701A 2.5 GHz Active Probe Data Sheet
5091-3594E
HP 1180/81/82A Testmobile Data Sheet
5091-2520E

Personal Trouble Shooting Tools

HP LogicDart Advanced Logic Probe E2310A Data Sheet
5966-0434EN

Electronic Counters

(PN 5370B-2) Better than 100 ps Accuracy in HP 5370B Time Interval Measurements
5952-7834
(PN 5371A) HP 5371A Frequency and Time Interval Analyzer
5952-7959
(PN 5372A-1) Jitter Spectrum Analysis
5091-1640E

Digital Multimeters/ Digital Voltmeters

HP Basic Instruments Catalog
5966-0703EN
HP 34401A 6½ Digital DMM Data Sheet
5964-0145EN
HP 34420A Nanovolt/Micro-ohm Meter Data Sheet
5963-7535EN
HP 3457A 7½ Digital DMM Data Sheet
5953-7002
HP 3458A 8½ Digital DMM Technical Data
5965-4971E

(PN 3458A-1) Optimizing Throughput and Reading Rate of the 3458A
5953-7058

Data Acquisition & Switching

HP 34970A Data Acquisition/Switch Unit Product Overview
5965-5290EN

Function Generators & Waveform Synthesizers

HP Basic Instruments Catalog
5966-0703EN
HP 33120A 15 MHz Function/Arb Generator Data Sheet
5964-0146EN
Phase Lock Option
5963-2174EN
HP 3245A Universal Source Data Sheet
5091-1723E
HP 3325B 21 MHz Function Generator Data Sheet
5954-7986

(PN 8904A-1) Using the HP 8904A Multifunction Synthesizer as a Communications Signaling Source
5951-6748
(PN 8904A-2) Using the HP 8904A Multifunction Synthesizer as an FM Stereo Composite Generator
5953-8487
(PN 8904A-3) Using the HP 8904A Multifunction Synthesizer as a Modulation Source for Navigation Applications
5953-8488

Universal & RF Counters

HP Basic Instruments Catalog
5966-0703EN
HP 53100-Series Universal & RF Counters Data Sheet
5964-0385EN

Software

HP Basic Instruments Catalog
5966-0703EN
HP BenchLink Scope, Arb, Meter Data Sheet
5965-1511EN
HP VEE Graphical Programming Data Sheet
5964-6864E

Digital Timing Analyzers

HP Basic Instruments Catalog
5966-0703EN
HP 54620 A/C Logic Analyzer Data Sheet
5964-4062E
HP 54645D Mixed Signal Oscilloscope Data Sheet
5964-9634EN

DC Electronic Loads

Electronic Loads Mainframes
5962-6858E
Single Input Electronic Load Family
5962-6857E
1997/98 Power Products Catalog
5965-5284E/LE
150-Watt Electronic Load Module
5962-6856E
240-Watt Electronic Load Module
5962-6854E
300-Watt Electronic Load Module
5962-6855E
500-Watt Electronic Load Module
5962-6948E
600-Watt Electronic Load Module
5962-6853E

Power Supplies

Models 6541A–6545A, 6551A–6555A and 6571A–6575A Analog Programmable DC Power Supplies
5962-6946E
DC Power Supply Handbook
5952-4020
HP's Answer To Your High Performance, High Power Burn-in Needs
5091-6952E
HP Basic Instruments Catalog
5966-0703EN
HP Model 66000A Modular Power System Mainframe
5962-6861E
HP Model 66001A-66006A Modular Power System Power Modules
5962-6860E
HP Models 6625A, 6626A, 6628A and 6629A Multiple Output Linear System DC Power Supplies
5962-6864E
Sources of Voltage Related Stress During Semiconductor Burn-in
5091-6953E
HP Models 6621A-6624A, 6627A System DC Power Supplies
5091-9510E
HP 6671A-6675A HP-IB System DC Power Supplies
5962-8774E
HP 6015A Autoranging DC Power Supply
5962-6863E
HP 6030A-6033A, 6035A, 6038A Autoranging System DC Power Supplies
5962-6862E
HP 6050A, 6051A Electronic Load Mainframes
5962-6858E
HP 60501B 150-Watt Electronic Load Module
5962-6856E
HP 60502B 300-Watt Electronic Load Module
5962-6855E
HP 60503B 240-Watt Electronic Load Module
5962-6854E
HP 60504B 600-Watt Electronic Load Module
5962-6948E
HP 6060B, 6063B Single-Input Electronic Load Family
5962-6857E
HP 6812A-6814A, 6834A Using the HP 6800 Series AC Source for AC Power Measurement and Generation
5963-7044E
HP-IB System DC Power Supplies, **HP Models 6631B-6634B**
5966-1108
HP-IB System DC Power Supplies, **HP Models 6641A-6645A**
5962-6947E
HP-IB System DC Power Supplies, **HP Models 6651A-6655A**
5962-8775E
HP-IB System DC Power Supplies, **HP Models 6671A-6675A**
5962-8774E
HP-IB System DC Power Supplies, **HP Models 6680A-6684A**
5091-8773E
12 Factors to Consider When Selecting a System Power Supply Brochure
5952-4199E
HP 66101A, 66102A, 66103A, 66104A, 66105A, 66106A Modular Power System Power Modules Technical Specifications Brochure
5962-6860E
1997/98 Power Products Catalog
5965-5284E/LE
HP E3600 Series Low Cost Bench Supply
5964-0383EN
HP E3631A Triple Output Programmable DC Power Supply, Data Sheet
5965-7031EN
HP Power Products Modification Services
5952-4299
HP E4350A, E4351A Solar Array Simulator
5966-0711
Use Solar Array Simulators
5966-0836E
HP 6611C-6614C System DC Power Supplies
5966-1109
HP 66312B, 66332A Dynamic Measurement DC Source
5965-1679EN

(PN 6285A) MPEG-2 Digital Video Encoder Stress Test Patterns – E6285A
5965-6492E
(PN 66000) HP 66000 Modular Power System
5091-2497E

Harmonic/Flicker Test Systems

1997/98 Power Products Catalog
5965-5284 E/LE
Application Note 1273, Regulatory Testing
5964-1917E

AC Source/Analyzers

HP 6800 Series AC Power Source/Analyzers, **HP Models 6812A-6814A, 6834A**
5962-7088E

(PN) HP 6800 Series AC Power Source/Analyzer
5963-7044E

Signal Sources Hewlett-Packard offers the widest variety of signal generators from dc to 110 GHz. They cover every application from low-frequency navigation signals, through cellular mobile radio, to millimeter-wave satellite systems. A variety of modulations are available, as well as pulse and digital formats for testing the latest communications systems.

Economy RF
Economy RF Signal Generators
Digital/I-Q Modulation
High-Performance RF
Synthesized Microwave Sweepers

Signal Analyzers These instruments provide frequency-, time-, and modulation-domain measurement capability. Some of the key measurements that can be made with a signal analyzer are absolute and relative frequency, absolute and relative amplitude, scalar, noise, distortion products, amplitude modulation (AM), frequency modulation (FM), pulsed RF, and digital modulation.

Spectrum Analyzers
Dynamic Signal Analyzers
Distortion and Audio Analyzers
Vector Signal Analyzers
Modulation Analyzers
Measuring Receivers
Modulation Domain Analyzers

Network/Spectrum Analyzers These analyzers are high-performance, cost-effective, intelligent analyzers with combined vector network and spectrum analysis capabilities.

RF Network
Spectrum
Impedance Analyzer
Baseband
IF Network
Spectrum Analyzers

Network Analyzers Vector network analyzers accurately characterize the linear and nonlinear electrical performance of components and circuits. They measure the effect of devices on the amplitude and phase of swept-frequency and swept-power test signals. Network analyzers provide the ability to measure the input characteristics of each port of a device as well as the transfer characteristics from one port to another.

RF Network Analyzers
Microwave Network Analyzers
Scalar Network Analyzers
S-Parameter Test Sets
Vector Voltmeters

Power Meters New generation power meters and sensors feature DSP technology, fast measurement speed, improved absolute accuracy and repeatability, and ease of use and portability. Peak power meters provide complete and accurate characterization of today's complex pulsed signals. Full-featured models are available for MMS and VXI systems.

Power Meters
Power Sensors
EPM Power Meters
ECP Power Sensors
Peak Power Meters
MMS and VXI Power Meters

Noise Figure Meters Automatic noise figure meters from 10 to 2047 MHz provide accurate and simple, swept or CW measurements with second-stage correction. Microwave noise figure measurement systems are fully specified and eliminate the time designing and building a test system and are as easy to operate as a noise figure meter.

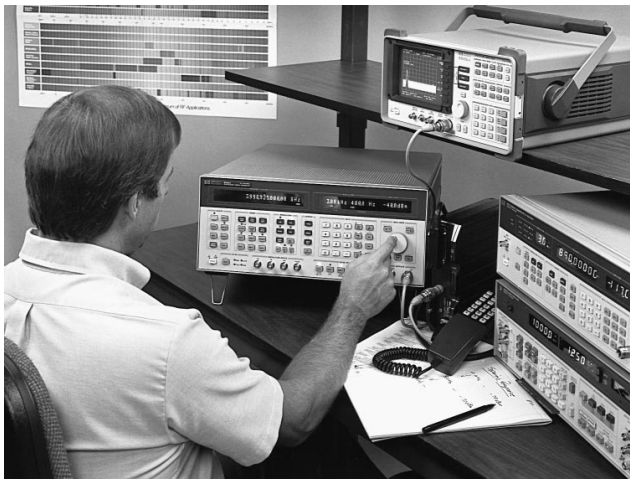
Automatic Noise Figure Meter
Microwave Noise Figure Measurement System
Noise Figure Test Set
Broadband Noise Sources

RF and Microwave Test Accessories Hewlett-Packard offers a complete line of RF and microwave test accessories for use in test and measurement systems from dc to 110 GHz. Products include step and fixed alternators, amplifiers, detectors, couplers, switches, switch drivers, adapters and waveguide devices.

Signal Sources

Signal Sources to 110 GHz

Overview



Hewlett-Packard offers the widest selection of high-performance signal sources from dc to 110 GHz. They cover every application range from low-frequency navigation signals, through cellular mobile radio, to millimeterwave satellite systems. Each offers synthesized frequency accuracy and stability as well as calibrated level and remote programmability. Modulation capabilities range from general purpose AM, ΦM, FM, pulse, and I-Q modulation to more specific formats such as QPSK, OQPSK, GMSK, π/4 DQPSK, and GFSK.

Signal Sources

4

Economy RF

Frequency	Model	Characteristics	Page
0.25 to 1000 MHz 0.25 to 2000 MHz 0.25 to 3000 MHz 0.25 to 4000 MHz	HP ESG-1000A HP ESG-2000A HP ESG-3000A HP ESG-4000A	**Analog signal generator platform.** Flexible architecture for upgrade paths. Superior level accuracy. Step sweep (frequency, power and list). Electronic attenuator to 4 GHz. Built-in function generator.	196
0.25 to 1000 MHz	HP 8647A	**HP's lowest cost synthesized source with electronic attenuator.** ±1.5 dB level accuracy. Remote sequencing capability. 10 Hz frequency resolution. –110 dBc/Hz @ 20 kHz SSB phase noise.	198
0.1 to 1000 MHz 0.009 to 2000 MHz 0.009 to 3200 MHz 0.009 to 4000 MHz	HP 8648A HP 8648B HP 8648C HP 8648D	**Economy signal generator family.** ±1 dB level accuracy up to 2.5 GHz. Provides HP 8647A performance plus improved residual FM, output power, switching speed, and phase noise. Electronic attenuator on HP 8648A. HP 8648B/C/D offer pulse modulation and high power options. All four models offer variable frequency modulation generator (Option 1E2).	198
0.1 to 990 MHz	HP 8656B	**Economically priced signal generator.** ±1.0 dB absolute level accuracy from +13 to –127 dBm in 0.1 dB steps. Calibrated AM and FM. Frequency resolution of 10 Hz. Timebase aging rate of ±2 ppm/year.	200
0.1 to 1040 MHz	HP 8657A	**Spectral purity and electronic attenuator at an affordable price.** < –130 dBc/Hz @ 500 MHz SSB phase noise. < –60 dBc spurious. Electronic attenuator. ±1 dB level accuracy. AM and FM.	200
0.1 to 2060 MHz	HP 8657B	**Spectral purity and pulse to 2 GHz at an affordable price.** < –130 dBc/Hz @ 500 MHz SSB phase noise. < –60 dBc spurious. ±1 dB level accuracy. AM, FM, and pulse with >90 dB on/off at 1030 MHz.	200

Digital/I-Q Modulation

Frequency	Model	Characteristics	Page
0.25 to 1000 MHz 0.25 to 2000 MHz 0.25 to 3000 MHz 0.25 to 4000 MHz	HP ESG-D1000A HP ESG-D2000A HP ESG-D3000A HP ESG-D4000A	**Digital and analog signal generator platform.** Flexible architecture for upgrade paths. Excellent modulation accuracy and stability. Analog I and Q. Optional digital modulation formats for CDMA, DECT, GSM, NADC, PDC, PHS, and TETRA. Data generation and burst capabilities.	202

High-Performance RF

Frequency	Model	Characteristics	Page
0.252 to 1030 MHz 0.252 to 2060 MHz	HP 8643A HP 8644B	**Performance signal generator for RF design.** < –130 dBc/Hz @ 1 GHz SSB phase noise HP 8643A; < –137 dBc/Hz HP 8644B. < –100 dBc spurious. AM, FM, pulse modulation. Advanced modulation source. Lowest specified leakage. Avionics option available (Option 009).	205
0.01 to 1280 MHz	HP 8662A	**Low close-in noise.** 0.1 Hz frequency resolution, 5 x 10^{-10}/day stability. Calibrated and leveled output from +13 to –140 dBm. Digital sweep. Completely HP-IB programmable. AM/FM modulation. Fast switching.	207
0.1 to 2560 MHz	HP 8663A	**Low close-in noise with complex modulation.** 0.1 Hz frequency resolution, 5 x 10^{-10}/day stability. Calibrated and leveled output from +16 to –130 dBm. Digital sweep. Completely HP-IB programmable. AM, ΦM, FM, pulse modulation. Fast switching.	207
0.1 to 3000 MHz 0.1 to 4200 MHz 0.1 to 6000 MHz	HP 8664A HP 8665A HP 8665B	**Performance signal generators for 3.0 GHz, 4.2 GHz and 6 GHz testing.** Excellent spectral purity. AM and FM. High-performance pulse modulation. Advanced modulation source.	205

CW Microwave

Frequency	Model	Characteristics	Page
1 to 20 GHz 0.01 to 20 GHz	HP 83711B HP 83712B	**Precision CW signals, pure and simple.** +10 to –90 dBm, < –50 dBc harmonics, < 1.5 x 10^{-9}/day stability, optional 1 Hz frequency resolution. Noise figure meter and millimeter source module compatible. HP-IB and SCPI programming. < 35 lbs.	210

High-Performance Microwave

1 to 20 GHz 0.01 to 20 GHz	HP 83731B HP 83732B	**Optimum choice for high-performance microwave receiver and subsystem test.** +10 to –90 dBm, harmonics, < –55 dBc, spurious < –60 dBc. < 1.5 x 10^{-9}/day stability, optional 1 Hz frequency resolution. Built-in multi-mode pulse generator, <10 ns pulse rise/fall time, < 25 ns pulse width. Logarithmic AM with > 60 dB depth. FM with >300 modulation index 10 MHz peak deviation. HP-IB and SCPI programming. < 35 lbs.	211
0.01 to 50 GHz	HP 8360B Series	**Versatile synthesized sweeper.** Covers many application needs, including signal simulation with pulse, scan, amplitude, and frequency modulation requirements. General-purpose sweeper with full network analyzer capability.	214

Swept Frequency Sources

0.01 to 20 GHz	HP 83751A/B HP 83752A/B	**Synthesized microwave sweeper.** Fully synthesized sweep. Continuous analog or digital step sweep, 2 MHz swept frequency accuracy, +17 dBm output power available. SCPI and HP-IB programmable, HP 8350 HP-IB mnemonics for drop-in replacement. Optimized for HP 8757 scalar network analyzers.	213
0.01 to 50 GHz	HP 8360L Series	General-purpose synthesized swept CW generator with full network analyzer compatibility. + 15 dBm output power available.	214

High-Performance Modular

1 to 20 GHz	HP 70340A	**Modular signal generator for MMS.** Full performance signal source in half-rack width (4/8 MMS). Logarithmic AM, FM, and pulse modulation. Optional 1 Hz frequency resolution and internal multimode pulse generator. < 10 ns pulse rise/fall times, < 25 ns pulse width. HP-IB, SCPI, and CIIL programming.	216
0.01 to 1 GHz	HP 70341A	**Companion low-frequency module to HP 70340A.** 1/8 MMS module adds 0.01 to 1 GHz frequency coverage when used with the HP 70340A. Extend high performance AM, FM, and pulse modulation to RF frequencies.	216

Frequency-Agile/Complex Signal Simulation

10 to 2500 MHz	HP E2507B and E2508A	**Multi-format communications signal simulator.** Generates the multi-channel cellular signals you need to accurately test your cellular amplifiers and related products. They also provide background environments that simulate field conditions for BER and other tests in the laboratory.	217
0.252 to 1030 MHz 0.252 to 2060 MHz	HP 8645A	**Performance signal generator for testing frequency-agile radios and surveillance receivers.** 15 μs switching speed. Spectral purity. AM, FM, pulse modulation. FM deviation to 20 MHz. Flexible control of frequency.	219
DC to 50 MHz	HP 8791 Model 7	**Baseband FASS.** Architecturally equivalent to the Model 11, the Model 7 provides exceptional baseband performance to 50 MHz. Full arbitrary control of AM, FM, FM, and pulse make this high-performance direct-digital synthesizer an excellent fit for entry-level FASS users in applications such as communications, digital, video, radar target simulation, and exciter design. Fully upgradeable to Model 11 or 21.	221
0.01 to 3 GHz	HP 8791 Model 11	**Reconfigureable agile-signal simulator for radar, EW, and spread-spectrum simulation.** Advanced frequency-agile signal simulation for EW, radar, and communication receiver test. 100 ns frequency-hopping over 3 GHz. Arbitrary control over AM, FM, FM, pulse modulation and agile carrier. 40 MHz modulation bandwidth. Easy-to-use application-specific instrument-on-a-disk software. Optional upconversion available to 18 GHz, upgradeable to Model 21.	221
0.05 to 18 GHz	HP 8791 Model 21	**Microwave-agile simulator.** Same as Model 11 (above), but uses state-of-the-art microwave-agile upconverter with 100 ns (typical) switching time for the entire range from 50 MHz to 18 GHz. Intended for "exotic" modulation requirements in radar/EW, and secure communication applications.	221

Millimeter Sources

26.5 to 40 GHz 33 to 50 GHz 40 to 60 GHz 50 to 75 GHz 75 to 110 GHz	HP 83554A HP 83555A HP 83556A HP 83557A HP 83558A	**Efficient frequency multipliers.** Effectively extends the performance of an 11 to 20 GHz microwave source HP 8673B/C/D, 8340, 8341, 8350B, 83751/52 or 8360 to the millimeter-wave frequency ranges.	223

Economy RF Signal Generators

HP ESG-1000A
HP ESG-2000A
HP ESG-3000A
HP ESG-4000A

- 250 kHz up to 4.0 GHz
- Flexible architecture, upgrade paths for options, and digital
- 4 GHz electronic attenuator for reliability and repeatability
- Superior level accuracy
- Wideband FM and Phase Modulation
- Step sweep (frequency, power and list)
- Built-in function generator

HP ESG-4000A

HP ESG Series Analog Signal Generators

The HP ESG Series of analog RF signal generators offer excellent in-channel performance with superior quality and reliability, at an affordable price. The first in a new generation of signal generators, they provide excellent frequency and level control, and wide modulation capabilities. They are ideally suited to meet the demanding requirements of today's receiver test, component test and local oscillator applications.

Adaptable to Tomorrow's Requirements

The innovative design of the HP ESG series provides a flexible architecture that can be tailored to meet the changing demands of evolving markets. These signal generators provide upgrade paths for options (current or future), and analog to digital.

Low Cost of Ownership

Lower initial cost, high reliability and a two-year calibration cycle, all strive to minimize the cost of ownership. The HP ESG series of RF signal generators are designed for long-term dependability, maximizing production throughput and uptime.

Specifications

Frequency

HP ESG-1000A: 250 kHz to 1000 MHz
HP ESG-2000A: 250 kHz to 2000 MHz
HP ESG-3000A: 250 kHz to 3000 MHz
HP ESG-4000A: 250 kHz to 4000 MHz
Resolution: 0.01 Hz
Switching Speed:
Modulation On: < 45 ms, typical
Modulation Off: < 35 ms, typical
Accuracy: Stability x fc timebase

Sweep Modes

Operating modes: Step: frequency and power, and arbitrary list
Dwell Time: 1 ms to 60 sec
Number of points: 2 to 401

Internal Reference Oscillator

Timebase Stability:

	Standard (typical)	High Stability (Option 1E5)
Aging Rate	< ± 2 ppm/yr.	< ± 0.1 ppm/yr. or < ± 0.0005 ppm/day after 45 days
Temperature (0° to 55° C)	< ± 1ppm	< ± 0.05 ppm, typical
Line Voltage	< ± 0.1 ppm (+5%, –10%)	< ± 0.002 ppm, typical (+5%, –10%)

Timebase Reference Output:
Frequency: 10 MHz
Amplitude: > 0.35 V_{rms} into 50 Ω load
External Reference Input:
Frequency: 1, 2, 5, 10 MHz ± typ. 10 ppm (1 ppm, Option 1E5)
Amplitude: > 0.15 V_{rms}
Input Impedance: 50 Ω

Output

Range
250 kHz to 1000 MHz: +13 to –136 dBm
> 1000 MHz to 3000 MHz: +10 to –136 dBm
> 3000 MHz to 4000 MHz: +7 to –136 dBm
Resolution: 0.02 dB
Level Accuracy (at 23° ± 5° C):

	+7 to –127 dBm	< –127 dBm
250 kHz to 2 GHz	± 0.5 dB	± 1.5 dB
2 GHz to 4 GHz	± 0.9 dB	± 2.5 dB

Attenuator Hold Level Range: > 17 dB
Switching Speed: < 25 ms typical
With Power Search Mode: < 210 ms typical
Reverse Power Protection[1]:
250 kHz to 2000 MHz: 50 watts
> 2000 MHz to 4000 MHz: 25 watts
Max. DC Voltage: 50 V
SWR (typical):
250 kHz to 2000 MHz: < 1.4:1
> 2000 to 4000 MHz: < 1.9:1
Output Impedance: 50 ohms

Frequency Bands

Band	Frequency Range	N #
1	250 kHz to ≤ 249.999 MHz	1
2	> 249.999 to ≤ 500 MHz	0.5
3	> 500 MHz to ≤ 1 GHz	1
4	> 1 to ≤ 2 GHz	2
5	> 2 to ≤ 4 GHz	4

Spectral Purity

SSB Phase Noise (typical, at 20 kHz offset)
at 500 MHz: < –120 dBc/Hz
at 1000 MHz: < –116 dBc/Hz
at 2000 MHz: < –110 dBc/Hz
at 3000 MHz: < –104 dBc/Hz
at 4000 MHz: < –104 dBc/Hz
Residual FM (CW mode, 0.3–3 kHz BW, CCITT, rms)
Phase Noise Mode 1: < N x 2 Hz
Phase Noise Mode 2: < N x 4 Hz
Harmonics (≤ + 4 dBm output level): < – 30 dBc
Nonharmonics (> 3 kHz offset, < + 7 dBm output level)[2]
250 kHz to 1000 MHz: < – 65 dBc
> 1000 MHz to 2000 MHz: < – 59 dBc
> 2000 MHz: < – 53 dBc
Subharmonics
≤ **1000 MHz:** None
> 1000 MHz: < – 40 dBc

Frequency Modulation

Maximum Deviation: N x10 MHz
Resolution: 0.1% of deviation or 1 Hz, whichever is greater
Deviation Accuracy (1 kHz rate, dev. < N x 100 kHz):
< ± (3.5% of FM deviation + 20 Hz)

Modulation Frequency Response (deviation = 100 kHz)

Path	Rates	
	1 dB Bandwidth	**3 dB Bandwidth, typical**
FM1	dc/20 Hz to 100 kHz	dc/5 Hz to 10 MHz
FM2	dc/20 Hz to 100 kHz	dc/5 Hz to 1 MHz

Distortion (1 kHz rate, THD, dev.=N x 100 kHz): < 1%

[1]The reverse power protection circuitry triggers at nominally 1 watt.
[2]Specifications apply for FM deviations < 100 kHz and are not valid for ΦM. Performance is typically limited to –45 dBc at the symbol rate of π/4 DQPSK modulating signals.

Phase Modulation

Maximum Deviation: N x 90 radians
Resolution: 0.1% of set deviation
Deviation Accuracy (1 kHz rate)**:** < ± (5% of deviation + 0.01 radians)

Modulation Frequency Response:

ΦM Mode	Maximum Deviation	Rates (3 dB BW)	
		ΦM1	**ΦM2**
Normal	N x 90 rad	dc–100 kHz	dc–100 kHz
High Bandwidth	N x 2π rad N x π/2 rad	dc–1.5 MHz (typ.) dc–4 MHz (typ.)	dc–1 MHz (typ.) dc–0.9 MHz (typ.)

Distortion (1 kHz rate, THD, dev < N x 90 radians)**:** < 1%

Amplitude Modulation[3] f_c > 500 kHz

Range (envelope peak ≤ max. specified power)**:** 0 to 100%
Resolution: 0.1%
Rates (3 dB bandwidth)**:** dc/10 Hz to 10 kHz
Distortion (1 kHz rate, THD)**:** 30% AM: < 1.5%, 90% AM: < 4 %
Accuracy (1 kHz rate)**:** < ± (5% of setting + 1%)

Pulse Modulation

On/Off Ratio: ≤ 3 GHz: > 80 dB; > 3 GHz: > 60 dB
Rise/Fall Times: 150 ns, typical
Minimum Width (typical)**:** ALC On: 2µs; ALC Off: 0.4µs
Pulse Repetition Frequency (typical)**:**
- **ALC On:** 10 Hz–250 kHz
- **ALC Off:** DC–1.0 MHz

Level Accuracy (relative to CW)[4]**:** ± 0.5 dB, typical
Internal Pulse Generator
Squarewave Rates: 0.1 Hz–50 kHz
Pulse
Period: 16 µs to 30 sec
Width: 8 µs to 30 sec
Resolution: 4 µs

Internal Modulation Source

Provides FM, ΦM, and AM Modulation Signals and LF Out
Waveforms: Sine, square, ramp, triangle, pulse, and noise
Rate Range:
- **Sine:** 0.1 Hz–50 kHz
- **Square, Ramp, Triangle:** 0.1 Hz–10 kHz

Resolution: 0.1 Hz
Pulse Only: 4 µs
Frequency Accuracy: 0.005%
Swept Sine Mode (Frequency, Phase Continuous)
- **Operating Modes:** Triggered or Continuous Sweeps
- **Frequency Range:** 0.1 Hz to 50 kHz
- **Sweep Time:** 1 ms to 65 sec
- **Resolution:** 1 ms

Dual Sinewave Mode
- **Frequency Range:** 0.1 Hz to 50 kHz
- **Amplitude Ration:** 0 to 100%
- **Amplitude Resolution:** 0.1%

LF Out (Internal Modulation Source)

Amplitude: 0 to 3 V_{peak} into 50 Ω
Output Impedance: < 1 Ω

External Modulation Inputs

Modulation Types:
- **Ext1:** FM, ΦM, AM, and Burst Envelope
- **Ext2:** FM, ΦM, AM, and Pulse

High/Low Indicator (100 Hz to 10M Hz BW, AC coupled inputs only)**:**
Activated when input level error exceeds 3% (normal)

Simultaneous Modulation

All modulation types may be simultaneously enabled, except: FM with ΦM, AM with Burst Envelope. AM, ΦM, and FM can sum simultaneous inputs from any two sources (INT, EXT1, and EXT2). Any given source (INT, EXT1, or EXT2) may only be routed to one activated modulation type.

Remote Programming

Interface: HP-IB (IEEE-488.2-1987) with Listen and Talk. RS-232.
Control Languages: SCPI version 1992.0, also compatible with HP 8656B and 8657A/B/D/J mnemonics
Functions Controlled: All front-panel functions except power switch and knobs
IEEE-488 Functions: SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT0, C0, E2

General

Power Requirements: 90 to 254 V; 50, 60, or 400 Hz; 200 W maximum
Operating Temperature Range: 0 to 55° C
Leakage: Conducted and radiated interference meets MIL-STD-461B RE02 Part 2 and CISPR 11
Storage Registers: Up to 100 storage registers, up to 10 sequences available
Weight: < 12.7 kg (28 lb) net, < 21 kg (46 lb) shipping
Dimensions: 133 mm H x 426 mm W x 432 mm D
(5.25 in H x 16.8 in W x 17 in D)

Key Literature

HP ESG and ESG-D Series Brochure, p/n 5965-9088E
ESG Series Technical Specifications, p/n 5965-3096E
Source Selection Guide, p/n 5965-3094E

Ordering Information

HP ESG-1000A E4400A
HP ESG-2000A E4420A
HP ESG-3000A E4421A
HP ESG-4000A E4422A
- **Opt 1EM** Move Connectors to Rear Panel
- **Opt 1E5** Add High-Stability Timebase

Accessories
Transit Case p/n 9211-1296
HP 83300A Remote Interface

[3] AM is typical above 3 GHz.
[4] With ALC on, specifications apply for repetition rates < 10 kHz and pulse widths ≥ 5 ms.

HP 8647A
HP 8648A
HP 8648B
HP 8648C
HP 8648D

- ±1 dB level accuracy through 2.5 GHz
- 4 Hz residual FM at 500 MHz
- Electronic attenuator (1 GHz models)
- +10/+13 to –136 dBm output power
- Simple, dependable operation
- Pager signaling (HP 8648A Option 1EP)

HP 8648A/B/C/D

HP 8647A and HP 8648A/B/C/D Synthesized Signal Generators

HP-IB

4

Superior Value in Economy Signal Generators

The HP 8647A and 8648A/B/C/D family of synthesized signal generators delivers solid performance and reliability at an affordable price. These signal generators provide the features and performance needed for semi-automated receiver testing and for use in a variety of general-purpose applications over a 9 kHz to 4000 MHz frequency range.

High Reliability and Simplicity

Designed to Hewlett-Packard's stringent quality specifications, these signal generators provide consistent performance. The all-electronic attenuator in the HP 8647A and 8648A easily handles millions of amplitude cycles with highly repeatable output levels.

An easy-to-use front panel interface shortens the operator's learning curve and increases productivity. A front panel organized in functional blocks speeds identification of the task and simplifies operation.

Ideal for Manufacturing and Semi-Automated Test

The HP 8647A and 8648 series are ideal for manufacturing high-volume products such as cordless telephones, pagers, and two-way radios. The HP 8647A is the basic model providing essential performance. The HP 8648 series provides enhancements in frequency range, residual FM, level accuracy, and phase noise, in addition to optional high power, pulse modulation, and waveform modulation. The HP 8648 series provides ±1 dB absolute amplitude accuracy up to 2.5 GHz. All of the models offer ultra stable dc FM, with ±500 Hz carrier frequency accuracy below frequencies of 1001 MHz, and low RF leakage.

Applications such as receiver tuning and alignment benefit from the simple user interface. These signal generators are so easy to learn and use that experienced operators are no longer required. With 300 full storage registers and ten user-definable sequences, the signal generator easily adapts to any test procedure. Once setups are stored in registers, operators can quickly sequence through them, either from the front panel or through a remote keypad (HP 83300A). In addition, the HP 83301A memory interface provides the means to transfer register information from one HP 8647/8 to another.

For automated test applications, the HP 8647/48 offers full HP-IB programmability and uses SCPI programming codes. In addition, the HP 8648 series reduces software development costs by providing full HP-IB code compatibility with the HP 8656B and 8657A/B signal generators.

New Cost-Effective Pager Testing

The HP 8648A with Option 1EP provides an economical, one-box solution for pager test. Option 1EP adds the pager encoding capability for POCSAG, FLEX, and FLEX-TD formats to the HP 8648A. Ideal for pager test applications, the HP 8648A with Option 1EP offers superior frequency accuracy, deviation accuracy, and dc FM performance.

Specifications

Frequency
HP 8647A: 250 kHz to 1000 MHz
HP 8648A: 100 kHz to 1000 MHz
HP 8648B: 9 kHz to 2000 MHz
HP 8648C: 9 kHz to 3200 MHz
HP 8648D: 9 kHz to 4000 MHz

Resolution
HP 8647A: 1 Hz; HP 8648A/B/C/D: 0.001 Hz
Display: 10 Hz

Switching Speed (typical)
HP 8647A: < 120 ms
HP 8648A/B/C/D: <1001 MHz: < 75 ms; ≥ 1001 MHz: < 100 ms

Accuracy (after one hour warm-up and within one year calibration): Typically ± 3 x 10^{-6} x carrier frequency in Hz, ± 0.15 x 10^{-6} x carrier frequency in Hz for Option 1E5 (typically ± 0.072 x 10^{-6} x fc)

Internal Reference Oscillator
Accuracy and Stability (calibration adjustment dependent; after one hour warm-up and within one year of calibration), ± aging rate ± temperature effects ± line voltage effects

	Standard Timebase	Option 1E5
Aging	< ± 2 ppm/yr	< ± 0.1 ppm/yr; < ± 0.0005 ppm/day
Temperature	< ± 1 ppm	< ± 0.01 ppm (typ.)
Line Voltage (± 5%)	< ± 0.5 ppm	N/A

Output: 10 MHz, typically > 0.5 V_{rms} into 50 Ω
External Reference Oscillator Input: Accepts 2, 5, 10 MHz ±5 ppm, and a level range of 0.5 V to 2 V_{rms} into 50 Ω

Spectral Purity
Harmonics (output ≤ 4 dBm): < –30 dBc
Subharmonics (output ≤ +4 dBm) < 1001 MHz: –60 dBc; ≥ 1001 MHz: –50 dBc; > 3200 MHz: –40 dBc
Nonharmonics (≥ 5 kHz offset, ≤ +4 dBm output level)
HP 8647A: < –60 dBc (–55 dBc from 220 to 250 MHz)
HP 8648A/B/C/D
< 249 MHz: < –55 dBc; < 2001 MHz: < –54 dBc
< 1001 MHz: < –60 dBc; ≤ 4000 MHz: < –48 dBc
Residual FM (CCITT, rms)
HP 8647A
< 249 MHz: < 20 Hz, typically < 11 Hz
< 501 MHz: < 10 Hz, typically < 6 Hz
≤ 1000 MHz: < 20 Hz, typically < 11 Hz
HP 8648A/B/C/D
< 249 MHz: < 7 Hz, typically < 4 Hz
< 501 MHz: < 4 Hz, typically < 2 Hz
< 1001 MHz: < 7 Hz, typically < 4 Hz
< 2001 MHz: < 14 Hz, typically < 8 Hz
≤ 4000 MHz: < 28 Hz, typically < 12 Hz
SSB Phase Noise (at 20 kHz offset, typical)
HP 8647A
@ fc 500 MHz: < –110 dBc/Hz; @ fc 1000 MHz: < –106 dBc/Hz
HP 8648A/B/C/D
@ fc 500 MHz: < –120 dBc/Hz; @ fc 3000 MHz: < –106 dBc/Hz
@ fc 1000 MHz: < –116 dBc/Hz; @ fc 4000 MHz: < –104 dBc/Hz
@ fc 2000 MHz: < –110 dBc/Hz

Output Range
HP 8647A and 8648A: +10 to –136 dBm
HP 8648B/C/D: ≤ 2500 MHz: +13 to –136 dBm; > 2500 MHz: +10 to –136 dBm

Max. Power with Option 1EA (High Power) on HP 8648B/C/D only

Freq. (MHz)	< 0.1	≤ 1000	≤ 1500	≤ 2100	≤ 2500	≤ 4000
Power (dBm)	+17	+20	+19	+17	+15	+13

Display Resolution: 0.1 dB
Accuracy (specified power < 13 dBm to –127 dBm)
HP 8647A: ± 1.5 dB
HP 8648A/B/C/D (applies at 25° ± 5° C):
≤ 2500 MHz: ± 1.0 dB
≤ 3200 MHz: ± 1.5 dB (≥ –100 dBm; ± 3.0 dB < –100 dBm)
≤ 4000 MHz: ± 2.0 dB (≥ –100 dBm; ± 3.0 dB < –100 dBm)
Reverse Power Protection (watts into 50 Ω)
HP 8647A and 8648A/B: 50 watts
HP 8648C/D: 50 watts ≤ 2000 MHz; 25 watts > 2000 MHz

SWR: (output < –6 dBm, typical)
HP 8647A: < 2.0:1
HP 8648A/B/C/D:
< 249 kHz: < 2.5:1
≤ 2500 MHz: < 1.5:1
≤ 3200 MHz: < 2.0:1
Output Impedance: Nominally 50 Ω

Frequency Modulation

Peak Deviation (rates > 25 Hz ac FM)	8647A	8648A/B/C/D
< 249 MHz	0 to 100 kHz	0 to 200 kHz
< 501 MHz	0 to 50 kHz	0 to 100 kHz
< 1001 MHz	0 to 100 kHz	0 to 200 kHz
< 2001 MHz	N/A	0 to 400 kHz
≤ 4000 MHz	N/A	0 to 800 kHz

Resolution
For ≤ 10% peak deviation
< 2001 MHz: 10 Hz
≥ 2001 MHz: 20 Hz
For > 10% to maximum peak deviation
< 2001 MHz: 100 Hz
≥ 2001 MHz: 200 Hz
Deviation Accuracy (internal 1 kHz rate)
HP 8647A: ± 7.5% of FM deviation ± 30 Hz
HP 8648A/B/C/D
< 1001 MHz: ± 3% of deviation ± 30 Hz
< 2001 MHz: ± 3% of deviation ± 60 Hz
≤ 4000 MHz: ± 3% of deviation ± 120 Hz
HP 8648A Option 1EP only:
50 Hz at 276 to 284 MHz, 406 to 512 MHz, and 929 to 932 MHz
Rates
HP 8647A
Internal: 400 Hz or 1 kHz
External dc: DC to 75 kHz (typical, 3 dB BW)
External ac: 20 Hz to 75 kHz (typical, 3 dB BW)
HP 8648A/B/C/D
Internal: 400 Hz to 1 kHz (10 Hz to 20 kHz for Option 1E2)
External dc: dc to 150 kHz (typical, 3 dB BW)
External ac: 1 Hz to 150 kHz (typical, 3 dB BW)
Distortion (1 kHz rate, THD + N, 0.3 to 3 kHz BW)
< 1001 MHz: < 1% at deviations > 4 kHz
< 2001 MHz: < 1% at deviations > 8 kHz
≤ 4000 MHz: < 1% at deviations > 16 kHz
HP 8648A/B/C/D 88 to 108 MHz: < 0.5% at deviations ≥ 75 kHz
Carrier Frequency Accuracy (relative to CW in dc FM, at 25° ± 5° C)
< 1001 MHz: ± 100 (typ. 40*) Hz, deviations < 10 kHz
< 2001 MHz: ± 200 (typ. 80*) Hz, deviations < 20 kHz
≤ 4000 MHz: ± 400 (typ. 160*) Hz, deviations < 40 kHz
FM + FM: Internal 1 kHz to 400 Hz source plus external. In internal plus external FM mode, the internal source produces the set level of deviation. The external input should be set to ≤ ±0.5 V peak or 0.5 Vdc (one-half the set deviation).

Phase Modulation
Peak Deviation
< 249 MHz: 0 to 10 radians
< 501 MHz: 0 to 5 radians
< 1001 MHz: 0 to 10 radians
< 2001 MHz: 0 to 20 radians
≤ 4000 MHz: 0 to 40 radians
Resolution
< 2001 MHz: 0.01 radian
≥ 2001 MHz: 0.02 radian
Deviation Accuracy (internal 1 kHz rate, typical)
HP 8647A: ± 7.5% of deviation ± 0.05 radians
HP 8648A/B/C/D
< 1001 MHz: ± 3% of deviation ± 0.05 radians
< 2001 MHz: ± 3% of deviation ± 0.1 radians
≤ 4000 MHz: ± 3% of deviation ± 0.2 radians
Rates
Internal: 400 Hz or 1 kHz (10 Hz to 20 kHz for Option 1E2, 8648A/B/C/D only)
External: 20 Hz to 10 kHz (typical, 3 dB BW)
Distortion (1 kHz rate)
HP 8647A < 2% at deviations ≥ 3 radians
HP 8648A/B/C/D
< 1001 MHz: < 1% at deviations ≥ 3 radians
< 2001 MHz: < 1% at deviations ≥ 6 radians
≤ 4000 MHz: < 1% at deviations ≥ 2 radians

*Within one hour after dc FM calibration

Amplitude Modulation
(AM is not specified below 1.5 MHz and is typical above 1001 MHz.)
Range: 0 to 100%; output ≤ +4 dBm
Resolution: 0.1%
Accuracy (1 kHz rate): ± 5% of setting ± 1.5% (for HP 8648B/C/D, specification is applicable at 25° ±5° C and < 70% depth)
Rates
Internal: 400 Hz or 1 kHz (10 Hz to 20 kHz for Option 1E2, 8648A/B/C/D only)
External dc: dc to 25 kHz (typical, 3 dB BW)
External ac: 1 Hz to 25 kHz (typical, 3 dB BW)
Distortion (1 kHz rate, THD+ N, 0.3 to 3 kHz BW)
HP 8647A and 8648A: @ 30% AM: < 2%; @ 90% AM: < 3%
HP 8648B/C/D: @ 30% AM: < 2%; @ 70% AM: < 3%
Pager Test Option 1EP (HP 8648A only)
Signaling Formats: POCSAG, FLEX, and FLEX-TD (RCR-43)
Pulse Option 1E6 (HP 8648B/C/D only)
On/Off Ratio: > 80 dB < 2000 MHz; > 70 dB ≥ 2000 MHz
Rise/Fall Times: < 10 ns
Modulation Generator Option 1E2 (HP 8648A/B/C/D only)
Adds variable frequency modulation generator.
Frequency Range: Sine: 10 Hz to 20 kHz;
Square, Triangle, Sawtooth: 100 Hz to 2 kHz
Frequency Accuracy: ± 0.01% typical
Frequency Resolution: 1 Hz (3 digits displayed)

Modulation Source
Internal: 400 Hz or 1 kHz, front panel BNC connector provided at nominally 1 V (p-p) into 600 Ω
External: 1 V peak into 600 Ω (nominal) required for full scale modulation. (High/Low indicator provided for external signals ≤ 10 kHz.)

Remote Programming
Interface: HP-IB (IEEE-488.2-1987) with Listen and Talk
Control Languages: SCPI version 1992.0. The HP 8648A/B/C/D are code compatible with the HP 8656B and 8657.
Functions Controlled: All front panel functions except power switch and knobs
IEEE-488: SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT0, C0, E2

ISO Compliant
The HP 8647A and 8648A/B/C/D signal generators are manufactured in an ISO 9002 registered facility in concurrence with HP's commitment to quality.

General

Power Requirements: 90 to 264 V, 48 to 440 Hz; 170 VA max.
Operating Temperature: 0° to 50° C
Leakage: Conducted and radiated interference meets MIL-STD-461B RE02 and FTZ 1046. Typically < 1 µV.

Key Literature

HP 8647A and 8648A/B/C/D Data Sheet, p/n 5965-3432E
Signal Generator Selection Guide, p/n 5965-3094E
HP 8647A and 8648A/B/C Brochure, p/n 5962-6191E
HP 8648A Option 1EP Pager Encoder Datasheet, p/n 5964-4116E

Ordering Information

HP 8647A Synthesized Signal Generator
HP 8648A Synthesized Signal Generator
HP 8648B Synthesized Signal Generator
HP 8648C Synthesized Signal Generator
HP 8648D Synthesized Signal Generator
Opt 1EA High Power (HP 8648B/C/D only)
Opt 1EP Pager Encoder (HP 8648A only)
Opt 1E6 Pulse (HP 8648B/C/D only)
Opt 1E2 Modulation Generator
Opt 1E5 High-Stability Timebase
Opt 1CM Rack Kit, p/n 08647-61020 (HP 8647A)
Opt 1CM Rack Kit, p/n 08648-60001 (HP 8648)
HP 83300A Remote Interface
HP 83301A Memory Interface

HP 8656B
HP 8657A
HP 8657B

- 100 kHz up to 2060 MHz
- Electronic attenuator on HP 8657A
- ± 1.0 dB level accuracy (typically ± 0.5 dB on HP 8657A)
- 50 W reverse power protection on HP 8657A/B
- AM, FM, and optional pulse modulation

HP 8657A

HP 8657B

HP 8656B Synthesized Signal Generator

The HP 8656B is a programmable synthesized signal generator that combines performance, quality, and economy, covering the 0.1 to 990 MHz frequency range.

Precise Output Control

The HP 8656B provides ±1.0 dB absolute level accuracy and 0.1 dB resolution with calibrated power levels over +13 to –127 dBm. The output level can be offset to compensate for losses external to the generator. RF leakage is well-shielded at < 1.0 µV and 25 W reverse power protection guards against accidental damage.

Versatile Modulation

The HP 8656B is capable of simultaneous AM and FM modulation. The instrument provides internal 1 kHz and 400 Hz sources and also accepts external sources. AM is ac-coupled, while FM can be either ac- or dc-coupled. The dc-coupling is exceptionally stable (< 10 Hz/hour drift) and accurate (± 500 Hz center frequency accuracy).

HP 8657A/B Synthesized Signal Generators

The HP 8657A and 8657B offer excellent performance at an affordable price. The HP 8657A covers a 100 kHz to 1040 MHz frequency range while the HP 8657B covers 100 kHz to 2060 MHz.

High-Performance Spectral Purity and Output Power

The low residual FM (< 4 Hz at frequencies < 1040 MHz) and the excellent phase noise performance of these signal generators make them ideal for almost all measurements requiring test signals at adjacent or out-of-channel offsets. Features such as carrier phase adjust allow you to characterize phase-sensitive devices such as phase detectors or phase interferometers, using precise 1-degree phase offsets with respect to another signal source. Display blanking and nonvolatile memory-clear are also available for operation in secure environments.

These signal generators offer wide dynamic output range, from +13 to –143.5 dBm, with unparalleled accuracy of ±1.0 dB. The solid-state electronic attenuator in the HP 8657A is so reliable, it is backed with a five-year warranty against failure. The HP 8657A/B also have extremely low radiated emissions for making sensitivity measurements on your receiver or for design work on extremely sensitive circuitry. Reverse power protection is provided standard for protection up to 50 W.

High-Performance Versatile Modulation

The HP 8657A and 8657B can combine modulation modes for AM/AM, FM/FM, and AM/FM from both internal and external modulation sources. AM is ac-coupled, while FM can be either ac- or dc-coupled. The patented dc-coupling technique provides excellent long term stability (< 10 Hz/hour drift) as well as center frequency accuracy (± 500 Hz worst case). When dc FM is enabled, SSB phase noise and residual FM performance are not degraded as with other generators.

Pulse modulation is available with the HP 8657B Option 003. This option offers fast rise time and high isolation. Rise times are 35 to 50 ns (typically 10 to 18 ns) and on/off ratios are 70 to 95 dB. For pulse modulation coverage to 1040 MHz only, order the HP 8657B Option H60.

Ease of Operation for Improved Productivity

Up to 100 complete front-panel setups can be stored in the signal generator's memory for recall during testing. These setups can be accessed sequentially by pushing one front-panel key or by using the rear-panel SEQ port. The SEQ port can be connected to a foot switch or other operator-controlled device.

HP 8656B, 8657A/B Specification Summary

Specifications	HP 8656B	HP 8657A	HP 8657B
Frequency			
Range	100 kHz to 990 MHz	100 kHz to 1040 MHz	100 kHz to 2060 MHz
Resolution	10 Hz	10 Hz	1 Hz
Timebase aging rate	± 2 ppm/year (typ.)	± 2 ppm/year (typ.)	± 2 ppm/year (typ.)
Option 001	1.5×10^{-8} parts/day after 10 days (typ.)	1.5×10^{-8} parts/day after 10 days (typ.)	1×10^{-9} parts/day after 45 days (typ.)
Switching speed (w/i 100 Hz)	< 35 ms (25 ms typ. at 25° C)	< 35 ms (30 ms typ. at 25° C)	< 35 ms (30 ms typ. at 25° C)
Spectral Purity			
SSB phase noise			
(f_c = 500 MHz, 20 kHz offset)	< –114 dBc/Hz	< –130 dBc/Hz	< –130 dBc/Hz
Nonharmonics (> 5 kHz offset, CW)	< –60 dBc	< –60 dBc	< –60 dBc, < 1030 MHz < –54 dBc, ≥ 1030 MHz
Harmonics (at levels ≤ + 7 dBm)	< –30 dBc	< –30 dBc	< –30 dBc, < 1030 MHz < –25 dBc, ≥ 1030 MHz
Subharmonics	None	None	None, 100 kHz to 1030 MHz < –35 dBc, 1030 to 2060 MHz
Residual FM			
(0.3 to 3 kHz f_c = 500 MHz, CW)	< 7 Hz rms	< 4 Hz rms	< 2 Hz rms (< 6 Hz > 1040 MHz)

Specifications (cont'd)	HP 8656B	HP 8657A	HP 8657B
Output Level			
Range	+13 to –127 dBm into 50 Ω	+12 to –143.5 dBm into 50 Ω, +10 dBm, 100 kHz to 1 MHz	+13 to –143.5 dBm into 50 Ω, +10 dBm, < 1030 MHz w/Opt 003
Resolution	0.1 dB	0.1 dB	0.1 dB
Absolute accuracy	< ± 1 dB, ≥ 123 MHz, +7 to –124 dBm < ± 1.5 dB, < 123.5 MHz and < –124 dBm or > +7 dBm	< ±1 dB, ≥ –127 dBm < ±1.5 dB, > +7 dBm	< ±1 dB, ≥ –127 dBm < ±1.5 dB, ≥ +3.5 dBm
Reverse power protection	25 W	50 W	50 W
Amplitude Modulation			
Depth (output at ≤ + 7 dBm)	0 to 99%	0 to 99% f_c ≥400 kHz	0 to 100% f_c ≥ 400 kHz
Resolution	1%	1%	1%
Bandwidth (1 dB)	20 Hz to 40 kHz	20 Hz to 40 kHz	20 Hz to 40 kHz
Accuracy (internal rates) (< 90% AM < + 7 dBm)	< ± (2% ± 4% of setting)	< ± (2% + 6% of setting)	< ± (2% + 6% of setting)
Distortion (internal rates) (0 to 30% AM, < + 7 dBm)	< 1.5% THD + noise	< 1.5% THD + noise	< 1.5%, <1030 MHz < 4%, > 1030 MHz
Frequency Modulation			
Maximum peak deviation[1]	99 kHz, f_c < 123.5 and > 247 MHz 50 kHz, f_c 123.5 to 247 MHz	99 kHz, f_c < 130 and > 260 MHz 50 kHz, f_c 130 to 260 MHz	50 kHz to 200 kHz, f_c < 1040 MHz 400 kHz, f_c 1040 to 2060 MHz
Resolution	100 Hz, deviations < 10 kHz, 1 kHz, deviations ≥ 10 kHz	100 Hz, deviations < 10 kHz, 1 kHz, deviations ≥ 10 kHz	100 Hz, < 1040 MHz, dev. < 20 kHz 200 Hz, > 1040 MHz, dev. < 20 kHz
Bandwidth (1 dB)	dc/20 Hz to 50 kHz	dc/20 Hz to 50 kHz	dc/20 Hz to 50 kHz
Indicator accuracy	< ± 5% of setting	< ± 5% of setting	< ±5% of setting
Distortion (internal rates, deviation 3 kHz)	< 0.5% THD + noise	< 0.5% THD + noise	< 0.5% THD + noise, (≥ 6 kHz dev. for f_c ≥ 1040 MHz)
Pulse Modulation	Not applicable	Not applicable	Option 003
On/off ratio			>70 dB (> 95 dB, f_c ≥ 1030 MHz)
Rise/fall time, 10% to 90%			< 35 ns (< 50 ns, f_c ≥ 1030 MHz)
Repetition rate			dc to 30 MHz, typical
Duty cycle			0% to 100%
Remote Programming			
Interface	HP-IB (HP's implementation of IEEE-488)		
IEEE-488 functions	SH0, AH1, T0, L2, SR0, RL1, PP0, DC1, DT0, C0, E1		
General			
Save/recall/sequence registers	100 nonvolatile registers to save front-panel settings		
Operating temperature	0° to 55° C		
Power requirements	100 V, 120 V, 220 V or 240 V (+ 5, –10%) from 48 to 440 Hz HP 8656B: 125 VA maximum; HP 8657A: 175 VA maximum; HP 8657B: 200 VA maximum		
Size	HP 8656B, 8657A: 133 mm H x 425 mm W x 520 mm D (5.25 in x 16.75 in x 20.5 in) HP 8657B: 133 mm H x 425 mm W x 574 mm D (5.25 in x 16.75 in x 22.6 in)		
Weight	HP 8656B: 18.1 kg (40 lb); HP 8657A: 18.2 kg (40 lb); HP 8657B: 20.5 kg (45 lb)		

[1] Deviations reduced for low-rate modulation; not specified for $f_c - (f_{pk}) < 100$ kHz.

Key Literature

HP 8656/57 Series Economy Synthesized Signal Generators
Technical Data, p/n 5091-1556E
HP 8656/57 Series Economy Synthesized Signal Generators
Brochure, p/n 5091-1555E

Ordering Information

		HP 8656B	HP 8657A	HP 8657B
Options				
001	High-Stability Timebase			
002	RF Connectors on Rear Panel Only			
003	Pulse Modulation			
H60	Pulse Modulation, Frequencies to 1040 MHz			
907	Front Handle Kit (5061-9689)			
908	Rack Flange Kit (5061-9677)			
909	Combined Front/Rack Flange Kit (5061-9683)			
910	Extra Operation/Calibration and Two Service Manuals			
915	Add Service Manual	(08656-90205)	(08657-90004)	(08657-90007)
W30	Three-year Repair Service			
W32	Three-year Calibration Service			
W34	Three-year Standard Compliant Cal. Service			
W50	Five-year Repair Service			

HP ESG-D1000A
HP ESG-D2000A
HP ESG-D3000A
HP ESG-D4000A

- 250 kHz up to 4.0 GHz
- Built-in digital modulation formats for CDMA, DECT, GSM, NADC, PDC, PHS, and TETRA (Options H03/UN3/UN4)
- Analog I and Q
- Superior level accuracy
- Step sweep (frequency, power and list)
- Wideband FM and phase modulation
- Internal data generator and burst capabilities

HP ESG-D4000A

HP ESG-D Series Digital and Analog Signal Generators

HP-IB

The HP ESG-D series of RF signal generators provide a wide range of digital modulation capabilities, in addition to a comprehensive feature set and excellent analog performance—all at an affordable price. The first in a new generation of signal generators, they provide excellent modulation accuracy and stability, as well as unprecedented level accuracy. They are ideally suited to meet the demanding requirements of today's digital receiver test, component test and local oscillator applications.

4

Built-in Personalities for Common Communication Standards

Internally generate π/4 DQPSK, GMSK, GFSK, signals to meet the test requirements of NADC, PDC, PHS, TETRA, GSM, and DECT receivers with Options UN3/UN4. Test CDMA mobile components and enable transmitter tests by generating QPSK and OQPSK signals with Option H03. A choice of internal or external data generation, and flexible framing and time-slot configuration capabilities is available. In addition, adjustable data rates, filter factors, and burst shaping provides operators enormous measurement versatility.

Flexible Frames and Timeslots, as well as Internal Burst and Data Generation

Easily configure timeslots to simulate different types of traffic, control, or synchronization channels (or bursts). Generate mobile- or base-station transmissions for a variety of digital communications standards with the internal burst capabilities. Also, reduce the need for external equipment with comprehensive data generation capabilities.

Broadband I and Q Modulation

Use the analog I and Q inputs to generate the complex modulation formats (such as BPSK, QPSK, and 16QAM), required for the development and testing of RF digital communications systems. A built-in quadrature modulator processes the I and Q input signals to provide superior modulation accuracy and stability over a 10 MHz (1 dB) bandwidth.

Excellent Level Accuracy

Make sensitivity tests accurately and efficiently with the wide power range (+13 to –136 dBm) and superior level accuracy of the HP ESG-D series RF signal generators. Level accuracies of better than ±1.1 dB for the built-in modulation formats and typically less than ±0.6 dB, ensures precise measurement of even the most sensitive digital receivers.

Wideband FM and Phase Modulation

Extremely stable dc FM precisely reproduces digital signaling for FM receivers with selective squelch control. Wideband phase modulation capabilities are useful for satellite communications applications, offering deviations up to 90 radians and 6 MHz rates.

Specifications

Frequency
HP ESG-D1000A: 250 kHz to 1000 MHz
HP ESG-D2000A: 250 kHz to 2000 MHz
HP ESG-D3000A: 250 kHz to 3000 MHz
HP ESG-D4000A: 250 kHz to 4000 MHz

For Analog Specifications, see ESG Series on page 196.

Wide Band AM
Rate (1 dB bandwidth, typical):
ALC On: 400 Hz –10 MHz
ALC Off: dc –10 MHz
Input: I Input
Impedance: 50 Ω
Sensitivity: 0.5 V = 100%

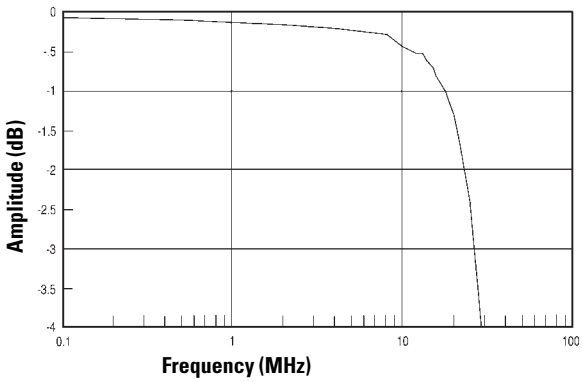
Level Accuracy with Digital Modulation

(With ALC on; relative to CW; with PRBS-modulated data; if using I/Q inputs, = $\sqrt{I^2 + Q^2}$ = 0.5 V_{rms} nominal)[1]
π/4 DQPSK or QPSK Formats: ± 0.15 dB (with raised cosine or root-raised cosine filter and $\alpha \geq 0.35$; with 10 kHz < symbol rate <1 MHz; at RF freq. > 25 MHz; power < max. specified –3 dBm).
Constant Amplitude Formats (FSK, GSMK, etc.)**:** no degradation in power level accuracy
Level Accuracy with ALC Off[2]**:** ± 0.3 dB, typical (after power search is executed; relative to CW level accuracy with ALC on; if external I/Q is enabled: $\sqrt{I^2 + Q^2}$ = 0.5 V_{rms})

IQ Modulation

I&Q Inputs:
Input Impedance: 50 Ω
Full Scale Input: $\sqrt{I^2 + Q^2} = 0.5\ V_{rms}$
External Input Bandwidth (1 dB): 10 MHz, typical

I/Q Bandwidth



Adjustments/Impairments (nominal):
DC Offset: (I and Q independently adjustable) +100%
I/Q Gain Ratio: ± 4 dB

DC Vector Accuracy[3]**:** (relative to full scale, power ≤ + 7 dBm)

Frequency (GHz)	< 0.6	0.6 to 2	2 to 3.7	≤ 4
Static EVM[1] (rms)	< 0.75%	< 0.5%	0.75%	< 1%
Magnitude Error[1] (rms)	< 0.5%	< 0.35%	< 0.5%	< 0.75%
Phase Error[1] (rms)	< 0.35°	< 0.25°	< 0.35°	< 0.5°
Origin Offset (dBc)	< –46	< –46	< –40	< –40

[1] Measured at full scale with origin offset removed.

Burst Envelope

On/Off Ratio: V_{IN}: ≤ –1.05 V
≤ **3 GHz:** > 75 dB
> **3 GHz:** > 60 dB
Rise/Fall Time: < 2 μs, typical
Minimum Burst Rate:
ALC On: 10 Hz, typical
ALC Off: DC
External Input: Ext 1
Input Impedance: 50 Ω
Input Voltage: RF Off: –1.0 V; RF On: 0 V

	NADC	PDC	PHS	TETRA	DECT	GSM (DCS, PCS)
Modulation Format	π/4 DQPSK				**GFSK**	**GMSK**
Data Rate (default, kbits/sec)	48.6	42	384	36	1,152	270.83
Adjustment Range (kbits/sec)	40 to 75.5	40 to 75.5	320 to 605	31 to 37.8	922 to 1209.6	163 to 300
Filter	**Root Raised Cosine or Raised Cosine**				**Gaussian**	
Default Value	∝ = 0.35	∝ = 0.5	∝ = 0.5	∝ = 0.35	$B_bT = 0.5$	$B_bT = 0.3$
Range (∝ or B_bT)		0.3, 0.35, 0.4, 0.5, 0.6			0.2 to 0.7 in 0.05 steps	
Error Vector Magnitude[1] (% rms)	**Cont. Burst**	**Cont. Burst**	**Cont. Burst**	**Cont. Burst**		
Optimize EVM Mode	1.4 1.9	1.9 1.8	1.5 1.5	1.5 1.9	N/A	N/A
Optimize EVM Mode (typical)	0.8 1.4	0.9 1.4	0.9 0.9	0.8 1.5	N/A	N/A
Optimize ACP Mode (typical)	1.4 1.8	1.0 1.2	1.2 1.2	3.1 3.2	N/A	N/A
Global Phase Error[1] (rms/pk)	N/A	N/A	N/A	N/A	N/A	0.8° / 2.8° 0.25° / 1.5° (typ.)
Deviation Accuracy[1] (kHz)	N/A	N/A	N/A	N/A	6.1 (2.5, typ)	N/A
Channel Spacing (kHz)	30	25	300	25	1,728	200
Adjacent Channel Power[1] (ACP) (Optimize ACP Mode dBc, typical)	**Cont. Burst**	**Cont. Burst**	**Cont. Burst**	**Cont. Burst**	**N/A**	**Cont. Burst**
at Adjacent Channel[3]	–35 –34	— —	— —	–68 –65	N/A	–38 –37
at 1st Alternate Channel[3]	–75 –73	–71 –69	–76 –75	–77 –76	N/A	–71 –69
at 2nd Alternate Channel[3]	–78 –77	— —	–78 –77	–79 –79	N/A	–81 –79
at 3rd Alternate Channel[3]	–78 –78	–78 –78	— —	–79 –79	N/A	–83 –81
Supported Burst Types	Custom, Up/Down TCH	Custom, Up/Down TCH, Up Vox	Custom, TCH, Sync	Custom, Up Control 1 & 2, Up Normal, Down Normal, Down Sync	Custom, Dummy B 1 & 2, Traffic B, Low Capacity	Custom, Normal, FCorr, Sync, Dummy, Access
Scramble Capabilities	—	—	Yes	Yes	—	—

[1] Specifications apply for the frequency range, data rates, root raised cosine filter and filter factors (∝ or B_bT) specified for each standard, and at power levels ≤ + 7 dBm (≤ 4 dBm for TETRA).
[2] ACP for TETRA is measured over a 25 kHz bandwidth, with an 18 kHz root raised cosine filter applied.
[3] The "channel spacing" determines the offset size of the adjacent and alternate channels: Adjacent Chan. offset = 1 x channel spacing, 1st Alt. Chan. = 2 x channel spacing, 2nd Alt. Chan. = 3 x channel spacing, etc.

HP ESG-D1000A
HP ESG-D2000A
HP ESG-D3000A
HP ESG-D4000A

Optional I/Q Baseband Generator (UN3/UN4)

Data Structure
Frames and timeslots may be configured as different types of traffic or control channels. The data field of a timeslot can accept user file, PRBS (PN9 or PN15), or external data with the appropriate clock.

Internal Data
- **Pseudo-Random Patterns:** Continuous PN9 or PN15
- **Repeating Sequence:** Any 4-bit sequence

Downdoadable Data
- **Type:** Serial data
- **Minimum Size:** Must fill entire field for which it was selected
- **Maximum Size** (Pattern RAM)**:** 1 Mbits (Option UN3), 8 Mbits (Option UN4)
- **Maximum Size** (User File)**:** 128 kbytes

External Data
- **Type:** Serial data
- **Inputs:** Data, bit/symbol clocks (accepts rates ± 5% of specified data rate)
- **Reference Frequency:** Internal or External 1, 2 ,5, 10 MHz reference. (Data clock can be locked to an external 13 MHz GSM reference)

Frame Trigger Delay Control
- **Range:** 0 to 65,000 bits
- **Resolution:** 1 bit

Internal Burst Shape Control
- **Rise/Fall Time Range:** Up to 30 bits
- **Rise/Fall Delay Range:** 0 to 63.5 bits (varies w/standard)

I/Q Outputs
- **Level:** ($\sqrt{I^2 + Q^2}$ = 0.5 V_{rms}, nominal)
- **π/4 DQPSK EVM** (optimize EVM Mode)**:** 2% (1% typ.)
- **GMSK Global Phase Error:** 1° rms
- **GFSK Deviation Accuracy:** 8 kHz

Optional Forward or Reverse Single-Channel CDMA Capability (Option H03)

The following table provides performance characteristics of Option H03 which apply over the 700 to 900 MHz and 1500 to 2000 MHz frequency ranges; performance at IF bands is comparable with PCS bands. High Crest mode optimizes internal settings to minimize distortion. Option H03 is not compatible with Options 1EH, UN3, or UN4.

Modulation Types: QPSK, offset QPSK (OQPSK)
Frequency Range: 250 kHz to maximum instrument frequency
Level Range: –127 to + 7 dBm
Level Accuracy
- **With Modulation Off:** ± 0.5 dB (25° ± 5° C)
- **With Modulation On:** ± 0.1 dB additional error, typical

Chip (Symbol) Rate: 1.2288 MHz, adjustable from 650 kHz to 1.25 MHz
FIR Filters
- **Standard:** As defined by IS-95
- **Modified:** For reduced spurious emissions, meets IS-95 error function

Spreading: Conforms to IS-95, may be turned on or off
Internal Data: Continuous PN9, PN15, and 4-bit repeating sequences
External Data: Accepts serial data with corresponding data clock and symbol sync
Downloadable Data: Serial data up to 1 Mbits long

Spurious Emissions: (In 30 kHz BW, ≤ 0 dBm output level, high crest factor mode on, modified filter, equalizer off)

Freq. (MHz)	0.885–1.25 offsets	1.25–1.98 offsets	> 1.98 offsets
700–900	≤ –68 dBc (–71 dBc typ.)	≤ –74 dBc typ.	≤ –77 dBc typ.
1500–2000	≤ –62 dBc (–66 dBc typ.)	≤ –69 dBc typ.	≤ –77 dBc typ.

RHO (< 4 dBm, typical)
- **QPSK:** Equalizer on: 0.998; equalizer off: 0.945
- **OQPSK:** Standard filter: 0.998; modified filter: 0.997

Pilot Time Offset (typical)**:** < ±1 µs

Error Vector Magnitude: (< 4 dBm, RF and baseband, typ.)

	Equalizer On	Equalizer Off
Standard Filter	< 2 % rms	< 1.3 % rms
Modified Filter	< 4 % rms	< 4 % rms
Rear Panel Outputs	Even Second, Chip (Bit) Clock	Baseband I and Q

Coherent Carrier Out[6]

Range: 250 MHz to maximum carrier frequency
Level: 0 dBm ± 5 dB, typical
Impedance: 50 Ω

Remote Programming

Interface: HP-IB (IEEE-488.2-1987) with Listen and Talk. RS-232.
Control Languages: SCPI version 1992.0, also compatible with HP 8656B and 8657A/B/D/J mnemonics
Functions Controlled: All front-panel functions except power switch and knobs
IEEE-488 Functions: SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT0, C0, E2

General

Power Requirements: 90 to 254 V; 50, 60, or 400 Hz; 200 W maximum
Operating Temperature Range: 0 to 55°C
Leakage: Conducted and radiated interference meets MIL-STD-461B RE02 Part 2 and CISPR 11
Storage Registers: Up to 100 storage registers, up to 10 sequences available
Weight: < 12.7 kg (28 lb) net; < 21 kg (46 lb) shipping
Dimensions: 133 mm H x 426 mm W x 432 mm D (5.25 in H x 16.8 in W x 17 in D in)

Key Literature

HP ESG and ESG-D Series Brochure, p/n 5965-9088E
ESG Series Technical Specifications, p/n 5965-3096E
Source Selection Guide, p/n 5965-3094E

Ordering Information

HP ESG-D1000A E4430A
HP ESG-D2000A E4431A
HP ESG-D3000A E4432A
HP ESG-D4000A E4433A
- **Opt 001** Upgrade 1EH to UN3, baseband I/Q generator with 1 Mbit pattern RAM
- **Opt 002** Upgrade 1EH to UN3, baseband I/Q generator with 8 Mbit pattern RAM
- **Opt 003** Retrofit UN4, baseband I/Q generator with 8 Mbit pattern RAM
- **Opt 1CM** Rackmount kit, p/n 5063-9214
- **Opt 1CN** Front handle kit, p/n 5063-9227
- **Opt 1CP** Rackmount kit with handles, p/n 5063-9221
- **Opt 1E5** Add high stability time base
- **Opt 1EM** Move all front panel connectors to rear panel
- **Opt H03** Single Channel CDMA Capability
- **Opt UN3** Add baseband I/Q generator with 1 Mbits of pattern RAM (includes premodulation filtering, PRBS, and DECT, GSM, NADC, PDC, PHS, and TETRA standards)
- **Opt UN4** Add baseband I/Q generator with 8 Mbits of pattern RAM (includes premodulation filtering, PRBS, and DECT, GSM, NADC, PDC, PHS, and TETRA standards)
- **Opt W30** Three-year warranty
- **Opt W50** Five-year warranty

Accessories
Transit Case p/n 9211-1296
HP 83300A Remote Interface

[1] Typically, level accuracy with ALC on will be maintained with drive levels between 0.25 and 1.0 V_{rms}.
[2] When applying external I/Q signals with ALC off, output level will vary directly with I/Q input level.
[3] Valid for 10 days after executing internal calibration routine, provided temperature is maintained within ± 5° C of calibration temperature.
[4] Selecting the raised cosine filter degrades instrument switching speed by 40 ms.
[5] Valid for 30 days after executing the internal calibration routine, provided temperature is maintained within ± 5° C if calibration temperature.
[6] Coherent carrier is modulated by FM or FM when enabled.

HP 8643A
HP 8644B
HP 8664A
HP 8665A
HP 8665B

- Frequency ranges of 1 GHz, 2 GHz, 3 GHz, 4.2 GHz, or 6 GHz
- Lowest overall noise and spurious
- AM, FM, and pulse modulation
- Lowest specified leakage (optional)
- Internal modulation source for complex waveforms
- Onsite repair and calibration

These signal generators offer RF designers and manufacturers a selection of frequency range and high performance. The HP 8643A, 8644B, and 8664A are for traditional out-of-channel receiver test applications. The HP 8665A/B are for high-performance applications up to 6 GHz, particularly radar, telemetry and spurious testing of UHF receivers. All signal generators within this performance family have options that allow them to be configured to meet specific application needs.

HP 8643A 1 GHz/2 GHz Signal Generator

HP has optimized the HP 8643A's configuration with the performance necessary for out-of-channel receiver tests while maintaining a low price. Options have been limited on the HP 8643A, but many performance/feature capabilities have been included as standard.

Standard Electronic Attenuator and Advanced Modulation Source

Reliability is enhanced by the use of an electronic attenuator on the 1 GHz version. Instead of using mechanical relays for setting levels, the HP 8643A uses solid-state components accurate to within ±1.0 dB. The HP 8643A comes standard with an advanced internal modulation synthesizer that provides coverage to 400 kHz and two-tone capability with the selection of sine, square, sawtooth, and white Gaussian noise waveforms.

HP 8644B 1 GHz/2 GHz High-Performance Signal Generator

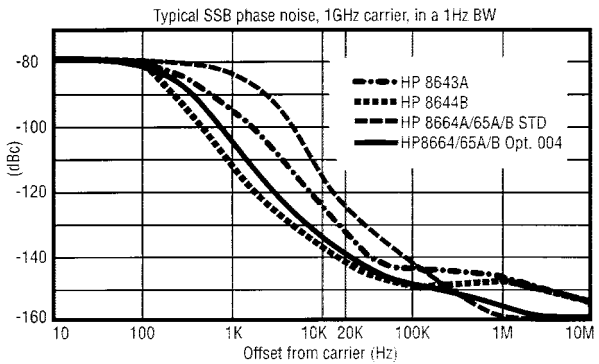
The HP 8644B represents the highest overall performance in HP's line of 1 GHz and 2 GHz signal generators. The HP 8644B builds on the HP 8643A's performance by lowering SSB phase noise (–136 dBc/Hz versus –130 dBc/Hz) and lowering spurious (–105 dBc versus –100 dBc). The HP 8644B can be used either for specific tests that require the lowest SSB phase noise or for applications with diversified performance requirements.

HP 8664A 3 GHz, HP 8665A 4.2 GHz and HP 8665B 6 GHz High-Performance Signal Generators

These three signal generators offer identical performance except for frequency coverage and price. Your application will dictate which instrument is required. The HP 8664A and HP 8665A/B are suited for out-of-channel receiver measurements through the use of Option 004 (low-noise enhancement) and for such applications as radar testing through the use of Option 008 (pulse modulation).

Wideband FM and Optional Pulse Modulation

FM rates of up to 2 MHz and deviations to 20 MHz peak are suitable for many applications such as higher-rate digital communications. An optional pulse modulator with on/off ratio of > 80 dB and rise/fall times of < 5 ns is available. Pulse width and delay can be internally adjusted between 50 ns and 999 ms, eliminating the need for an external pulse generator.



Typical SSB Phase Noise, at 1 GHz Carrier, in a 1 Hz BW

Specifications

	HP 8643A	HP 8644B	HP 8664A; HP 8665A/B
Frequency			
Range	0.252 to 1030 MHz 0.252 to 2060 MHz (Option 002)	0.252 to 1030 MHz 0.252 to 2060 MHz (Option 002)	0.1 to 3000 MHz (HP 8664A) 0.1 to 4200 MHz (HP 8665A) 0.1 to 6000 MHz (HP 8665B)
Resolution	0.01 Hz	0.01 Hz	0.01 Hz
Accuracy	Timebase stability x f_c	Timebase stability x f_c	Timebase stability x f_c
Switching speed (typical)	< 90 ms; < 200 ms with FM on	< 350 ms	< 100 ms (Option 004)

Internal Reference Oscillator

Output: 10 MHz, > 0.15 V_{rms} into 50 Ω; (IES) > I V_{rms} into 50 Ω

Timebase Stability

	Standard Timebase	High Stability (Opt. 001)
Aging Rate:	1.5×10^{-8}/day	3×10^{-10}/day
Temperature Effects:	7×10^{-10}	6×10^{-10}
Line Voltage Effects:	2×10^{-10}	1×10^{-10}

Specifications, cont'd

	HP 8643A	HP 8644B	HP 8664A; HP 8665A/B
Spectral Purity			
SSB phase noise @ 1 GHz (20 kHz offset)	–130 dBc/Hz	–136 dBc/Hz	–117 dBc/Hz; –134 dBc/Hz (Option 004)
Nonharmonics: (>10 kHz offset)	< –100 dBc, 0.252 to 1030 MHz < –94 dBc, 1030 to 2060 MHz	< –105 dBc, 0.252 to 1030 MHz < –100 dBc, 1030 to 2060 MHz	< –100 dBc, 187.5 to 2060 MHz < –90 dBc, 2060 to 6000[1] MHz, 0.1 to 187.5 MHz
Harmonics	< –25 dBc, output ≤ +8 dBm	< –25 dBc, output ≤ +10 dBm	< –30 dBc, output ≤ +10 dBm
Subharmonics	None, 0.252 to 515 MHz < –52 dBc, 515 to 1030 MHz < –40 dBc, 1030 to 2060 MHz	None, 0.252 to 515 MHz < –52 dBc, 515 to 1030 MHz < –40 dBc, 1030 to 2060 MHz	< –75 dBc, 0.1 to 1500 MHz < –40 dBc, 1500 to 3000 MHz < –50 dBc, 3000 to 6000 1 MHz
Residual FM @ 1 GHz: 0.3 to 3 kHz post det. BW	< 2 Hz rms	<1 Hz rms	< 7.5 Hz rms; <1.2 Hz rms (Option 004)
Output Level			
Range	+ 13 to –137 dBm	+ 16 to –137 dBm, + 13 dBm (Option 002, 005)	+ 13 to –139.9 dBm, + 9 dBm (Option 008)
Resolution	0.1 dB	0.1 dB	0.1 dB
Absolute accuracy	± 1 dB, output ≥ –127 dBm	± 1 dB, output ≥ –127 dBm	± 1 dB, output ≥ –119.9 dBm, 1 to 1000 MHz ± 1.5 dB, output ≥ –119.9 dBm, 1000 to 3000 MHz ± 2 dB, output ≥ –119.9 dBm, > 3000[1] MHz, < 1 MHz
Reverse power protection	50 W	50 W	25 W[2], 0.1 to 2060 MHz; 1 W, > 2060[1] MHz
Amplitude Modulation			
Depth: (@ ≤ + 7 dBm)	0 to 100%	0 to 100%	0 to 100%
Resolution	0.1%	0.1%	0.1%
Bandwidth (3 dB) ≤ + 7 dBm	dc to 100 kHz, 128 MHz < f_c < 1030 MHz	dc to 100 kHz, 128 MHz < f_c < 1030 MHz	dc to > 10 kHz, > 10 MHz
Accuracy: 1 kHz rate	± (7% of setting + 1%) up to 80% depth	± (7% of setting + 1%) up to 80% depth	± (6% of setting + 1%) up to 90% depth
Distortion: 30% depth, 1 kHz rate	< 2%; < 4% (Option 002)	< 2%; < 4% (Option 002)	< 4%
Frequency Modulation			
Maximum peak deviation (Deviation halves per lower octave)	2 MHz, 1030 to 2060 MHz; 1 MHz, 515 to 1030 MHz	20 MHz/200 kHz[3], > 1030 MHz; 10 MHz/100 kHz[3], > 515 MHz	20 MHz, 3000 to 6000[1] MHz; 10 MHz, 1500 to 3000 MHz
Resolution	2.5% of setting	2.5% of setting	2.5% of setting
Bandwidth (3 dB)	dc to 100 kHz	dc to 100 kHz	dc to 800 kHz
Carrier accuracy in FM	± 0.5% of setting	± 0.5% of setting	± 0.6% of setting
Indicator accuracy	< 5%, < 30 kHz rate; < 10%, < 100 kHz rates	< 5%, < 30 kHz rates; < 10%, < 100 kHz rates	± 9%, < 20 kHz rates
Distortion	< 5%, 20 Hz to 100 kHz rates	< 5%, 20 Hz to 100 kHz rates	< 1%, 20 Hz to 20 kHz rates
Pulse Modulation			**Option 008**
On/off ratio	> 50 dB; > 80 dB, > 1030 MHz	> 35 dB; > 80 dB, > 1030 MHz	> 80 dB
Rise/fall time, 10 to 90%	< 100 ns	< 100 ns	< 8 ns
Repetition rate	dc to 1 MHz	dc to 1 MHz	dc to 10 MHz
Internal width/delay	N/A	N/A	Variable, 50 ns to 1s
Internal Modulation Source			
Waveforms and rates	Sine; white Gaussian noise (0.1 Hz to 400 kHz); Triangle, sawtooth, square (0.1 Hz to 50 kHz)		
Frequency accuracy	Same as timebase		
Output level (into 600 Ω)	1 V pk, 2 V pk for HP 8643A and 8644B		
Output resolution	2 mV pk		
Frequency Sweep			
Digital sweep	Digitally stepped sweep over entire frequency range. Linear/log selection. 0.5 to 1000 s sweeps.		
Markers/Z-axis output	3 markers available/Z-axis output nominally + 5 V/X-axis output nominally 0 to 10 V		
Phase continuous sweep	40 MHz of span available at maximum carrier frequency. 20 ms to 10 s sweep times.		
Remote Programming			
Interface	HP-IB (IEEE 488.2-1987)		
Control language	Hewlett-Packard Systems Language (HP-SL). All functions controlled except power.		
IEEE-488 functions	SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT0, C0, E2		
General			
Power requirements	± 10% of 100 V, 120 V, 220 V, or 240 V; 48 to 440 Hz; 500 VA (except HP 8643A/44B: 400 VA)		
Operation temperature	0° to 55° C		
Leakage	Conducted and radiated interference meets MIL-STD-461B RE0 <None> 2 and FTZ 1046		
Calibration interval	Recommended 3 years (MTBC)		
Weight	HP 8643A: 23 kg (50 lb). HP 8644B: 30 kg (67 lb). HP 8664A/65A/B: 35 kg (78 lb).		
Size	177 mm H x 426 mm W x 624 mm D (7 in x 16.8 in x 24.6 in). Option 010 adds 35 mm (1.4 in) to D.		

[1] 3000 MHz for HP 8664A, 4200 MHz for HP 8665A, 6000 MHz for HP 8665B
[2] N/A to HP 8665B
[3] Low-noise mode

Ordering Information

	HP 8643A	HP 8644B	HP 8664A	HP 8665A	HP 8665B
Options					
001 High-Stability Timebase					
002 2 GHz Doubled Output					
004 Low-Noise Option					
005 Electronic Attenuator (N/A with Option 002)					
008 Pulse Modulation					
009 Specified VOR/ILS[2]					
011 2 GHz Internal Frequency Counter					
Service Kit	(08645-61116)	(08645-61116)	(08665-61116)	(08665-61116)	(08665-61116)
003 Rear-Panel Input/Output					
010 Reduced-Leakage Configuration					
W30 Add 3 Years to Return Warranty					
907 Front-Handle Kit (5062-3990)					
908 Rack Flange Kit (5062-3978)					
909 Combined Front/Rack Flange Kit (5061-9684)					

[2] Not compatible with Options 002 or 005

HP 8662A
HP 8663A

- 10 kHz to 1280 MHz frequency range
- < – 147 dBc/Hz SSB phase noise at 10 kHz offset
- 0.1 Hz frequency resolution

HP 8662A

- 100 kHz to 2560 MHz frequency range
- AM/FM/ΦM/pulse in one generator
- Internal variable modulation oscillator

HP 8663A

HP 8662A/HP 8663A Synthesized Signal Generators

Spectral purity is the key contribution of both the HP 8662A and 8663A, making them ideal for many radar, satellite communication, and phase noise measurement applications. Typical absolute phase noise performance of these generators at a 1 kHz offset is as low as –135 dBc/Hz, depending on the band of operation.

The frequency range of the HP 8662A is 10 kHz to 1280 MHz. It offers versatile AM/FM, using either internal 400 Hz and 1 kHz rates or externally applied modulating signals which can be either ac- or dc-coupled. It also has simultaneous modulation capability.

The HP 8663A and 8662A provide the U.S. Air Force MATE (Modular Automatic Test Equipment) capability, via Option 700. This option is an external translator that allows the signal generator to be controlled by the MATE language CIIL (Control Interface Intermediate Language).

HP 8662A Specifications

Frequency

Range: 10 kHz to 1280 MHz (1279.9999998 MHz)
Resolution: 0.1 Hz (0.2 Hz above 640 MHz)
Accuracy and Stability: Same as reference oscillator
Internal Reference Oscillator: 10 MHz quartz oscillator. Aging rate < 5 x 10^{-10}/day after 10-day warmup (typically 24 hrs. in normal operating environment).

Spectral Purity

Front-Panel Absolute SSB Phase Noise (dBc/Hz):

	Frequency range (MHz)					
	0.01 to 119.9[1]		120 to 159.9[2]		160 to 319.9[2]	
	Spec	Typ	Spec	Typ	Spec	Typ
1 Hz	– 68	– 78	– 66	– 76	– 60	– 70
10 Hz	– 98	– 108	– 96	– 106	– 90	– 100
100 Hz	– 116	– 126	– 115	– 125	– 109	– 119
1 kHz	– 126	– 132	– 129	– 135	– 124	– 130
3 kHz	– 126	– 135	– 129	– 138	– 124	– 133
5 kHz	– 128	– 138	– 131	– 141	– 126	– 136
10 kHz	– 132	– 138	– 142	– 148	– 136	– 142
100 kHz	– 132	– 139	– 142	– 148	– 136	– 142

	Frequency range (MHz)					
	320 to 639.9[2]		640 to 1279.9[3]		1280 to 2559.9[4]	
	Spec	Typ	Spec	Typ	Spec	Typ
1 Hz	– 54	– 64	– 48	– 58	– 42	– 52
10 Hz	– 84	– 94	– 78	– 88	– 72	– 82
100 Hz	– 103	– 114	– 97	– 108	– 92	– 102
1 kHz	– 118	– 125	– 112	– 119	– 106	– 113
3 kHz	– 118	– 127	– 112	– 121	– 106	– 115
5 kHz	– 120	– 130	– 114	– 124	– 108	– 118
10 kHz	– 131	– 136	– 124	– 130	– 118	– 124
100 kHz	– 131	– 136	– 124	– 130	– 118	– 124

Residual SSB Phase Noise (dBc/Hz):

	Frequency range (MHz)					
	0.01 to 119.9[1]		120 to 159.9[2]		160 to 319.9[2]	
	Spec	Typ	Spec	Typ	Spec	Typ
10 Hz	– 108	– 114	– 112	– 119	– 106	– 113
100 Hz	– 121	– 126	– 122	– 129	– 118	– 124
1 kHz	– 128	– 133	– 131	– 138	– 127	– 134
3 kHz	– 128	– 136	– 131	– 139	– 127	– 135
5 kHz	– 129	– 138	– 133	– 141	– 129	– 136
10 kHz	– 132	– 137	– 142	– 147	– 136	– 142
100 kHz	– 132	– 137	– 142	– 147	– 136	– 142

	Frequency range (MHz)					
	320 to 639.9[2]		640 to 1279.9[3]		1.28 to 2559.9[4]	
	Spec	Typ	Spec	Typ	Spec	Typ
10 Hz	– 100	– 107	– 93	– 101	– 88	– 95
100 Hz	– 112	– 119	– 105	– 112	– 100	– 106
1 kHz	– 121	– 128	– 115	– 122	– 109	– 116
3 kHz	– 121	– 129	– 115	– 123	– 109	– 117
5 kHz	– 123	– 130	– 117	– 124	– 111	– 118
10 kHz	– 131	– 136	– 124	– 130	– 118	– 124
100 kHz	– 131	– 136	– 124	– 130	– 118	– 124

[1] HP 8663A band begins at 0.1 MHz; specifications extend up to and including 119.9999999 MHz.
[2] Specifications extend up to and including 0.1 Hz less than the starting frequency of the next band.
[3] Specifications extend up to and including 1279.9999998 MHz.
[4] This band available on HP 8663A only; specifications extend up to and including 2559.9999996 MHz.

Option 003 Specified SSB Phase Noise for Rear-Panel 640 MHz Output:

	Spec	Typ
1 Hz	– 54	–64
10 Hz	– 84	–94
100 Hz	– 104	–114
1 kHz	– 121	–126
3 kHz	– 121	–127
5 kHz	– 129	–138
10 kHz	– 145	–149
100 kHz	– 157	– 159

SSB Broadband Noise Floor in 1 Hz BW at 3 MHz Offset From Carrier: < –146 dBc for fc between 120 and 640 MHz at output levels above +10 dBm.

Spurious Signals:

	Frequency Range (MHz)				
	0.01 to 120	**120 to 160**	**160 to 320**	**320 to 640**	**640 to 1280**
Spurious non-harmonically related[1,2]	–90 dBc	–100 dBc	–96 dBc	–90 dBc	–84 dBc
Sub-harmonically related $\left(\frac{1}{2}, \frac{3f}{2}, \text{etc.}\right)$	none	none	none	none	–75[3] dBc
Power-line (60 Hz) related or microphonically generated (within 300 Hz)[4]	–90 dBc	–85 dBc	–80 dBc	–75 dBc	–70 dBc
Harmonics	< –30 dBc				

Output

Level Range: +13 to –139.9 dBm (1V to 0.023 μV_{rms} into 50 Ω)
Resolution: 0.1 dB
Absolute Level Accuracy (+15° to +45° C)**:** ±1 dB between +13 and –120 dBm; ± 3 dB between –120 and –130 dBm
SWR: Typically from 1.5 to 1.8, depending on output level and frequency
Reverse Power Protection: Typically up to 30 W or ± 8 Vdc

Amplitude Modulation

Depth: 0 to 95% at output levels of +8 dBm and below (+10 dBm in uncorrected mode). AM available above these output levels but not specified.
Resolution: 1%, 10 to 95% AM; 0.1%, 0 to 9.9% AM
Incidental PM (at 30% AM)**:** 0.15 to 640 MHz, < 0.12 radian peak; 640 to 1280 MHz, < 0.09 radian peak
Incidental FM (at 30% AM)**:** 0.15 to 640 MHz, < 0.12 x f_{mod}; 640 to 1280 MHz, < 0.09 x f_{mod}
Indicated Accuracy: ± 5% of reading ± 1% AM. Applies for rates given in table below, internal or external mode, for depths ≤ 90%.

Rates and Distortion with Internal or External Modulating Signal:

		AM Distortion		
Frequency Range	**AM Rate**	**0 to 30% AM**	**30 to 70% AM**	**70 to 90% AM**
0.15 to 1 MHz	dc to 1.5 kHz	2%	4%	5.75%
1 to 10 MHz	dc to 5 kHz	2%	4%	5.75%
10 to 1280 MHz	dc to 10 kHz	2%	4%	5.75%

Frequency Modulation

FM Rates (1 dB bandwidth)**:** External ac, 20 Hz to 100 kHz; external dc, dc to 100 kHz
FM Deviation: 25 to 200 kHz, depending on carrier frequency
Indicated FM Accuracy: ± 8% of reading plus 10 Hz (50 Hz to 20 kHz)
FM Resolution: 100 Hz for deviations < 10 kHz, 1 kHz for deviations ≥ 10 kHz
Incidental AM (AM sidebands at 1 kHz rate and 20 kHz deviation)**:** < –72 dBc, f_c < 640 MHz; < –65 dBc, f_c ≥ 640 MHz
FM Distortion: < 1.7% for rates < 20 kHz, < 1% for rates < 1 kHz
Center Frequency Accuracy and Long-Term Stability in AC Mode: Same as CW mode

Supplemental Characteristic

Frequency-Switching Speed:[5] From 420 µs to 12.5 ms, depending on the programming mode

HP 8663A Specifications

The HP 8663A signal generator is related to the HP 8662A in both concept and structure. Like the HP 8662A, the HP 8663 is an extremely low phase noise signal source, incorporating signal generator modulation capabilities and output characteristics. The HP 8663A also offers increased frequency range to 2560 MHz, increased output level to +16 dBm, and the addition of phase and pulse modulation while maintaining high spectral purity. The result is a highly flexible and powerful signal generator that uses and extends the proven circuitry of the HP 8662A. Thus, the HP 8662A and HP 8663A share many of the same specifications.

Frequency

Range: 100 kHz to 2560 MHz (2559.9999996 MHz)
Resolution: 0.1 Hz (f_c < 640 MHz);
0.2 Hz (640 MHz to 1280 MHz);
0.4 Hz (f_c ≥ 1280 MHz)
Accuracy, Stability, and Internal Reference Oscillator: Identical to HP 8662A

Spectral Purity

(See HP 8662A specifications)
Spurious Signals: Identical to HP 8662A, except that for f_c between 1280 and 2560 MHz the spurious non-harmonics are –78 dBc; the sub-harmonically related (f/2, 3f/2, etc.) between 640 and 1280 MHz are –70 dBc and between 1280 and 2560 MHz are –40 dBc; and the power-line (60 Hz) or microphonically generated spurious are –65 dBc.
Harmonics: < –30 dBc, ≤ + 13 dBm output; < –25 dBc, + 13 dBm to + 16 dBm output, f_c < 1280 MHz; < –25 dBc, f_c ≥ 1280 MHz

Output

Level Range: + 16 dBm to –129.9 dBm
Resolution: 0.1 dB
Absolute Level Accuracy (+ 15° to + 45° C)**:** ± 1 dB, + 16 dBm to –119.9 dBm; ± 3 dB, –120 dBm and below
SWR: < 1.5

Amplitude Modulation

Depth: 0 to 95% at levels of + 10 dBm and below
Resolution: 0.1%
Incidental FM (at 30% AM)**:** Identical to HP 8662A except: < 0.3 x f_{mod} for 1280 ≤ f_c < 2560 MHz
Indicated Accuracy: ± 6% of reading ± 1% AM (400 Hz and 1 kHz, depth 90%)
AM Bandwidth (1dB)**:** dc to > 1.5 kHz, 0.15 MHz ≤ f_c < 1 MHz; dc to > 5 kHz, 1 MHz ≤ f_c ≤ 10 MHz; dc to > 10 kHz, f_c > 10 MHz: external dc coupling. External ac coupling or internal; low-frequency coupling is 20 Hz.
Distortion (400 Hz and 1 kHz)**:** < 2% (0 to 30% AM); < 3% (30 to 70% AM); < 4% (70 to 90% AM)

Frequency Modulation

FM Rates (1 dB bandwidth): External ac, 20 Hz to 100 kHz, external dc, dc to 100 kHz
Maximum Allowable Peak Deviation: Identical to HP 8662A for f_c between 100 kHz and 1280 MHz. Up to 400 kHz for f_c between 1280 and 2560 MHz.
Indicated FM Accuracy (50 Hz to 20 kHz)**:** ± 7% of setting + 10 Hz
FM Resolution: 100 Hz to 1 kHz, depending on f_c and deviation setting
Incidental AM (AM sidebands at 1 kHz rate and 20 kHz deviation)**:** < –72 dBc (10 ≤ f_c < 2560 MHz)
FM Distortion: < 1% (400 Hz and 1 kHz rates); < 1.7% (rates less than 20 kHz)

[1] In the remote mode it is possible to have microprocessor clock-related spurious signals spaced 3 MHz apart at an absolute level of typically less than –145 dBm.
[2] Spurious signals can be up to 3 dB higher in the dc FM mode.
[3] f/2 spurs not specified for carrier frequencies above 850 MHz.
[4] At a 50 Hz line frequency, power-line or microphonically-related spurious signals may be up to 3 dB higher and appear at offsets as high as 1 kHz from the carrier.
[5] Due to automatic leveling loop bandwidth changes, brief (30 ms) level inaccuracies may occur when switching through 150 kHz and 1 MHz RF output frequencies.

Phase Modulation (Option 002)

Maximum Peak Phase Deviation: From ± 25° for f_c between 120 and 160 MHz to ± 400° for f_c between 1280 and 2560 MHz
Maximum Rate: From 10 kHz for f_c between 0.15 and 10 MHz to 10 MHz for f_c between 640 and 2560 MHz
Phase Deviation Resolution: 1° (0.1 ≤ f_c < 640 MHz); 2° (640 ≤ f_c < 1280 MHz); 4° (1280 ≤ f_c < 2560 MHz)
Phase Modulation Distortion: 10% at maximum rate

Biphase Modulation (BPSK)

Biphase modulation is available on the standard HP 8663A for f_c less than 640 MHz and available for all f_c with Option 002.
Deviation: ± 90°
Carrier Null when Modulated with 1 MHz, 50% Duty Cycle Square Wave: > 25 dBc
Modulation Input Required: TTL positive true. The internal modulation oscillator can be used for 50% duty-cycle modulation. External input is on rear panel.

Pulse Modulation[1]

Pulse On/Off Ratio: > 80 dB (50 to 2560 MHz)
Pulse Rise/Fall Time: < 250 ns (50 to 120 MHz); < 800 ns (120 to 640 MHz); < 100 ns (f_c ≥ 640 MHz)
Pulse Repetition Frequency (50% duty cycle)**:**
Internal: 10 Hz to 99.9 kHz
External: 10 Hz to 2 MHz, 50 MHz < f_c < 640 MHz; 10 Hz to 5 MHz, f_c > 640 MHz
Internal Modulation Oscillator
Rates: 10 Hz to 99.9 kHz
Frequency Resolution: 3 digits
Frequency Accuracy: Same as reference oscillator
Output Level (available on rear panel)**:** 1 V peak into 600 Ω
Output Impedance: 600 Ω
Flatness (referenced to 1 kHz)**:** < ± 1%
Distortion: < 1%

Other HP 8662A and HP 8663A Information

Remote Programming: The HP-IB interface is standard on the HP 8662A and HP 8663A signal generators. All functions controlled from the front panel, with the exception of the line switch, are programmable with the same accuracy and resolution as in manual mode.
Operating Temperature Range: 0° to + 55° C
Leakage: Meets radiated and conducted limits of MIL-STD-461A methods RE02 and CE03 as well as BVDE 0871
Power Requirements: 115 (90 to 126) V or 230 (198 to 252) V; 48 to 66 Hz; 450 VA max
Size:
HP 8662A: 425 mm W x 178 mm H x 572 mm D (16.75 in x 7 in x 22.5 in)
HP 8663A: 425 mm W x 178 mm H x 642 mm D (16.75 in x 7 in x 25.3 in)
Note: depth includes front panel depth of 45 mm (1.75 in).
Weight: HP 8662A: net, 30 kg (65.5 lb); shipping, 36 kg (80 lb)
HP 8663A: net, 33.8 (74 lb); shipping, 40 kg (88 lb)

Key Literature

Synthesized Signal Generator 10 kHz to 1280 MHz
Technical Data, p/n 5953-8402
Synthesized Signal Generator 100 kHz to 2.56 GHz
Technical Data, p/n 5953-8376

Ordering Information

HP 8662A 1280 MHz Signal Generator[2]
Opt 001 RF Connectors on Rear Panel Only
Opt 003 Specified SSB Phase Noise for 640 MHz Output
Opt 700 External MATE Translator
Opt 907 Front Handle Kit (5062-3990)
Opt 908 Rack Flange Kit (5062-3978)
Opt 909 Rack Flange Kit w/Front Handles(5062-3984)
Opt 910 Two Sets of Operating and Service Manuals (08662-90069)
Opt W30 Extended Repair Service (see page 584)
Opt W32 Calibration Service (see page 584)

HP 11721A

HP 8663A 2560 MHz Signal Generator[2]
Opt 001 RF Connectors on Rear Panel Only
Opt 002 Wideband Linear Phase Modulation
Opt 003 Specified SSB Phase Noise for 640 MHz Output
Opt 700 External MATE Translator
Opt 907 Front Handle Kit (5061-9690)
Opt 908 Rack Flange Kit (5061-9678)
Opt 909 Rack Flange Kit w/Front Handles (5061-9684)
Opt 910 Additional Operation and Calibration Manual (08663-90069) and Service Manuals (08663-90071)
Opt 915 Add Service Manual (08663-90071)
Opt W30 Extended Repair Service (see page 584)
Opt W32 Calibration Service (see page 584)
HP 11714A Service Support Kit (required for servicing HP 8662A/8663A)

[1] Pulse modulation is available for f_c < 50 MHz but is unspecified.
[2] HP-IB cables not supplied. For description and price, see page 80.

4

HP 11721A Frequency Doubler

The HP 11721A doubler is an ideal accessory for extending the usable frequency range of signal generators, frequency synthesizers, or other signal sources. Operating on input frequencies of 50 MHz to 1300 MHz, it provides a doubled output in the range of 100 MHz to 2600 MHz. The HP 11721A will work well with any RF source with an output in the range of 50 to 1300 MHz.

The 50 Ω passive circuit of the HP 11721A offers low conversion loss, low spurious, and excellent flatness over its entire frequency range when operated above +10 dBm.

HP 11721A Specifications

Input Frequency Range: 50 to 1300 MHz
Output Frequency Range: 100 to 2600 MHz
Conversion Loss (+13 dBm input, 50 to 1280 MHz)**:** < 15 dB
Spurious Referenced to Desired Output Frequency f:
(+ 13 dBm input with harmonics < – 50 dBc, 50 to 1280 MHz):
f/2, –15 dB; 3f/2, –15 dB
Input SWR: 1.5 typical
Input/Output Impedance: 50 Ω nominal
Operating Temperature Range: 0° to 50° C
Connectors: Input, type-N male; output, type-N female
Size: 161 mm L x 30 mm W x 20.5 mm H (6.38 in x 1.19 in x .19 in)
Weight: Net, .02 kg (0.5 lb); shipping, 0.4 kg (1 lb)

Ordering Information

HP 11721A Frequency Doubler
Opt W30 Extended Repair Service (see page 584)

HP 83711B
HP 83712B
HP 83731B
HP 83732B

Typical single-sideband phase noise at 50 MHz, 1 GHz and 20 GHz, 25° C, CW mode. Offsets less than 100 Hz require the high stability timebase, Option 1E5.

HP 83711B/12B and HP 83731B/32B Signal Sources

4

The HP 83711B/12B synthesized CW generators and HP 83731B/32B synthesized signal generators set new standards for performance at prices that are surprisingly affordable. No longer will you have to give up frequency coverage, modulation, or reliability to meet your budget. These signal sources will perform beyond your expectations at a price within your reach.

Clean Signals with Plenty of Power

Choose the HP 83711B/83731B, 1 to 20 GHz, or the HP 83712B/ 83732B, 10 MHz to 20 GHz, for your receiver and system test applications. Fundamental oscillators and switched low-pass filters deliver < –55 dBc harmonics, eliminate subharmonics, and suppress spurious to < –60 dBc. These signal sources provide plenty of output power (typically > + 14 dBm), while spectral purity is maintained even at high power levels (typical output power at frequencies below 1 GHz is + 20 dBm). These signal sources deliver >100 dB dynamic range. Level resolution is 0.01 dB with typical accuracy of ± 1.0 dB at any frequency or power level. User Level Correction simplifies generating accurate, leveled power at distant test ports.

HP 83731B and HP 83732B Provide Unmatched Modulation Performance

Sophisticated modulation lets you simulate real-world signals. Test state-of-the-art radar and EW receivers with high-fidelity pulse modulation. < 10 ns pulse rise/fall times, < 25 ns pulse width, and > 80 dB pulse on/off ratio give you the performance you need to verify modern receivers. A built-in multimode pulse generator adds the flexibility to generate triggered, doublet, and gated burst pulse modes.

In addition, logarithmic and linear AM is a standard feature in the HP 83731B/32B. Use the > 60 dB depth log AM and the fast pulse modulation simultaneously (scan modulation) for accurate simulation of antenna scanning patterns, or sweep power linearly and accurately to test power-sensitive devices.

The HP 83731B/32B offer unmatched performance for testing satellite communications and telemetry receivers. 10 MHz peak FM and optional 100 radians peak phase modulation deviations, combined with the highest-modulation index available (> 300 for FM), simplify simulation of these difficult-to-generate signals. The HP 83731B/32B remain fully synthesized even at high-modulation indices, eliminating the troublesome frequency drift of other signal sources.

Real-world signals often combine two or more modulations. The HP 83731B/32B let you use all three modulations simultaneously with optional independent internal modulation generator without any degradation in performance. FM and phase modulation cannot be applied simultaneously.

Versatile and Reliable

The HP 83711B/12B and HP 83731B/32B signal sources are the recommended local oscillators for the HP 8970B noise figure meter. Low broadband noise minimizes errors in measurements of low gain devices. Use these signal sources with the HP 83550 series millimeter-wave modules to generate signals to 110 GHz. All front-panel functions are completely HP-IB-programmable and SCPI-compatible.

These signal sources are designed to remain within factory specifications for the entire life of the instrument. The recommended two-year performance verification cycle minimizes downtime and cost of ownership. If a unit ever drifts, automated adjustment routines can be run to return the unit to factory performance in less than six hours. Extensive use of surface-mount technology and a minimum number of adjustments combine to deliver an estimated MTBF of more than 20,000 hours. Built-in functional verification routines speed servicing.

Key Literature

HP 83711B/12B and HP 83731B/32B Technical Data Sheet, p/n 5963-6615E

Specifications

Frequency Characteristics
Frequency Range:
HP 83711B, 1.0 to 20 GHz
HP 83712B, 10 MHz to 20 GHz
HP 83731B, 1.0 to 20 GHz
HP 83732B, 10 MHz to 20 GHz
Frequency Resolution: 1 kHz, 1 Hz with Option 1E8

Internal Reference Oscillator

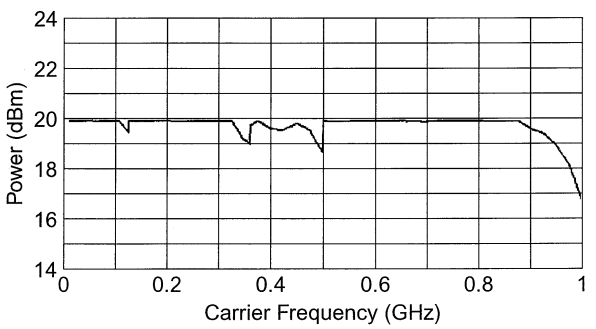
Frequency: 10 MHz
Timebase Stability:

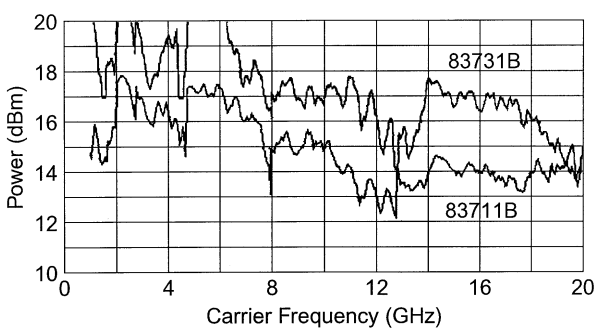
	Standard Timebase	Option 1E5
Aging Rate	< 1.0×10^{-8}/day	< 1.5×10^{-9}/day
Temperature	< 5×10^{-6}	< 1×10^{-7}
Line Voltage	N/A	< 5×10^{-10} (10% change in voltage)

Timebase Accuracy = ± aging rate ± temperature effects ± line voltage effects

Output Characteristics

Output Power (with Option 1E1): 0.01 to 1 GHz + 13 dBm
Maximum Leveled Output Power: 1 to 18 GHz + 10 dBm; 18 to 20 GHz + 8 dBm
Minimum Leveled Output Power: –4 dBm; with Option 1E1, –110 dBm

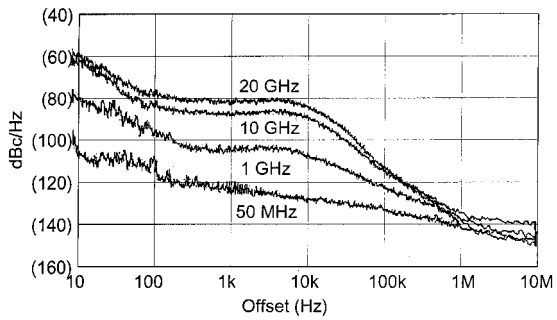




Resolution: 0.01 dB
Accuracy (–4 dBm to maximum specified leveled output power):
10 MHz to 50 MHz, ± 1.3 dB
50 MHz to 20 GHz, ± 1.0 dB
Accuracy (over all specified temperatures, and power levels):
10 MHz to 50 MHz, ± 2.3 dB
50 MHz to 20 GHz, ± 2.0 dB
Flatness: ± 0.5 dB

Spectral Purity

Harmonics:
HP 83711B/83712B, < –50 dBc (at levels < + 6 dBm)
HP 83731B/83732B, < –55 dBc (at levels < + 6 dBm)
Sub-Harmonics: None
Non-Harmonic Spurious (> 3 kHz)**:** –60 dBc
Phase Noise (@ 10 kHz offset)**:** 500 MHz: –103 dBc/Hz;
2 GHz: –92 dBc/Hz; 18 GHz: –76 dBc/Hz
(Phase noise decreases 6 dB/octave below 500 MHz and reaches a floor of < –140 dBc/Hz)



Typical single-sideband phase noise at 50 MHz, 1 GHz, 10 GHz and 20 GHz, 25° C, CW mode. Offsets less than 100 Hz require the high-stability timebase, Option 1E5.

General Specifications

Operating Temperature Range: 0° to + 55° C
Size: 426 mm W x 133 mm H x 498 mm D (16.8 in x 5.2 in x 19.6 in)
Weight: < 16 kg (35 lb)
Power: 90 to 132 V, 48 to 440 Hz; 198 to 264 V, 48 to 66 Hz; 400 VA max.
EMC: Meets or exceeds EN55011/CISPR 11/1990, Class A and MIL-STD-461C Part 2 RE02, CE03, CS02, RS03

HP 83731B, 83732B Modulation Specifications

Pulse Modulation

On/Off Ratio: > 80 dB
Rise/Fall Times: < 10 ns
Minimum Pulse Width: < 25 ns, 1 to 20 GHz

Internal Multimode Pulse Modulation Source

Modes: Internal free-run, triggered, doublet, and gated burst modes
Pulse Repetition Frequency: 3 Hz to > 3 MHz
Pulse Width: 25 ns to 419 ms
Pulse Delay: –419 ms to +419 ms, free-run mode; 225 ns to 419 ms, triggered mode
Minimum Pulse Parameter Resolution: 25 ns

Frequency Modulation

Rates: 1 kHz to 1 MHz
Maximum Deviation: 10 MHz pk, 2 to 20 GHz; 5 MHz pk, 1 to 2 GHz; decreases by a factor of 2 for each octave below 1 GHz
Maximum Modulation Index: > 300

Option 800 Analog Phase Modulation

Sensitivity: Two ranges

Maximum Deviation:

Frequency	Low range	High range
2 to 20 GHz	4 rad	200 rad
1 to 2 GHz	2 rad	100 rad
0.5 to 1 GHz	1 rad	50 rad
0.256 to 0.5 GHz	0.5 rad	25 rad

Logarithmic Amplitude Modulation

Depth: > 60 dB
Sensitivity: –10 dB/V
Step Response: < 5 μs for 50 dB step

Linear Amplitude Modulation

Sensitivity: Two ranges selectable: 30% V_{pk} + 100% V_{pk}
Maximum Depth: 90% (> 90% typical)

Key Literature

HP 83711B/12B and HP 83731B/32B Technical Data, p/n 5963-6615E

Ordering Information

HP 83711B Synthesized CW Generator
HP 83712B Synthesized CW Generator
HP 83731B Synthesized Signal Generator
HP 83732B Synthesized Signal Generator
Opt 1E1 Add 110 dB Output Step Attenuator
Opt 1E2 Add High-Performance Modulation Generator[1]
Opt 1E5 Add High-Stability Timebase
Opt 1E8 Add 1 Hz Frequency Resolution
Opt 1E9 3.5 mm RF Output Connector
Opt 800 Add Analog Phase Modulation[1]
Opt 0B0 Delete Manual Set
Opt 0B1 Extra User's Guide
Opt 0BV Service Manual (Component Level)
Opt 0BW Service Manual (Assembly Level)
Opt 0BX Service Manual (Assembly and Component Level)
Opt 1CM Rackmount Kit (HP p/n 5062-3977)
Opt 1CP Rackmount and Handle Kit (HP p/n 5062-3983)
Opt 1CR Rack Slide Kit (HP p/n 1494-0059)
Opt W30 Two Additional Years Return-to-HP Service:
HP 83711B
HP 83712B
HP 83731B
HP 83732B

[1] Available on the HP 83731B/32B only.

HP 83751A
HP 83751B
HP 83752A
HP 83752B

- Fully synthesized (phase-locked) CW, step, and ramp modes
- 2 MHz swept frequency accuracy
- Power flatness correction
- Broad 20 GHz frequency coverage
- +17 dBm output power at 20 GHz
- Internal pulse generator

HP 83753B

HP 83750 Series Sweepers

The HP 83750 sweepers bring outstanding synthesized performance to the component-test marketplace. They deliver the best performance for the price in general-purpose benchtop, swept test, or scalar applications.

The latest technological advances in fundamental oscillator design provide up to 20 GHz of frequency coverage with superior harmonic suppression and no subharmonics. When this excellent spurious performance is combined with high-output power capabilities, high-measurement dynamic range is achieved.

The HP 83750 synthesized sweepers provide superior accuracy and stability while maintaining the speed of analog sources. Fully-synthesized CW, stepped, and ramp sweep modes are available in broadband and narrowband operation. The synthesis capabilities are particularly useful for the characterization of narrowband devices, in which the frequency instabilities of open-loop sources become most apparent.

Excellent output-power flatness and accuracy can be translated to the input port of the device-under-test with the power flatness correction feature of these sources. This feature uses a power meter to create an array of power corrections that compensate for power variations in the measurement path between the source and the test device.

Swept testing of frequency translation devices can be achieved simply and economically with the HP 83570 series synthesized sweepers. A traditionally difficult measurement, sweeping the RF and local oscillator (LO) input ports at a fixed offset over a wide frequency span, is easy to implement with superior frequency accuracy by positioning two synchronously tracking HP 83750s in a two-tone configuration. With broadband frequency coverage and excellent performance, the HP 83750 synthesized sweepers are ideal stimuli for frequency translation measurements.

The HP 83750 series make optimal companion sources for scalar-measurement applications. Full compatibility is available via the HP 8757 system interface bus. The HP 8757D scalar analyzer and HP 83750 series have a complementary design that achieves superior frequency accuracy, power accuracy, and flatness while significantly reducing measurement uncertainty. In addition, the HP 83750's high-power and low-harmonic capabilities increase the spurious-free measurement dynamic range of scalar systems. Ten independent, continuously variable markers and a marker sweep function allow fast, efficient analysis of the test device at or between critical measurement frequencies. CW, stepped, ramp, or power sweep modes are available for device characterization. A 25 dB power sweep range is particularly useful for compression measurements of active devices such as amplifiers and mixers.

The high-power models HP 83751B and 83752B provide +17 dBm output power with –20 dBc harmonics from 2 to 20 GHz. This high-power capability eliminates the need to externally amplify the signal for test devices that require high-input power levels. When Option 1EE (source module interface connector and extension cable) is added, these sources can directly drive the HP 83550 series mm-wave source modules to provide waveguide frequency coverage up to 110 GHz. All HP 83750 sweepers with Option 1EE automatically provide bias, power flatness correction, and internal leveling for the HP 83550 series source modules.

HP 83750 sweepers offer two operating languages to ensure compatibility with instruments today and in the future. The default language is SCPI (Standard Command for Programmable Instruments), an industry standard. The second operating language employs HP 8350 mnemonics to provide programming compatibility with HP 8350-based measurement systems.

Specifications

Frequency Characteristics

Frequency Range
- **HP 83751B:** 2 to 20 GHz
- **HP 83752B:** 0.01 to 20 GHz

Internal Reference Oscillator

Frequency: 10 MHz

Timebase Stability
- **Standard Timebase:** ± 10 x 10^{-6}
- **High-Stability Timebase** (Option 1E5)
- **Aging Rate:** 5 x 10^{-10}/day; 1 x 10^{-7}/year
- **Temperature Effects:** 1 x 10^{-10}/ °C
- **Line Voltage Effects:** 5 x 10^{-10} (10° change in voltage)

CW and Manual Modes
- **Accuracy:** Stability x f_c time base
- **Resolution:** 1 Hz
  - **Switching Time** (typical)**:** 70 ms max.

Ramp Sweep Mode
- **Accuracy**[1,2]**:** The greater of ± 0.01% of span ± timebase stability x f_c or ± 75 k Hz ± timebase stability x f_c
- **Sweep Time:** 10 ms to 100 s; 50 ms for full span
- **Resolution:** 1 kHz

Step Sweep Mode
- **Accuracy:** Timebase stability x f_c
- **Number of Points:** 2 to 1601
- **Switching Time** (typical)[3]**:** 7 ms ± 8 ms/GHz step

Output Power Characteristics

Maximum Leveled Power[1,4]
- **HP 83751A, 83752A:** 10 dBm
- **HP 83751B, 83752B:** 17 dBm (16 dBm < 2 GHz on HP 83752B)

Minimum Settable Power
- **HP 83751A, 83752A:** –15 dBm (–85 dBm w/Option 1E1)
- **HP 83751B, 83752B:** –10 dBm (–80 dBm w/Option 1E1)

Resolution: 0.01 dB settable

Accuracy[1]
- **HP 85751A, 83752A only:** ± 1.0 dB (levels > –10 dBm)
- **HP 83751A/B, 83752A/B:** ± 1.5 dB (levels > –75 dBm)

Flatness
- **HP 85751A, 83752A only:** ± 0.7 dB (levels > –10 dBm)
- **HP 85751A/B, 83752A/B:** ± 1.3 dB (levels > –75 dBm)

Power Sweep Range: 25 dB/sweep

Power Slope Range: 0 to ± 2 dB/GHz, 25 dB max

Source Match (typical)**:** < 1.7:1 SWR

Spectral Purity

Harmonics
- **HP 83751A, 83752A:** –45 dBc (–30 dBc < 1.5 GHz on HP 83752A)
- **HP 83751B, 83752B:** –20 dBc

Subharmonics: None

Non-Harmonic Spurious[5]**:** –50 dBc

Residual FM: 1 kHz RHS in CW mode (0.05 to 15 kHz BW)

Phase Noise (typical)**:** < –75 dBc/Hz at 10 GHz in CW mode, 10 kHz offset

Modulation

External AM (typical)
- **Sensitivity:** 1 dB/V
- **3 dB Bandwidth:** > 100 kHz, usable to 1 MHz

Depth
- **HP 83751A, 83752A:** 20 dB (–10 to + 10 dBm)
- **HP 83751B, 83752B:** 22 dB (–5 to + 17 dBm)
- **Input Impedance:** 3.5 Ω

External FM (typical)
- **DC/Unlocked Mode**
  - **Rates:** dc to 10 MHz
  - **Maximum Deviation**
  - dc to 100 Hz Rates: ± 75 MHz
  - 100 Hz to 1 MHz Rates: ± 7 MHz
  - 1 to 2 MHz Rates: ± 5 MHz
  - 2 to 10 MHz Rates: ± 1 MHz
- **AC/Locked Mode**
  - **Rates:** 50 kHz to 10 MHz
  - **Maximum Deviation:** Same as unlocked mode up to 25 x rate

Pulse (typical)
- **On/Off Ratio:** 60 dB
- **Rise/Fall Times**
  - 50 MHz to 2 GHz: 15 ns
  - 2 to 20 GHz: 100 ns rise/50 ns fall
- **Minimum Pulse Width:** 2 µs
- **Internal Pulse Generation**
  - **Width Range:** 1 µs to 65 ms
  - **Period Range:** 2 µs to 65 ms
  - **Resolution:** 1 µs
- **Internal Square Wave:** 1 kHz and 27.8 kHz (scalar analyzer mode)

General

Bandwidth Points: 2 GHz, 3.75 GHz, 6.75 GHz, and 11 GHz. The 3.75 and 6.75 GHz synthesizer switch will disappear if sweep is < 0.8 of an octave in the 2 to 11 GHz band.
RF Output Connector: 3.5 mm
Option 1ED: Type-N
Operating Temperature Range: 0° to 55° C
Weight: Net 16 kg (35 lb)
Size: 425 W mm x 133 H mm x 483 D mm (16.75 in x 5.25 in x 19 in)

Key Literature

HP 83751A/B and HP 83752A/B Synthesized Sweepers
Technical Data, p/n 5091-5908E

Ordering Information

HP 83751A 2 to 20 GHz Synthesized Sweeper
HP 83751B 2 to 20 GHz Synthesized Sweeper (High Power)
HP 83752A 0.01 to 20 GHz Synthesized Sweeper
HP 83752B 0.01 to 20 GHz Synthesized Sweeper (High Power)
- **Opt 1E1** 70 dB Step Attenuator
- **Opt 1E4** Rear-Panel RF Output
- **Opt 1E5** High-Stability Time Base
- **Opt 1ED** Type-N Connector Output
- **Opt 1EE** Source Module Interface Connector and Extension Cable

[1] For operating temperatures of 25 ± 5° C.
[2] For 100 ms sweep times; improves with slower sweeps.
[3] Up to 50 ms switching times can occur when crossing the 2 GHz band switch point.
[4] Option 1E1 reduces output power up to 1 dB.
[5] For spurs > 500 kHz from output frequency.

HP 8360B Series
HP 8360L Series

- +20 dBm (HP 83624B) to –110 dBm (Option 001) calibrated output power
- –50 dBc harmonics < 26.5 GHz typical
- SSB phase noise < –80 dBc at 10 GHz and 10 kHz offset
- Complete analog sweeper
- 1Hz frequency resolution (Option 008)
- Pulse, amplitude and frequency modulation (HP 8360B series only)

The HP 8360B/L series for the winning combination of precision, versatility and flexibility

HP 8360B/L Synthesized Swept Signal and CW Generator Series

4

The HP 8360 family consists of the general-purpose B-model series and the L-model (without modulation) series. They combine the excellent frequency resolution, level control, signal purity, and modulation capabilities you expect of a high-performance synthesized signal generator with the speed and convenience of a sweep oscillator. They are ideal for the demanding requirements of signal simulation, local oscillator, and stimulus/response component or subsystem test applications.

The HP 8360 family offer a choice of models to meet a variety of application requirements. Ultra-broadband frequency coverage for 10 MHz to 50 GHz is available in coax using a 2.4-mm precision connector. High-power models with up to +20 dBm are also available. The HP 8360 can also be customized with 1 Hz frequency resolution, fast pulse, a synthesized internal modulation generator, and a blank front panel for automated test applications.

Flexible and Upgradeable for Growth

The HP 8360 is designed to facilitate future growth. The hardkey and softkey front-panel design offers easily-accessible functions that are simple to use. Softkey flexibility and modular architecture provide upgrade capability, while retaining system compatibility. The family delivers the cost-effective and state-of-the-art performance you need today, while protecting your investment in the future.

Pulse, Scan, Amplitude, and Frequency Modulation (HP 8360B series only)

High-performance pulse modulators with > 80 dB on/off ratio, and rise/fall times < 10 ns (Option 006), make the HP 8360B suitable for the most demanding pulse modulation applications.

In addition to its linear AM mode (100%/V), the HP 8360B offers a scan modulation mode (10 dB/V). Both modes have dc-coupled amplitude modulation capability with a 3 dB bandwidth of 100 kHz, and 99.7% (50 dB) of modulation depth. Pulse and amplitude modulation capabilities can be used independently and simultaneously.

The HP 8360B also offers dc-coupled frequency modulation capabilities with rates up to 8 MHz.

Specifications Summary

Frequency
Range (by model):
HP 83620B 10 MHz to 20 GHz
HP 83622B 2 GHz to 20 GHz
HP 83623B 10 MHz to 20 GHz (high power)
HP 83624B 2 GHz to 20 GHz (high power)
HP 83630B 10 MHz to 26.5 GHz
HP 83640B 10 MHz to 40 GHz
HP 83650B 10 MHz to 50 GHz
HP 83623L 10 MHz to 20 GHz
HP 83630L 10 MHz to 26.5 GHz
HP 83640L 10 MHz to 40 GHz
HP 83650L 10 MHz to 50 GHz
Resolution: 1 kHz (1 Hz with Option 008)

Internal Reference Oscillator

Frequency: 10 MHz
Timebase Stability
Aging Rate: 5×10^{-10}/day; 1×10^{-7}/year
Temperature Effects: 1×10^{-10}/°C
Line Voltage Effects: 5×10^{-10} (10° C change in voltage)

CW and Manual Modes

Accuracy: Timebase stability xf_c
Switching Time
For Steps Within a Frequency Band: 15 ms + 5 ms/GHz step size
Maximum, or Across Band Switch Points: 50 ms
Step or List Modes Within a Frequency Band: 5 ms + 5 ms/GHz step size

Step Sweep Mode

Accuracy: Timebase stability xf_c
Minimum Step Size: Same as frequency resolution
Number of Points: 2 to 801
Switching Time: Same as CW
Dwell Time: 100 µs to 3.2 s

List Mode

Accuracy: Timebase stability xf_c
Minimum Step Size: Same as frequency resolution
Number of Points: 1 to 801
Switching Time: Same as CW
Dwell Time: 100 µs to 3.2 s

Ramp Sweep Mode

Accuracy: (Sweep time ≥ 100 ms and ≤ 5 s)
Sweep Widths ≤ n x 10 MHz: 0.1% of sweep width ± timebase stability xf_c
Sweep Widths > n x 10 MHz: Lesser of 1% of sweep width or n x 1 MHz + 0.1% of sweep width
Sweep Time: 10 ms to 100 s, 300 MHz/ms maximum rate

RF Output

Output Power

Maximum Leveled (dBm)	Standard	Option 006 (B models only)
HP 83620B, 83622B	+ 13	+ 13
HP 83623B	+ 17	+ 17
HP 83623L	+ 15	N/A
HP 83624B	+ 20	+ 17
HP 83630B/L		
Output Frequencies < 20 GHz	+ 13	+ 13
Output Frequencies ≥ 20 GHz	+ 10	+ 10
HP 83640B/L		
Output Frequencies < 26.5 GHz	+ 10	+ 10
Output Frequencies ≥ 26.5 GHz	+ 6	+ 6
HP 83650B/L		
Output Frequencies < 26.5 GHz	+ 10	+ 10
Output Frequencies ≥ 26.5 GHz and < 40 GHz	+ 5	+ 5
Output Frequencies ≥ 40 GHz	+ 2.5	+ 2.5

Minimum Settable Output Power
Standard: –20 dBm
Option 001: –110 dBm
Resolution: 0.02 dB
RF Output Connector
Nominal output impedance 50 ohms (precision 3.5-mm male on 20 and 26.5 GHz models, 2.4-mm male on 40 and 50 GHz models, front panel)

Spectral Purity

Spurious Signals (dBc)

Output Frequencies	83620B 83622B	83623B 83624B	83623L	83630B/L	83640B/L 83650B/L
Harmonics					
< 2.0 GHz					
Standard	–30	–25[1]	–25[1]	–30	–30[1]
Option 006	–30[1]	–25[1]	—	–30[1]	–30[1]
≥ 2.0 GHz and < 26.5 GHz					
Standard	–50	–25	–45	–50	–50
Option 006	–60	–60	—	–60	–50
≥ 26.5 GHz					
Standard	—	—	—	—	–40
Option 006	—	—	—	—	–40
Subharmonics					
< 7 GHz	None	None	None	None	None
≥ 7 and ≤ 20 GHz	–50	–50	–50	–50	–50
≥ 20 GHz and ≤ 40 GHz	—	—	—	–50	–40[2]
> 40 GHz	—	—	—	—	–35[2]

[1] Specification is –20 dBc below 50 MHz.
[2] Specifications typical below 0 dBm.

Nonharmonically Related
10 MHz to < 2.0 GHz[3]: –60
≥ 2.0 to < 20 GHz: –60
> 20 GHz to ≤ 26.5 GHz: –58
> 26.5 to ≤ 40 GHz: –54
≥ 40 GHz to ≤ 50 GHz: –52

Single-Sideband Phase Noise (dBc/Hz)

	Offset from Carrier			
Frequency Range	**100 Hz**	**1 kHz**	**10 kHz**	**100 kHz**
10 MHz to < 7 GHz	– 70	– 78	– 86	–107
7 GHz to < 13.5 GHz	– 64	– 72	– 80	–101
13.5 GHz to 20 GHz	– 60	– 68	– 76	– 97
> 20 GHz to < 26.5 GHz	– 58	– 66	– 74	– 95
26.5 GHz to < 38 GHz[4]	– 54	– 62	– 70	– 91
38 GHz to 50 GHz	– 52	– 60	– 68	– 89

Modulation (HP 8360B series only)

All modulation specifications are only applicable to the HP 8360B series. Pulse modulation specifications apply for output frequencies 400 MHz and above.

Pulse (HP 8360B only)	Standard	Option 006
On/Off Ratio	80 dB	80 dB
Rise/Fall Times	25 ns	10 ns
Minimum Width		
Internally Leveled	1 µs	1 µs
Search Mode		
Output Frequencies < 2.0 GHz	50 ns	50 ns
Output Frequencies ≥ 2.0 GHz	50 ns	15 ns
ALC Off Mode		
Output Frequencies < 2.0 GHz[4]	50 ns	50 ns
Output Frequencies ≥ 2.0 GHz	50 ns	15 ns

AM and Scan (HP 8360B only)
Bandwidth
(3 dB, 30% depth, modulation peaks 3 dB below maximum rated power): dc to 100 kHz
Modulation Depth
Normal Mode: –20 dBm to maximum available power
Deep Mode: 50 dB below maximum available power
Sensitivity
Linear: 100%/volt
Exponential: 10 dB/volt

FM (HP 8360B only)
Locked Mode
Maximum Deviation: ± 8 MHz
Rates (3 dB bandwidth, 500 kHz deviation)**:** 100 kHz to 8 MHz

[3] Specification applies at output levels 0 dBm and below.
[4] This band is 26.5 GHz to 40 GHz on the HP 83640A.
[5] Frequency range is 26.5 GHz to 40 GHz on the HP 83640B/L.

Unlocked Mode
Maximum Deviation
At rates ≤ 100 Hz: ± 75 MHz
At rates > 100 Hz: ± 8 MHz
Rates (3 dB bandwidth, 500 kHz deviation)**:** dc to 8 MHz
Sensitivity: 100 kHz, 1 MHz, or 10 MHz/volt, switchable
Accuracy (1 MHz rate, 1 MHz deviation)**:** 10%

Internal Modulation Generator (Option 002)

AM, FM Modulation Signals (HP 8360B only)
Internal Waveforms: Sine, square, triangle, ramp, noise

Rate
Range:
Sine: 1 Hz to 1 MHz
Square, triangle, ramp: 1 Hz to 100 kHz
Resolution: 1 Hz

Depth, deviation
Range: Same as the base instrument
Resolution: 0.1%
Accuracy: Same as the base instrument

Pulse (HP 8360B only)
Modes: Free-run, gated, triggered, delayed
Period Range: 300 ns to 400 ms
Width Range: 25 ns to 400 ms
Resolution: 25 ns
Accuracy: 5 ns
Video Delay
Internal sync pulse: 0 to 400 ms
Externally-supplied sync pulse: 225 ns to 400 ms

Weight and Dimensions
Net Weight: 27 kg (60 lb)
Dimensions: 178 H x 425 W x 648 mm D (7.0 x 16.75 x 25.5 inches)

Additional Key Literature

Brochure, p/n 5964-6793E
Technical Specifications, p/n 5964-6162E
Configuration Guide, p/n 5964-6062E

Ordering Information

HP 83620B 10 MHz to 20 GHz
HP 83622B 2 GHz to 20 GHz
HP 83623B 10 MHz to 20 GHz (high power)
HP 83624B 2 GHz to 20 GHz (high power)
HP 83630B 10 MHz to 26.5 GHz
HP 83640B 10 MHz to 40 GHz
HP 83650B 10 MHz to 50 GHz
HP 83623L 10 MHz to 20 GHz
HP 83630L 10 MHz to 26.5 GHz
HP 83640L 10 MHz to 40 GHz
HP 83650L 10 MHz to 50 GHz
Opt 001 Adds Step Attenuator*
Opt 002 Adds Internal Modulation Generator (HP 8360B only)
Opt 004 Rear-Panel RF Output
Opt 006 Fast-Pulse Modulation (HP 8360B only)*
Opt 008 1 Hz Frequency Resolution
Opt 700 MATE System Compatibility
Opt 806 Rack Slide Kit
Opt 908 Rack Flange Kit
Opt 910 Extra Operating and Service Manuals
Opt 913 Rack Flange Kit
Opt W30 3 Years of Customer Return Repair Service*

Upgrades
Model and frequency upgrades are available. Please contact your Hewlett-Packard sales representative for details (listed on page 591).
Dedicated HP 8510 System Source Models
HP 83621B 45 MHz to 20 GHz
HP 83631B 45 MHz to 26.5 GHz
HP 83651B 45 MHz to 50 GHz

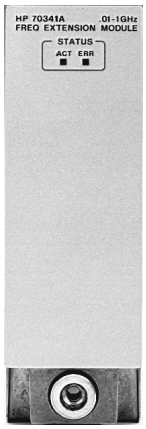
*Price of this option varies for different HP 8360 series models.

Modular Measurement System

HP 70340A
HP 70341A

- Broadband frequency coverage: 10 MHz to 20 GHz
- High-performance modulation: AM, FM, and Pulse
- Excellent spectral purity: –55 dBc harmonics, –60 dBc spurious
- Outstanding output level accuracy and flatness
- Industry-standard programming: SCPI

HP 70340A



HP 70341A

HP 70340A Modular Synthesized Signal Generator
HP 70341A Frequency Extension Module

All the Performance of Traditional Rack-and-Stack Sources in Half the Rack Space

Test receivers and subsystems from 10 MHz through 20 GHz with confidence knowing that even at full specified power the HP 70340/41A provides superior harmonic (–55 dBc) and spurious (–60 dBc) performance. Excellent output-power accuracy (± 1 dB) and flatness (± 0.5 dB) is maintained across the HP 70340/41A's > 100 dB dynamic range. Sweep power linearly and accurately to test power sensitive devices. Generate real world signals using the FM, pulse, and logarithmic AM modulations. The HP 70340/41A modular signal generator satisfies the demands of tomorrow's ATE for a downsized, high-performance modular signal source.

Extend Your Capabilities to 10 MHz with HP 70341A

The HP 70341A frequency extension module brings microwave performance to RF and IF testing. Now the HP 70340A's powerful modulation, low-harmonics (–55 dBc) and zero subharmonics are available at frequencies from 10 MHz to 1 GHz with higher-output power (+13 dBm) and lower phase noise. Digital frequency dividers lower phase noise 6 dB/octave as the output frequency is reduced making the HP 70340A/41A combination a powerful in-channel receiver test stimulus. Elimination of downconversion mixers reduces broadband noise while switched low pass filters generate fast, high-fidelity pulse modulation. Logarithmic AM provides capability not found in conventional RF signal sources. Full 10 MHz to 20 GHz coverage is yours from a single RF output connector without a sacrifice in level accuracy or flatness. The HP 70341A is slaved to the HP 70340A so all your system software runs on the combination without any change.

Setting the Standard for Modular Signal Sources

The HP 70340A/41A are ideal in modern ATE systems. Their small size, light weight, excellent reliability, and high performance make them the signal sources of choice for downsized and portable ATE. Their high MTBF (> 20,000 hours, extended calibration cycle (two years) and low calibration time (< six hours for full cal) reduce system downtime in high-throughput commercial ATE. A wide selection of options adds extra capability where you need it and saves money in less stringent systems. SCPI programming assures that system software designed around the HP 70340A/41A will remain compatible and upgradeable for years to come.

Specification Summary

(For complete specifications, refer to the HP 70340A/41A Technical Data Sheet, HP p/n 5091-4649E.)
Frequency Range: 1 to 20 GHz; 10 MHz to 20 GHz with HP 70341A
Frequency Resolution: 1 kHz; 1 Hz with Option 1E8
Leveled Output Power (with Option 1E1 installed)
10 MHz to 1 GHz: + 13 dBm to –90 dBm
1 GHz to 18 GHz: + 10 dBm to –90 dBm
18 GHz to 20 GHz: + 8 dBm to –90 dBm
Resolution: 0.01 dB
Accuracy: ± 2 dB (all frequencies, power levels, and temperatures)
Flatness: ± 0.5 dB
Harmonics: < –55 dBc
Sub-Harmonics: None
Non-Harmonic Spurious: -60 dBc
SSB Phase Noise (10 kHz offset)**:** 500 MHz: –103 dBc/Hz;
2 GHz: –91 dBc/Hz; 18 GHz: –73 dBc/Hz
External Pulse Modulation
On/Off Ratio: > 80 dB
Minimum Pulse Width: < 25 ns 500 MHz to 20 GHz;
< 100 ns 64 to 500 MHz; < 1 µs 10 to 64 MHz
Maximum Rise/Fall Time: < 10 ns 1 to 20 GHz;
< 20 ns 500 to 1000 MHz; < 35 ns 128 to 500 MHz
External Frequency Modulation
Rates: 1 kHz to > 1 MHz
Maximum Deviation: 10 MHz
Maximum Modulation Index: > 300
External Amplitude Modulation
Type: Logarithmic AM
Depth: 0 to 60 dBc
Sensitivity: –10 dB/V
Step Response: < 5 µs for 50 dB step
Size: 4-slot wide MMS module HP 70340A; 1-slot wide MMS module HP 70341A
Weight: < 9 kg (20 lbs.) HP 70340A; < 4 kg (10 lbs.) HP 70341A

Key Literature

HP 70000 Family Modular Measurement System Catalog, p/n 5965-2818E

Ordering Information

HP 70340A Modular Signal Generator
Opt 1E1 Add Output Step Attenuator
Opt 1E2 Internal Pulse Modulation Source
Opt 1E8 1 Hz Frequency Resolution
Opt 1E9 3.5-mm RF Output Connector
Opt 0B2 Operation Manual
Opt 0B3 Service Manual
Opt W30 Two Add'l Years HP Service Warranty
HP 70341A Frequency Extensions Module

- Arbitrary number of carriers or tones
- Arbitrary, yet precisely controlled, phase relationships between carriers or tones
- Precision active channel modulations for spectral regrowth measurements
- Multichannel background signals found in field testing
- Multiple Walsh channels for CDMA

HP E2507B

HP E2507B, E2508A Multi-Format Communications Signal Simulator (MCSS)

HP-IB

Generate the Precise Test Signals You Need for Testing Today's Wireless Communications Components and Products

Ensuring that new digital-communications designs and products meet system standards and customer specifications is a critical part of your development process. With the new HP-MCSS (multi-format communications signal simulator) you can have the confidence that your designs will work as intended in the multi-signal environments of real use. The MCSS is personal computer controlled with an easy-to-use MS-Windows® interface. The digital signal synthesis of the MCSS delivers outstanding signal purity and fidelity and allows easy expansion of system capabilities via software upgrades. The MCSS simplifies your test process by replacing several signal sources with one cost-effective solution.

Accurate and Easy Distortion Testing

The MCSS generates the multiple-carrier (multi-tone) signals you need to accurately test your multi-channel amplifiers and related products. Such multi-tone signals test the intermodulation performance of multi-channel amplifiers much more realistically than traditional TOI tests. The MCSS precisely controls the amplitude and relative phase of each tone individually to deliver the most realistic and accurate results in multi-tone testing. The relative phase can be random. This specific random pattern can then be repeated on other MCSS systems to give great consistency from measurement to measurement. Generate multiple sets of signals with different phase relationships to simulate the varying phase conditions encountered in actual use. The multiple sets of multi-tone signals give the necessary degree of randomness to predict the intermodulation distortion in the final environment. The MCSS generates these multiple phase relationships quickly, easily, and repeatably to speed your testing.

In Adjacent Channel Power (ACP) measurements the MCSS delivers the highest signal purity available today. Digital signal synthesis eliminates those errors common in traditional I/Q signal generators and provides maximum ACP dynamic range. All of today's digital wireless modulations are provided (including CDMA). Use standard signal specifications or build your own custom signals for maximum signal generation flexibility. The MCSS Error Vector Magnitude is typically <0.5 percent.

Active Channel Signal Generation Is Fast and Easy

PHS, NADC, GSM, DECT, PDC, CT2, and TETRA signals have been pre-programmed for fast, easy generation. Or customize your own signal with user-selectable parameters. Apply spectral masks using the Nyquist and Gaussian filters with variable rolloff factors. Bit rates to 10,000 kb/s are available. As new signal formats emerge, count on HP to include them in MCSS system-software upgrades.

You can even generate a new modulation format. All you need to do is build a text file containing the I and Q data file, perhaps using a spreadsheet program or various mathematical programs. MCSS can create a new active channel by accepting those data files for modulating the carrier.

Generate CDMA Signals with Up to 64 Simultaneous Walsh Codes

CDMA signals have never been easier to generate. Combine one, several, or all Walsh code channels for realistic forward link simulation. The MCSS CDMA application is ideal for testing base station power amplifiers for distortion and spectral regrowth. MCSS uses a truncated Short Code with no degradation of spectral purity or signal fidelity. You can control the relative power of each Walsh channel as well as which channels are active with the user-friendly MCSS interface.

Dynamic Signal Environments Replicate Field Test Conditions in Your Lab

The MCSS Dynamic Signal Environment (DSE) application replicates the time-varying, multi-signal environments your design will encounter in actual field use. Now you can minimize the time and expense associated with field testing by generating these test environments quickly and easily in the lab. Up to 125 simultaneous channels can be generated with complete and independent control of all the parameters of each signal. Control the frequency, amplitude, modulation, and data pattern on each channel. Generate up to 20 multi-signal environment states and sequence through them to simulate time-varying conditions such as fading or base station handoff. Any and all of the signals you can generate with the Active Channel application can be combined and used in your DSE environments. With a single MCSS you can simulate mixed-mode systems such as AMPS and CDMA.

HP E2507B
HP E2508A

Generate Signals for Noise Power Ratio Testing

The Noise Power Ratio (NPR) application of the MCSS allows you to fill your selected frequency band with pseudo-random noise. Then you can create notches in that noise spectrum. When that signal stimulates a DUT, distortion in the DUT tends to fill in the notches. The ratio of the amplified output noise power level to the noise power level in the notches is the NPR. For satellite payloads where power consumption is critical, a higher-than-necessary NPR often means that too much power is being consumed by the output amplifiers. MCSS is very useful for testing that the satellite hardware adjusts the power consumed but still achieves the required NPR.

Digital Signal Precision and Flexibility

The heart of the MCSS is the HP 8770 arbitrary waveform synthesizer. This advanced digital signal synthesizer uses 8-ns sample rates, 12-bit architecture, and 125-MHz internal clock to generate precise wideband (50 MHz) signals. HP proprietary DAC "deglitching" circuitry provides superior spectral purity. The 512K memory depth delivers sufficient randomness in your signals' data patterns. The control architecture for the memory is very flexible. It allows disconnected portions of memory to be played in sequence. It also allows any of the portions of the sequence to be repeated an arbitrary number of times. The HP 8770A assures that your MCSS will produce consistently precise test stimuli, today and tomorrow, anytime, and anywhere.

4

Repeatability from System to System

The MCSS signal data, even the random data, can be saved and transferred to other MCSS systems. This gives a degree of repeatability to random testing that eliminates testing conflicts between vendors and customers that are otherwise so common.

Plenty of Coverage with Room for Expansion

A two-stage upconverter maintains the HP 8770's clean signal and provides the MCSS frequency coverage to 2.5 GHz (MCSS Model 100). Testing intermodulation distortion is easy with the lower than –65 dBc distortion of the MCSS. The 80-dB dynamic range, 1-dB resolution, ± 0.05-dB power accuracy (after calibration with external power meter) and ± 0.5-dB flatness give you precise control of your test signal. Low phase noise and broadband noise floor deliver improved test-system dynamic range.

MCSS Models 60 and 100 Technical Specifications

Frequency

Range: Model 60: 800 to 1000 MHz, 1400 to 1600 MHz, 1600 to 1800 MHz, 1800 to 2000 MHz; Model 100: 800 to 1000 MHz, 1400 to 1600 MHz, 1600 to 1800 MHz, 1800 to 2000 MHz, 2100 to 2300 MHz, 2300 to 2500 MHz
Resolution: 1 Hz

RF Output

Power Level: 0 dBm (external amplifiers available) to –70 dBm
Resolution: 0.1 dB (signal generation mode), 1.0 dB (output control mode)
Flatness: ± 1.5 dB across modulation bandwidth typical
Accuracy: ± 0.05 dB typical after calibration with power meter

Spectral Purity

Spurious: –65 dBc within 4 MHz bandwidth of a single carrier (using the default HP 8770 center frequency) –50 dBc elsewhere

Multitone Stimulus

Number of Tones: 1 to 1000 tones within 25 MHz bandwidth
Spacing: 238 Hz to 10 MHz
Resolution: 238 Hz with 1 phase set; 12.2 kHz using 50 phase sets
Magnitude Distribution: Constant, linear, custom
Phase Distribution: Constant, random (1 to 50 phase sets), custom
IM Distortion: –65 dBc average distortion relative to individual tone powers (measured at 0 dBm total signal power for 16 tones spaced 100 kHz with a 100-pattern random-phase stimulus)

Active Channel Stimulus

Signals: PHS, NADC, PDC, GSM, DECT, CT2, TETRA, Custom (user-selectable parameters)
Modulations: BPSK, QPSK, pi/4DQPSK, OQPSK, MSK, FSK, None, and Custom (user-definable I/Q waveform files)
Filter Shapes: Nyquist (alpha: 0 to 1), Square Root Nyquist (alpha 0 to 1), Gaussian (cut-off frequency: 0 to 10 times bit rate), None
Data Sequences: PRBS (four patterns available), All 1s, All 0s, Alternate, AAAA's, 5555's, Custom (user-defined data sequence file)
Bit Rate: 1k bps to 10 Mb/s
Signal Length: 4 ms (repeating)
Adjacent Channel Power: PHS RCR-28: adjacent channel: –65 dBc, alternate channel: –65 dBc typical
Error Vector Magnitude: 0.5% typical

Dynamic Signal Environment

Channels: 1 to 125 simultaneous within 25 MHz bandwidth (depending on context size)
Modulations: All active channel standard and custom formats, CDMA, base and mobile, and noise power ratio signals
Channel Spacing: 5 kHz to 5 MHz
Channel States: Up to 20 with reduced signal lengths
Configuration: Any combination of channels on, off, or modulated: modulated channels may have same or different modulations and same or different data sequences
Magnitude Distribution: Constant, Linear, or Custom
Phase Distribution: Constant, Parabolic, Random, or Custom

CDMA Signal Stimulus

Number of Walsh Channels: 1 to 64 simultaneous
Data: None, random
Relative Channel Amplitudes: ± 40 dB
Short Code Length: 4 k bits (truncated)

Noise Power Ratio Stimulus

Noise Bandwidth: 10 kHz to 25 MHz (50 MHz typical)
Spectral Line Spacing: 238 Hz to 7.6 kHz, Custom
Phase Distribution: Random, Parabolic, Constant, Custom
Magnitude Distribution: Constant, Linear, Custom
Number of Notches: 0–10
Notch Width: 480 Hz to 25 MHz
Notch Depth: 0 to 80 dB

Remote Image Control

Recall images, set power levels, change frequencies, and control trigger types from file inputs. These files can be provided from the PC hard disk or on a network server.

General

Size: 426 mm W X 661 mm H x 623 mm D (16.75 in x 26 in x 24.5 in), without monitor or keyboard
Weight: 120 lb
Power: 1500 VA max

Key Literature

HP E2507B/2508A Multiformat Communications Signal Simulator Model 60 and 100 Brochure, p/n 5964-1640E
Technical Data Sheet, p/n 5964–1603E

Ordering Information

HP E2507B MCSS Model 60
HP E2508A MCSS Model 100
MCSS models include:
HP 8770A Arbitrary Waveform Synthesizer
HP 8648C Synthesized Signal Generator
HP Vectra Personal Computer
MCSS Software
MCSS Upconverter

- 252 kHz to 1030 MHz frequency range with optional coverage to 2060 MHz
- 15 µs frequency switching
- Standalone control of frequency agility
- Specified performance while fast hopping
- FM rates to 10 MHz, deviations to 20 MHz
- Low spurious and phase noise

HP 8645A

HP 8645A Agile Signal Generator

The HP 8645A agile signal generator combines high performance with frequency agility for new fast-switching test requirements. These capabilities are important for performance testing of such devices as frequency agile radios and surveillance receivers. Besides extending traditional receiver testing to agile applications, the HP 8645A can be used to create complex signal simulations involving several modulation types and frequency agility. These complex RF signals can quantitatively exercise a receiver's vulnerability to a jamming transmission. The HP 8645A can also be a fast-switching stimulus needed to decrease production test times. The high performance and frequency agility of the HP 8645A provide capability for both static and agile test requirements with just one calibrated signal generator.

Specified Agile Performance

The HP 8645A provides specified signal performance in both static and agile operation. Fully-synthesized outputs with high timebase accuracy are standard when not frequency hopping. The Fast Hop mode activates a frequency-lock loop to allow frequency switching as fast as 15 µs from 128 to 2060 MHz. Over the frequency range of 8 to 2060 MHz, the fastest switching time is 85 µs and outputs below 8 MHz require 500 µsec. Frequency accuracy of each output is better than ± 2 ppm while in Fast Hop mode. At each frequency, a specific amplitude can be assigned within a 20 dB range for performance tests versus amplitude while frequency hopping. For a full test of a receiver, up to 4000 frequencies can be entered and sequences of up to 8000 frequency settings can be specified. Performance parameters such as phase noise, spurious, amplitude accuracy, and modulation remain high-quality and are completely specified while fast hopping to insure confident test results.

Flexible, High-Performance Modulation

For receiver measurements, the HP 8645A offers independent or simultaneous FM and AM for both static and hopped frequency tests. The modulating signal can be the internal 0.1 Hz to 400 kHz synthesizer or an external input that allows FM deviations up to 20 MHz at rates up to 10 MHz. In Fast Hop operation, maximum deviation is 3.5 MHz with 10 MHz rates. AM is available with up to 100 kHz rates and 99% depth. Pulse modulation allows a 35 dB on/off ratio with 100 ns rise/fall times.

Complete Control of Frequency Hopping

The HP 8645A offers flexible and comprehensive control of the frequency hopping output. Parameters can be entered from the front panel, through the HP-IB port or using TTL inputs on the rear panel. Extensive hopped-frequency simulations including hop frequencies, amplitude, dwell times, hop rate, modulation, and so forth can be entered into nonvolatile memory from the front panel. Activating a hop sequence requires only a press of the Hop key. Agile control is available by a computer with the added advantage of using the Hewlett-Packard Systems Language (HP-SL). For real-time control, rear-panel inputs accept TTL signals for triggering, dwell time, and frequency selection to allow direct connection with the hardware under test. With this wide choice of control, use of the HP 8645A can be readily customized to a wide variety of test situations from benchtop use to ATE systems.

HP 8645A Specifications

Frequency

Range: 251.46485 kHz to 1030 MHz; 251.46485 kHz to 2060 MHz with Option 002 or with HP 11845A 2 GHz retrofit kit installed
Frequency Bands: The exact endpoints of each frequency band can be determined by dividing the 1030 to 2060 MHz band by two for each band decrease. The specifications use approximate endpoints.
Phase Offset: Adjustable in 1 degree increments
Reference Oscillator Stability, Option 001: < 5 x 10^{-10}/day aging

Fast-Hop Operation

Frequency Switching Time: 128 to 1030 MHz: < 15 µs, 8 to 1030 MHz: < 85 µs, 0.25 to 1030 MHz: < 500 µs. Option 002: add 5 µs.
Frequency Hop Range: 0.25 to 2060 MHz. With FM on, limited to any three consecutive frequency bands.
Frequency Accuracy[1]**:** ± 2 ppm of carrier frequency
Amplitude Accuracy: ± 1 dB, > –127 dBm output
(± 1.5 dB, > –127 dBm output when amplitude level is varied up to –5 dB from the constant learned value during Fast Hop)
Channel and Sequence Tables: In Fast Hop, each specific frequency and amplitude to be output is entered into a Channel Table. The order of channels to be output is entered into a Sequence Table.
Maximum Number of Channels: 4000
Maximum Number of Channels in Sequence Table: 8000
Hop-Rate Range: Fixed rates from 8 Hz to 50 kHz using internal timer. An external input allows more range and variable rates.
Dwell-Time Range: Fixed times of 6.4 µsec to 99 ms using the internal timer. External input allows longer and variable dwell.
Learn-Cycle Time: Typically, 10 seconds to 3.5 minutes, depending on sequence size
Fast-Hop Bus: Allows real-time selection of any channel for output. Typically, frequency switching time increases by 5 µs.
Modulation: Internal or external AM, FM, or simultaneous AM/FM
Output Level: Allowed amplitude variation of all channels entered is 0 to 20 dB. Output level is reduced by > 60 dB while switching between channels. External dc AM can be used to shape the output.

Spectral Purity

SSB Phase Noise (CW, AM, or FM[2] operation)**:**

Carrier frequency (MHz)	Standard operation 20 kHz (dBc/Hz)	100 kHz (dBc/Hz)	Fast Hop 20 kHz (dBc/Hz)
1030 to 2060	–120	–127	–116
515 to 1030	–127	–134	–123
257 to 515	–132	–137	–128
128 to 257	–136	–140	–133
64 to 128	–139	–141	–137
32 to 64	–141	–141	–139
16 to 32	–142	–142	–141
8 to 16	–143	–143	–142
4 to 8	–144	–144	–143
Less than 4 MHz	–144	–144	–144

Harmonics: < –30 dBc, output ≤ 10 dBm. Option 002, output > 8 dBm: < –30 dBc, 0.25 to 1030 MHz; < –25 dBc, 1030 to 2060 MHz.
Subharmonics: None, < 515 MHz; < –60 dBc, 515 to 1030 MHz; < –40 dBc, > 1030 to 2060 MHz
Nonharmonics: > 20 kHz offset[3]: < –100 dBc, < 1030 MHz; < –94 dBc, > 1030 to 2060 MHz

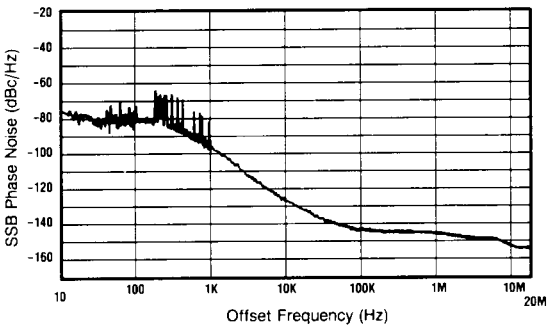
[1] Typically, + 2 ppm of carrier frequency multiplied by the temperature change in °C must be added if ambient temperature changes occur between the learn operation and the conclusion of frequency hopping. FM at minimum deviation.
[2] FM at minimum deviation.
[3] Typically, nonharmonic spurs at all offsets are < 30 dB above the instrument's phase noise level as measured in a 1 Hz bandwidth.

Frequency Agile/Complex Signal Simulation (cont'd)

Residual FM[1] (CW, AM, FM[2] operation):

Carrier Frequency (MHz)	Post Detection Bandwidth 0.3 to 3 kHz (Hz rms)	0.05 to 15 kHz (Hz rms)
0.25 to 257	< 1	< 1.2
257 to 515	< 1.2	< 2
515 to 1030	< 2	< 4
1030 to 2060	< 4	< 8

Typical SSB Phase Noise and Spurs at 1 GHz:



Residual AM: < 0.01% AM rms, 0.3 to 3 kHz post detection BW
Typical SSB AM Noise Floor, Offsets > 100 kHz: < –157 dBc/Hz at + 16 dBm output, 0.25 to 1030 MHz. < –150 dBc/Hz at + 13 dBm output, 1030 to 2060 MHz.

Output

Maximum Level: + 16 dBm, 0.25 to 1030 MHz; Option 002: + 14 dBm, 0.25 to 1030 MHz. + 13 dBm, above 1030 MHz.
Minimum Level: –137 dBm
Absolute Accuracy: ± 1 dB, output ≥ –127 dBm
Reverse Power Protection: 50 watts from a 50 Ω source, 25 Vdc
Typical Third Order Intermodulation: < – 50 dBc, outputs < 8 dBm
Typical Output Level Overrange: 2 dB more than maximum level
Typical SWR and Output Impedance: < 1.7:1 at < – 2 dBm; 50 Ω

Modulation

External Modulation Input: Coupling is ac or dc for AM, FM, and phase modulation. Pulse modulation input is dc coupled. Displayed deviation or depth corresponds to ± 1 V external input.
Simultaneous Modulation: AM/FM, AM/Phase, AM/Pulse, FM/Pulse, Phase/Pulse, AM/FM/Pulse, AM/Phase/Pulse
Simultaneous Internal/External Modulation: FM and Phase

Amplitude Modulation

Depth: 0 to 99.9%, for output < ± 7 dBm
AM Indicator Accuracy: ± (6% of setting + 2%, AM), up to 90% depth and 1kHz rate for carrier frequencies > 1 MHz. When amplitude level is varied up to – 5 dB from the constant learned value during Fast Hop: ± (7% of setting + 1% AM) up to 80% depth, 1 kHz rate.

Distortion, at 400 Hz and 1 kHz Rates:

Depth	Carrier Frequency 0.25 to 1030 MHz	1030 to 2060 MHz
0 to 30%	< 2%	< 5%
30 to 70%	< 3%	< 5%
70 to 90%	< 5%	< 8%

3 dB Bandwidth[3]**:** > 5 kHz, 0.25 to 8 MHz. > 50 kHz, 8 to 128 MHz; > 100 kHz, 128 to 2060 MHz
Incidental Phase Modulation: < 0.2 rad peak, at 30% depth and1 kHz
Typical External Input Impedance: 600 Ω

Frequency Modulation

FM Deviation and Rate: In the highest frequency band of 1030 to 2060 MHz, the maximum FM peak deviation is 20 MHz for standard operation and 3.52 MHz for Fast Hop. Maximum FM rate (3 dB bandwidth) in the 515 to 1030 MHz band and above is 10 MHz. Divide rate and deviation by two for each frequency band decrease.
FM Indicator Accuracy: ± 10%, < 50 kHz rate and < 10% of maximum deviation (< 50% of maximum deviation in Fast Hop)
FM Distortion: Rates 20 Hz to 100 kHz: < 2.7%, deviation < 2% of maximum available (Fast Hop: < 10% of maximum deviation)
Carrier Frequency Accuracy in FM: ± 0.4% of deviation setting, ac- or dc-coupled. Typically add 1% of deviation in Fast Hop.
Incidental AM: < 0.5%, deviation limited to < 6% of max. or 20 kHz
Typical External FM Group Delay: 30 µs for rates 20 Hz to 20 kHz, decreases to < 1 µs at rates > 200 kHz. Fast Hop: < 1 µs.
Typical External FM Input Impedance: 50 or 600 Ω

Pulse Modulation

On/Off Ratio: > 35 dB
Rise/Fall Time: < 100 ns, between 10% and 90% response points
Maximum Pulse Repetition Frequency: 1 MHz
Minimum Pulse Width: 0.5 µs
Typical Output Level Accuracy: ± 2 dB
Typical External Input Levels and Impedance: On: > 3.0 V peak; Off: < 0.8 V peak. Damage level: ≥ ± 10 V peak. 600 Ω.

Internal Modulation Source

Waveforms: Sine, square, sawtooth, and white Gaussian noise
Frequency Range: Sine, white Gaussian noise: 0.1 Hz to 400 kHz. Square, sawtooth: 0.1 Hz to 50 kHz.
Frequency Accuracy: Same as internal reference oscillator
Output Level: Typically, 1 V_{pk} max. into 600 Ω. Accuracy: ± 20 mV.
Output Level Resolution: 2 mV. Typical impedance: 600 Ω.
Distortion: < 0.1%, output at 1 V peak and ≤ 15 kHz

Frequency Sweep

Phase Continuous Sweep: Linear sweep with times from 10 ms to10 s, not dependent on span. Maximum span is 40 MHz from 1030 to 2060 MHz frequency band, divided by two for each band decrease.
Fast Hop Sweep: Linear or log stepped with times from 10 ms to100 s. Number of steps varies with time selected. Typical time per step is 30 µs for outputs within 128 to 2060 MHz, 170 µs for 8 to 2060 MHz, and 650 µs for 0.25 to 2060 MHz.
Sweep Control and Markers: X-axis: 0 to + 10 V. Z-axis: + 5 V retrace, + 1 V trace, 0 V markers. Three markers available.

General

Remote Control: HP-IB (IEEE-488.2-1987). The control language used is the Hewlett-Packard Systems Language (HP-SL). All front-panel functions except power switch and knob. A unique Fast Hop bus interface accepts TTL levels for frequency agile control.
Operating Temperature Range: 0° to +55° F
Leakage: Meets MIL-STD-461B-RE02 and FTZ 1046
Storage Registers: 10 full function and 40 freq./ampl. locations
Memory Erasure: All memory contents according to MIL-STD-380-380
Size: 426 mm W x 177 mm H x 624 mm D (16.8 in x 7 in x 24.6 in)
Weight: Net, 31 kg (69 lb); shipping, 42 kg (95 lb)

Key Literature

HP 8645A Agile Signal Generator Data Sheet, p/n 5953-8498E
HP 8645-1 Communications-Agile Operation of the HP 8645A Product Note, p/n 5951-6711

Ordering Information

HP 8645A Agile Signal Generator[4]
Opt 001 High-Stability Timebase
Opt 002 2 GHz Output
Opt 003 RF Connectors on Rear Panel Only
Opt 907 Front Handle Kit (5062-3990)
Opt 908 Rack Flange Kit (5062-3978)
Opt 909 Rack Flange Kit with Front Handles (5062-3984)
Opt 910 Provides an additional operation/calibration manual (08645-90023) and 2 service manuals
Opt 915 Add Service Manual (08645-90104)
08645-61116 Service Kit
9211-2662 Transit Case
1494-0059 Non-Tilting Rack Slide Kit
1494-0063 Tilting Rack Slide Kit

[1] Specified for 48 to 63 Hz power line. Typical for 400 Hz power line and Fast Hop operation.
[2] Deviation < 0.1% of maximum available.
[3] Lower 3 dB bandwidth limit is 0 Hz for dc coupling and typically 20 Hz for ac coupling.
[4] HP-IB cables not included. For description and price, see page 80.

- Advanced dynamic control
- 100 ns frequency agility
- 40 MHz instantaneous modulation bandwidth
- Arbitrary control over AM, FM, ΦM, pulse, and frequency hop
- Easy-to-use application-specific software
- Precise synthesized signal control
- Standalone or subsystem operation
- 40 GHz operation with optional upconverters
- Phase-coherent frequency hopping

HP 8791 Model 11 with optional external upconverter

HP-IB

Model 21 (0.05 to 18 GHz), Model 11 (10 to 3000 MHz), Model 7 (DC to 50 MHz) Frequency Agile Signal Simulators

High-Precision Signals for EW, Radar, and Advanced Communications

The HP 8791 family of Frequency Agile Signal Simulators (FASS) generate the complex yet realistic test signals needed for today's sophisticated signal simulation and system test. Whether you're simulating advanced EW threats, radar target returns, satellite transponder traffic, or cellular radio's multiple-signal environments, FASS combines powerful modulation capability with digitally-generated signal precision. The 40 MHz instantaneous modulation bandwidth can be switched anywhere across the 0.05 to 18 GHz coverage of Model 21 (3 GHz for Model 11) in 100 nanoseconds to generate spread spectrum formats, radar chirps, video, pseudo-noise, multiple carriers, QAM and FSK. Comprehensive application software harnesses the power of FASS, giving the system an easy-to-use, mouse-driven front panel.

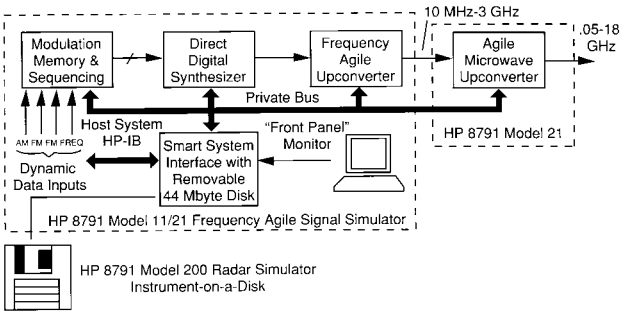
Application-specific Instrument-on-a-Disk (ID) software includes the HP 8791 Model 100 precision signal generator which provides quick access to all FASS modulation and signal capability in the easy-to-use format of a traditional signal generator. The Model 200 radar simulator features various pulse modulations and antenna scans that simplify radar target return simulations. Optional upconversion extends FASS coverage to 40 GHz.

Description

The Frequency Agile Signal Simulator uses high-speed memory, signal processing, digital-to-analog conversion, and direct digital and analog synthesis for precise signal simulation with unprecedented flexibility. The Frequency Agile Signal Simulator is characterized by:

- High-performance modulation and agility
- Instrument-grade quality, repeatability, accuracy
- Easy-to-use, software-reconfigurable user interface
- Low cost of ownership
- Off-the-shelf instrumentation

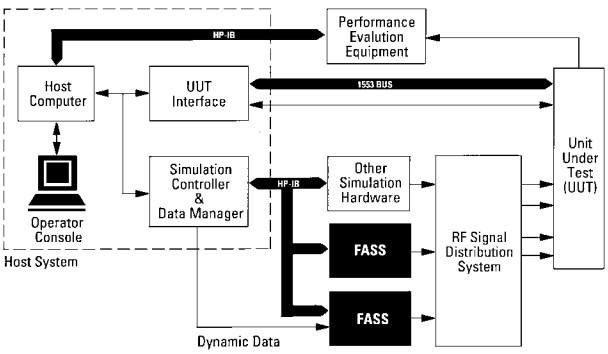
The modulation data source's digital memory and sequencers store signal characteristics, namely carrier frequency and hop patterns, amplitude, frequency, phase, and pulse modulation data. This data is supplied to the agile carrier synthesizer, where it is processed and converted to an analog signal made up of a carrier and its modulation. Model 7 outputs this dc to 50 MHz signal directly, while Model 11 translates it anywhere between 10 and 3000 MHz using the agile upconverter. A second agile upconverter, used in the HP 8791 Model 21 FASS, translates the signal between 0.05 and 18 GHz. The smart interface manages data flow and signal generation functions within FASS, as specified by inputs from its menu-driven front panel or over HP-IB.



Application Overview

Electronic Warfare

FASS is ideal for simulating advanced threats with intrapulse modulation, PRI stagger, frequency agility, and antenna scan modulation. Being fully synthesized, FASS is especially well suited for pulse Doppler radar simulation.



Communications

FASS can produce a variety of sophisticated signals for testing satellite, terrestrial, and mobile communications systems and components. In parametric testing, FASS's high clock rate, frequency agility, and digital precision can significantly shorten test times for tests like NPR, group delay, and gain flatness. More importantly, FASS can simulate actual link traffic and signal environments, increasing accuracy and realism while eliminating the need for time-consuming and costly field testing. Link FASS with your computer simulation software to generate production test signals identical to the test vectors used in your design simulations. Add signal impairments and propagation effects to evaluate system operating margins. Complex signals like TDMA and CDMA are easily generated using FASS dynamic sequencing.

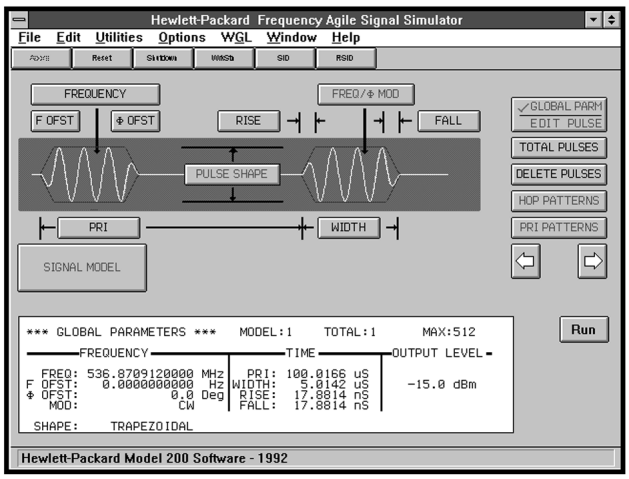
Radar

FASS can simulate target returns for testing and calibrating radar receivers. FASS can also be used as a major subsystem for instrumentation radars, serving as a complex waveform exciter or a frequency agile STALO for coherent systems.

Modes of Operation

Instruments-on-a-Disk (IDs)

Instruments-on-a-Disk (IDs) make this otherwise complex system easy to use and give FASS the front panel personality of specific applications. By clicking clearly-labeled softkeys with the mouse, users can modify sophisticated signal characteristics like PRI stagger quickly and easily.



HP 8791 Model 200 screen

Remote HP-IB

Remote HP-IB commands in FASS come in two varieties. There are the commands that mimic front-panel keystrokes of an ID and the general-purpose commands that give access to all the functions of FASS. Whichever set of standard HP-IB commands is used, integrating FASS's high-integrity, advanced signal simulation capability into an existing simulation system is very convenient.

Waveform Generation Language (WGL)

For advanced applications where existing ID software is insufficient, users can program FASS with the Waveform Generation Language (WGL) software. WGL could be used to generate nonstandard signals such as nonlinear chirps or complex signal environments such as TDMA or CDMA.

Dynamic Data/Dynamic Sequence

Dynamic data mode allows selective, external control of instantaneous frequency, FM, ΦM, and AM, as well as pulse modulation and level. In dynamic data mode, data maps are downloaded to the modulation data source's frequency and modulation memories. Dynamic data supplied at rates of up to 33 MHz addresses desired locations in memory. The output of FASS is determined by the values mapped at that location. Dynamic sequence allows external real-time selection of up to 1024 unique waveform sequences.

Performance Characteristics

HP 8791 Model 21 Frequency Agile Signal Simulator

Frequency
- **Range:** 0.05 to 18 GHz (to 40 GHz with upconversion)
- **Resolution:** 0.125 Hz
- **Switching Speed:** < 100 ns typical over full 18 GHz BW

Amplitude
- **Fast-Level Control Switching Speed:** < 100 ns typical in 6.02 dB steps
- **Output Power:** + 10 to –107 dBm

Modulation Capabilities
- **Instantaneous Bandwidth:** 40 MHz
- **Formats:** Arbitrary FM, ΦM, AM, Pulse, Frequency Hopping

Spectral Purity
- **Spurious Response:** –55 dBc, typical
- **Phase Noise:** < –110 dBc/Hz @ 10 kHz offset, 9.77 GHz, typical

Remote Operation
HP-IB compatible
- **Dynamic Data:** AM, FM, ΦM, carrier frequency, pulse
- **Dynamic Data Rates:** Up to 33 megawords/sec/channel

General
Size: Rack: 600 mm W x 1237 mm H x 803 mm D (23.6 x 48.7 in x 31.6 in); console: 754 mm W x 1064 mm H x 756 mm D (29.7 in x 41.9 in x 29.8 in)
Weight: Shipping, rack 319 kg (700 lb); console 75 kg (165 lb)

HP 8791 Model 11 Frequency Agile Signal Simulator

Same specifications as Model 21 except:
Frequency Range: 0.01 to 3 GHz (to 18.5 GHz with upconversion)
Switching Speed: < 100 ns typical over full 3 GHz BW

HP 8791 Model 7 Frequency Agile Signal Simulator

Same specifications as Model 21 except:
Frequency Range: DC to 50 MHz (other output frequencies available using external upconverters)
Switching Speed: 8 ns to within 10° of final frequency
Amplitude
- **Output Power:** + 10 to –100 dBm

Spectral Purity
- **Phase Noise:** ± 127 dBc/Hz at 10 kHz offset at 40 MHz typical

Instantaneous Modulation BW: 50 MHz p-p
Weight: Shipping, rack 258 kg (568 lb); console 75 kg (165 lb)

HP 8791 Model 100 Precision Signal Generator

The HP 8791 Model 100 Precision Signal Generator Instrument-on-a-Disk (PSID) software configures FASS to be a high-precision signal generator.
Carrier: Amplitude, phase, frequency
AM: Modulation index: 0 to 100% (80 dB DSB-SC);
Modulation frequency: 0.0625 Hz to 20 MHz
PM: Peak phase deviation: 0° to 180°;
Modulation frequency: 0.0625 Hz to 20 MHz typical
FM: Frequency deviation: 0.125 Hz to 20 MHz;
Modulation frequency: 0.0625 Hz to 20 MHz;
0 to approximately 2 MHz typical
Modulation Waveforms
- **Sine:** AM, PM, FM
- **Rectangle:** 0 to 100% duty cycle AM (allows for pulse modulation)
- **Arbitrary User-defined:** ≤ 8192 points

HP 8791 Model 200 Radar Simulator

The Model 200 Radar Simulator Instrument-on-a-Disk (RSID) software configures FASS to simulate advanced pulsed radar emitters.
Frequency Hopping: Constant, linear, scheduled, user-defined
Intrapulse Modulation: Coherent, noncoherent, chirp, Barker, user-defined
Pulse Width: 29.8 ns to 100 ms
Rise and Fall: 29.8 ns to 230 µs
Pulse Shapes: Trapezoidal, Gaussian, exponential, user-defined
Pulse Repetition Frequency: 1 Hz to 625 kHz
PRF Patterns: Constant, burst, stagger, jitter, wobbulation, user-defined
Antenna Scan Rate: 4 to 100,000 RPM
Main Beam Width: 0.1 to 360°
Antenna Scan Patterns: Circular, conical, raster, sector, user-defined
Antenna Radiation Patterns: Rectangular, Hamming, Hanning, Blackman, 3-term, $\cos^n$, programmable

Key Literature

HP 8791 Models 11 and 21 FASS Technical Data Sheet, p/n 5091-4425E
HP 8791 Model 7 FASS Technical Data Sheet, p/n 5091-2914E

Ordering Information

HP 8791
Model 21 Frequency Agile Signal Simulator (E2505A)
Model 11 Frequency Agile Signal Simulator (E2500B)
Model 7 Frequency Agile Signal Simulator (E2506A)
Model 100 Precision Signal Generator (E2502A Option 012)
Model 200 Radar Simulator (E2501A Option 012)

HP 83554A
HP 83555A
HP 83556A
HP 83557A
HP 83558A

- 26.5 to 110 GHz frequency range
- Leveled high output power
- Can be driven by many HP microwave sources
- Source module remotable up to one meter length
- Low entry cost

HP 83550 Series Millimeter-Wave Source Modules

The five HP 83550 series millimeter-wave source modules provide a simple approach to extend the frequency range of 11 to 20 GHz sources to cover 26.5 to 40 GHz (HP 83554A), 33 to 50 GHz (HP 83555A), 40 to 60 GHz (HP 83556A), 50 to 75 GHz (HP 83557A), and 75 to 110 GHz (HP 83558A) bands. The HP 83550 series source modules offer leveled high output power, full waveguide band frequency coverage, and the high-frequency accuracy and resolution of the driving microwave source.

As shown in the figure in the right column, there are two basic ways of configuring a millimeter-wave source to best suit your specific needs. You can choose between an individual synthesized sweeper (HP 83623B/L, HP 83624B, HP 83751B, or HP 83752B) or a combination of an HP 8349 amplifier and another HP 8360 B/L series or HP 8370 series synthesized sweeper.

Pulse, AM, and FM Modulation

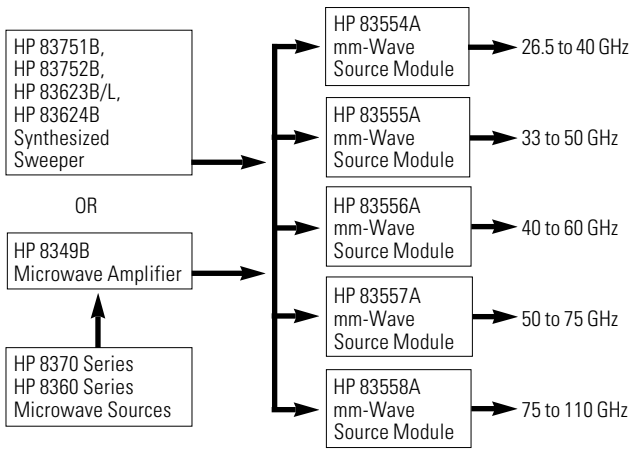
The high-performance pulse modulators of the Hewlett-Packard synthesized sources offer > 80 dB on/off ratio and < 50 ns rise and fall times. Pulse amplitudes are leveled for pulse widths as narrow as 1 µs.

The HP 8360 B-series also feature dc-coupled AM with a 3 dB bandwidth of 250 kHz. Pulse and amplitude modulation can be used to simultaneously simulate antenna scan patterns.

FM rates between 100 kHz and 8 MHz may be applied to the HP 8360 B-series synthesizer input to achieve deviations up to 16 MHz (HP 83554A) and 24 MHz (HP 83555A, 83556A), 32 MHz (HP 83557A), and 48 MHz (HP 83558A) at millimeter-wave frequencies.

High-Output Power

Leveled-output power from the source modules is rated at +8 dBm for the HP 83554A, +3 dBm for the HP 83555A, +3 dBm for the HP 83556A, +3 dBm for the HP 83557A, and 0 dBm for the HP 83558A. This high-output power can permit the source module to serve as a mixer LO in some applications and also expands the available dynamic range in frequency response measurements.



All at a Lower Cost

The HP 83550 series source modules combine performance and quality with a low cost of entry. This is possible because the source modules are backward-compatible with existing HP microwave sources. Thus you can generate a full waveguide band of millimeter-wave frequencies for just the cost of a source module and an HP 8349B amplifier (where required). Also, the cost of ownership is reduced even further by the two-year warranty on the microcircuits of the HP 83550 series source modules and the HP 8349B microwave amplifier.

HP 83554A Output Characteristics

	HP 8360 Series/8349B, HP 83623B/L, 83624B	HP 8370 Series/8349B, HP 83751B, 83752B
Maximum leveled power (25° ± 5° C) **Minimum settable power**	+ 8 dBm – 5 dBm	+ 8 dBm – 5 dBm
Power level accuracy[2] (25° ± 5° C) **Power flatness** (at max. leveled power)	± 2.00 dB ± 1.50 dB[3]	± 2.00 dB ± 1.50 dB[3]
Source output SWR	< 2.0	< 2.0
Spurious signals[4] Harmonically related spurious: 26.5 to 26.7 GHz 26.7 to 40.0 GHz	 < – 25 dBc < – 40 dBc	 < – 25 dBc < – 20 dBc

[1] All specifications apply to internally leveled operation only.
[2] Specified with respect to HP 83550A or HP 8349B power display. Includes power level flatness.
[3] Must have 0.5 V/GHz modification on microwave source.
[4] Expressed in dB relative to the carrier level (dBc).

HP 83550 Series Millimeter-Wave Source Modules (cont'd)

HP 83555A Output Characteristics[1]

	HP 8360 Series/8349B, HP 83623B/L, 83624B	HP 8370 Series/8349B, HP 83751B, 83752B
Maximum leveled power (25° ±5° C)	+3 dBm	+3 dBm
Minimum settable power	–5 dBm	–5 dBm
Power level accuracy[2] (25° ± 5° C)	± 2.00 dB	± 2.00 dB
Power flatness (at max. leveled power)	± 1.50 dB[3]	± 1.50 dB[3]
Source output SWR	< 2.0	< 2.0
Spurious signals[4]		
Harmonically related spurious:		
33.0 to 37.5 GHz	< –20 dBc	< –20 dBc
37.5 to 49.5 GHz	< –40 dBc	< –50 dBc
49.5 to 50.0 GHz	< –20 dBc	< –20 dBc

HP 83556A Output Characteristics[1]

	HP 8360 Series/8349B, HP 83623B/L, 83624B	HP 8370 Series/8349B, HP 83751B, 83752B
Maximum leveled power (25° ± 5° C)	+3 dBm	+3 dBm
Minimum settable power:	–5 dBm	–5 dBm
Power level accuracy[2] (25° ±5° C)	± 2.25 dB	± 2.25 dB
Power flatness (at max. leveled power)	± 1.75 dB[3]	± 1.75 dB[3]
Source output SWR	< 2.0	< 2.0
Spurious signals[4]		
Harmonically related spurious:		
40.0 to 45.0 GHz	< –20 dBc	< –20 dBc
45.0 to 60.0 GHz	< –40 dBc	< –50 dBc

HP 83557A Output Characteristics

	HP 8360 Series/8349B, HP 83623B/L, 83624B	HP 8370 Series/8349B, HP 83751B, 83752B
Maximum leveled power (25° ± 5° C)	+3 dBm	+3 dBm
Minimum settable power	–2 dBm	–2 dBm
Power level accuracy (25° ± 5° C)	± 2.0 dB	± 2.5 dB
Power flatness (at max. leveled power)	± 1.5 dB	± 2.0 dB
Source output SWR		
Leveled:	< 2.0	< 2.0
Unleveled:	< 3.0	< 3.0
Spurious signals[4]		
Harmonically related spurious:	< –20 dBc	< –20 dBc

HP 83558A Output Characteristics

	HP 8360 Series/8349B, HP 83623B/L, 83624B	HP 8370 Series/8349B, HP 83751B, 83752B
Maximum leveled power (25° ± 5° C)	0 dBm	0 dBm
Minimum settable power	–5 dBm	–5 dBm
Power level accuracy (25° ± 5° C)	± 2.0 dB	± 2.5 dB
Power flatness (at max. leveled power)	± 1.5 dB	± 2.0 dB
Source output SWR		
Leveled:	< 2.0	< 2.0
Unleveled:	< 3.0	< 3.0
Spurious signals[4]		
Harmonically related spurious:	< –20 dBc	< –20 dBc

[1] All specifications apply to internally leveled operation only.
[2] Specified with respect to HP 83550A or HP 8349B power display. Includes power level flatness.
[3] Must have 0.5 V/GHz modification on microwave source.
[4] Expressed in dB relative to the carrier level (dBc).

General Specifications

Waveguide Output Connector
HP 83554A: EIA size WR 28 waveguide; JAN UG-599 flange
HP 83555A: EIA size WR 22 waveguide; JAN UG-383 flange
HP 83556A: EIA size WR 19 waveguide; JAN UG-383 (mod.) flange
HP 83557A: EIA Size WR 15 waveguide: JAN UG-385 flange
HP 83558A: EIA Size WR 10 waveguide: JAN UG-387 flange
Weight: Net, 1.7 kg (4 lb)
Size: Module, 80 mm W x 80 mm H x 210 mm D (3.15 in x 3.15 in x 8.27 in)
Furnished with Each Source Module: Operating and Service Manual, Modification Procedures for 0.5 V/GHz Output, Type-N RF Cable, Module Base Assembly, Synthesizer Interface Cable

Key Literature

HP 83557A/83558A Data Sheet, p/n 5958-0398
HP 83554A/83555A/83556A, MM-Wave Source Modules Data Sheet, p/n 5954-8364D

Ordering Information

HP 83554A 26.5 to 40.0 GHz mm-Wave Source Module
HP 83555A 33.0 to 50.0 GHz mm-Wave Source Module
HP 83556A 40.0 to 60.0 GHz mm-Wave Source Module
HP 83557A 50.0 to 75.0 GHz mm-Wave Source Module
HP 83558A 75.0 to 110.0 GHz mm-Wave Source Module
Opt 910 Extra Service Manual
Opt W30 Extended Repair Service (see page 584)
HP 83554/5/6
HP 83557/8
Opt W32 Calibration Service (see page 584)
HP 83554/5/6
HP 83557/8

Hewlett-Packard offers a complete line of signal analyzers to provide frequency-, time-, order-, angle-, and modulation-domain measurement capability. This section is devoted primarily to the frequency domain. It includes spectrum analyzers, distortion analyzers, audio analyzers, modulation analyzers, and measuring receivers. Each type of instrument has distinctive capabilities that make it the preferred instrument for a particular measurement application.

The spectrum analyzer is a swept-tuned, superheterodyne receiver that provides a display of amplitude versus frequency. It is essentially a frequency-selective, peak-responding voltmeter calibrated to display the rms value of a sine wave. The spectrum analyzer can show the individual frequency components that make up a complex signal. (It does not provide phase information about a signal, however.) The swept receiver technique used in Hewlett-Packard spectrum analyzers enables frequency-domain measurements to be made over a large dynamic range and a wide frequency range (30 Hz to 325 GHz).

The Fourier analyzer uses digital sampling and mathematical transformation techniques to form a Fourier spectrum of a signal. This method is useful for measuring signals from a few µHz to 100 kHz, and provides frequency, amplitude, and phase information. With its real-time signal analysis capability, the Fourier analyzer is able to capture periodic as well as random transient events.

Distortion analyzers and audio analyzers employ broadband detectors and notch filters to measure signal properties such as total harmonic distortion. These tunable filters enable the analyzer to selectively display the level and frequency of harmonic and distortion products. Measurement results are shown on a meter or digital display. Audio analyzers include a signal source, making possible measurements such as SINAD, which include signal and distortion levels. The frequency range covered by HP distortion and audio analyzers extends from 5 Hz to 600 kHz.

Modulation analyzers and measuring receivers are designed to capture and analyze a fundamental signal and its entire modulation envelope. Modulation analyzers use independent AM and FM detection circuits for simultaneous analysis of complex modulated signals. When these analyzers are combined with a downconverter and local oscillator, accurate measurements of frequency, power, and modulation characteristics can be made on signals from 150 kHz to 26.5 GHz. All measurement results are presented on a digital display.

Spectrum Analyzers

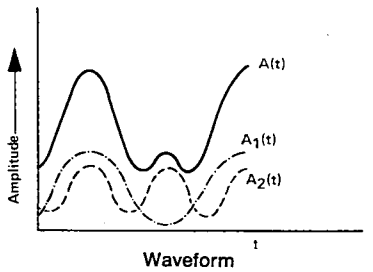
Spectrum analyzers take advantage of the frequency-conversion properties of the swept-tuned heterodyne receiver to make significant contributions to frequency-domain signal analysis. The following are some of the measurements that can be made with spectrum analyzers:

- Absolute and relative frequency
- Absolute and relative amplitude
- Scalar
- Noise
- Distortion products
- AM, FM, pulsed RF, and digital modulation
- Stimulus response
- Electromagnetic compatibility (EMC)

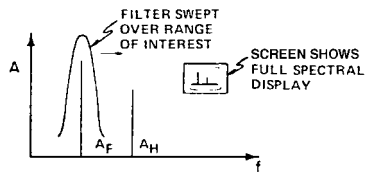
These measurements are possible because spectrum analyzers have the following characteristics:

- Broad frequency coverage from 30 Hz to 325 GHz
- Wide amplitude range from –156 dBm to +30 dBm
- Tracking generators for scalar measurements
- Excellent sensitivity for low signal detection
- Excellent frequency stability
- High resolution of frequency and amplitude
- Digital demodulation capability

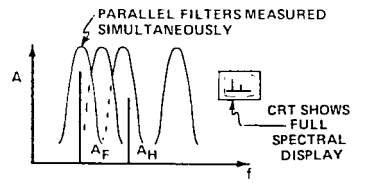
These capabilities allow spectrum analyzers to provide frequency-domain signal analysis for numerous applications, including the manufacture and maintenance of microwave communication links, radar, telecommunications equipment, CATV systems and broadcast equipment, mobile communication systems, EMI diagnostic testing, component testing, lightwave measurements, and signal surveillance.



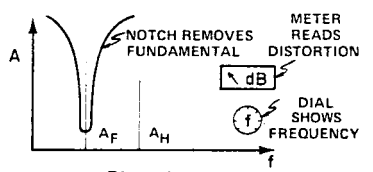
Waveform



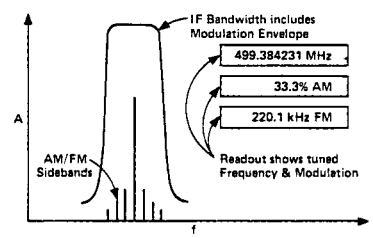
Spectrum analyzer



Fourier analyzer



Distortion analyzer



Modulation analyzer

In addition to the swept-tuned frequency mode, spectrum analyzers can also be used in the fixed-tuned mode (zero span) to provide time-domain measurement capability much like that of an oscilloscope.

Vector signal analyzers extend the capabilities available in a spectrum analyzer. Though similar to Fourier analyzers, vector signal analyzers provide capabilities through the RF range, offering fast, high-resolution spectrum measurements, demodulation, and advanced time-domain analysis. They are especially useful for characterizing complex signals such as burst, transient, or modulated signals used in communications, video, broadcast, sonar, and ultrasound imaging applications.

With the addition of computers, the capability of spectrum analyzers can be greatly enhanced. Computers can be used to directly control the operation of spectrum analyzers over HP-IB. Computers can also be used to develop downloadable programs (DLPs) for spectrum analyzers with the capability to store such programs in non-volatile memory. These custom measurement routines are then as easy to use as any of the standard instrument features. Custom measurement "personality" cards are available for many spectrum analyzers.

In addition, spectrum analyzers can directly control a plotter or printer, enabling a hard copy of the display to be made without the use of a computer. Application areas that require accurate, high-speed, repetitive routines, physical separation of the operator and the analyzer, unattended operation or operation by personnel with limited technical skills are all candidates for automation.

Areas that benefit significantly from automated spectrum analysis include:

- EMC testing
- frequency spectrum monitoring
- production testing of RF or microwave components, subsystems, or systems
- remote-site testing

The basic measurement capabilities of the spectrum analyzer, combined with its ability to automate and to interface with other HP-IB instruments and peripherals, make this instrument ideal for many general-purpose and specialized applications.

Fourier Analyzers

Fourier analyzers offer fast, high-resolution spectrum and network analysis. Unlike conventional swept analyzers, Fourier-based analyzers can measure dynamic signals because they measure all frequencies simultaneously, not one at a time.

Fourier analyzers characterize signals using digital signal-processing techniques based on the Discrete Fourier Transform. For a complete description of these techniques, see Application Note 243, *The Fundamentals of Signal Analysis.*

Fourier analyzers are especially useful on low-frequency signals (< 100 kHz) or where very fast measurements are desired. They can improve measurement speed from a factor of 10 to 100, and allow accurate measurements on frequencies as low as a few µHz. Signal components as closely spaced as 20 µHz can be clearly resolved and accurately measured.

Since both the magnitude and phase of each frequency component are measured, the Fourier analyzer can measure the statistical properties of signals, or the joint properties or relationships of two or more signals. Applications include acoustic, modal, vibration, or rotating machine analysis. In addition, various types of modulation can be detected and measured.

Simultaneous measurement of magnitude and phase on two or more channels provides high-quality network measurements. Transfer functions or frequency response can be easily measured, and the use of band-limited or band-translated random noise as the stimulus allows the entire frequency span of interest to be measured at once. Measurement of the coherence function can provide an indication of the validity of many network measurements.

Distortion and Audio Analyzers

The Hewlett-Packard distortion and audio analyzers consist of narrow-band rejection filters and broadband detectors. Before the fundamental is rejected, the analyzer first measures the amplitude of the fundamental, all the harmonic components, and the noise. Then the rejection filter is employed to remove the fundamental. The ratio of the two measurements is total harmonic distortion plus noise.

Audio Analyzers

The audio analyzer performs several basic low-frequency measurements in addition to distortion, making it a general-purpose audio test set. The audio analyzer includes the SINAD function for testing mobile radio receiver sensitivity. It contains a low-distortion audio oscillator for stimulus-response testing in combination with its distortion analyzer. It has a true rms voltmeter and dc voltmeter for accurate measurement of complex waveform levels. Swept ac level and swept distortion measurements can be made using the internal source and rms voltmeter. A reciprocal frequency counter is included that continuously counts the frequency of the input signal.

True Harmonic Distortion Measurements

Computer-controlled spectrum analyzers provide a rapid means of measuring true harmonic distortion levels. The fundamental and its harmonic components are rapidly measured one at a time, and the distortion is computed and either stored or printed.

Modulation Analyzers/ Measuring Receivers/ Vector Signal Analyzers

A modulation analyzer is a precision receiver designed to detect the entire modulation envelope of a signal under test. It can measure and display the carrier characteristics of RF frequency and power, as well as AM, FM, and phase modulation characteristics such as AM depth, peak deviation, residual modulation, and various associated ratios. The modulation analyzer faithfully recovers the actual modulation signal for further analysis such as distortion testing.

In addition to having all the capabilities of the modulation analyzer, the measuring receiver can measure power down to –127 dBm. With very high accuracy, it can look at signals up to millimeter-wave frequencies. This makes it ideal for the calibration of signal generators and attenuators.

Vector Signal Analyzers

The vector signal analyzer is also capable of modulation analysis. Similar to Fourier analyzers, vector signal analyzers extend the capabilities of DSP through the RF range. Since both the magnitude and the phase of signals are captured, vector signal analyzers can provide a broad range of measurements including spectrum, modulation, and power on baseband, IF, or RF signals. Vector or I and Q formats can be analyzed in addition to AM, FM, and PM formats. Vector signal analyzers are especially useful when a broad range of measurements is required, for example, in the development of digital communication systems.

Microwave Modulation Analyzers

Most modern microwave communication and radar/EW system designers are turning to the use of complex modulations, which involves the use of quadrature or vector modulation formats such as QPSK or 16 QAM in the case of communication systems or complex, coded formats in the case of radar/EW systems.

In all these receivers, the signal processing is not handled in the traditional one-channel, amplitude-only mode, but instead is demodulated into in-phase and quadrature-phase signals that provide dynamic phase and amplitude information about the modulation of the carrier.

Modulation-domain analyzers represent an extension of Hewlett-Packard's counter/timer technology. They provide helpful views of the frequency, phase, or timing of a signal versus time. They also provide histograms and statistical analyses, making it easy to quickly analyze large amounts of measurement data. Modulation-domain analyzers allow you to directly view frequency switching and settling of VCOs, PLLs, and synthesizers. They also make it easy to analyze complex phase and frequency modulations found in modern communications systems. See page 119 for a complete overview.

Peak Power Analysis

For comprehensive measurement and analysis of RF and microwave pulsed power, the HP 8990/91A peak power analyzer measures eight time parameters and five amplitude parameters. Its powerful waveform math routines can measure ratios and differences and can determine the statistics of parameters measured with two RF channels or two video (100 MHz) channels.

Signal Analyzer Selection Guide

Spectrum Analyzers[1]

Frequency range	Frequency accuracy (±)[2]	Resolution bandwidth range	Average noise level (narrowest RBW)	Optimum dynamic range 2nd/3rd order	Amplitude accuracy (±)[3]	HP model number	Page
Low frequency							
122 mHz to 102.4 kHz	30 ppm	61 mHz to 1024 Hz	<–140 dBVrms/√Hz	90 dB typical	0.25 dB	35665A/35670A	542
dc to 10 MHz	30 Hz	312 µHz to 3 MHz	–170 dBm	75 dB/75 dB	0.7 dB	89410A[4]	250
RF (data given for CF = 1 GHz)							
9 kHz to 1.5 GHz	2.0 kHz	1 kHz to 3 MHz	–116 dBm	78 dB/85 dB	1.5 dB	ESA-L1500A	229
9 kHz to 1.8 GHz	2.1 kHz	1 kHz to 3 MHz	–115 dBm	70 dB/80 dB	1.7 dB[5]	8590L	234
1 MHz to 1.8 GHz	210 Hz	30 Hz to 3 MHz[6]	≤ – 88 dBmV	76 dB/88 dB[6]	1.7 dB	8591C	520
9 kHz to 1.8 GHz	210 Hz[6]	30 Hz to 3 MHz[6]	–130 dBm[6]	77 dB/90 dB[6]	1.7 dB[5]	8591E	234
dc to 2.65 GHz	180 Hz	312 µHz to 3 MHz	–185 dBm	75 dB/75 dB	1.1 dB	89441A	250
9 kHz to 2.9 GHz	210 Hz[6]	30 Hz to 3 MHz[6]	–127 dBm[6]	78 dB/88 dB[6]	1.7 dB[5]	8594E	234
30 Hz to 2.9 GHz + mm	106 Hz	1 Hz to 2 MHz	–145 dBm	88 dB/103 dB	1.85 dB	8560E	241
100 Hz to 2.9 GHz	110 Hz	10 Hz to 300 kHz (3 MHz)[6]	–134 dBm (–156 dBm)[6]	82 dB/92 dB	1.5 dB (0.9 dB)[7]	71100C/P	246
30 Hz to 6.5 GHz + mm	106 Hz	1 Hz to 2 MHz	–145 dBm	88 dB/103 dB	1.85 dB	8561E	242
9 kHz to 6.5 GHz	210 Hz[6]	30 Hz to 3 MHz[6]	–125 dBm[6]	77 dB/86 dB[6]	2.2 dB[5]	8595E	234
9 kHz to 12.8 GHz	210 Hz[6]	30 Hz to 3 MHz[6]	–125 dBm	77 dB/86 dB[6]	2.7 dB[5]	8596E	234
30 Hz to 13.2 GHz	103 Hz	1 Hz to 2 MHz	–151 dBm	95 dB/108 dB	2.1 dB	8562E	242
Microwave (data given for CF = 10 GHz)							
100 Hz to 26.5 GHz + mm	1 kHz	10 Hz to 3 MHz	–137 dBm (–155 dBm)[6]	99 dB/96 dB	2 dB (0.9 dB)[7]	71209A/P	246
100 Hz to 22 GHz + mm[6] + lightwave	1 kHz	10 Hz to 3 MHz	–136 dBm (–153 dBm)[6]	96 dB/98 dB	2.5 dB(0.9 dB)[7]	71210C/P	246
50 kHz to 22 GHz + mm[6]	1 kHz	10 Hz to 3 MHz	–109 dBm (–135 dBm)[6]	84 dB/91 dB	2 dB (0.9 dB)[7]	71200C/P	246
9 kHz to 22 GHz (26.5 GHz)[6]	20 kHz	1 kHz to 3 MHz	–102 dBm	96 dB/71 dB	2.7 dB[5]	8592L	234
9 kHz to 22 GHz (26.5 GHz)[6]	1.2 kHz[6]	30 Hz to 3 MHz[6]	–117 dBm[6]	103 dB/81 dB[6]	2.7 dB[5]	8593E	234
9 kHz to 26.5 GHz + mm (30 Hz to 26.5 GHz)[6]	1 kHz	1 Hz to 2 MHz	–145	117 dB/102 dB	3 dB	8563E	242
100 Hz to 40 GHz + mm[6]	1 kHz	10 Hz to 3 MHz	–136 dBm (–155 dBm)[6]	99 dB/96 dB	2 dB (0.9 dB)[7]	71209A/P Z40	246
9 kHz to 40 GHz	1 kHz	1 Hz to 2 MHz	–143	117 dB/100 dB	3 dB	8564E	242
9 kHz to 50 GHz	1 kHz	1 Hz to 2 MHz	–143	117 dB/100 dB	3 dB	8565E	242

[1] Data shown here is for comparison purposes only. Consult data sheets for more complete specifications.
[2] Accuracy includes 1-year aging. Settability and temperature drift not included.
[3] Relative accuracy consists of relative frequency response plus the lesser of either scale fidelity or IF gain accuracy.
[4] Combination vector-network and spectrum analyzer.
[5] Based on IF gain accuracy specified over 60 dB range.
[6] Includes optional performance.
[7] Transfer accuracy using HP 70100A-H01 power meter.

Signal Analyzers

Signal Analyzer Selection Guide

Dynamic Signal Analyzers

Frequency range	Channel match	Frequency resolution in lines	Real-time bandwidth*	Dynamic range	Amplitude** accuracy (+)	HP model number	Page
0.000122 Hz to 102.4 kHz	± 0.04 dB, ± 0.5°	100 to 1600	25.6 kHz	80 dB, 90 dB typ.	0.15 dB	35670A	544
0.000244 Hz to 102.4 kHz	± 0.04 dB, ± 0.5°	100 to 800	12.8 kHz	< –72 dB	0.25 dB	35665A	542
0.000122 Hz to 102.4 kHz	± 0.1 dB, ± 0.5°	25 to 3200	25.6 kHz	80 dB	0.15 dB	3567A	546
0.000122 Hz to 12.8 kHz	± 0.1 dB, ± 0.5°	25 to 3200	12.8 kHz (4 ch.)	72 dB	0.15 dB	3566A	546
0.0325 Hz to 40 kHz	± 0.2 dB, ± 0.5°	50 to 1600	> 2.0 kHz	60 dB	0.5 dB	3560A	541
dc to 4 MHz	NA	51 to 12,800	1 MHz	80 to 110 dBFS	0.03 dB	3587S	328
0.0002 Hz to 10 MHz	± 0.25 dB, ± 2.0°	51 to 3201	78.125 kHz (1 ch.)	75 dB, 85 dB typ.	0.5 dB	89410A	250
0.0325 - 25.6 µHz	± 0.1 dB, ± 1.0°	50 to 1600, Octaves	> 6.4 kHz, 20 kHz Octaves	72 dB	0.5 dB	3569A	540

*One-year aging; settability and temperature drift included.
**Relative accuracy = relative frequency response + lesser of either scale fidelity or IF gain accuracy.

Distortion/Audio Analyzers

Fundamental frequency range	Minimum distortion	Auto set level	Auto nulling	True RMS	AM detector	Filters	Internal source	HP-IB	HP model number	Page
20 Hz to 100 kHz	0.01% (–80 dB)	•	•	•	See Note	•	•	•	8903B*	488
20 Hz to 100 kHz	0.01% (–80 dB)	•	•	•	See Note	•	—	•	8903E**	488

*The HP 8903B also performs frequency count, signal/noise, SINAD, watts, and ac/dc voltage measurements.
**The HP 8903E also performs frequency count, SINAD, and ac/dc voltage measurements.
Note: The HP 8901A modulation analyzer provides complete demodulation of AM, FM, and ΘM signals.

Modulation Analyzers/Measuring Receivers/Vector Signal Analyzers

Frequency range	Modulation measurements	Amplitude measurement range	Audio frequency count + distortion measurement	HP model number	Page
150 kHz to 1300 MHz	AM, FM, ΘM	+30 to 0 dBm	No	8901A	490
150 kHz to 1300 MHz	AM, FM, ΘM	+30 to –20 dBm	Yes	8901B	490
150 kHz to 1300 MHz	AM, FM, ΘM	+30 to –127 dBm	Yes	8902A	232
150 kHz to 18 GHz or 26.5 GHz	AM, FM, ΘM	+30 to –100 dBm	Yes	8902S	233
dc to 2650 MHz	Baseband, IF, RF, I, Q, mag/phase, AM, FM, ΘM	+25 to –160 dBm	No	89441A	250

*50 to 200 MHz standard. Operation above 200 MHz available as specials.

Modulation Domain Analyzers

Frequency range	Resolution freq./time	Sample rate	Memory size	Analysis and displays	HP model number	Page
10 Hz to 200 MHz (2.5 GHz option)	10 digits/200 ps	2.5 M (8 M rep.)	8 K (32 K option)	Frequency and time interval vs. time, histograms, statistics (digital RF communications option)	53310A	124
50 Hz to 150 MHz	10 digits/100 ps	80 M	512 K	Frequency, time interval, time stamp, histograms, statistics (application specific software solutions available)	E1740A (VXI)	122

Peak Power Analysis

Frequency range	Time parameters	Amplitude parameters	Functions available	HP model number	Page
50 MHz to 40 GHz	Rise time, fall time, pulse width, off time, PRI, PRF, delay	Pulse-top amplitude, pulse-base amplitude, peak power, overshoot, average power	2 RF power, 2 video channels, ratios, differences, statistical averages, means, glitch-finding triggering	8990A 8991A	290 290

VCO/PPL Signal Test System

Frequency range	Maximum sensitivity (depends on offset frequency)	Functions available	HP model number	Page
10 MHz to 3 GHz	–147 dBc/Hz @ offset freq. 100 kHz to 10 MHz (as phase noise measurement performance)	Frequency, power level, C/N ratio, FM deviation, and dc consumption current	4352S VCO/PLL Signal Test System	335

- Frequency range of 9 kHz to 1.5 GHz
- Frequency accuracy of ± 2.0 kHz at 1 GHz (without temperature)
- 5 minute warmup
- Rugged, portable package follows you from lab, to factory, to field

HP ESA-L1500A

HP ESA-L1500A 1.5 GHz Portable Spectrum Analyzer

HP introduces the ESA-L1500A, our new, low-cost, fully synthesized spectrum analyzer. Now get quick and accurate results every time, at an affordable price. It has the performance of a high-quality spectrum analyzer and the rugged ease of use expected in a field instrument.

Fast measurements
The HP ESA-L1500A gives you a rapid display update rate and state-of-the-art 5 ms sweep time that reduces test time and increases throughput.

Accurate results
The phase-locked synthesizer adds stability and repeatability to frequency measurements, and the automatic background alignment offers continuous calibration. Plus, you'll have specified performance only 5 minutes after power-up.

Reliable operation
Increase your manufacturing up-time: costly repairs can be avoided with the automatic input overload protection, and the use of component integration reduces the probability of failure.

Rugged packaging and construction
Ideal for field environments, the HP ESA-L1500A has a sealed front panel, louvered air vents, and side-mounted fan to protect the instrument in a wide range of weather conditions. Rubber-encased front and rear frames resist the rigors of transportation.

Easy to use
The combination hard key/soft key front panel offers simple operation for basic measurements while providing access to sophisticated features. In addition, testing is simplified with built-in limit lines and pass/fail messages.

Low cost
All this at a very affordable price.

PC Software for the ESA-L1500A
The new HP BenchLink Spectrum Analyzer PC software provides an easy-to-use communications link between your PC and the HP ESA-L1500A spectrum analyzer. Taking full advantage of the Windows® interface, you can easily transfer screen images or trace data via HP-IB or RS-232 interfaces, thereby making it easy to capture, analyze, and document measurement results in your PC. For more information, see page 231.

Specifications

Frequency
Frequency Range
50 ohms: 9 kHz to 1.5 GHz
75 ohms (Option 1DP): 1 MHz to 1.5 GHz
Frequency Reference
Aging: ± 2 x 10^{-6}/year
Settability: ± 0.5 x 10^{-6}
Temperature Stability: ± 5 x 10^{-6}

Frequency Readout Accuracy
(Start, Stop, Center, Marker): ± (frequency readout x frequency reference error[1] + span accuracy + 20% of RBW)
Marker Frequency Counter
Resolution: Selectable from 1 Hz to 100 kHz
Accuracy: ± (marker frequency x frequency reference error[1] + counter resolution)
Frequency Span
Range: 0 Hz (zero span), 100 Hz to 1.5 GHz
Resolution: Four digits or 2 Hz, whichever is greater
Accuracy: ± 1% of span
Sweep Time
Range: 5 ms to 2000 s
Accuracy (5 ms to 2000s): ± 1%
Sweep Trigger: Free Run, Single, Line, Video, External
Resolution Bandwidth
Range (–3 dB width): 1 kHz to 3 MHz, in 1-3-10 sequence. 5 MHz, characteristic
Accuracy (1 kHz to 3 MHz RBW): ± 20%
Shape (1 kHz to 3 MHz RBW): Approximately Gaussian shape
Selectivity (1 kHz to 3 MHz RBW) (60 dB/3 dB bandwidth ratio): < 15:1, characteristic
Video Bandwidth (–3 dB)
Range: 30 Hz to 1 MHz in 1-3-10 sequence. 3 MHz, characteristic.
Stability (noise sidebands, offset from CW signal with 1 kHz RBW, 30 Hz VBW and sample detector)
≥ 10 kHz: ≤ –90 dBc/Hz
≥ 20 kHz: ≤ –98 dBc/Hz
≥ 30 kHz: ≤ –102 dBc/Hz
≥ 100 kHz: ≤ –112 dBc/Hz
Residual FM
1 kHz RBW, 1 kHz VBW: ≤ 100 Hz peak-to-peak in 100 ms
System-Related Sidebands, offset from CW signal:
≥ 30 kHz: ≤ –65 dBc

Amplitude

Measurement Range
50 ohms: –120 dBm to +30 dBm
75 ohms (Option 1DP): –65 dBmV to +72 dBmV
Input Attenuator Range: 0 to 60 dB, in 5 dB steps
Maximum Safe Input Level (Input attenuator setting ≥ 15 dB)
Average Continuous Power: +30 dBm (1 W); + 72 dBmV (0.2 W) for 75 Ω (Option IDP)
Peak Pulse Power: +30 dBm (1 W); +72 dBmV (0.2 W) for 75 Ω (Option IDP)
dc: 100 Vdc
1 dB Gain Compression: Total power at input mixer[2]: 0 dBm; 75 Ω (Option 1DP): +54 dBmV
Displayed Average Noise Level (Input terminated, 0 dB attenuation, 30 Hz VBW, sample detector, 1 kHz RBW)
400 kHz to 1 MHz: ≤ –118 dBm
1 MHz to 500 MHz: ≤ –120 dBm
500 MHz to 1.2 GHz: ≤ –116 dBm
1.2 GHz to 1.5 GHz: ≤ –113 dBm
75 Ω (Option 1DP):
1 MHz to 500 MHz: ≤ –65 dBmV
500 MHz to 1 GHz: ≤ –61 dBmV
1 GHz to 1.5 GHz: ≤ –55 dBmV
Display Range
Log Scale: 0 to –85 dB from reference level is calibrated; 0.1, 0.2, 0.5 dB/division and 1 to 20 dB/division in 1 dB steps; ten divisions displayed
Linear Scale: ten divisions
Scale Units: dBm, dBmV, dBμV, V, and W
Frequency Response (Relative to 50 MHz, 9 kHz to 1.5 GHz)
10 dB attenuation
20 to 30° C: ± 0.75 dB
0 to 55° C: ± 1.0 dB
0 dB, 5 dB, 15 to 60 dB atten.: ± 1.0 dB, characteristic
Input Attenuation Switching Uncertainty at 50 MHz
0 dB to 5 dB attenuation: ± 0.3 dB
10 dB attenuation: Reference
15 dB attenuation: ± 0.3 dB
20 to 60 dB attenuation: ± (0.1 dB + 0.01 x attenuator setting)

HP ESA-L1500A

Absolute Amplitude Accuracy at reference settings[3]: ± 0.3 dB
RF Input VSWR (characteristic)
9 kHz to 1.5 GHz (50 ohms) or 1 MHz to 1 GHz (75 ohms (Option 1DP)):
0 to 5 dB attenuation: 1.55:1
10 to 60 dB attenuation: 1.35:1
1 GHz to 1.5 GHz (75 ohms):
0 to 60 dB attenuation: 2.0:1
Resolution Bandwidth Switching Uncertainty (at reference level)
3 kHz RBW: Reference
1 kHz, 10 kHz to 3 MHz RBW: ± 0.4 dB

Reference Level

Range: Adjustable over amplitude measurement range
Resolution
Log Scale: ± 0.01 dB
Linear Scale: ± 0.12% of reference level
Accuracy: (at a fixed frequency, a fixed attenuation, and referenced to (–35 dBm + attenuation setting))
≥ –70 dBm + atten. setting: ± (0.3 dB + 0.01 x absolute value (ref level–atten. setting + 35 dBm))
< –70 dBm + atten. setting: ± (0.6 dB + 0.01 x absolute value (ref level–atten. setting + 35 dBm))
Accuracy, 75 Ω (Option 1DP) (at a fixed frequency, a fixed attenuation, and referenced to (+16.76 dBmV + atten. setting))
≥ –21.24 dBmV[4] + atten. setting: ± (0.3 dB + 0.01 x absolute value [ref level–atten. setting–16.76 dBmV])
< –21.24 dBmV[4] + atten. setting: ± (0.6 dB + 0.01 x absolute value [ref level–atten. setting–16.76 dBmV])
Display Scale Switching Uncertainty
Linear to Log Switching: ± 0.25 dB at reference level
Log Scale Switching: No error
Display Scale Fidelity
Log Maximum Cumulative
0 to –85 dB from reference level: ± (0.3 dB + 0.01 x dB from reference level)
Log Incremental Accuracy
0 to –70 dB from reference level: ± 0.4 dB/4 dB
Linear Accuracy: ± 3% of reference level)
Spurious Responses
Second Harmonic Distortion
2 MHz to 1.5 GHz: < –75 dBc for –40 dBm (+ 14 dBmV, 75 Ω) signal at input mixer[2] + 35 dBm SHI (second harmonic intercept)
Third Order Intermodulation Distortion
2 MHz to 5 MHz: + 5 dBm (+ 59 dBmV, 75 Ω), characteristic TOI (third order intercept)
5 MHz to 1.5 GHz: < –74 dBc for two –30 dBm (+ 24 dBmV, 75 Ω) signals at input mixer[2] and > 50 kHz: separation + 7 dBm (+ 61 dBmV, 75 Ω) TOI
Other Input Related Spurious
30 kHz ≤ offset ≤ 1200 MHz: < –65 dBc, for –20 dBm (+ 34 dBmV, 75 Ω) signal at input mixer[2] ≤ 1.5 GHz
Residual Responses (Input terminated and 0 dB attenuation)
150 kHz to 1.5 GHz: < –90 dBm
1 MHz to 1.5 GHz (75 Ω): < –36 dBmV
AM Demod: Tune and listen to AM signals

[1] Frequency reference error = (aging rate x period of time since adjustment + settability + temperature stability)
[2] Mixer power level (dBm) = input power (dBm) –input attenuation (dB)
[3] Settings are: reference level –25 dBm; input attenuation 10 dB; center frequency 50 MHz; Res BW 3 kHz; video BW 10 kHz; scale linear; span 2 kHz; sweep time coupled, sample detector, signal at reference level
[4] –16.24 dBmV if frequency is > 1 GHz and resolution bandwidth is 30 kHz.

Options

Tracking Generator Specifications (Option 1DN or IDQ)

Output Frequency Range
50 Ω (Option 1DN): 9 kHz to 1.5 GHz
75 Ω (Option 1DQ): 1 MHz to 1.5 GHz
Residual FM
1 kHz RBW, 1 kHz VBW: ≤ 100 Hz peak-to-peak in 100 ms, characteristic

Output Power Level

Range
50 Ω (Option 1DN): 0 to –70 dBm
75 Ω (Option 1DQ): +42.76 to –27.24 dBmV
Resolution: 0.1 dB
Absolute Accuracy (at 50 MHz with coupled source attenuator)**:**
50 Ω (Option 1DN): ± 0.5 dB, referenced to 0 dBm
75 Ω (Option 1DQ): ± 0.5 dB, referenced to +42.76 dBmV
Vernier
Range: 10 dB
Accuracy (with coupled source attenuator)**:**
50 Ω (Option 1DN): ± 0.75 dB, for 0 to –10 dBm, referenced to 0 dBm
75 Ω (Option IDQ): ± 0.75 dB, for + 42.76 to + 32.76 dBmV, referenced to + 42.76 dBmV
Output Attenuator Range: 0 to 60 dB in 10 dB steps

Output Power Sweep

Range
50 Ω (Option 1DN): (–15 dBm to 0 dBm) – (source attenuator setting)
75 Ω (Option 1DQ): (+ 27.76 to + 42.76 dBmV) – (source attenuator setting)
Resolution: 0.1 dB
Accuracy (zero span)**:** < 1.5 dB peak-to-peak
Output Flatness (referenced to 50 MHz, 0 dB attenuator)
9 kHz to 10 MHz (50 Ω) and 1 MHz to 10 MHz (75 Ω): ± 2 dB
10 MHz to 1.5 GHz: ± 1.5 dB
Spurious Outputs
50 Ω (Option 1DN), 0 dBm output, 9 kHz to 1.5 GHz;
75 Ω (Option 1DQ), + 42.76 dBmV output, 1 MHz to 1.5 GHz
Harmonic Spurs: < –25 dBc
Non-Harmonic Spurs: < –35 dBc
Dynamic Range
50 Ω (Option 1DN):
400 kHz to 1 MHz: ≥ 118 dB
1 MHz to 500 MHz: ≥ 120 dB
500 MHz to 1.2 GHz: ≥ 116 dB
1.2 GHz to 1.5 GHz: ≥ 113 dB
75 Ω (Option 1DQ):
1 MHz to 500 MHz: ≥ 107.76 dB
500 MHz to 1 GHz: ≥ 103.76 dB
1 GHz to 1.5 GHz: ≥ 97.76 dB
Output Tracking
Drift: No error
Swept Tracking Error: No error for coupled sweep times
Output VSWR: < 2.5:1, characteristic

General

Temperature Range
Operating: 0 °C to + 55° C
Storage: –40 °C to + 75° C
Audible Noise (ISO 7779)
Sound pressure at 25° C: < 33 dB (< 4.8 Bels power)
Military Specification: Has been type tested to the environmental specifications of MIL-PRF-28800F Class 3
EMI Compatibility: Conducted and radiated emission is in compliance with CISPR Pub.11/1990 Group 1 Class A
Power Requirements (Uses CUKonvertor® topology in the power supply)
Voltage: 90 to 250 Vac rms
Frequency: 47 to 440 Hz
Power Consumption, On: < 200 W
Power Consumption, Standby: < 5 W
Weight (without options)
Net: 12.3 kg (27 lb), characteristic
Shipping: 25 kg (55 lb), characteristic
Dimensions
Height: 222 mm (8.75 in)
Width: 373 mm (14.7 in) w/o handle, 408 mm (16.1 in) w/handle
Depth: 409 mm (16.1 in) w/o handle, 516 mm (20.3 in) w/handle

Inputs and Outputs

Internal
50 MHz oscillator
Frequency: 50 MHz
Frequency Accuracy: Frequency reference error[1]
Amplitude: –27 dBm, nominal (+ 24.8 dBmV, nominal for 75 Ω)

Front Panel
Input
Connector/Impedance: Type N (f), 50 ohm, nominal; BNC (f), 75 ohm, nominal (Option 1DP)
RF Out
Option 1DN, Connector/Impedance: Type N (f), 50 ohm, nominal
Option 1DQ, Connector/Impedance: BNC (f), 75 Ω, nominal
Probe Power
Voltage/Current: +15 Vdc, –12.6 Vdc at 150 mA max., characteristic
Ext. Keyboard: 6-pin mini-DIN, PC keyboards
Speaker: Front-panel knob controls volume
Headphone: 3.5-mm (⅛ inch) miniature audio jack

Rear Panel
10 MHz Ref Out: BNC (f), 50 ohm, > 0 dBm, characteristic
10 MHz Ref In: BNC (f), –15 to +10 dBm, characteristic
Ext.Trig In: BNC (f), (5 V TTL)
Hi Swp Out: BNC (f), (5 V TTL)
VGA Output: VGA-compatible monitor, 15-pin mini D-SUB, (31.5 kHz horizontal, 60 Hz vertical sync rates, non-interlaced)
Analog RGB, Resolution: 640 x 480
Aux IF Out (Option A4J): BNC (f), 21.4 MHz, nominal (–10 to –70 dBm (uncorrected), characteristic
Aux Video Out (Option A4J): BNC (f), 0 to 1 V (uncorrected), characteristic
Hi Swp in (Option A4J): BNC (f), low stops sweep, (5 V TTL)
Hi Swp out (Option A4J): BNC (f), (5 V TTL)
Swp Out (Option A4J): BNC (f), 0 to + 10 V ramp, characteristic
HP-IB Interface (Option A4H): IEEE-488 bus connector
Serial Interface (Option 1AX): RS-232, 9-pin D-SUB
Parallel Interface (Option A4H or 1AX): 25-pin D-SUB, printer port only

[1] Frequency reference error = (aging rate x period of time since adjustment + settability + temperature stability)

Key Literature

HP ESA-L1500A 1.5 GHz Portable Spectrum Analyzer, Product Overview p/n 5965-6309E

Ordering Information

HP ESA-L1500A (E4411A) 9 kHz to 1.5 GHz Portable Spectrum Analyzer
Opt A4H HP-IB and parallel (Centronics) interfaces (cannot combine with Option 1AX)
Opt 1AX RS-232 and parallel (Centronics) interfaces (cannot combine with Option A4H)
Opt A4J IF, Sweep, and Video Ports
Opt 1DN 50 Ohm Tracking Generator (9 kHz to 1.5 GHz)
Opt 1DP 75 Ohm Input Impedance (1 MHz to 1.5 GHz)
Opt 1DQ 75 Ohm Tracking Generator (1 MHz to 1.5 GHz) (requires Option 1DP)
Opt A5D 12 Vdc power cable for operating directly from 12 to 20 Vdc power sources such as automotive batteries. 4 m long.
Opt 1D7 50 to 75 Ohm matching pad (type N(m) to BNC (f))
Opt UK9 Front panel protective cover
Opt 1CP Rackmount kit with handles and slides
Opt 0B1 Additional user and calibration guides
Opt 0BX Assembly level service guide and schematics
Opt UK6 Commercial calibration certificate with data
Opt 0B0 Delete manuals

Accessories

HP DeskJet 340 (C2655A) portable monochrome/color printer
HP DeskJet 400 (C2642A) monochrome/color printer
HP DeskJet 680C (C4549A) color printer
HP DeskJet 690C (C4562A) color printer
HP DeskJet 693C (C4589A) color printer
HP DeskJet 870C (C4565A, C4555A) color printer
HP C2950A Parallel printer cable (2 meter)
HP 10833A HP-IB cable (1 meter)
HP 24542U RS-232 cable (3 meter, 9 pin F to 9 pin F) (for serial 9 pin PC connection to analyzer)
HP 24542G RS-232 cable (3 meter, 25 pin M to 9 pin F) (for serial 25 pin PC or printer connection to analyzer)
HP 24542M RS-232 cable (3 meter, 25 pin M to 9 pin F) (for serial 25 pin modem connection to analyzer)
HP 87405A Preamplifier (10 MHz to 3 GHz, 24 dB gain) (fastened to RF input, powered from analyzer)
HP 85905A 75 Ohm preamplifier (45 MHz to 1 GHz, 20 dB gain) (powered from analyzer)
HP C1405B Keyboard
HP 41800A Active probe (5 Hz to 500 MHz)
HP 85024A High frequency active probe (300 kHz to 3 GHz)
HP 85901A Portable AC power source
HP 34397A DC-to-AC power inverter for operating ESA-L1500A from 11 to 15 Vdc power sources such as automotive batteries

HP E4444A BenchLink Spectrum Analyzer Software

NEW

HP BenchLink Spectrum Analyzer provides an easy-to-use communications link between your PC and the HP 856x, 859x* and ESA-L1500A spectrum analyzer families. HP BenchLink Spectrum Analyzer is a member of the HP BenchLink family of PC/basic instrument connectivity solutions, and takes full advantage of the Windows® interface to easily transfer screen images or trace data via HP-IB or RS-232 interfaces.

HP BenchLink Spectrum Analyzer makes it easy to capture, analyze, and document measurement results in your PC. HP has done all the programming for you.

You'll be able to transfer:

- Screen images–you can transfer a picture of the spectrum analyzer screen to your PC for viewing , annotation, storage, or printing. HP BenchLink Spectrum Analyzer provides convenient annotation tools, and Windows makes it easy to cut and paste your annotated image into other applications like word processing, presentation, and graphics packages or E-mail. You can also save your image in PCX, TIF, GIF, and BMP formats. You'll find documenting measurement results to be fast and simple.
- Trace data–HP BenchLink Spectrum Analyzer transfers the trace frequency/amplitude pairs of data from your spectrum analyzer to your PC for further review and analysis. Once the trace data is captured, you can use pan and zoom and trace markers in BenchLink to analyze the trace. Additionally, the frequency/amplitude pairs of trace data can be easily copied as comma-separated-values to spreadsheets or other analysis programs using files or the Windows clipboard.

The software runs on Windows® 3.1, Windows® 3.11, Windows® 95, and Windows NT® 4.0 and includes a complete context-sensitive on-line help system. System requirements are IBM PC compatible with at least 486-25 MHz processor, 8 MB ram, and 2 MB disk space available.

*The 8590 EM-series is not supported.

Ordering Information

E4444A BenchLink Spectrum Analyzer Software

Measuring Receiver, 150 kHz to 1300 MHz

HP 8902A

- RF power: digital power meter accuracy
- Tuned RF level: 0 to –127 dBm dynamic range
- Carrier noise: AM and phase noise measurements to –140 dBc/Hz
- AM and FM: 1% accuracy; ØM: 3% accuracy
- RF frequency: 1 Hz resolution
- Audio: level, frequency, and distortion

HP 8902A

HP 8902A Measuring Receiver

4

The HP 8902A measuring receiver combines 6 precise measurement functions into one fully automatic, HP-IB programmable instrument. It accurately measures RF power, tuned RF level , carrier noise/adjacent channel power, modulation, and RF frequency, and it characterizes audio signals. For precise signal analysis, the HP 8902A measuring receiver provides the performance you need.

Metrology and Calibration

The HP 8902A measuring receiver makes signal generator and attenuator calibration easier than ever before. The HP 8902A provides exceptional accuracy, wide dynamic range, and a broad range of measurements.

It quickly and accurately measures your signal generator's RF frequency, RF level flatness, output level accuracy to –127 dBm, AM and FM with 1% accuracy, incidental and residual AM, FM and phase modulation, and carrier noise down to –140 dBc/Hz, and characterizes the demodulated audio signals.

For attenuator calibration and other relative measurements, the HP 8902A gives you great accuracy and dynamic range. Option 050 provides ±(0.015 db + 0.005 dB/10 dB) relative power accuracy to test attenuators to the most stringent specificaations.

RF Signal Characterization

The HP 8902A measuring receiver is an excellent lab and production tool for accurately characterizing RF signals from 150 kHz to 1300 MHz.

Level measurements down to –127 dBm with superb accuracy make the HP 8902A ideal for testing devices such as antennas, multiplexers, log/linear amplifiers, filters, and mixers. Unlike diode detectors, the HP 8902A's power meter accurately measures signals with harmonics and spurious.

The HP 8902A makes accurate AM-to-ØM and FM-to-AM conversion measurements of phase- and amplitude-sensitive devices, such as bandpass filters and multiple-channel receivers. Excellent isolation between AM and FM makes it simple to separate the AM and ØM of AM stereo, the incidental AM of FM transmitters, and the AM, FM, and ØM components of complex signals.

Automatic Test Systems

The HP 8902A is an important component of automatic RF test systems. All functions—power, level, frequency count, carrier noise, modulation, audio analysis—are fully automatic and easily programmed. With these measurements combined in one instrument, interfacing requirements, hardware costs, and software development time are reduced.

HP 8902A Specifications

RF Power (with HP 11722A Sensor Module)

Range: + 30 dBm (1W) to –20 dBm (10 μW)
Frequency Range: 0.1 MHz to 2.6 GHz
Linearity: ± 0.02 dB (within range) ± 0.02 dB per range change from reference range ± 1 count LSD
Input SWR: < 1.15

Tuned RF Level

Range: 0 to –127 dBm
Frequency Range: 2.5 to 1300 MHz
Relative Accuracy: ± 0.02 dB ± 0.02 dB per IF range change ± 0.04 dB per RF range change ± 1 digit
Worst-Case Cumulative Relative Power Accuracy (with Option 050[1,2]):
± 0.005 dB/10 dB step (0 to –100 dBm)
± 0.050 dB/10 dB step (–100 to –120 dBm)
± 0.015 dB ± 1 digit

Selective Power Measurements (Carrier Noise, Options 030 to 037)

Frequency Range: 10 to 1300 MHz
Carrier Power Range:
+ 30 dBm to –20 dBm: 12.5 kHz, 25 kHz and 30 kHz filters
± 30 dBm to –10 dBm: carrier noise filter
Relative Measurement Accuracy:
± 0.5 dB; levels > –95 dBc: 12.5 kHz, 25 kHz and 30 kHz filters
± 0.5 dB; levels > –129 dBc/Hz: carrier noise filter
Filter Bandwidths: 2.5 kHz, carrier noise filter; 8.0 kHz, 12.5 kHz filter; 16.0 kHz, 25 kHz filter; 30.0 kHz, cellular radio filter

RF Frequency

Range: 150 kHz to 1300 MHz
Maximum Resolution: 1 Hz

Amplitude Modulation

Rates: 20 Hz to 100 kHz
Depths: To 99%
Accuracy: ± 1% of reading ± 1 digit, for rates 50 Hz to 50 kHz and depths ≥ 5%

Frequency Modulation

Rates: 20 Hz to 200 kHz
Deviations: To 400 kHz
Accuracy: ± 1% of reading ± 1 digit, for rates 50 Hz to 100 kHz

Phase Modulation

Rates: 200 Hz to 20 kHz
Deviations: To 400 radians
Accuracy: ± 3% of reading ± 1 digit

Audio Level, Frequency, and Distortion Capability

Audio Level Accuracy: ± 4% of reading, 100 mV to 3 V
Audio Frequency Display Resolution: 6 digits, to 250 kHz
Audio Distortion Accuracy: ± 1 dB, 400 Hz and 1 kHz

[1] Specifications are warrented when using a Hewlett-Packard synthesized source with less than 100 Hz peak residual FM measured in a 3 kHz post-detection bandwidth over a 30-second period.
[2] Accuracy specifications do not include mismatch uncertainty.

Ordering Information

HP 8902A Measuring Receiver
- **Opt 001** Rear-Panel Instead of Front-Panel Connectors for Input, Modulation Output, and Calibrators
- **Opt 002** 1x10^{-9}/Day Internal Reference Oscillator
- **Opt 003** Rear-Panel External LO Connectors
- **Opt 004** Operation from 48 to 440 Hz Power Line (temp. < 40° C)
- **Opt 021** Add HP 11722A Sensor Module
- **Opt 030** High Selectivity (select only two filter options) Options 032 to 037 require Option 030. Option 030 includes Option 003 connections for external local oscillator.
- **Opt 032** 12.5 kHz Filter
- **Opt 033** 25.0 kHz Filter
- **Opt 035** Cellular Radio Filter
- **Opt 037** Carrier Noise Filter
- **Opt 050** Increased Power Measurement Accuracy
- **Opt 907** Front Handle Kit (5061-9690)
- **Opt 908** Rack Flange Kit (5061-9678)
- **Opt 909** Rack Flange Kit (5061-9684) with Front Handles
- **Opt 910** Additional Operation and Calibration Manual (08902-90029) and 2 Service Manuals (08902-90031)
- **Opt 915** Add Service Manual (08902-90031)
- **Opt W30** Extended Repair Service
- **Opt W32** Calibration Service

HP 11812A

HP 11812A Verification Kit

The HP 11812A verification kit is available to verify the performance of the HP 8902A Option 050 tuned RF level function to ±(0.015 dB + 0.010 dB/10dB step). The kit consists of a step attenuator, two 10 dB pads semi-permanently attached, a cable, and a case.

HP 11812A Specifications

Frequency: 30 MHz
HP 11812A Accuracy: ± (0.003 dB + 0.003 dB/10 dB step)
Option 050 Worst-Case Cumulative Tuned RF Level Accuracy Verified with the HP 11812A:
± 0.010 dB/10dB step (0 to –100 dBm)
± 0.050 dB/10 dB step (–100 to –120 dBm)
± 0.015 dB ±1 digit

Ordering Information

HP 11812A Verification Kit

HP 11722A Sensor Module (100 kHz to 2.6 GHz)[1]

The HP11722A sensor module was designed for use with the HP 8901B modulation analyzer and the HP 8902A measuring receiver. The HP 11722A contains a silicon monolithic thermocouple as a power-sensing element.

With the HP 11722A sensor module, you get all the performance of the HP 8901B or HP 8902A, plus superb power-measurement accuracy, at a single connector. You can characterize a signal without switching back and forth between the power sensor and the analyzer's RF input.

Ordering Information

HP 11722A Sensor Module (100 kHz to 1300 MHz)

Extend the HP 8902A to Microwave with the HP 11792A and HP 11793A Converter

HP 11792A and HP 11793A

The HP 11793A microwave converter and the HP 11792A sensor module combined with an external signal generator extends the HP 8902A's measurement range into the microwave region. They allow the HP 8902A to deliver accuracy and resolution of a high performance power meter up to 26.5 GHz from +30 to –100 dBm. The extended system counts signals to 26.5 GHz with 10 Hz resolution and excellent long-term frequency stability.

HP 11793A Microwave Converter

The HP 11793A microwave converter downconverts microwave signals to the frequency range of the HP 8902A measuring receiver. For signals above 1.3 GHz, the HP 11793A routes the signal through its internal mixer. Below 1.3 GHz, signals are routed directly to the input of the HP 8902A. The HP 11793A requires an external signal generator with +8 dBm leveled output. For signal generators with insufficient power above 18 GHz, the HP 11793A offers an optional 18 to 25.5 GHz amplifier to provide the necessary mixer drive.

HP 11792A Sensor Module (50 MHz to 26.5 GHz)[1]

The HP 11792A sensor module gives you all the performance of the HP 8902S system, plus superb power-measurement accuracy, at a single connector. You can characterize a signal without manually switching between the power sensor and the receiver input.

Ordering Information

HP 8902S Measuring System
HP 11793A Microwave Downconverter
- **Opt 001** Add 18 to 26.5 GHz Amplifier
- **Opt 010** Front Right LO Input Connector
- **Opt 011** Amplifier and Front Right LO Connector
- **Opt 020** Rear-Panel Connector
- **Opt 021** Amplifier and Rear-Panel Connector
- **Opt 907** Front Handle Kit (5062-3988)
- **Opt 908** Rackmount Flange Kit (5062-3974)
- **Opt 909** Handles w/Rackmount Flange Kit (5062-3975)

HP 11792A Sensor Module (50 MHz to 26.5 GHz)[1]

For complete ordering information, see HP 8902S Measurement System Ordering Information Guide, or call your local HP sales office.

[1] Each HP 11722A and HP 11792A sensor module is individually calibrated, traceable to the U.S. National Institute of Standards and Technology. The calibration factors are printed on the sensor module for fast reference. Enter these factors into the HP 8902A's non-volatile memory and the instrument automatically compensates for the power sensor's efficiency and mismatch loss at each frequency.

Spectrum Analyzers, Portable

HP 8590 E-Series
HP 8590L
HP 8592L

- Easy-to-use, expandable, portable spectrum analyzers
- Full range of price and performance options
- One-button measurements for FFT, TOI, ACP, and more
- Expanded memory and trace-storage capability
- Optional narrow resolution bandwidths
- New custom measurement personalities

HP 8590 Series Spectrum Analyzers

HP-IB

The HP 8590 E-Series and 8590 L-Series spectrum analyzers offer a wide range of performance, features, and prices designed to fit your budget. Choose from low-cost, basic performance analyzers or from higher-performance models. Whatever your choice, you'll find HP 8590 series spectrum analyzers easy to use and reliable. Their expandable feature sets allow them to be easily configured to meet your growing measurement needs.

Application measurement personalities customize the analyzer for tasks such as cable TV, EMC, digital cellular radio, RF communication, noise-figure, and scalar network analysis measurements (see page 235). You can also add a variety of printers, plotters, and other accessories.

One Spectrum Analyzer for Many Applications

You can change the test capabilities of these spectrum analyzers to fit specific measurement needs. A memory card reader enables you to load application measurement personalities. Complex measurement routines are reduced to a keystroke. An option cardcage, unique to the HP 8590 E-series, allows you to add circuit-card options for additional capability. Optional built-in tracking generators provide a synchronously swept signal source for stimulus-response measurements. Operating any HP 8590 series spectrum analyzer requires only minimal training.

Easy-to-Use Features

Numerous features make it easier to control measurements and to analyze the results. These spectrum analyzers have built-in, automatic calibration to ensure measurement consistency. Frequency panning lets you quickly reposition signals without repeated sweeps. The internal memory allows over 50 traces to be stored, and more can be stored on RAM cards using the memory-card reader. Time and date stamping come standard. Direct output to printer or plotter is available with either the HP-IB/parallel or the RS-232/parallel interface option. Both Hewlett-Packard and selected Epson printers are supported.

PC Software for HP 8590 Series

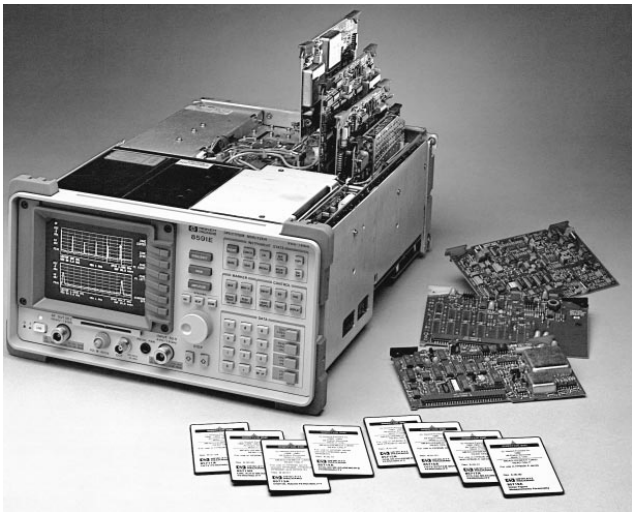
NEW

The new HP BenchLink Spectrum Analyzer PC software provides an easy-to-use communications link between your PC and the HP 8590 Series spectrum analyzers. Taking full advantage of the Windows interface, you can easily transfer screen images or trace data via HP-IB or RS-232 interfaces, thereby making it easy to capture, analyze, and document measurement results in a PC environment. For more information, see page 231.

HP 8591E, 8593E, 8594E, 8595E, and 8596E Spectrum Analyzers

These portable spectrum analyzers bring powerful, comprehensive measurement capabilities to RF, microwave, and digital applications. Five models offer a choice of frequency coverage starting at 9 kHz and extending to 26.5 GHz.

Performance specifications include low phase noise of –105 dBc at 30 kHz offset and frequency-synthesized accuracy of 2.1 kHz at 1 GHz, which can be improved to 210 Hz with an optional precision frequency reference. Second- and third-order dynamic ranges are 77 and 90 dB, respectively. Calibrated amplitude range is +30 to –130 dBm with Option 130, and calibrated onscreen display range is 70 dB. Narrow resolution bandwidths of 30, 100, 200 EMI, and 300 Hz are available on an optional circuit card, which can be added to these analyzers at any time.



HP 8591E with measurement personality and circuit card options

Standard Features

A window capability divides the display into two horizontal areas, allowing you to zoom in on critical areas of a measurement trace or to display test data and the trace simultaneously. Many one-button measurements are standard, including a marker table, FFT, N dB bandwidths, third-order intercept, percent AM, and adjacent-channel power. A built-in memory card reader allows you to load measurement personalities, your own custom programs, and measurement data on 32-, 128-, 256-, and 512-K memory cards.

Option Flexibility

A growing number of circuit-card options provides even more measurement capability. Circuit cards are installed easily into a built-in cardcage, and most are retrofittable.

Circuit-card options include:

- Narrow resolution bandwidths of 30, 100, 200 EMI, and 300 Hz
- Time-gated spectrum analysis
- "Analog+" display and fast time-domain sweeps
- AM/FM demodulator
- TV receiver/video tester
- Quasi-peak detector
- Noise-figure measurements
- Demodulators for CT2-CAI and DECT
- Digital demodulators and/or digital signal processing for GSM900, DCS-1800, PCS-1900, NADC-TDMA, PHS, CDMA and PDC wireless communication formats

A built-in 1.8 GHz tracking generator (retrofittable) is available for the HP 8591E, and a 2.9 GHz tracking generator (retrofittable) for the HP 8593E, 8594E, 8595E, and 8596E. The HP 85902A burst carrier trigger provides a TTL timing reference for digital wireless communication measurements. See page 249.

HP 8590L and 8592L Spectrum Analyzers

These models offer general-purpose RF and microwave measurement performance with frequency accuracy at a low cost. The HP 8590L has a frequency range of 9 kHz to 1.8 GHz, amplitude range of –115 to +30 dBm. The HP 8592L extends the frequency range to 22/26.5 GHz.

- One button measurement solutions
- Save time, money and training
- Customized for your application
- Easy to use

Easy-to-install measurement personalities

Measurement Personalities

Measurement personalities are software programs provided on ROM-based memory cards. They customize your HP 8590 analyzer to perform complex tests simply and quickly with the push of a button from easy-to-follow screen menus. The personalities automatically set the analyzer controls and perform calculations required by application standards, improving accuracy and repeatability.

Cable TV and Broadcast

(See page 520 for more information.)

HP 85721A Cable TV Measurements and System Monitor Personality
The HP 85721A measurement personality customizes the HP 8591C and 8590 E-series analyzers for easy, noninterfering proof-of-performance measurements on NTSC-, PAL-, or SECAM-format signals. The personality includes the capability to measure power levels for digital carriers. This software adds dedicated cable TV test functions and measurements for channel and system operation. Three video measurements as well as differential gain and phase and chrominance-to-luminance delay inequality can be performed if the spectrum analyzer has Option 107 TV receiver/video tester.

HP 85724A Broadcast Measurement Personality
The HP 85724A adds measurements for testing TV broadcast transmitters and relays. It allows selection of PAL-I/B/G, NTSC-M, and SECAM-D/K systems, channel bands CCIR VHF, UHF, S, M & B, FCC-AIR, and PRC, and channel number. Tests include carrier level, chroma level, vision, three-tone intermodulation, depth of modulation, spurious signals, NICAM carrier power and intermodulation, and FE deviation. Three video measurements as well as differential gain and phase, and chrominance-to-luminance delay inequality can be performed if the spectrum analyzer has Option 107 TV receiver/video tester.

Lightwave

(See page 429 for more information.)

HP 11982A Option 001 Lightwave Converter Personality
The HP 11982A Option 001 personality provides frequency response correction and amplitude conversion of the optical marker for lightwave signals when used with the HP 11982A amplified lightwave converter and an HP 8590 series analyzer.

Component Test

(See page 245 for more information.)

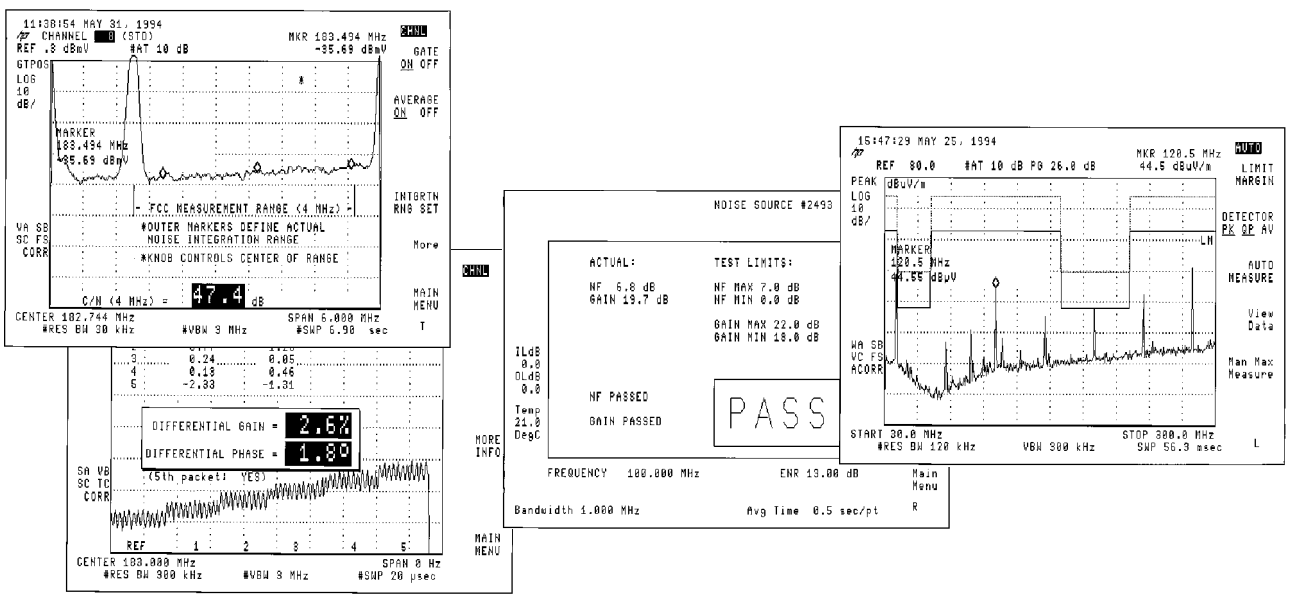
HP 85714A Scalar Measurement Personality
An HP 85714A measurement personality and HP 8590 series analyzer with optional built-in tracking generator make fast, accurate scalar transmission measurements from 100 kHz to 2.9 GHz. Features include guided calibration, pass/fail limit line testing, 120 dB display, bandwidth, Q factor, and shape factor. The HP 85630A scalar test set adds simultaneous transmission/reflection display.

HP 85719A Noise Figure Measurement Personality
The HP 85719A noise figure measurement personality customizes an HP 8590 Option 119 E-series spectrum analyzer for displayed swept noise figure and gain measurements from 10 MHz to 2.9 GHz.

Electromagnetic Compatibility

(See page 324 for more information.)

HP 85712D EMC Auto-Measurement Personality
The HP 85712D simplifies precompliance EMI measurements. The spectrum analyzer is set up automatically with the correct limit lines, transducer factor corrections, frequency range, and bandwidths which are supplied on the personality card. It can perform automatic peak, quasi-peak, and average on up to 20 signals at a time and print the results directly, or store them to a RAM card for future viewing.



Wide selection of measurement personalities

Wireless Communications

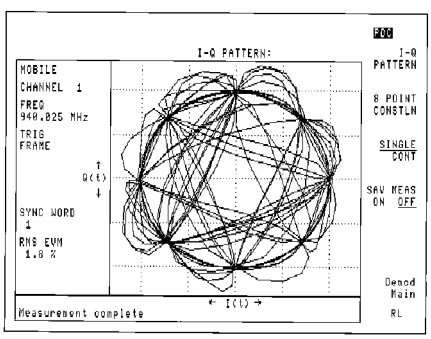
4

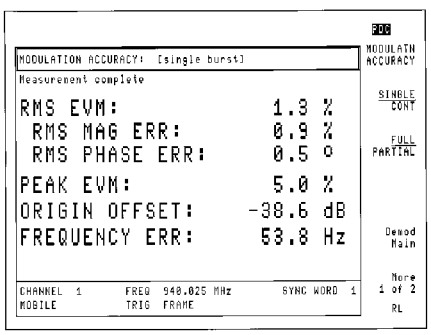
(See page 480 for more information.)

HP 85715B GSM Measurement Personality
The HP 85715B provides all the GSM900 transmitter tests specified in the GSM 11.10 (mobile) and GSM 11.20 (base) recommendations. Measurements include those for power, frequency, timing, and modulation accuracy. GSM Phase II specification limits are used and the extended GSM (E-GSM) frequency bands are supported.

HP 85717A CT2-CAI Measurement Personality
The HP 85717A personality provides all transmitter measurements in the MPT 1375 and I-ETS 300-131 specifications for second generation cordless telephone with common air interface. In addition, it has the flexibility to allow you to define your own custom channel tuning plan and band edges as well as spurious parameters. Transmitter tests include: mean carrier power, carrier-off power, adjacent channel power, out-of-band power, spurious emissions, intermodulation attenuation, and frequency error and deviation.

HP 85718B NADC-TDMA Measurement Personality
Based on EIA/TIA IS-54 and IS-136 standards, the HP 85718B simplifies testing of time-division multiple access (TDMA) transmitters for North American Dual-Mode Cellular (NADC) and PCS IS-136 radio systems. The personality provides nine power, frequency, and timing tests as well as seven modulation accuracy tests.





HP 85720C PDC Measurement Personality
The HP 85720C provides transmitter measurements for Personal Digital Cellular (PDC) time-division multiple access radio systems. Tests are based on the RCR STD-27C standard. There are 11 power, frequency, and timing tests as well as six modulation accuracy tests.

HP 85722B DCS1800 Measurement Personality
The HP 85722B provides all the DCS1800 transmitter tests specified in the GSM 11.10 (mobile) and GSM 11.20 (base) recommendations. Measurements include those for power, frequency, timing, and modulation accuracy. Phase II specification limits are used. GSM-based PCS measurements at 1900 MHz may be made using the HP 85722B special Option H19.

HP 85723A Option H01 DECT Measurement Personality
The HP 85723A Option H01 adds the key DECT transmitter measurements to the HP 8590 E-series analyzers. With the measurement personality, DECT power, frequency, timing, and modulation accuracy tests can be made. An optional DECT source built-in to the analyzer can be used as a stimulus for module testing or sensitivity measurements.

HP 85725C CDMA Measurement Personality
Simplify your measurements of cellular, PCS, and other spread spectrum transmitters based on EIA/TIA IS-95, -97, -98, and J-STD-008 with the HP 85725C. Frequency- and time-domain measurements are provided. The new C version of this personality adds the adjacent channel power ratio (ACPR) measurement, as well as tuning plans for Japan and Korea. The HP 85725C is designed with a great amount of flexibility, including on-screen help messages, enabling measurements to be easily configured to meet your special needs.

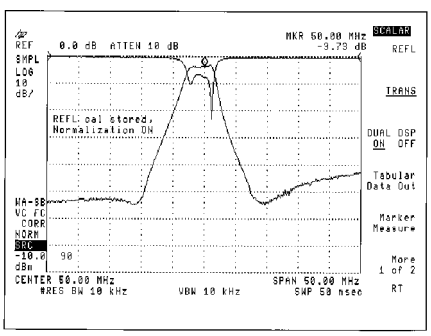
HP 85726B PHS Measurement Personality
Measure Personal Handy Phone System (PHS) personal and cell station transmitters operate easily, quickly, and reliably. The HP 85726B PHS personality provides tests based on RCR STD-28. Measurements included are antenna power, adjacent channel power, burst ramp-up and ramp-down power versus time, carrier-off time leakage power, spurious emission, occupied bandwidth, and modulation accuracy (EVM).

Digital Radio Measurements

(See page 465 for more information.)

HP 85713A Digital Radio Measurement Personality
The HP 85713A measurement personality for microwave spectrum analyzers includes five major agency masks for testing to US, UK, and FRG digital radio specifications. Automatic compare-to-mask and mean power level measurements are made on the modulated signal. Functions include transient analysis monitoring and frequency response measurement. You can create and store your own masks for later use. For additional digital radio tests, see the HP 11758V digital radio test system.

HP 11770A Link Measurement Personality
The HP 11770A enables group delay and amplitude flatness measurements on systems that carry digital data, such as microwave radio systems, coax cable, and satellite links. Capability includes end-to-end link, DADE, and IF return loss measurements.



HP 8591E

HP 8591E, 8593E, 8594E, 8595E, 8596E

Specifications

Specifications apply to any of these analyzers unless otherwise noted.

Frequency

Frequency Range
HP 8591E:
50 Ω: 9 kHz to 1.8 GHz
75 Ω: 1 MHz to 1.8 GHz
HP 8594E: 9 kHz to 2.9 GHz, dc-coupled; 100 kHz to 2.9 GHz, ac-coupled
HP 8595E: 9 kHz to 6.5 GHz, dc-coupled; 100 kHz to 6.5 GHz, ac-coupled

	Band	LO harmonic = N	Center frequency
HP 8596E	0	1	9 kHz to 2.9 GHz (dc-coupled)
	0	1	100 kHz to 2.9 GHz (ac-coupled)
	1	1	2.75 to 6.5 GHz
	2	2	6.0 to 12.8 GHz
HP 8593E	0	1	9 kHz to 2.9 GHz
	1	1	2.75 to 6.5 GHz
	2	2	6.0 to 12.8 GHz
	3	3	12.4 to 19.4 GHz
	4	4	19.1 to 22 GHz
	4	4 (Option 026/027)	19.1 to 26.5 GHz

Frequency Reference
Aging: ± 2 x 10^{-6}/year; ± 1 x 10^{-7}/year (Option 004)
Temperature Stability: ± 5 x 10^{-6}; ± 1 x 10^{-8} (Option 004)
Initial Achievable Accuracy: ± 0.5 x 10^{-6}; ± 2.2 x 10^{-8} (Option 004)
Frequency Readout Accuracy (start, stop, center, marker):
± (freq. readout x freq. ref error + span accuracy + 1% of span + 20% of RBW + 100 Hz x N)
Marker Count Accuracy
Span ≤ 10 MHz x N: ± (marker freq. x freq. ref error + counter resolution + 100 Hz x N)
Span > 10 MHz x N: ± (marker freq. x freq. ref error + counter resolution + 1 kHz x N)
Counter Resolution
Span ≤ 10 MHz x N: Selectable from 10 Hz to 100 kHz
Span > 10 MHz x N: Selectable from 100 Hz to 100 kHz
Frequency Span
Range: 0 Hz (zero span) and
HP 8591E: 10 kHz to 1.8 GHz; 1 kHz min (Option 130)
HP 8594E: 10 kHz to 2.9 GHz; 1 kHz min (Option 130)
HP 8595E: 10 kHz to 6.5 GHz; 1 kHz min (Option 130)
HP 8596E: [10 x N] kHz to 12.8 GHz; [1 x N] kHz min (Option 130)
HP 8593E: [10 x N] kHz to 19.25 GHz; [1 x N] kHz min (Option 130)
Resolution: Four digits or 20 Hz x N, whichever is greater
Accuracy
Span ≤ 10 MHz x N: ± 2% of span
Span > 10 MHz x N: ± 3% of span
Sweep Time
Range
Span = 0 Hz or > 1 kHz: 20 ms to 100 s
Span = 0 Hz (Option 101): 20 µs to 100 s
Accuracy
20 ms to 100 s: ± 3%
20 µs to < 20 ms (Option 101): ± 2%
Sweep Trigger: Free run, single, line, video, external

Resolution Bandwidth: 1 kHz to 3 MHz (3 dB) in 1, 3, 10 sequence; 9 kHz and 120 kHz (6 dB) EMI bandwidths. Option 130 adds 30, 100, and 300 Hz (3 dB) bandwidths and 200 Hz (6 dB) EMI bandwidth.
Accuracy: ± 20%
Selectivity (characteristic)
–60 dB/–3 dB: 3 kHz to 10 kHz, 15:1
100 kHz to 3 MHz, 15:1
1 kHz, 30 kHz, 16:1
–40 dB/–3 dB: 30 Hz to 300 Hz, 10:1
Video Bandwidth Range: 30 Hz to 1 MHz in 1, 3 sequence (1 Hz to 1 MHz with Option 130)
Stability
Noise Sidebands (1 kHz RBW, 30 Hz VBW, sample detector)
> 10 kHz offset from CW signal: ≤ –90 dBc/Hz + 20 log N
> 20 kHz offset from CW signal: ≤ –100 dBc/Hz + 20 log N
> 30 kHz offset from CW signal: ≤ –105 dBc/Hz + 20 log N
Residual FM
HP 8591E:
1 kHz RBW, 1 kHz VBW: ≤ 250 Hz pk-pk in 100 ms
30 Hz RBW, 30 Hz VBW: ≤ 30 Hz pk-pk in 300 ms
HP 8593E, 8594E, 8595E, 8596E:
1 kHz RBW, 1 kHz VBW: ≤ (250 x N) Hz pk-pk in 100 ms
30 Hz RBW, 30 Hz VBW: ≤ (30 x N) Hz pk-pk in 300 ms
System Related Sidebands (> 30 kHz offset from CW signal): ≤ –65 dBc + 20 log N
Comb Generator Frequency (HP 8593E, 8596E): 100 MHz fundamental frequency; ± 0.007% frequency accuracy

Amplitude

Amplitude Range: Displayed average noise level to + 30 dBm
HP 8591 Option 001: Displayed average noise level to + 72 dBmV
Maximum Safe Input Level (input attenuator ≥ 10 dB)
Average Continuous Power: + 30 dBm (1 W)
HP 8591E Option 001: + 72 dBmV (0.2 W)
Peak Pulse Power
HP 8591E: ± 30 dBm (1 W)
HP 8591E Option 001: + 72 dBmV (0.2 W)
HP 8593E, 8594E, 8595E, 8596E: +50 dBm (100 W) for < 10 µs pulse width and < 1% duty cycle, input atten. ≥ 30 dB
DC
HP 8591E: 25 Vdc
HP 8591E Option 001: 100 Vdc
HP 8593E: 0 Vdc
HP 8594E, 8595E, 8596E: 0 V (dc-coupled); 50 V (ac-coupled)
Gain Compression (> 10 MHz): ≤ 0.5 dB (total power at input mixer = –10 dBm)

Displayed Average Noise Level (input terminated, 0 dB atten., 30 Hz VBW or 1 Hz VBW with Option 130, sample detector)

	30 Hz RBW	1 kHz RBW
HP 8591E		
400 kHz to 1 MHz	≤ –130 dBm	≤ –115 dBm
1 MHz to 1.5 GHz	≤ –130 dBm	≤ –115 dBm
1.5 GHz to 1.8 GHz	≤ –128 dBm	≤ –113 dBm
HP 8591E Option 001		
1 MHz to 1.5 GHz	≤ –78 dBmV	≤ –63 dBmV
1.5 GHz to 1.8 GHz	≤ –76 dBmV	≤ –61 dBmV
HP 8594E		
400 kHz to 5 MHz	≤ –122 dBm	≤ –107 dBm
5 MHz to 2.9 GHz	≤ –127 dBm	≤ –112 dBm
HP 8595E		
400 kHz to 2.9 GHz	≤ –125 dBm	≤ –110 dBm
2.75 to 6.5 GHz	≤ –127 dBm	≤ –112 dBm
HP 8596E		
400 kHz to 2.9 GHz	≤ –125 dBm	≤ –110 dBm
2.75 to 6.5 GHz	≤ –127 dBm	≤ –112 dBm
6.0 to 12.8 GHz	≤ –115 dBm	≤ –100 dBm
HP 8593E		
400 kHz to 2.9 GHz	≤ –127 dBm	≤ –112 dBm
2.75 to 6.5 GHz	≤ –129 dBm	≤ –114 dBm
6.0 to 12.8 GHz	≤ –117 dBm	≤ –102 dBm
12.4 to 19.4 GHz	≤ –113 dBm	≤ –98 dBm
19.1 to 22 GHz	≤ –107 dBm	≤ –92 dBm
HP 8593E Option 026/027		
19.1 to 26.5 GHz	≤ –102 dBm	≤ –87 dBm

Specifications (cont'd)

Spurious Responses
- **Second Harmonic Distortion**
- **HP 8591E** (5 MHz to 1.8 GHz): < –70 dBc for –45 dBm tone at input mixer
- **HP 8593E** (10 MHz to 2.9 GHz): < –70 dBc for –40 dBm tone at input mixer
- **HP 8594E, 8595E, 8596E** (> 10 MHz): < –70 dBc for –40 dBm tone at input mixer
- **HP 8593E, 8595E, 8596E** (> 2.75 GHz): < –100 dBc for –10 dBm tone at input mixer (or below DANL)
- **Third-Order Intermodulation**
- **HP 8591E** (5 MHz to 1.8 GHz): < – 70 dBc for two –30 dBm tones at input and > 50 kHz separation
- **HP 8593E, 8594E, 8595E, 8596E** (> 10 MHz): < –70 dBc for two –30 dBm ones at input and > 50 kHz separation
- **Other Input-Related Spurious** (≥ 30 kHz offset, –20 dBm tone at input mixer)
- **HP 8591E, 8594E, 8595E, 8596E:** < – 65 dBc
- **HP 8593E:** < –65 dBc (applied frequency ≤ 18 GHz); < –60 dBc (applied frequency ≤ 22 GHz)

Residual Responses (input terminated, 0 dB attenuation)
- **1 MHz to 1.8 GHz** (HP 8591E Option 001): < –38 dBmV
- **150 kHz to 1.8 GHz** (HP 8591E): < –90 dBm
- **150 kHz to 2.9 GHz** (HP 8594E): <–90 dBm
- **150 kHz to 6.5 GHz** (HP 8593E, 8595E, 8596E): < –90 dBm

Display Range
- **Log Scale:** 0 to –70 dB from ref level is calibrated; 0.1, 0.2, 0.5 dB/div and 1 to 20 dB/div in 1 dB steps; 8 div displayed
- **Linear Scale:** 8 divisions
- **Scale Units:** dBm, dBmV, dBμV, V, W

Marker Readout Resolution
- **Log Scale:** 0.05 dB
- **Linear Scale:** 0.05% of ref level
- **Fast Time Sweep for Zero Span** (Option 101 or 301, 20 μs to 20 ms)
- **≤ 1 GHz:** 0.7% of ref level for linear scale
- **> 1 GHz:** 1.0% of ref level for linear scale

Reference Level
- **Range:** Same as amplitude range
- **Resolution:** ± 0.01 dB for log scale; ± 0.12% of ref level for linear scale
- **Accuracy:** ± 0.3 dB at –20 dBm; 0 to –59.9 dBm: ± (0.3 dB + 0.01 x dB from –20 dBm)

Frequency Response (10 dB input attenuation)
- **Absolute** (referenced to 300 MHz CAL OUT)
- **HP 8591E, 8594E:** ± 1.5 dB
- **HP 8595E:** ± 1.5 to ± 2.0 dB
- **HP 8596E:** ± 1.5 to ± 2.5 dB
- **HP 8593E:** ± 1.5 to± 5.0 dB (preselector peaked)
- **Relative Flatness** (referenced to midpoint between highest and lowest frequency response deviations)
- **HP 8591E, 8594E:** ± 1.0 dB
- **HP 8595E:** ± 1.0 to ± 1.5 dB
- **HP 8596E:** ± 1.0 to ± 2.0 dB
- **HP 8593E:** ± 1.0 to ± 2.0 dB (preselector peaked)

Calibrator Output Amplitude: –20 dBm ± 0.4 dB; + 28.75 dBmV ± 0.4 dB, HP 8591 Option 001

Resolution Bandwidth Switching Uncertainty (ref to 3 kHz RBW, at ref level)
- **3 kHz to 3 MHz RBW:** ± 0.4 dB
- **1 kHz RBW:** ± 0.5 dB
- **30 Hz to 300 Hz RBW:** ± 0.6 dB

Log to Linear Switching: ± 0.25 dB at ref level

Display Scale Fidelity
- **Log Incremental Accuracy** (0 to –60 dB from ref level): ± 0.4 dB/4 dB
- **Log Maximum Cumulative** (0 to –70 dB from ref level)
- **3 kHz to 3 MHz RBW:** ± (0.3 + 0.01 x dB from ref level)
- **30 Hz to 1 kHz RBW:** ± (0.4 + 0.01 x dB from ref level)
- **Linear Accuracy:** ± 3% of ref level

General Specifications

MIL-T-28800: Has been type-tested to the environmental specifications of MIL-T-28800 Class 5

Temperature
- **Operating:** 0° to +55° C
- **Storage:** – 40° to +75° C

EMI Compatibility: Conducted and radiated interference CISPR Pub. 11 and Messempfaenger Postverfuegung 526/527/79

Audible Noise: < 37.5 dBA pressure and < 5.0 Bels power (ISODP7779)

Power Requirements
- **On** (line 1): 90 to 132 V rms, 47 to 440 Hz
- 195 to 250 V rms, 47 to 66 Hz
- Power consumption < 500 VA; < 180 W
- **Standby** (line 0): Power consumption < 7 W

User Program Memory (nominal): 238 KB nonvolatile RAM

Data Storage (nominal)
- **Internal:** 24 traces or 32 states
- **External:** 50 traces, 8 states
- **Memory Cards:** HP 85700A (32 KB), 24 traces or 32 states; HP 85702A (128 KB), 99 traces or 128 states
- **Video Cassette Recorder** (VCR): Continuous video recording of display supported through composite video output

Size (nominal, without handle, feet, or cover): 325 mm W x 163 mm H x 427 mm D

Weight: 14.5 kg (HP 8591E); 16.4 kg (HP 8593E, 8594E, 8595E, 8596E)

Option 010 and 011 Built-In Tracking Generators

Option 010 (50 Ω) is available for all HP 8590 series spectrum analyzers except the HP 8592L. Option 011 (75 Ω) is available for the HP 8590L and 8591E only.

Frequency Range
- **Option 010:** 100 kHz to 1.8 GHz (HP 8590L, 8591E); 9 kHz to 2.9 GHz (HP 8593E, 8594E, 8595E, 8596E)
- **Option 011:** 1 MHz to 1.8 GHz (HP 8590L, 8591E)

Output Level
- **Range**
- **Option 010:** 0 to –15 dBm (HP 8590L); 0 to –70 dBm (HP 8591E); –1 to – 66 dBm (HP 8593E, 8594E, 8595E, 8596E)
- **Option 011:** + 42.8 to +27.8 dBmV (HP 8590L); + 42.8 to–27.2 dBmV (HP 8591E)
- **Resolution:** 0.1 dB
- **Absolute Accuracy:** ± 1.5 dB (HP 8590L); ± 1.0 dB (HP 8591E); ± 0.75 dB (HP 8593E, 8594E, 8595E, 8596E)

Vernier
- **Range:** 15 dB (HP 8590L); 10 dB (HP 8591E); 9 dB (HP 8593E, 8594E, 8595E, 8596E)
- **Accuracy:** ±1.0 dB (HP 8590L); ± 0.75 dB (HP 8591E); ± 0.5 dB (HP 8593E, 8594E, 8595E, 8596E)

Output Flatness: ± 1.75 dB (HP 8590L, 8591E); ± 2.0 dB, > 10 MHz (HP 8593E, 8594E, 8595E, 8596E)

Spurious Output
- **Harmonic Spurs:** 0 dBm + 42.8 dBmV output, < –25 dBc (HP 8590L, HP 8591E); –1 dBm output, < –25 dBc (HP 8593E, 8594E, 8595E, 8596E)
- **Nonharmonic Spurs:** < –30 dBc (HP 8590L, 8591E); ≤ –27 dBc, 300 kHz to 2.0 GHz, ≤ –23 dBc, 2.0 GHz to 2.9 GHz (HP 8593E, 8594E, 8595E, 8596E)

Dynamic Range (characteristic; max. output level –TG feedthrough)
- **Option 010:** 106 dB (HP 8590L, 8591E); 106 dB (HP 8594E, > 400 kHz); 109 dB (HP 8595E, 8596E, > 400 kHz); 111 dB (HP 8593E, > 400 kHz)
- **Option 011:** 100 dB

Power Sweep
- **Range**
- **Option 010:** –15 dBm to 0 dBm (HP 8590L); –75 dBm to 0 dBm (HP 8591E); –66 dBm to –1 dBm in 8 dB increments (HP 8593E, 8594E,8595E, 8596E)
- **Option 011:** + 27.8 dBmV to +42.8 dBmV (HP 8590L); –32.2 to + 42.8 dBmV (HP 8591E)
- **Resolution:** 0.1 dB

- Low-cost general purpose spectrum analysis with frequency accuracy

HP 8590L and 8592L Specifications

Specifications apply to either analyzer unless otherwise noted.

Frequency

Frequency Range
HP 8590L:
50 Ω: 9 kHz to 1.8 GHz
75 Ω (Option 001): 1 MHz to 1.8 GHz
HP 8592L: 9 kHz to 22 GHz
HP 8592L (Option 026/027): 9 kHz to 26.5 GHz

Band	LO harmonic=N	Center frequency
0	1	9 kHz to 2.9 GHz
1	1	2.75 to 6.5 GHz
2	2	6.0 to 12.8 GHz
3	3	12.4 to 19.4 GHz
4	4	19.1 to 22.0 GHz
4	4 (Option 026/027)	19.1 to 26.5 GHz

Frequency Reference
Aging: ± 2 x 10^{-6}/year
Temperature Stability: ± 5 x 10^{-6}
Initial Achievable Accuracy: ± 0.5 x 10^{-6}
Frequency Readout Accuracy (start, stop, center, marker):
± (freq. readout x freq. ref. error + span accuracy + 1% of span + 20% of RBW + 100 Hz x N)
Marker Count Accuracy
Span ≤ 10 MHz x N: ± (marker freq. x freq. ref. error + counter resolution + 100 Hz x N)
Span > 10 MHz x N: ± (marker freq. x freq. ref. error + counter resolution + 1 kHz x N)
Counter Resolution
Span ≤ 10 MHz x N, selectable from 10 Hz to 100 kHz
Span > 10 MHz x N, selectable from 100 Hz to 100 kHz
Frequency Span
Range
HP 8590L: 0 Hz (zero span), 10 kHz to 1.8 GHz
HP 8592L: 0 Hz (zero span), [50 kHz x N] to 19.25 GHz
Resolution: Four digits
Accuracy:
HP 8590L: ± 3% of span
HP 8592L: Span ≤ 10 MHz x N^1 ± 2% of span; span > 10 MHz x N^1 ± 3% of span
Sweep Time
Range: 20 ms to 100 s
Accuracy: ± 3%
Sweep Trigger: Free run, single, line, video, external
Resolution Bandwidth (characteristic): 1 kHz to 3 MHz (3 dB) in 1, 3, 10 sequence, 9 kHz and 120 kHz (6 dB) EMI bandwidths
Accuracy: ± 20%
Video Bandwidth Range: 30 Hz to 1 MHz in 1, 3, 10 sequence
Stability (same as for HP 8590E series)
Noise Sidebands (1 kHz RBW, 30 Hz VBW and sample detector): ≤ –105 dBc/Hz + 20 log N at > 30 kHz offset from CW signal
System-Related Sidebands: ≤ – 65 dBc + 20 log N at > 30 kHz offset from CW signal
Comb Generator Frequency (HP 8592L): 100 MHz fundamental frequency
Accuracy: ± 0.007%

Amplitude

Amplitude Range
HP 8590L, 8592L: Displayed average noise level to +30 dBm
HP 8590L Option 001: Displayed average noise level to +75 dBmV
Maximum Safe Input Level (input attenuator ≥ 10 dB)
Average Continuous Power
HP 8590L, 8592L: +30 dBm (1 W)
HP 8590L Option 001: +75 dBmV (0.4 W)
Peak Pulse Power
HP 8590L: +30 dBm (1 W); + 75 dBmV (0.4 W) (Option 001)
HP 8592L: +50 dBm (100 W) for < 10 µs pulse width and < 1% duty cycle, input atten. ≥ 30 dB
DC
HP 8590L: 25 Vdc; 100 Vdc (Option 001)
HP 8592L: 0 Vdc
Gain Compression (> 10 MHz): ≤ 0.5 dB (total power at input mixer= –10 dBm)
Displayed Average Noise Level (input terminated, 0 dB atten., 1 kHz RBW, 30 Hz VBW, sample detector)
HP 8590L: ≤ –115 to ≤ –113 dBm; ≤ –63 to ≤ –61 dBmV (Option 001)
HP 8592L: ≤ –112 to ≤ –92 dBm; ≤ –112 to ≤ –87 dBm (Option 026)
Spurious Responses
Second Harmonic Distortion
HP 8590L: (> 5 MHz) < – 70 dBc for –45 dBm tone at input mixer
HP 8592L (10 MHz to 2.9 GHz): < – 70 dBc for –40 dBm tone at input mixer; > 2.75 GHz: < – 100 dBc for –10 dBm tone at input mixer (or below DANL)
Third-Order Intermodulation Distortion
HP 8590L
Distortion > 5 MHz: < – 70 dBc for two –30 dBm tones at input mixer and > 50 kHz separation
Other Input-Related: < – 65 dBc at ≥ 30 kHz offset, for – 20 dBm tone at input mixer
HP 8592L
Distortion > 10 MHz: < – 70 dBc for two –30 dBm tones at input mixer and > 50 kHz separation
Other Input-Related: < – 65 dBc at ≥ 30 kHz offset, for– 20 dBm tone at input mixer, ≤ 18 GHz; < – 60 dBc for– 20 dBm tone at input mixer, ≤ 22 GHz
Display Range
Log Scale: 0 to – 70 dB from ref. level is calibrated; 0.1, 0.2, 0.5 dB/div. and 1 to 20 dB/div. in 1 dB steps; 8 div. displayed
Linear Scale: 8 divisions
Scale Units: dBm, dBmV, dBµV, V, W
Marker Readout Resolution: 0.05 dB for log scale; 0.05% of reference level for linear
Reference Level
Range: Same as amplitude range
Resolution: 0.01 dB for log scale; 0.12% of ref. level for linear
Accuracy: ± 0.3 dB @ – 20 dBm; 0 dBm to –59.9 dBm: ± (0.3 dB + 0.01 x dB from –20 dBm)
Frequency Response (10 dB input attenuation)
Absolute (referenced to 300 MHz CAL OUT)
HP 8590L: ± 1.5 dB
HP 8592L (preselector peaked in band > 0): ± 1.5 to ± 5.0 dB
Relative: Referred to midpoint between highest and lowest frequency response deviations
HP 8590L: ± 1.0 dB
HP 8592L (preselector peaked in band > 0): ±1.0 to ± 2.0 dB
Calibrator Output Amplitude: – 20 dBm ± 0.4 dB;
HP 8590L Option 001: +28.75 dBmV ± 0.4 dB
Resolution Bandwidth Switching Uncertainty (ref. to 3 kHz RBW, at ref. level): ± 0.4 dB for 3 kHz to 3 MHz RBW; ± 0.5 dB for 1 kHz
Log to Linear Switching: ± 0.25 dB at ref. level
Display Scale Fidelity
Log Incremental Accuracy: ± 0.4 dB/4 dB, 0 to – 60 dB from ref. level
Log Maximum Cumulative: ± (0.4 dB + 0.01 x dB from ref. level), 0 to –70 dB from ref. level
Linear Accuracy: ± 3% of ref. level

General

Same as for HP 8590 E-series
Built-in tracking generator (see page 238)

4

Ordering Information

HP 8590L Spectrum Analyzer (9 kHz to 1.8 GHz)
HP 8592L Spectrum Analyzer (9 kHz to 22 GHz)
Options[1]
- **Opt 001** 75 Ω Input (HP 8590L only)
- **Opt 003** Memory Card Reader
- **Opt 010** Tracking Generator (100 kHz to 1.8 GHz, HP 8590L only)
- **Opt 011** Tracking Generator (75 Ω, HP 8590L only)
- **Opt 015** Soft Tan Carrying/Operating Case
- **Opt 016** Soft Yellow Carrying/Operating Case
- **Opt 041** HP-IB and Parallel Printer Interfaces
- **Opt 043** RS-232 and Parallel Printer Interfaces
- **Opt 026** 26.5 GHz Frequency Extension, APC-3.5 mm Connector (HP 8592L only)
- **Opt 027** 26.5 GHz Frequency Extension, Type-N Connector (HP 8592L only)
- **Opt 040** Front Panel Protective Cover With Storage
- **Opt 042** Protective Soft Carrying Case/Backpack
- **Opt 711** 50/75 Ω Matching Pad/100 Vdc Block
- **Opt 0Q8** Factory Service Training
- **Opt UK6** Commercial Calibration Certificate with Test Data
- **Opt ABX** Quick Reference Guide in Local Languages
- **Opt 908** Rackmount Without Handles
- **Opt 909** Rackmount With Handles
- **Opt 910** Additional Manual Set
- **Opt 915** Component Level Information and Service Guide
- **Opt W30** Two Additional Years Return-to-HP Service
- **Opt W32** Two Additional Years Return-to-HP Calibration

HP 8591E Spectrum Analyzer, 9 kHz to 1.8 GHz
HP 8594E Spectrum Analyzer, 9 kHz to 2.9 GHz
HP 8595E Spectrum Analyzer, 9 kHz to 6.5 GHz
HP 8596E Spectrum Analyzer, 9 kHz to 12.8 GHz
HP 8593E Spectrum Analyzer, 9 kHz to 22 GHz

Options[1]
- **Opt 001** 75 Ω Input (HP 8591E only)
- **Opt 004** Precision Frequency Reference
- **Opt 009** LO and Sweep + Tune
- **Opt 010** Tracking Generator (100 kHz to 1.8 GHz, HP 8591E only)
- **Opt 010** Tracking Generator (9 kHz to 2.9 GHz)
- **Opt 011** Tracking Generator (75 Ω, HP 8591E only)
- **Opt 012** Source for DECT Receiver Test
- **Opt 015** Soft Tan Carrying/Operating Case
- **Opt 016** Soft Yellow Carrying/Operating Case
- **Opt 026** 26.5 GHz Frequency Extension, APC-3.5 mm Connector (HP 8593E only)
- **Opt 027** 26.5 GHz Frequency Extension, Type-N Connector (HP 8593E only)
- **Opt 040** Front Panel Protective Cover With Storage
- **Opt 041** HP-IB and Parallel Printer Interfaces
- **Opt 042** Protective Soft Carrying Case/Backpack
- **Opt 043** RS-232 and Parallel Printer Interfaces
- **Opt 050** Improved Amplitude Accuracy (NADC-TDMA bands)
- **Opt 051** Improved Amplitude Accuracy for PDC Bands
- **Opt 052** Improved Amplitude Accuracy for PHS Band
- **Opt 053** Improved Amplitude Accuracy for CDMA Bands
- **Opt 101** Fast Time-Domain Sweeps and Analog+ Display
- **Opt 102** AM/FM Demodulator and TV Sync Trigger (TV Sync requires Option 101)
- **Opt 103** Quasi-Peak Detector, AM/FM Demodulator
- **Opt 105** Time-Gated Spectrum Analysis
- **Opt 107** TV Receiver Video Tester
- **Opt 110** CT2 Demodulator
- **Opt 111** Group Delay and Amplitude Flatness (HP 8593/4/5/6E only)
- **Opt 112** DECT Demodulator
- **Opt 119** Noise Figure
- **Opt 130** Narrow Resolution Bandwidths (30 to 300 Hz and 200 Hz EMI)
- **Opt 140** Narrow Bandwidths and Precision Frequency Reference
- **Opt 151** DSP, FAST ADC, and Digital Demodulator
- **Opt 160** PDC, PHS, NADC, and CDMA Firmware for Option 151
- **Opt 163** GSM900/DCS1800 Firmware for Option 151
- **Opt 180** TV Picture NTSC/PAL/SECAM
- **Opt 301** TV Sync Trigger, Fast Time-Domain Sweeps, AM/FM Demodulator, Analog+ Display
- **Opt 711** 50/75 Ω Matching Pad/100 Vdc Block
- **Opt 0Q8** Factory Service Training
- **Opt UK6** Commercial Calibration Certificate with Test Data
- **Opt ABX** Quick Reference Guide in Local Languages
- **Opt W30** Two Additional Years Return-to-HP Service
- **Opt W32** Two Additional Years Return-to-HP Calibration

Application Measurement Cards/Personalities[2,3]
HP 11770A Link Measurement Personality
HP 85700A Blank 32-KB Memory Card
HP 85702A Blank 128-KB Memory Card
HP 85704A Blank 256-KB Memory Card
HP 85705A Blank 512-KB Memory Card
HP 85712D EMC Measurement Personality
HP 85713A Digital Radio Measurement Personality
HP 85714A Scalar Measurement Personality
HP 85715B GSM900 Measurement Personality
HP 85717A CT2-CAI Measurement Personality
HP 85718B NADC-TDMA Measurement Personality
HP 85719A Noise-Figure Measurement Personality
HP 85720C PDC Measurement Personality
HP 85721A Cable TV Measurement Personality
HP 85722B DCS1800 Measurement Personality
HP 85723A DECT Measurement Personality
HP 85724A Broadcast Measurement Personality
HP 85725C CDMA Measurement Personality
HP 85726B PHS Measurement Personality

Printers and Accessories
HP DeskJet 340 (C2655A) portable monochrome/color printer
HP DeskJet 400 (C2642A) monochrome/color printer
HP DeskJet 680C (C4549A) color printer
HP DeskJet 690C (C4562A) color printer
HP DeskJet 693C (C4589A) color printer
HP DeskJet 870C (C4565A, C4555A) color printer
HP C1405B Keyboard (requires C1405-60015 Adapter)
HP 10833A HP-IB Cable (1 m)
HP 24542U RS-232 Cable 3 Meter (9 Pin F to 9 Pin F) Option 043 Only (for RS-232 9 Pin PC Connection to Analyzer)
HP 24542G RS-232 Cable 3 Meter (25 Pin M to 9 Pin F) Option 043 Only (for RS-232 25 Pin PC or Printer Connection to Analyzer)
HP C2932A RS-232 Cable 3 Meter (9 Pin M to 9 Pin F) Option 043 Only (for Serial 9 Pin LaserJet 4P/4Plus Connection to Analyzer)
HP C2950A HP IEEE-1284 A-B Parallel Cable (2 m)
HP ITEL-45CHVUB HP-IB/Parallel Converter (U.S./Canada)
HP ITEL-45CHVEB HP-IB/Parallel Converter (International) (requires HP F1011A ac adapter)

Key Literature

HP 8590 Series Configuration Guide, p/n 5963-6858E
HP 8590 E-Series Data Sheet, p/n 5963-6909E
HP 8590 L-Series Product Overview, p/n 5962-7575E
HP 8590 Series Brochure, p/n 5963-6908E

[1] Most options can be retrofitted. Please contact your local HP sales representative.
[2] Some measurement personalities are not supported by all HP 8590 series models. For complete information, please contact your local HP sales representative.
[3] HP 8590L series requires Option 003 memory card reader.

- Continuous 30 Hz to 2.9, 6.5, 13.2, 26.5, 40, or 50 GHz sweeps
- Resolution bandwidths of 1 Hz to 100 Hz digitally implemented for measurement speed
- Low phase noise and wide dynamic range
- Precision timebase and 1 Hz counter resolution
- Adjacent channel power, channel power, carrier power, and gated video measurements standard
- MIL-T-28800 rugged

HP 8563E

HP 8560 E-Series Spectrum Analyzers

The HP 8560 E-series portable spectrum analyzers offer the measurement capabilities and performance traditionally found only in larger, more expensive benchtop analyzers. These spectrum analyzers combine outstanding phase noise, sensitivity, 1 Hz resolution bandwidths, and wide dynamic range in a MIL-rugged package built to withstand harsh environmental conditions.

Capabilities for RF Communications

The ability to measure adjacent-channel power (ACP) on today's wireless telephones, pagers, and other transmitters is critical in both R&D and manufacturing. The HP 8560 E-series spectrum analyzers offer a complete solution for ACP testing of burst carrier signals using digital modulation such as is used in NADC-TDMA, GSM, DECT, CT2-CAI, PDC and PHS systems. Many of the implementation difficulties of the established standards have been addressed, providing fast, accurate, and easy-to-use ACP measurement capability.

Another standard feature is the ability to measure from .10 to 99.99 percent occupied bandwidth.

Time-gated signal analysis is another standard feature that allows you to easily measure time-varying signals such as pulsed RF, time-division multiple access, interleaved, and burst-modulated. The HP 85902A burst carrier trigger can supply a TTL trigger signal.

HP 8560 E-series specifications have been enhanced. Now, you can get better phase noise, sensitivity, dynamic range and frequency response from this high performance portable spectrum analyzer family.

The new HP 8562E spectrum analyzer provides a 13.2 GHz frequency range with increased dynamic range and third-order intercept (TOI) capability. This allows wireless-communication engineers to test high-performance components in burst operation systems.

With the HP 85672A spurious response measurements utility, you can use HP 8560 E-series spectrum analyzers to make fast and easy spurious response tests.

For more information on RF communications measurement capabilities, refer to page 485.

Fast Digital Resolution Bandwidths

Digitally-implemented resolution bandwidths of 1, 3, 10, 30, and100 Hz allow the HP 8560 E-series spectrum analyzers to sweep from 3 to 600 times faster than is possible with comparable analog filters. A narrow 5:1 shape factor allows you to view close-in, low-level signals easily. Digital bandwidths also provide the spectrum analyzer with a full 100 dB on-screen calibrated display.

PC Software for HP 8560 Series NEW

The new HP BenchLink Spectrum Analyzer PC software provides an easy-to-use communications link between your PC and the HP 8560 Series spectrum analyzers. Taking full advantage of the Windows interface, you can easily transfer screen images or trace data via the HP-IB interface, thereby making it easy to capture, analyze, and document measurement results your PC. For more information, see page 231.

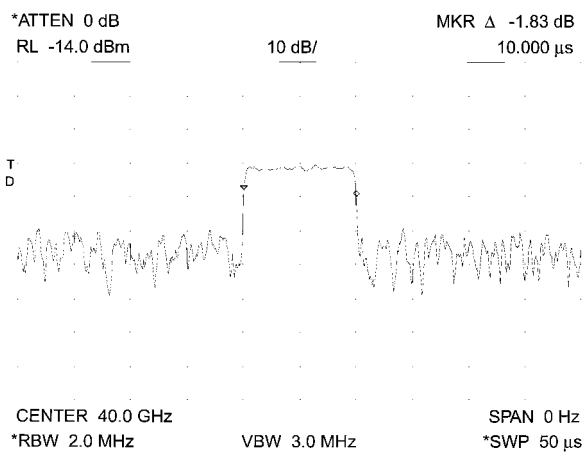
Precision Frequency and Amplitude

Measure frequencies accurately using the built-in frequency counter. A standard precision frequency reference, with an aging rate of 1×10^{-7} per year, and 1 Hz counter resolution provide confidence in measurement accuracy. At 1 GHz, frequency accuracy of ±135 Hz after a 15-minute warmup is achieved.

Amplitude measurement uncertainty can be reduced using the amplitude correction (AMPCOR) feature. AMPCOR allows you to enter up to 200 amplitude correction points to compensate for sources of amplitude uncertainty, such as cable losses, preamplifier gain, and spectrum analyzer frequency response. After developing a table of correction data, amplitudes that have been referenced to a power meter can be read directly on the spectrum analyzer display.

Digitized, Fast Time-Domain Sweeps

Add digitization to fast time-domain (zero span) sweeps with Option 007. Use markers, trace math, trace storage, and get hardcopy output, for measurements such as rise/fall times, pulse widths, and time between events.



With Option 007 markers can be used even with the fastest time-domain (zero-span) sweep times.

HP 8560 E-Series

HP 8560E and 8561E RF Spectrum Analyzers

The HP 8560E and 8561E offer excellent performance for RF design, manufacturing, and service applications. The HP 8560E has a frequency range of 30 Hz to 2.9 GHz, and the HP 8561E extends this range up to 6.5 GHz. Both have synthesized tuning for drift-free accurate measurements.

HP 8562E RF Spectrum Analyzer

The HP 8562E is a high-performance spectrum analyzer that provides the frequency and dynamic range needed for today's high-speed digital wireless communication applications. It allows manufacturing and R&D engineers to test network components with state-of-the-art performance. The HP 8562E has a frequency range of 30 Hz to 13.2 GHz, which covers the spur-search ranges specified by leading standards organizations in Europe and in the United States.

HP 8563E Microwave Spectrum Analyzer

The HP 8563E extends the outstanding features and capabilities of the HP 8560 E-series RF spectrum analyzers into the microwave frequency range. The HP 8563E has a standard frequency range of 9 kHz to 26.5 GHz (preselected from 2.75 GHz to 26.5 GHz), with optional low-end frequency coverage to 30 Hz. The image-enhanced, double-balanced harmonic mixer of the HP 8563E achieves noise-figure performance similar to that of a fundamentally-mixed front end.

4

HP 8564E and 8565E Millimeter Spectrum Analyzers

Whether you want to measure the third harmonic of a 15 GHz oscillator or the noise sidebands of a 38 GHz carrier, the HP 8564E and 8565E make spectrum analysis easier than ever before. A single coaxial connection is all you need to measure signals from 30 Hz to 50 GHz. Preselection minimizes images and multiple responses at higher frequencies.

The HP 8564E has a frequency range of 9 kHz to 40 GHz, the HP 8565E of 9 kHz to 50 GHz. Both have optional low-end coverage to 30 Hz and are preselected above 2.75 GHz.

HP 11970 Series and 11974 Series Millimeter Mixers

For millimeter-wave measurements*, preselection can be extended to 75 GHz using the HP 11974 mixers. Unpreselected frequency range can be extended to 110 GHz using the HP 11970 series mixers, and to 325 GHz using mixers from other manufacturers.

HP 85620A Mass Memory Module

This standard plug-in module adds measurement personality capability, enough memory to store 100 traces, memory-card capability, and computer capability without an external controller. Create complex measurement routines and save them as single-key measurements stored on memory cards or in the module's 128 KB of battery-backed RAM. A clock/calendar and automatic save and execute functions let you configure the spectrum analyzer for unattended, automatic measurements.

HP 85629B Test and Adjustment Module

This accessory for the HP 8560E, 8561E, and 8563E (limited use on HP 8562E/64E) makes it easier to service your spectrum analyzer. The module plugs into the rear panel of the instrument and automates high-level diagnostics, self tests, and adjustment procedures. It performs more than 1,000 troubleshooting adjustments. Readjustments are fast and accurate because the module controls internal analyzer settings as well as external test equipment.

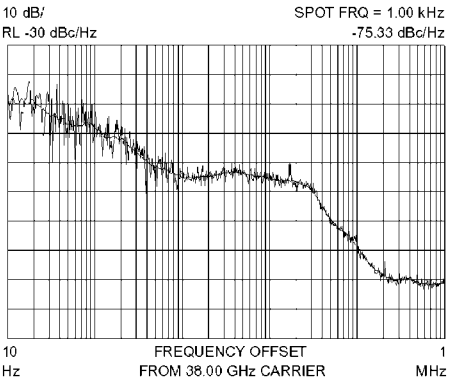
HP 85710A Digital Radio Measurement Personality

The HP 85710A Digital Radio Measurement Personality customizes the HP 8560 E-series spectrum analyzers for digital radio measurements. It contains five agency masks for testing to U.S. FCC, U.K., and FRG specifications. A compare-to-mask function allows you to characterize spectral emissions. Other functions include mean power level, transient analysis monitoring, and frequency-response measurements. You can also create and store your own custom masks.

* Millimeter-wave coverage is not available with Option 002 on the HP 8560E.

HP 85671A Phase Noise Measurement Utility

This downloadable program transforms your HP 8560 Series spectrum analyzer into a phase noise tester. It eliminates the task of hand-drawing phase noise plots. To measure oscillator phase noise, you can generate graphs of phase noise (dBc/Hz) versus log offset frequency without having to manually tune to multiple frequency offsets. Other productivity features include direct phase noise readout, variable filtering (for controlling trade-offs between measurement repeatability and speed), calculation of RMS noise (displayed in radians and degrees), spot-frequency measurements (phase noise measurements at a single offset frequency), and digitized hardcopy and storage.



Use the HP 85671A phase noise utility to easily characterize noise sidebands of an oscillator.

HP 85672A Spurious Response Measurements Utility

The HP 85672A is a downloadable program on a card that inserts directly into any HP 8560 E-series spectrum analyzer. This new test utility provides fast and easy spurious response test capability for all of HP's high-performance spectrum analyzers. Test setup time can be drastically reduced for manufacturing and R & D engineers with this one-button solution. HP 85672A offers five preprogrammed tests: third-order intermodulation product/third order intercept (TOI), harmonics and total-harmonic distortion (THD), discrete sideband spurs, general-spur search, and mixing products.

Scalar Network Analysis Capability

The HP 85640A tracking generator and the optional built-in tracking generator for the HP 8560E both cover 300 kHz to 2.9 GHz . See page 245 for details.

Specifications

Frequency

Frequency Range (internal mixing)
HP 8560E: 30 Hz to 2.9 GHz
HP 8561E: 30 Hz to 6.5 GHz
HP 8562E: 30 Hz to 13.2 GHz
HP 8563E: 9 kHz to 26.5 GHz; 30 Hz to 26.5 GHz (Option 006)
HP 8564E: 9 kHz to 40 GHz; 30 Hz to 40 GHz (Option 006)
HP 8565E: 9 kHz to 50 GHz; 30 Hz to 50 GHz (Option 006)

Frequency Range (external mixing): 18 GHz to 325 GHz in 12 waveguide bands (not available with HP 8560E Option 002)

Frequency Reference Accuracy		Option 103
Temperature Stability	± $1x10^{-8}$	± $1x10^{-6}$
Aging (per year)	± $1x10^{-7}$	± $2x10^{-6}$
Setability	± $1x10^{-8}$	± $1x10^{-6}$
	± $2.2 x 10^{-8}$ (8562E)	

Warmup (nominal), 5 minute ± $1x10^{-7}$; 15 minute ± $1x10^{-8}$
Frequency Readout Accuracy (N = LO Harmonic))
Span > 2 MHz x N: ± (freq. readout x freq. ref. accuracy + 5% x span +15% x RBW +10 Hz)
Span ≤ 2 MHz x N: ± (freq. readout x freq. ref. accuracy +1% x span +15% x RBW +10 Hz)

Marker Count Accuracy (S/N ≥ 25 dB): ± (marker freq. x freq. ref. accuracy +2 Hz x N +1 LSD)
Counter Resolution: Selectable from 1 Hz to 1 MHz
Frequency Span
Range: 0 Hz, 100 Hz to maximum frequency
Sweep Time
Range
Span = 0 Hz: 50 µs to 6,000 s
Span ≥ 100 Hz: 50 ms to 100 ks
Accuracy (span = 0 Hz)
Sweep Time > 30 ms: ± 1% digital
Sweep Time < 30 ms: ± 10% analog; ± 0.1% digital (Option 007)
Sweep Trigger: Delayed, free run, single, line, video, external
Resolution Bandwidth
Range (–3 dB): 1 Hz to 1 MHz in a 1, 3, 10 sequence and 2 MHz
Accuracy
1 Hz to 300 kHz: ± 10%; 1 MHz: ± 25%; 2 MHz: +50%, –25%
Selectivity (–60 dB/–3 dB)
RBW≥ 300 Hz: < 15:1; RBW ≤ 100 Hz: < 5:1
Video Bandwidth Range: 1 Hz to 3 MHz in a 1, 3, 10 sequence

Noise Sidebands (center frequency ≤ 1 GHz)

Offset	Non-Option 103	Option 103
100 Hz	< –88 dBc/Hz	< –70 dBc/Hz
1 kHz	< –97 dBc/Hz	< –90 dBc/Hz
10 kHz	< –113 dBc/Hz	< –113 dBc/Hz
100 kHz	< –117 dBc/Hz	< –117 dBc/Hz

Residual FM (zero span): < 1 Hz p-p in 20 ms; < 0.25 Hz p-p in 20 ms (nominal); < 10 Hz p-p in 20 µs (Option 103)

Amplitude

Range: Displayed average noise level to +30 dBm
Maximum Safe Input Level
Average Continuous Power: +30 dBm (1W, input atten. ≥ 10 dB)
Peak Pulse Power (< 10 µs pulse width and < 1% duty cycle): +50 dBm (100 W, input atten. ≥ 30 dB)
DC Volts: < ± 0.2 V (dc-coupled); < ± 50 V (ac-coupled, HP 8560E, HP 8561E and HP 8562E only)
1 dB Gain Compression
10 MHz to 2.9 GHz: mixer level ≤ –5 dBm
2.9 to 6.5 GHz (HP 8561E): mixer level ≤ –3 dBm
2.9 to 6.5 GHz (HP 8562E/63E/64E/65E): mixer level ≤ 0 dBm
> 6.5 GHz: ≤ –3 dBm (HP 8562E/63E); ≤ 0 dBm (HP 8564E/65E)

Displayed Average Noise Level (0 dB input atten., 1 Hz RBW [1])

Frequency	HP 8560E/61E	HP 8562E	HP 8563E	HP 8564E/65E
30 Hz	–90 dBm	–90 dBm	–90 dBm	–90 dBm
1 kHz	–105 dBm	–105 dBm	–105 dBm	–105 dBm
10 kHz	–120 dBm	–120 dBm	–120 dBm	–120 dBm
100 kHz	–120 dBm	–120 dBm	–120 dBm	–120 dBm
1 to 10 MHz	–140 dBm	–140 dBm	–140 dBm	–140 dBm
10 MHz to 2.9 GHz	–151 dBm[8]	–151 dBm	–149 dBm	–145 dBm
2.9 to 6.5 GHz	–145 dBm[2]	–148 dBm	–148 dBm	–147 dBm
6.5 to 13.2 GHz	—	–145 dBm	–145 dBm	–143 dBm
13.2 to 22.0 GHz	—	—	–140 dBm	–140 dBm
22.0 to 26.5 GHz	—	—	–139 dBm	–136 dBm
26.5 to 31.15 GHz	—	—	—	–139 dBm
31.15 to 40.0 GHz	—	—	—	–130 dBm
40.0 to 50.0 GHz	—	—	—	–127 dBm[3]

[1] 10 Hz RBW (Min. RBW with Option 103) add 10 dB to noise floor
[2] HP 8561E only
[3] HP 8565E only
[4] HP 8563E/64E/65E only
[5] HP 8563E only
[6] HP 8564E/65E only
[7] Except HP 8561E
[8] For HP 8561E: –145 dBm
[9] TOI reference to single tone

Spurious Responses	Mixer Level	Distortion
General Spurious	–40 dBm	< (–75+20 log N) dBc
Second Harmonic Dist.		
20 MHz to 1.45 GHz [7]	–40 dBm	<–79 dBc
1 MHz to 1.45 GHz	–40 dBm	< –72 dBc
1.45 GHz to 3.25 GHz [2]	–20 dBm	< –72 dBc
1.45 GHz to 2.0 GHz [4]	–10 dBm	< –85 dBc
2 GHz to 6.6 GHz 7	–10 dBm	<–100 dBc
2.0 GHz to 13.25 GHz [5]	–10 dBm	< –100 dBc
2.0 to 20 GHz [6]	–10 dBm	< –90 dBc
20 GHz to 25 GHz [3]	–10 dBm	< –90 dBc
3rd Order Intermodulation [9]		
20 MHz to 2.9 GHz [7]	–30 dBm	< –82 dBc
1 MHz to 2.9 GHz	–30 dBm	< –78 dBc
2.9 GHz to 6.5 GHz	–30 dBm	< –90 dBc
6.5 GHz to 26.5 GHz	–30 dBm	< –75 dBc
26.5 GHz to 40 GHz [6]	–30 dBm	< –85 dBc (nominal)
40 GHz to 50 GHz [3]	–30 dBm	≤ –85 dBc (nominal)
Images		
10 MHz to 26.5 GHz	–10 dBm	< –80 dBc
26.5 GHz to 50 GHz	–30 dBm	< –60 dBc
Multiples and Out-of-Band Responses		
10 MHz to 26.5 GHz	–10 dBm	< –80 dBc
26.5 GHz to 50 GHz	–30 dBm	< –55 dBc

Residual Responses (> 200 kHz, N=1): < –90 dBm
Display: Viewing area — Approx. 7 cm (V) x 9 cm (H)
Scale calibration — 10 x 10 divisions
Log scale — 10, 5, 2, 1 dB per division
Linear scale — 10% of ref. level per division

Display Scale Fidelity
Log: ± 0.1 dB/dB to a maximum of ± 0.85 dB, 0 to –90 dB; maximum of ± 1.5 dB, 0 to –100 dB (RBW ≤ 100 Hz)
Linear: ± 3% of reference level
Reference Level Range: Log = –120 to +30 dBm in 0.1 dB steps; Linear = 2.2 µV to 7.07 V in 1% steps

Frequency Response, Relative (10 dB input atten.)

Frequency	HP 8560E	HP 8561E	HP 8562E	HP 8563E	HP 8564E/65E
100 MHz to 2.0 GHz	± 0.7 dB	± 1.0 dB	± 0.9 dB	± 1.0 dB	± 0.9 dB
30 Hz to 2.9 GHz	± 1.0 dB	± 1.0 dB	± 1.25 dB	± 1.25 dB	± 1.0 dB
2.9 GHz to 6.5 GHz	—	± 1.5 dB	± 1.5 dB	± 1.5 dB	± 1.7 dB
6.5 GHz to 13.2 GHz	—	—	± 2.2 dB	± 2.2 dB	± 2.6 dB
13.2 GHz to 22.0 GHz	—	—	—	± 2.5 dB	± 2.5 dB
22.0 GHz to 26.5 GHz	—	—	—	± 3.3 dB	± 3.3 dB
26.5 GHz to 31.15 GHz	—	—	—	—	± 3.1 dB
31.15 GHz to 40.0 GHz	—	—	—	—	± 2.6 dB
40.0 GHz to 50.0 GHz	—	—	—	—	± 3.2 dB[3]

Calibrator Output: 300 MHz x (1 ± freq. ref. acc'y), –10 dBm: < ± 0.3 dB
Input Attenuator
Range
HP 8560E/61E/62E/63E: 0 to 70 dB in 10 dB steps
HP 8564E/65E: 0 to 60 dB in 10 dB steps
Switching Uncertainty (ref. to 10 dB, 30 Hz to 2.9 GHz): < ± 0.6 dB/10 dB step, ± 1.8 dB max.
Repeatability: ± 0.1 dB (nominal)
IF Gain Uncertainty (10 dB atten., 0 to –80 dBm ref. level): < ± 1 dB
Resolution Bandwidth Switching Uncertainty: < ± 0.5 dB
Pulse Digitization Uncertainty (pulse response mode, PRF ≥ 720/sweep time, RBW ≤ 1 MHz): < 1.25 dB pk-pk (Log); < 4% of reference level pk-pk (Linear)

Time-Gated Spectrum Analysis

Gate Delay	Edge Mode	Level Mode
Range	3 µs to 65.535 ms	≤ 0.5 µs
Resolution	1 µs	

Accuracy (from gate trigger input to pos. edge of gate output): < ± 1 µs

Gate Length
Range: 1 µs to 65.535 ms
Resolution: 1 µs
Accuracy (from pos. edge to neg. edge of gate output): < ± 1 µs

Specifications (cont'd)

Delayed Sweep

Trigger Modes: Free run, line, external, video
Range: 2 µs to 65.535 µs; Option 007, Sweeptime < 30 µs; –9.9 µs to +65.535 µs; Sweeptime ≥ 30 µs, +2 µs to +65.535 µs
Resolution: 1 µs
Accuracy: ± 1 µs

Demodulation (Spectrum)

Modulation Type: AM and FM
Audio Output: Speaker and phone jack with volume control

Inputs and Outputs (All values nominal)

Front-Panel Connectors
- **RF Input** (50 Ω)
  HP 8560E/61E/62E/63E, Type-N female
  HP 8563E Option 026, APC-3.5 male
  HP 8564E/65E, 2.4-mm male
  VSWR (≥ 10 dB atten.): < 1.5:1 below 2.9 GHz; < 2.3:1, ≥ 2.9 GHz
  LO Emission Level (average with 10 dB atten.): < – 80 dBm
- **Second IF Input** (SMA female, 50 Ω)
  Frequency: 310.7 MHz
  Full Screen Level: –30 dBm
  Gain Compression: –20 dBm
- **First LO Output** (SMA female, 50 Ω)
  Frequency: 3.0 to 6.8107 GHz
  Amplitude:+16.5 dBm ± 2 dB;+14.5 dBm ± 3 dB (Option 002)
- **Cal Output:** BNC female, 50 Ω
- **Probe Power:** +15 Vdc,–12.6 Vdc, and GND (150 mA maximum each)

Rear Panel Connectors
- **10 MHz Reference In/Out** (shared BNC female, 50 Ω)
  Output Freq. Accuracy: 10 MHz ± (10 x MHz freq. ref. acc'y)
  Output Amplitude: 0 dBm
  Input Amplitude:– 2 to +10 dBm
- **Video Output** (BNC, 50 Ω)
  Amplitude (RBW ≥ 300 Hz): 0 to +1 V full scale
- **LO Sweep I FAV Output** (shared BNC female, 2 kΩ)
  Amplitude (LO sweep): 0 to 10 V, no load
- **Blanking/Gate Output:** Shared BNC female, 50 Ω, TTL output
- **External/Gate Trigger Input** (shared BNC female, > 10 kΩ): settable to high TTL or low TTL
- **HP-IB** (IEEE-488 bus connector)
  Interface Functions: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT0, C1, C28, E1
  Interface Functions (For HP 8562E): SH1, AH1, T6, LE0, RL1, PP1, DC1, DT1, C1, C28, TE0, SR1

General Specifications

Environmental
- **Military Specs:** Per MIL-T-28800
- **Calibration Interval:** Two years (HP 8560E/61E/62E/63E); one year (HP 8564E/65E)
- **Warmup Time:** 5 minutes in ambient conditions
- **Temperature:** –10° to +55° C (operating); –51° to +71° C (not operating)
- **Humidity:** 95% @ 40° C for five days
- **Rain Resistance:** Drip-proof at 16 liters/hour/sq. ft.
- **Altitude:** 15,000 ft. (operating); 50,000 ft. (not operating)
- **Pulse Shock** (half sine): 30 g for 11 ms duration
- **Transit Drop:** 8-inch drop on six faces and eight corners

Electromagnetic Compatibility: Conducted and radiated interference in compliance with CISPR Pub. 11 (1990). Meets MIL-STD-461C, part 4, with certain exceptions.

Power Requirements
- **115 Vac Operation:** 90 to 140 V rms, 3.2 A rms max., 47 to 440 Hz
- **230 Vac Operation:** 180 to 250 V rms, 1.8 A rms max., 47 to 66 Hz

Maximum Power Dissipation: 180 W (HP 8560E/61E/62E/63E); 260 W (HP 8564E/65E)
Audible Noise (nominal)**:** < 5.0 Bels power at room temp. (ISO DP7779)
Size (w/o handle, feet, cover)**:** 337 mm W (13 ¼ in.) x 187 mm H (7 ⅜ in.) x 461 mm D (18 ⅛ in.)
Weight (carrying, nominal)**:** 20 kg (44 lb)

Option 002 Built-in Tracking Generator (HP 8560E only)

Frequency
- **Range:** 300 kHz to 2.9 GHz
- **Accuracy** (after peaking): ± (freq. ref. accuracy x tuned freq. + 5% x span +295 Hz)
- **Tracking Drift** (nominal): Usable in 1 kHz RBW after 5-min. warmup; usable in 300 Hz RBW after 30-min. warmup
- **Minimum RBW:** 300 Hz

Amplitude
- **Output Level:** –10 to +1 dBm; –10 to 2.8 dBm, typical
- **Resolution:** 0.1 dB
- **Accuracy** (25° C ± 10° C)
  Vernier: ± 0.2 dB/dB, ± 0.5 dB max.
  Absolute: ± 0.75 dB
  Level Flatness: ± 2.0 dB
- **Dynamic Range:** 95 dB at 300 kHz to 1 MHz; 115 dB at 1 MHz to 2.0 GHz; 110 dB at 2.0 GHz to 2.9 GHz
- **Power Sweep:** 10 dB range, 0.1 dB resolution

Inputs/Outputs
- **RF Output** (front panel): Type-N female, 50 Ω (nominal)
- **Ext. ALC Input** (rear panel): BNC female; use with negative detector

Key Literature

HP 8560E, 8561E, 8563E Technical Data, p/n 5091-3274E
HP 8562E Technical Specifications, p/n 5964-9793E
HP 8564E, 8565E Technical Data, p/n 5091-8182E
HP 85671A Technical Data, p/n 5091-7089E
HP 85672A Product Overview, p/n 5965-1337E
HP 85710A Technical Data, p/n 5952-1452

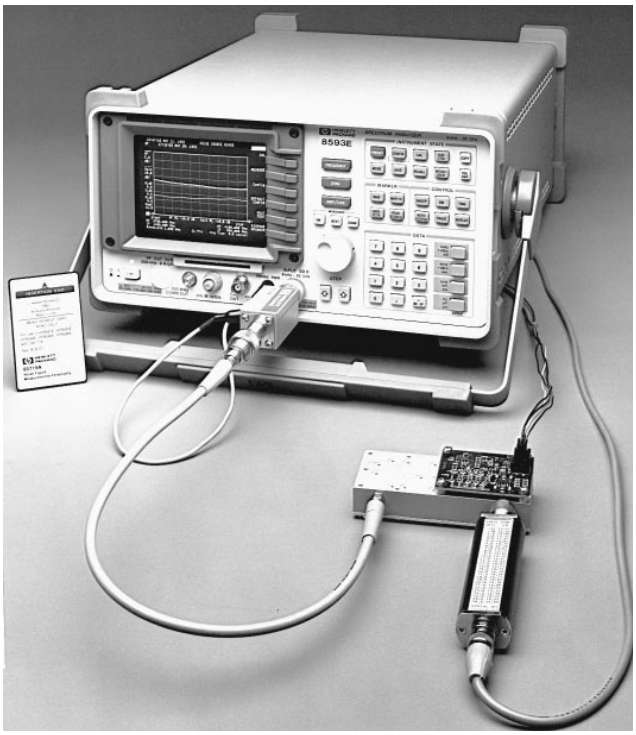
Ordering Information

HP 8560E Spectrum Analyzer, 30 Hz to 2.9 GHz
HP 8561E Spectrum Analyzer, 30 Hz to 6.5 GHz
HP 8562E Spectrum Analyzer, 30 Hz to 13.2 GHz
HP 8563E Spectrum Analyzer, 9 kHz to 26.5 GHz
HP 8564E Spectrum Analyzer, 9 kHz to 40 GHz
HP 8565E Spectrum Analyzer, 9 kHz to 50 GHz
- **Opt 001** Second IF Output (310.7 MHz)
- **Opt 002** Built-In Tracking Generator (HP 8560E)
- **Opt 005** Alternate Sweep Out (cannot be used with Option 002)
- **Opt 006** 30 Hz to Freq. Coverage (HP8563E/64E/65E)
- **Opt 007** Digitized Fast Time-Domain Sweeps
- **Opt 008** Signal Identification
- **Opt 026** APC-3.5 mm Input Connector (HP 8563E)
- **Opt 042** Protective Soft Carrying Case/Backpack
- **Opt 0Q8** Service Training (HP 8562E)
- **Opt 103** Delete Precision Frequency Reference, and 1 Hz and 3 Hz RBWs
- **Opt 104** Delete Mass Memory Module
- **Opt 908** Rackmount Kit without Handles
- **Opt 909** Rackmount Kit with Handles
- **Opt 910** Extra Manual Set
- **Opt 915** Service Guide
- **Opt 916** Extra Quick Reference Guide (English)
- **Opt 1BN** MIL-STD-45662A Calibration (no data)
- **Opt 1BP** MIL-STD-45662A Calibration (with data)
- **Opt UK6** Commercial Calibration (with data)

Accessories
HP 85620A Mass Memory Module
HP 85629B Test and Adjustment Module
HP 85640A Tracking Generator (300 kHz to 2.9 GHz)
HP 8449B 1 to 26.5 GHz Preamplifier
HP 83050A 2 to 50 GHz Power Preamplifier
HP 83051A 45 MHz to 50 GHz Preamplifier
HP 85700A 32 KB RAM Memory Card
HP 85702A 128 KB RAM Memory Card
HP 85671A Phase Noise Measurements Utility
HP 85672A Spurious Response Measurements Utility
HP 85710A Digital Radio Measurement Personality
HP 85901A Portable AC Power Source
HP 85902A Burst Carrier Trigger
HP 41800A Active Probe (5 Hz to 500 MHz)
HP 85024A High-Frequency Probe (300 kHz to 3 GHz)

HP 85630A
HP 85640A
HP 85714A
HP 85719A

- Noise-figure measurement personality
- High-performance tracking sources
- Scalar measurement personality
- Scalar test set for transmission/reflection measurements



HP 85719A

Accessories for Noise-Figure Measurements

The HP 85719A noise-figure measurements personality adds unique capability to an HP 8590 E-series spectrum analyzer with the Option 119 noise-figure card. Combined with the HP 346B noise source and HP 87405A preamplifier, the measurement personality and spectrum analyzer provide displayed swept noise-figure and gain measurements from 10 MHz to 2.9 GHz. Features include one-point measurement capability for quick results, noise-figure and spectrum analyzer mode-switching for stray signal detection, selectable measurement bandwidths to directly measure narrowband devices, and a repeatability calculator to determine measurement time and repeatability tradeoffs.

The noise-figure personality makes use of many features found in the spectrum analyzer. For example, the save/recall functions and the memory-card reader are used to store measurement data, states, displays, and ENR data tables. Marker functions make it easy to read noise-figure and gain measurements for the entire sweep, and a menu-driven interface makes the entire system easy to use.

Accessories for Scalar Network Analysis

A variety of accessories are designed to enhance HP spectrum analyzers by adding scalar measurement capability. These powerful solutions allow you to meet both your scalar-network analysis and spectrum analysis needs.

HP 85640A Portable Tracking Generator

This portable tracking generator provides the HP 8560 series spectrum analyzers with scalar measurement capability from 300 kHz to 2.9 GHz. See page 249.

HP 85630A and HP 85714A

HP 85714A Scalar Measurement Personality
HP 85630A Scalar Transmission/Reflection Test Set

The HP 85714A is a downloadable program that enhances an HP 8590 series spectrum analyzer and tracking generator for transmission measurements. The addition of an HP 85630A scalar test set provides the user interface with a powerful yet economical transmission/reflection measurement system.

The scalar measurement personality adds a number of useful features to the scalar/spectrum analyzer system. These include guided OPEN/SHORT and THRU calibration, pass/fail limit line testing, an enhanced 120 dB display for high, dynamic-range measurements, a tabular display format, and one-button measurements for 3 or 6 dB bandwidth, insertion loss/gain, shape factor, Q, and center frequency measurements.

The scalar test set allows you to view transmission and reflection data simultaneously on the screen, so you can make adjustments on a device-under-test while monitoring the results. You can also make calibrated transmission and reflection measurements on a device using a single setup, without the usual need to recalibrate and reconfigure as with spectrum-analyzer-only systems.

Other capabilities provided by the test set include a reflection coefficient measurement marker, VSWR measurement markers, return loss measurement, automatic switching between transmission and reflection mode, and source attenuation.

Ordering Information

HP 85630A Scalar Transmission/Reflection Measurement Test Set
HP 85640A Portable Tracking Generator
HP 85714A Scalar Measurement Personality
HP 85719A Noise-Figure Measurements Personality
HP 8590 E-Series Spectrum Analyzers
  Opt 119 Noise-Figure Card
HP 346B Noise Source
HP 87405A Preamplifier

HP 70000 Series Spectrum Analyzers

HP 71100C
HP 71100P
HP 71200C
HP 71200P
HP 71209A
HP 71209P
HP 71210C
HP 71210P

- Superb performance from 100 Hz to 40 GHz
- Automated, reconfigurable systems
- HP 8566B code compatibility

HP 71209A

HP 70000 Series Spectrum Analyzers

The HP 70000 series spectrum analyzers are part of the growing modular measurement system (MMS) family at HP. Four factory-configured spectrum analyzers combine high performance, ease of use, and the benefits of modularity for RF and microwave applications:

- HP 71100C/P RF spectrum analyzer, 100 Hz to 2.9 GHz
- HP 71200C/P microwave spectrum analyzer, 50 kHz to 22 GHz
- HP 71209A/P microwave spectrum analyzer, 100 Hz to 26.5 GHz, with an outstanding set of performance features
- HP 71210C/P microwave spectrum analyzer, 100 Hz to 22 GHz, with ultimate sensitivity and a dynamic tracking preselector

New "P" Series Feature PC Display

The "P" series spectrum analyzer systems replace the mainframe display with a high performance HP Vectra PC and the display software. The key features of the "P" systems are capability for output to PC printers and mass storage devices, and lower system price. While performing measurements, you can copy the virtual screen and cut and paste data to spreadsheets or reports. Test data can be logged and stored in a data file limited in size only by the computer's disk capacity.

All A/C spectrum analyzers feature a color display with color editor, a custom hardkey panel with the most commonly-used spectrum-analyzer functions, downloadable programming capability, and a memory card reader.

HP 71209A/P Microwave Spectrum Analyzer

The HP 71209A/P is the MMS standard for microwave spectrum analysis, offering exceptional performance for a lower price. Special features include a built-in mixer interface for completely preselected coverage from 100 Hz to 75 GHz (using HP 11974 series mixers), programming code compatibility with the HP 8566B spectrum analyzer, similar performance to that of the HP 71210C/P, an IF output with AGC, a 5 dB step attenuator, and a built-in baseband limiter. Option 001 includes a preselector bypass and increases the front-end bandwidth to aid upgrading to the bandwidth receiver system.

HP 70875A Noise-Figure Measurement Personality

The HP 70875A noise-figure measurement personality customizes HP 70000 series spectrum analyzers for displayed swept noise-figure and gain measurements from 10 MHz to 26.5 GHz. Features include one-point measurement capability for quick results, noise-figure and spectrum analyzer mode switching for stray signal detection, selectable measurement bandwidths to directly measure narrowband devices, and marker functions with limit lines.

Key Literature

A complete list of all MMS products with full descriptions, specifications, and services is available. For a free copy of the *HP 70000 Modular Measurement System* catalog, contact your local HP sales office listed on page 591. Ask for HP p/n 5065-2818E.

Ordering Information

HP 71100C Spectrum Analyzer, 100 Hz to 2.9 GHz
HP 71100P Spectrum Analyzer
HP 71200C Spectrum Analyzer, 50 kHz to 22 GHz
HP 71200P Spectrum Analyzer
HP 71209A Spectrum Analyzer, 100 Hz to 26.5 GHz
Opt 001 Wide Bandwidth RF Section
Opt Z40 Spectrum Analyzer, 100 Hz to 40 GHz
HP 71209P Spectrum Analyzer

HP 70000 Series Spectrum Analyzer Specification Summary

	HP 71100C HP 71100P	HP 71200C HP 71200P	HP 71209A HP 71209P	HP 71210C HP 71210P
Frequency range (tunable in 1 Hz increments)	100 Hz to 2.9 GHz (dc-coupled); 100 kHz to 2.9 GHz (ac-coupled)	50 kHz to 22 GHz	100 Hz to 26.5 GHz (100 Hz to 40 GHz Option Z40)	100 Hz to22 GHz
With external mixers	75 GHz with HP 11974 preselected mixers; 110 GHz with HP 11970 harmonic mixers; 325 GHz with other mixers			
Resolution bandwidth range	10 Hz to 300 kHz; 3 MHz option		10 Hz to 3 MHz	
Phase noise	–108 dBc/Hz at 10 kHz offset	–108 dBc/Hz at 10 kHz offset, to 6.2 GHz		
Optimum dynamic range (2nd/3rd order)	82 dB/92 dB	70 dB/88 dB	99 dB/96 dB	96 dB/98 dB
Amplitude accuracy (relative frequency + lesser of scale fidelity or IF gain accuracy)	± 2 dB (± 0.9 dB) [1]	± 2 dB (± 0.9 dB) [1]	± 2 dB (± 0.9 dB) [1]	± 2.5 dB (± 0.9 dB) [1]
Displayed average noise level, 10 Hz RBW				
at 2.9 GHz	–131 dBm	<–129 dBm	–136 dBm	–139 dBm
at 22 GHz	—	<–116 dBm	–128 dBm	–133 dBm
at 26.5 GHz	—	<–115 dBm	–126 dBm	—
Displayed average noise level with HP 70620 Series preamplifiers				
at 2.9 GHz	–156 dBm	–140 dBm	–155 dBm	–155 dBm
at 22 GHz	—	–119 dBm	–148 dBm	–150 dBm
at 26.5 GHz	—	–155 dBm	–145 dBm	—

[1] ± 0.9 dB transfer accuracy using the HP 70100A–H01 modular power meter.

HP 71910A and 71910A Option 11 configurations

HP 71910A and HP 71910P Receiver

Modular Receiver for Surveillance and Signal Monitoring

The HP 71910A/P is a receiver in the MMS format for monitoring signals from 100 Hz to 26.5 GHz. The receiver provides cost-effective combination search and wide-bandwidth collection capabilities for surveillance and signal monitoring of satellite, digital radio, and radar/EW transmissions.

The wide-bandwidth receiver consists of the HP 71209A/P Option 001 spectrum analyzer plus the HP 70911A ultra-wide bandwidth IF module. System options include a preamplifier module for enhanced noise figure and smaller-size, single-mainframe configurations.

Search and Collection Modes of Operation

The HP 71910A/P receiver has two modes of operation: search and collection. To search for signals, the receiver relies on its fast spectrum analyzer tuning. It sweeps over user-specified spans up to 26.5 GHz wide using bandwidths up to 3 MHz. Wide dynamic range ensures that signals of various amplitudes can be quickly identified.

Once a signal is located, the receiver is fixed-tuned and the wide IF bandwidths in the HP 70911A IF module are used for signal collection. The HP 70911A provides IF bandwidths up to 100 MHz (in 10% increments) and up to 70 dB IF step gain. A linear IF signal path provides good signal fidelity with standard outputs of 321.4 MHz IF and linear video. Optional outputs include 70 and 140 MHz IF, analog I/Q, and demodulated FM.

HP 71910A and HP 89410 VSA

Pulse Shape Characterization

Traditional shape measurements of pulsed microwave signals using a spectrum analyzer are significantly enhanced by the 100 MHz bandwidth. Using an oscilloscope connected to the video output, pulse rise and fall times of microwave signals are easily measured to 7 ns.

I/Q Signal Identification

The optional analog I/Q demodulator provides I and Q outputs which will produce a constellation display on an oscilloscope when the HP 71910A/P is tuned to a suitable digitally modulated signal. Sub-Hz tuning (minimum of 1 Hz resolution on-screen) allows ultrafine adjustments to compensate for phase offsets when it is not possible to phase-lockthe receiver to the source, such as in off-the-air monitoring. By stopping the spinning caused by a non-phaselocked system, modulation formats are easily identified.

HP 71910P

When more thorough analysis is required, the I and Q outputs can be connected to a dual-channel vector signal analyzer (VSA). This configuration can provide full-signal demodulation of microwave signals with double the bandwidth normally provided by the VSA alone.

Digital Demodulation and Vector Signal Analysis

Add high performance digital demodulation and vector signal analysis capability by combining the HP 71910A/P and HP 89410A VSA. Measurements such as error vector magnitude (EVM) along with constellation, eye diagram and time domain analysis as well as group delay, AM to PM and phase versus drive, for example, can be made on microwave communication signals.

System Specification Summary

Frequency Range: 100 Hz to 26.5 GHz (110 GHz with external mixers)
Noise Figure at 12 GHz: 32 dB (13 dB with preamplifier module)
TOI at 12 GHz: +2.0 dBm (without preamplifier module)
Tuning Resolution: 1 Hz
LO Phase Noise at 6 GHz: –108 dBc/Hz at 10 kHz offset
IF Bandwidths: 10 Hz to 100 MHz (continuously variable in 10% increments in most cases)
- **Spectrum Analyzer RBW:** 10 Hz to 3 MHz
- **Receiver IF Bandwidth:** 10 MHz to 100 MHz

IF Filter Type: 5-pole, synchronously tuned
Optional Filter Type: 6-pole, Chebyshev channel filters
IF Step Gain: 70 dB (in 1 dB steps)

Outputs
321.4 MHz IF
- **Bandwidth:** 10 MHz to 100 MHz (preselector bypass)
- **Bandwidth:** > 36 MHz for 2.7 to 26.5 GHz RF path (preselector ON)
- **Bandwidth:** > 48 MHz for 100 Hz to 2.9 GHz RF path

Video: AM, FM (optional), pulse (bandwidth same as 321.4 MHz IF)
- **Optional 70 MHz** IF (bandwidth ≥ 40 MHz)
- **Optional 140 MHz** IF (bandwidth ≥ 70 MHz)
- **Optional Analog I/Q** (I bandwidth ≥ 50 MHz; Q bandwidth ≥ 50 MHz)

Key Literature

MMS Catalog, p/n 5965-2818E
HP 71910A/P Wide Bandwidth Receiver, p/n 5965-7916E
HP 89410A Vector Signal Analyzer, p/n 5964-3586E

Ordering Information

HP 71910A Wide Bandwidth Receiver
HP 71910P Wide Bandwidth Receiver
- **Opt 001** 70 MHz IF Output
- **Opt 002** 140 MHz IF Output
- **Opt 004** Analog I/Q Output
- **Opt 005** FM Output
- **Opt 007** Channel Filters
- **Opt 011** Delete Display, NB IFs, PFR (71910A only)
- **Opt 016** HP 7060B Option 001 Preamplifier Module

HP 70911A Ultra-Wide Bandwidth IF Module

Millimeter Mixers

HP 11970 Series
HP 11974 Series

- Preselected mixers to eliminate signal identification
- State-of-the-art technology
- Easier automated measurements
- Low conversion loss
- Individually amplitude calibrated
- No bias or tuning adjustments
- High 100 mW safe input level

HP 11970, 11974 Series Mixers

HP 11974 Series Preselected Millimeter Mixers

4

Eliminate the need for signal identification at millimeter frequencies. The HP 11974 series mixers are preselected from 26.5 to 75 GHz for faster, easier testing of millimeter devices and systems. Preselection reduces mixer overload from broadband signals and reduces radiation of local oscillator harmonics back to the device-under-test. Equipment operators can quickly locate true signals, and software development for automated measurements is greatly simplified.

These mixers feature advanced barium-ferrite technology and come with a standalone power supply. They are particularly useful for broadband millimeter signal analysis, millimeter electromagnetic-interference (EMI) measurements, and unattended monitoring of millimeter signals.

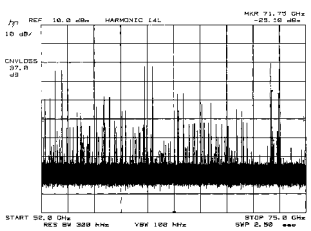
HP 11974 series preselected mixers are available in four bands

HP model	Frequency range (GHz)	Sensitivity[1] (displayed avg. noise level/10 Hz) (dBm)	Calibration accuracy[1] (dB)	Image rejection[1] (dB)	1 dB Gain compression (dBm)
11974A	26.5 to 40	–111	< ±2.3	–54	+6
11974Q	33 to 50	–106	< ±2.3	–50	+0
11974U	40 to 60	–109	< ±2.6	–50	+0
11974V	50 to 75	–100	< ±4.5	–40	+3

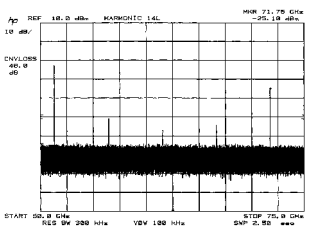
[1] Specifications apply when connected to the HP 8566B or 70000 series spectrum analyzers.

Compatibility

Upgrade kits are available to assure the compatibility of HP 8566A/B spectrum analyzers and the HP 70907A external mixer interface module. Consult your HP sales representative to determine requirements. All HP 8560 E-series spectrum analyzers and the HP 70907B external mixer interface modules are fully compatible with the HP 11974 series.



50 to 75 GHz Sweep Without Preselection



50 to 75 GHz Sweep Using HP 11974 Series Mixer

HP 11970 Series Harmonic Mixers

The HP 11970 series waveguide mixers are general-purpose harmonic mixers. They employ a dual-diode design to achieve flat-frequency response and low conversion loss. These are achieved without external dc bias or tuning stubs. Manual operation and computer-controlled hardware operation are simplified because mixer bias and tuning adjustments are not required.

HP 11970 series harmonic mixers are available in six bands

HP model	Frequency range (GHz)	LO harm number	Conversion loss (dB)	Noise level (dB) 1 kHz RBW	Freq.[1] response (dB)	Gain compression (dBm)
11970K	18 to 26.5	6+	24	–105	± 1.9	–3
11970A	26.5 to 40	8+	26	–102	± 1.9	–5
11970Q	33 to 50	10+	28	–101	± 1.9	–7
11970U	40 to 60	10+	28	–101	± 1.9	–7
11970V	50 to 75	14+	40	–92	± 2.1	–3
11970W	75 to 110	18+	47	–85	± 3.0	–1

[1] Frequency response of the mixers is reduced by 1 dB for LO range of 14 to 18 dBm.

Compatibility

The HP 11970 series mixers extend the frequency range of the HP 8560 E-series portable spectrum analyzers, of the HP 8566B spectrum analyzer (used with the HP 11975A amplifier), and of the HP 70000 modular measurement system (used with the HP 70907A/B external mixer interface modules).

HP 11970 and 11974 Series Specifications

IF Range: dc to 1.3 GHz
LO Amplitude Range: +14 dB to +16 dB; +16 dB optimum
Calibration Accuracy: +2 dB for HP 11970 series with optimum LO amplitude
Typical RF Input SWR: < 2.2:1, < 3.0:1 for HP 11974 series
Bias Requirements: None
Typical Odd-Order Harmonic Suppression: > 20 dB (does not apply to HP 11974 series)
Maximum CW RF Input Level: +20 dBm (100 mW), +25 dBm for HP 11974 series
Maximum Peak Pulse Power: 24 dBm (250 mW) with < 1 µs pulse (avg. power = +20 dBm)
Bandwidth: 100 MHz minimum (HP 11974 series only)
Environmental: Meets MIL-T-28800, Type III, Class 3, Style C
IF/LO Connectors: SMA (female)
TUNE IN Connector: BNC
LO Range: 3 to 6.1 GHz

Key Literature

HP 11970 Series Technical Data, p/n 5954-2714
HP 11974 Series Technical Data, p/n 5952-2748

Ordering Information

HP 11974A 26.5 to 40 GHz Preselected Mixer
HP 11974Q 33 to 50 GHz Preselected Mixer
HP 11974U 40 to 60 GHz Preselected Mixer
HP 11974V 50 to 75 GHz Preselected Mixer
  Opt 003 Delete Power Supply (HP 11974 series only)
HP 11970K 18 to 26.5 GHz Mixer
HP 11970A 26.5 to 40 GHz Mixer
HP 11970Q 33 to 50 GHz Mixer
HP 11970U 40 to 60 GHz Mixer
HP 11970V 50 to 75 GHz Mixer
HP 11970W 75 to 110 GHz Mixer
HP 11970
  Opt 009 Mixer Connection Set adds three 1-m low-loss SMA cables, wrench, Allen driver for any HP 11970 series mixer
HP 11975A 2 to 8 GHz Amplifier
HP 281A/B Coaxial to Waveguide Adapters
  R281A 26.5 to 40 GHz, 2.4 mm (f)
  R281B 26.5 to 40 GHz, 2.4 mm (m)
  Q281A 33 to 50 GHz, 2.4 mm (f)
  Q281B 33 to 50 GHz, 2.4 mm (m)

HP 85640A Portable Tracking Generator

This portable, rugged tracking generator adds scalar analysis capability from 300 kHz to 2.9 GHz to an HP 8560 series portable spectrum analyzer. Use the HP 85640A to measure gain, frequency response, compression, flatness, and return loss on components and subsystems. A built-in attenuator gives output power of –80 to 0 dBm. Together, the spectrum analyzer and tracking generator have a dynamic range greater than 100 dB.

HP 85902A Burst Carrier Trigger

For performing transmitter tests, this accessory provides a TTL time reference that allows an HP 8590 A/E-series or 8560 E-series spectrum analyzer to trigger reliably off the RF signal. It has an input range of 60 dB and a separate built-in preamplifier for greater sensitivity. The HP 85902A works with all digital communication formats: NADC-TDMA, E-TDMA, PDC, GSM900, DCS-1800, PCS1900, CT2-CAI, DECT, and PHS. Frequency range is 10 to 2000 MHz.

HP 85671A Phase Noise Measurement Utility

Characterize the phase noise of VCOs and varactor oscillators easily using this downloadable program with an HP 8560 series portable spectrum analyzer. It provides fast measurements of phase noise versus log offset frequency. Results are displayed graphically and can be stored in the analyzer, printed, or plotted.

HP 85672A Spurious Response Measurements Utility

This test utility provides fast and easy spurious response test capability for all of HP's high-performance spectrum analyzers. HP 85672A offers five programmed tests. These are: third-order intermodulation product/third order intercept (TOI), harmonics and total-harmonic distortion (THD), discrete sideband spurs, general-spur search, and mixing products.

HP 8447 Series RF Amplifiers

These amplifiers, with a frequency range of 9 kHz to 1.3 GHz, have low noise, and wide bandwidths, and improve spectrum analyzer sensitivity and noise figure while providing input isolation. See page 301.

HP 8449B Preamplifier

This high-gain, low-noise preamplifier has a frequency range of 1 to 26.5 GHz. It increases the sensitivity of any microwave spectrum analyzer for detection and analysis of very low-level signals. Its improved sensitivity can reduce measurement time. See page 302.

HP 87405A Preamplifier

The HP 87405A preamplifier has a frequency range of 0.01 to 3 GHz. Compact size, 22 to 27 dB gain, 6.5 dB noise figure, and convenient probe-power bias connection make it ideal for use with a number of instruments.

HP 85901A Portable AC Power Source

This easy-to-carry power source can be used as a standalone battery for over 1 hour of operation at 100 W continuous load, or can be connected to an external 12 Vdc source for longer use. It shuts off automatically when the charge gets low, and can be recharged in six hours or less. Over-voltage, short-circuit, and overload protection on the inverter output are built in. Also included are over-voltage protection on the inverter input and over-charge and over-discharge protection on the internal battery.

HP 11867A and 11693A Limiters

Protect the input circuits of spectrum analyzers, counters, amplifiers, and other instruments from high power levels with minimal effect on measurement performance. The HP 11867A RF limiter (dc to 1.8 GHz) reflects signals up to 10 W average power and 100 W peak power. Insertion loss is less than 0.75 dB. The HP 11693A microwave limiter (100 MHz to 12.4 GHz, usable to 18 GHz) guards against input signals over 1 mW up to 1 W average power and 10 W peak power.

HP 11694A 75 Ω Matching Transformer

From 3 to 500 MHz, this transformer allows measurements in 75 Ω systems while retaining amplitude calibration with a 50 Ω spectrum analyzer input. VSWRs are less than 1.2; insertion loss is less than 0.75 dB.

HP 86205A and 86207A RF Bridges

These bridges combine the directivity and broadband frequency range of directional bridges with the low insertion loss and flat coupling factor of directional couplers. Directivity is 40 dB, and the wide RF frequency ranges are 300 kHz to 6 GHz for the 50 Ω HP 86205A and 300 kHz to 3 GHz for the 75 Ω HP 86207A. Low insertion loss is nominally ± 1.5 dB. Frequency response of the coupled arm is within ± 0.2 dB of the nominal 16 dB value. The RF bridges are ideal for use with spectrum analyzers, scalar network analyzers, and vector network analyzers.

HP 41800A Active Probe

This probe offers high-input impedance from 5 Hz to 500 MHz. It works with many HP spectrum analyzers to evaluate the quality of circuits by measuring spurious level, harmonics, and noise. Low-input capacitance offers probing with negligible circuit loading for precise, in-circuit measurements of audio, video, HF, and VHF bands.

HP 85024A High-Frequency Probe

In-circuit measurements are easy with this 300 kHz to 3 GHz probe. Input capacitance of 0.7 pF shunted by 1 MΩ resistance permits high-frequency probing without adverse loading of the circuit under test. Excellent frequency response and unity gain guarantee highly-accurate swept measurements. High sensitivity and low distortion levels allow measurements that take advantage of full analyzer dynamic range. See page 276.

Ordering Information

HP 85902A Burst Signal Trigger
HP 85671A Phase Noise Measurement Utility
HP 85672A Spurious Response Measurements Utility
HP 85640A Portable Tracking Generator
HP 8444A Opt 059 Tracking Generator
HP 8447A Preamplifier (100 kHz to 400 MHz)
HP 8447D Preamplifier (100 kHz to 1.3 GHz)
HP 8447F Preamplifier-Power Amplifier (100 kHz to 1.3 GHz)
HP 8449B Preamplifier
HP 87405A Preamplifier
HP 85901A Portable AC Power Source
HP 11867A RF Limiter
HP 11693A Microwave Limiter
HP 41800A Active Probe
HP 11694A 75 Ω Matching Transformer
HP 85024A High-Frequency Probe
HP 86205A RF Bridge (50 Ω)
HP 86207A RF Bridge (75 Ω)

Vector Signal Analyzers, DC to 10 MHz, and DC to 2.65 GHz

HP 89410A
HP 89441A
HP 89411A
HP 89450A
HP 89451A

- Advanced, optimized time-gated spectrum analysis
- Digital modulation analysis (optional)
- Adaptive equalization for digital video, comms (optional)
- Precision digital AM, FM, PM demodulation
- Flexible internal RF signal source (optional)
- Narrowband spectrum speed to 60 updates/s
- Simultaneous time and frequency measurement
- 1 MSample time capture with postprocessing (optional)
- High-resolution, high-accuracy time domain
- Second 10 MHz input channel (optional)

HP 89441A DC to 2.65 GHz Vector Signal Analyzer

HP 89410A DC to 10 MHz Vector Signal Analyzer

HP 89400 Series Vector Signal Analyzers

Advanced Measurements on Complex Signals

Hewlett-Packard's Vector Signal Analyzers integrate frequency-domain and time-domain analysis to provide the most advanced measurements of complex and time-varying signals. Using state-of-the-art digitizing and signal processing technology, these analyzers offer complex signal analysis, such as digital modulation analysis and AM/FM/PM demodulation, vector spectrum analysis, and time-gated spectrum analysis. Simultaneous time-domain and frequency-domain measurements and displays improve productivity and enhance ease of use.

Complex and time-varying signals include burst, pulsed, transient, hopping, analog-modulated and digital-modulated signals. Signals such as these are common in RF communications, video broadcast, satellite, radar, sonar, and ultrasound imaging systems and must be characterized in the design, manufacture, and monitoring of these systems. Vector signal analyzers are ideally suited to making the needed power, frequency, and modulation measurements on these complex signals.

The HP 89410A covers baseband frequencies from dc to 10 MHz with one or two full-bandwidth input channels. The HP 89441A covers baseband through RF frequencies of dc to 2.65 GHz, with a single RF input and an (optional) dc to 10 MHz second baseband channel.

These analyzers provide unprecedented speed and power. Complex time and spectrum measurements are made and displayed up to 60 times each second. Deep time-capture RAM is available with flexible postprocessing in time and frequency domains. A variety of display types are available, including log frequency, polar, and (optionally) eye and constellation diagrams.

Digital Modulation Analysis

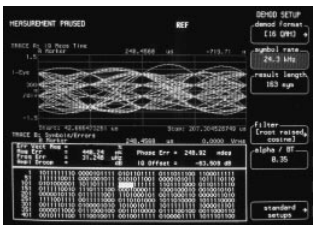
A vector signal analyzer with optional vector modulation analysis provides all the tools necessary to test throughout a system block diagram and to measure the quality of digitally modulated signals. Measurements are easy since no external filters, coherent carriers, or symbol timing signals are required.

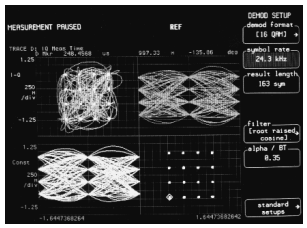
Measurements are made on baseband, IF, or RF signals with a selection of modulation formats, variable number of symbols, and a variety of filters shapes. A wide range of display formats is available including constellation, eye, or vector diagrams, in addition to numerous error and other signal quality analysis results.

Adjacent channel power, occupied bandwidth, and modulation accuracy are among the measurements that can be made with the ease of "one-button" setups using the HP 89451A Radio Test Personality. The measurements can be made on burst or continuous signals of NADC, CDMA, PDC, PHS, or user-defined systems.

In ATV/HDTV applications, designers of components and systems can speed design and troubleshooting with precise analysis of modulated signal quality. Option AYH characterizes both QAM and VSB modulated signals, showing results with eye, constellation, and other traditional displays. Advanced error magnitude measurements provide quantitative results and the new adaptive equalization capability allows measurements to be made on impaired channels.

Refer to page 486 for more information on RF communications applications and to page 518 for video applications.





Precision AM, FM, and PM Demodulation

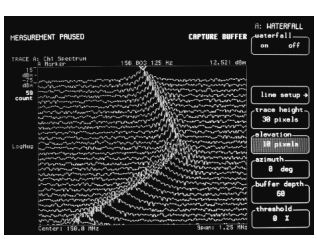
Precision, high-resolution digitized time-series data allows for advanced signal analysis, such as AM, FM, and PM demodulation. Signals can be analyzed for instantaneous amplitude, frequency, or phase versus time, and the resulting time-domain results can be translated into the frequency domain for further analysis. This is useful for characterizing phenomena such as phase noise, oscillator frequency transitions, and the amplitude or frequency behavior of transmitters at turn-on. Both deliberate and unintentional (or incidental) modulation can be characterized completely. Demodulation is selective, so that the type of modulation can be uniquely determined and separated from other types. FM and PM demodulation are made easier with an auto-carrier function.

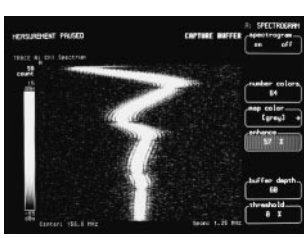
High-Speed, Narrow-Resolution Vector Spectrum

Using high-speed signal processing, these analyzers can measure both the magnitude and phase (in the frequency domain) of CW and nonstationary or burst signals. Multiple-signal processors and microprocessors display signal and circuit behavior in real time, and produce fast averaged measurements with enhanced signal-to-noise ratio.

High-measurement speed is preserved even in narrowband measurements, with display updates orders of magnitude faster than traditional analyzers performing equivalent measurements. Resolution is also better, with resolution bandwidths less than 0.001 Hz over the entire frequency range.

Optional waterfall and spectrogram display formats take full advantage of the high-measurement and display-update speed. Waterfalls display up to 300 successive spectra and scroll them through the display, while spectrograms use colors to indicate signal amplitudes. Both formats make it easy to monitor signal trends of short or long duration.





High-Resolution, High-Dynamic Range Time Domain

All measurements are made with a state-of-the-art A/D subsystem and proprietary signal processing. All frequency spans are image and alias protected, offering band-limited time-domain analysis not available in traditional oscilloscopes and waveform analyzers.

These products feature a deep-data memory of up to one million samples (optional). This memory can be used for long duration time capture, where the time-capture data can be selectively postprocessed (internally) or transferred via HP-IB to an external computer for further analysis.

Advanced Time-Selective Spectrum Analysis

For burst or time-varying signals, it may be necessary to examine only a selected part of the waveform. Time-selective spectrum analysis in the HP 89400 series vector signal analyzers allows the entire time-domain signal to be viewed and a specific portion selected for frequency-domain analysis. The selected data is identified clearly with gate markers and all of its traditional frequency-domain parameters (including noise or signal/noise) can then be measured. In addition, this time-selective analysis does not require a repetitive signal.

Powerful, Flexible Triggering

These vector signal analyzers have extremely flexible triggering to make the most of their time-selective analysis and demodulation features. Measurements can be triggered from the analyzer's own signal source, an external source, HP-IB, an input channel (HP 89410A), or the analyzer's own band-limited IF. The IF trigger allows the analyzer to establish a trigger from a selected frequency band of the input signal, ensuring that the trigger event can always be seen. Both analyzers also provide pre-trigger and post-trigger delays, along with manual, external, or automatic arming with programmable delay.

Advanced Data Analysis

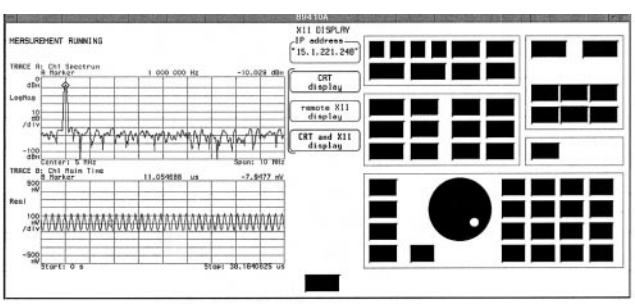
The high-resolution time-domain data of the HP 89400 analyzers allows for advanced data analysis functions. The built-in math functions can be used for scalar arithmetic and complex operations. Other advanced analysis capabilities include correlation functions, such as auto-correlation. This statistical function compares a signal with a delayed version of itself, useful in uncovering hidden periodic signals and analyzing multipath or other signal delays.

Measurement Automation and Convenience Features

Optional HP Instrument BASIC (a subset of HP BASIC) runs inside the analyzers to make repetitive measurements, to create custom displays and test sequences, and even to control other instruments in a test system. Automatic program generation is available with the "keystroke recording" feature, which creates complete executable programs by remembering keys pressed during an actual measurement.

LAN Access and Virtual Front Panel

For remote control from across the building or across the world, Option UFG allows direct transfer of instrument commands and measurement results to a LAN-equipped PC or workstation. Option UG7 adds access to instrument memory and file storage via FTP, along with an X-Windows-based "virtual front panel." This display, which can be sent to an X-compatible server anywhere on your network, shows not only the measurement display but also the complete instrument front panel. Press keys with your mouse or pointing device, and operate the analyzer just as if it were in front of you.



HP 89410A Baseband Vector Signal Analyzer

The HP 89410A covers a frequency range of dc to 10 MHz and offers an optional second channel. The second channel makes it possible to measure frequency response or perform vector network analysis, and the built-in math functions facilitate measurement calibration and correction.

Two-channel statistical measurements such as cross-correlation and coherence can also be made. Cross-correlation is similar to auto-correlation, but instead of comparing a signal with itself to see time delays or repetitions, one signal is compared with another. If the same repetitive signal is present in both waveforms, it will be discovered in the cross-correlation measurement. This technique is also useful in analyzing multipath distortions.

Coherence is a measure of the power in the output signal related to the power in the input. It is useful for troubleshooting noise or signal propagation through a circuit or system. Coherence is also a good indication of the quality of a network measurement in a noisy environment.

Flexible Source

The HP 89410A provides a flexible source for circuit stimulation. Sine waves, periodic chirps (sine-wave sweeps), and pseudo-random noise are available, along with user-definable arbitrary waveforms. The arbitrary waveforms operate on a block of up to 16,384 complex points.

Any of these signals can be used as a stimulus while spectrum measurements are made elsewhere in the circuit. Source level and dc offset of the pattern are all controllable by the user.

HP 89441A RF Vector Signal Analyzers

The HP 89441A covers baseband through RF frequencies of dc to 2.65 GHz, in scalar and vector analysis modes. The scalar RF instrument mode allows full-frequency coverage in spans to 2648 MHz in the HP 89441A. Vector RF mode offers exceptional speed and additional signal processing for enhanced time-domain characterization and demodulation. Vector spans as wide as 7 MHz (8 MHz with Option AYH) can be selected anywhere in 2.65 GHz frequency range. A vector baseband mode is also available to provide all of the features and functionality of the HP 89410A.

In vector RF mode, both phase and amplitude characteristics are captured in the time-series data. This information can be processed for narrow-resolution spectrum analysis, AM/FM/PM demodulation, time-selective analysis, vector modulation analysis (optional), and many other types of measurements.

Statistical Peak/Average Power Measurements

Precision statistical measurements of peak, average, and peak-to-average power can now be made automatically. A time domain marker function simplifies measurements by allowing direct entry of the peak percentage and quickly accumulating thousands of measurement samples.

Accurately setting signal levels is simplified by taking advantage of the analyzer's ability to recalculate results using different peak percentages without taking new data. It is even possible to simultaneously display multiple power parameters based on a single block of measured data.

This new capability is now standard with all 89400 Series Vector Signal Analyzers.

Adaptive Equalization Option AYJ

Adaptive equalization removes linear errors from I-Q modulated signals by dynamically creating and applying a compensating filter. These errors include group delay distortion, frequency response errors (tilt, ripple), and reflections or multipath distortion. Equalization allows designers to evaluate a transmitter in the same way a receiver, equipped with adaptive equalization, will see it.

Equalization allows measurement of some impaired channels and can be used to isolate linear vs. non-linear error mechanisms. This general purpose equalizer does not require symbol lock or prior knowledge of the signal (such as a training sequence). Added measurement data types include the derived channel frequency response and the impulse (time domain) response of the compensating filter.

HP 89410A
HP 89441A
HP 89411A
HP 89450A
HP 89451A

RF Signal Source

In vector RF mode, the HP 89441A offers an optional flexible source with up to 7 MHz bandwidth, settable to any frequency in the 2.65 GHz frequency range. As with the HP 89410A, sine waves, periodic chirps (sine-wave sweeps), and pseudo-random noise are available, along with user-definable arbitrary waveforms.

Microwave Measurements with Downconverter

The HP 89411A IF downconverter works with the HP 89410A to provide narrowband vector signal analysis at RF and microwave frequencies. The HP 89411A converts a 21.4 MHz IF output from an external receiver to the input frequency range of the HP 89410A. This downconverter is also compatible with the HP 89441A.

This downconverter is designed for use with various HP microwave spectrum analyzers and other devices with compatible 21.4 MHz IF outputs. Frequency coverage is thus available over the complete frequency range of the microwave receiver or analyzer.

Specifications Summary

Refer to the HP 89410A/89441A/89411A technical data sheets for full specifications. The following specifications apply from 0° to 55° C.

	HP 89410A	HP 89441A
Frequency		
Frequency range	dc to 10 MHz	2 MHz to 2650 MHz
Frequency span		
Scalar mode	1.0 Hz to 10 MHz	1.0 Hz to 2648 MHz
Vector mode	1.0 Hz to 10 MHz	1.0 Hz to 7 MHz (8 MHz with Option AYH)
Center frequency tuning resolution	0.001 Hz	0.001 Hz
Accuracy-initial	± 10 ppm (± 0.2 ppm optional)	± 0.1 ppm
Resolution bandwidth	312.5 µHz to 3 MHz (1, 3, 10 sequence or arbitrary)	312.5 µHz to 3 MHz (1, 3, 10 sequence or arbitrary)
Phase noise	(at center frequency = 10 MHz)	1000 MHz ≤ center frequency ≤ 2650 MHz
100 Hz offset	–106 dBc/Hz	–87 dBc/Hz
1 kHz offset	–110 dBc/Hz	–97 dBc/Hz
10 kHz offset	–120 dBc/Hz	–116 dBc/Hz (–124 dBc/Hz typ.)
100 kHz offset	–120 dBc/Hz	–116 dBc/Hz
Amplitude		
Input range		
50 Ω –30 dBm to +24 dBm	–50 dBm to +25 dBm	—
75 Ω –31.7 dBm to +22.2 dBm	—	—
1 M Ω (referenced to 50 Ω)	–30 dBm to +24 dBm	—
Accuracy–absolute full-scale	± 0.5 dB	± 2.0 dB (±0.5 dB typical)
Accuracy–amplitude linearity		—
0 to –30 dBfs	—	< 0.10 dB
–30 to –50 dBfs	—	< 0.15 dB
–50 to –70 dBfs	—	< 0.20 dB
Input noise density (50 Ω)	–114 dBfs/Hz	–112 dBfs/Hz
Sensitivity (lowest range, 50 Ω)	–144 dBm/Hz	–159 dBm/Hz
Spurious responses		
General spurious	≤ –.75 dBfs (≥1 MHz)	< –70 dBc
Second harmonic distortion	< –75 dBc (–80 dBc typical)	< –75 dBc
Intermodulation (third order relative to two tones at –6 dBfs)	≤ –75 dBc (–85 dBc typical)	< –75 dBc
Residual responses	< –75 dBfs (<1 MHz) –80 dBfs (≥1 MHz)	< –80 dBfs —
Analog demodulation		
Maximum bandwidth (typical)	10 MHz	7 MHz
Demodulation accuracy		
–AM	± 1% (typical)	± 1% (typical)
–PM	± 3 degrees (typical)	± 3 degrees (typical)
–FM	± 1% of span (typical)	± 1% of span (typical)
Trigger		
Scalar mode HP-IB, external	Free run, input channel, internal source,	Free run, HP-IB, internal source, external
Vector mode	Free run, input channel, IF channel, internal source, HP-IB, external	Free run, IF channel, internal source, HP-IB, external
Input		
Coupling	dc/ac	ac
Source		
Scalar mode	Fixed sine, arbitrary	—
Vector mode	Fixed sine, random noise, periodic chirp, arbitrary	Fixed sine, random noise, periodic chirp, arbitrary
Arbitrary source	Up to 16,384–32,768-real/complex points, depending on span	Up to 16,384–32,768-real/complex points, depending on span
Source level (fixed sine)	–110 dBm to +23.9 dBm	–40 dBm to +13 dBm

Note: specifications apply with the RF receiver selected. All HP 89410A specifications also apply for dc to 10 MHz measurements.

HP 89410A
HP 89441A
HP 89411A
HP 89450A
HP 89451A

Combined HP 89410A/89441A Specifications

Two Channel
Note: Requires second 10 MHz input channel (Option AY7)
Channel Match: (dc to 10 MHz): ± 0.25 dB, ± 2.0˚
Real-Time Bandwidth
Single-Channel Vector Mode Real-Time Bandwidth: 78.125 kHz (with frequency spans of 107/2 n Hz, arbitrary auto-coupled resolution bandwidth, markers off, averaging off, one displayed trace with calculations off on other traces, log-magnitude spectrum measure-ment, 1601 frequency points, channel 2 off)
Measurement Speed
Vector Mode Maximum Display Update Rate: 60 traces/second
Averaging
Scalar Mode: rms (video), rms (video) exponential, peak hold
Vector Mode: rms (video), rms (video) exponential, time, time exponential, peak hold
Number of Averages: 1 to 99,999
Time-Gating
Minimum Gate Length: < 400 ns (dependent on span and RBW window selected)
Time-Capture
Time-Capture Memory: 64 K sample (1 M sample with Option AY9)
Trace Math
Operands: Measurement data, data register, constant, other trace math functions, jv
Operations: +, –, x, ÷, cross correlation, conjugate, magnitude, phase, real, imaginary, square root, FFT, inverse FFT, natural logarithm, exponential
Marker Functions: Peak signal track, frequency counter, bandpower
Interfaces: Active probe power, sync output, external reference input/output, HP-IB, RS-232, Centronix, external multi-sync monitor (A second HP-IB and LAN interface are available with Option UFG)
Memory and Data Storage: Nonvolatile RAM disk (100 KB), volatile RAM disk (1 MB), internal 3.5-inch flexible disk (1.44 MB LIF or DOS format), external disk (HP-IB interface)
Standard Instrument Includes: Manuals, Standard Data Format Utilities (LIF to DOS conversions, SDF conversions, data and instrument state display, PC-MATLAB and MATRIXx conversions)
Vector Modulation Analysis (Option AYA)
Continuous or TDMA Formats: BPSK, QPSK, Offset QPSK, DQPSK, π/4 DQPSK, 8PSK, 16QAM, 32QAM, MSK, 2 and 4 level FSK
Digital Video Formats (Option AYH): 64-256QAM, 8-16VSB
Data Block Lengths: Adjustable up to 4096 symbols with Option UFG (2048 symbols max. with Offset QPSK demodulation)
User Selection of Filters: Raised cosine, root-raised cosine, IS-95 base phase eq., IS-95 Chebyshev, Gaussian, low pass, user-defined
Adjustable Alpha (BT): 0.05 to 100
Trace and Table Formats: Constellation, vector diagram, eye diagrams, trellis diagrams, continuous I or Q vs. time, continuous error vector magnitude vs. time, modulation quality summary, detected symbol table
Analysis Types: Error vector magnitude, phase error, magnitude error, amplitude droop, carrier frequency error, IQ offset, error vector spectrum, measured IQ spectrum, channel frequency response, impulse response of equalizer filter
One-Button Measurements (HP 89451A): Adjacent and alternate channel power, occupied bandwidth, modulation accuracy, power due to modulation (or full signal)

General Specifications

Environmental
Calibration Interval: 1 year
Warmup Time: 30 minutes
Temperature: 0˚ to 55˚ C (operating), –20˚ to 65˚ C (not operating)
Power Requirements
115 Vac Operation: 90 to 140 V rms, 47 to 440 Hz (47 to 63 Hz for HP 89441A)
230 Vac Operation: 198 to 264 V rms, 47 to 63 Hz
Maximum Power Dissipation: 750 VA (HP 89410A), 1025 VA (HP 89441A)
Audible Noise: LpA ≤ 50 dB (HP 89410A), ≤ 55 dB (HP 89441A) typical at 25˚ C
Physical
HP 89410A:
Size: 426 mm W x 230 mm H x 530 mm D (16.7 in x 9.1 in x 20.9 in)
Weight: 25 kg (55 lb)
HP 89441A IF section:
Size: 426 mm W x 230 mm H x 530 mm D (16.7 in x 9.1 in x 20.9 in)
Weight: 25 kg (55 lb)
HP 89441A RF section:
Size: 419 mm W x 173 mm H x 495 mm D (16.5 in x 6.8 in x 19.5 in)
Weight: 25 kg (55 lb)

HP 89411A 21.4 MHz Downconverter Specifications

Bandwidth
With HP 8566A/B: Approx. 3 MHz
With HP 70902A/70903A: Approx. 8 MHz
Power Requirements
115 Vac Operation: 90 to 132 V rms, 47 to 440 Hz
230 Vac Operation: 198 to 264 V rms, 47 to 63 Hz
Maximum Power Dissipation: 100 VA
Physical
Weight: 11.1 kg (25 lb)
Size: 426 mm W x 90 mm H x 520 mm D (16.7 in x 3.5 in x 20.5 in)

The HP 89400 series vector signal analyzers were designed with expandability in mind and the ability to keep up with customers' growing measurement needs. As performance is improved and features added, firmware upgrades are simple using the analyzer's internal disk drive.
Recent new features include:

- Offset QPSK demodulation and CDMA filters added to Option AYA
- Adaptive equalization added to Option AYH
- Adaptive equalization also available by adding Option AYJ to Option AYA
- 8 MHz information bandwidth for HP 89441A via Option AYH
- Peak-to-average power measurements
- Arb waveform block length expanded 4X to 16,384 complex points
- DC offset can be removed in the DC-coupled Ch1 + jCh2 mode

Key Literature

A videotaped demonstration, several Product Notes, and Technical Datasheets are available for the HP 89400 series vector signal analyzers. To receive a current literature index and order form via e-mail, send a message containing the single word "HP 89400" to: *lit_index@lsid.hp.com* or contact your local sales office (listed on page 591).

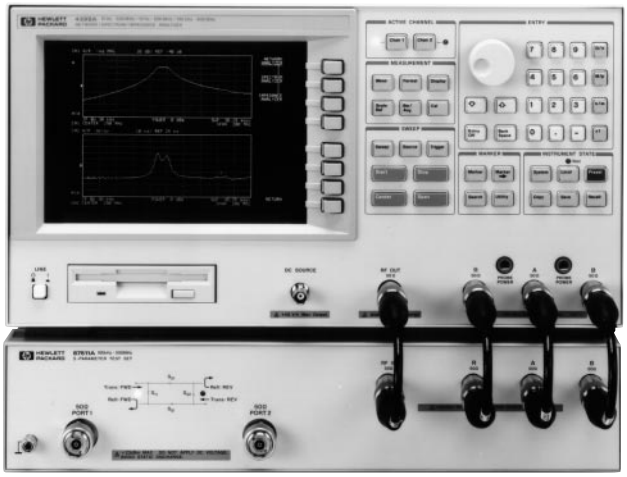
Ordering Information

HP 89410A DC to 10 MHz Vector Signal Analyzer
HP 89441A DC to 2.65 GHz Vector Signal Analyzer
Opt AY4 Delete High-Precision Frequency Reference (HP 89441A only)
Opt AY5 Precision Frequency Reference (HP 89410A only)
Opt AY7 Second 10 MHz Input Channel
Opt AY8 Internal RF Source (HP 89441A only)
Opt AY9 Extend Time Capture to 1 Msample
Opt AYA Vector Modulation Analysis
Opt AYB Waterfall and Spectrogram
Opt AYH Digital Video Modulation Analysis
Opt AYJ Adaptive Equalization
Opt UFG 4-MB Extended RAM and Additional I/O
Opt UG7 Advanced LAN Support
Opt 1C2 HP Instrument BASIC
Opt 1D7 50 to 75 Ω Minimum Loss Pad (HP 89441A only)
Opt 1F0 PC-Style Keyboard–U.S. Version (other options available for German, Spanish, French, U.K., Italian, and Swedish)
HP 89450A DMCA Radio Test Application Personality
HP 89451A Radio Test Personality
HP 89411A 21.4 MHz Downconverter
HP 89431A 2.65 GHz RF section (converts 89410A to 89441A)
HP 89400A +24C User Training (scheduled)
HP 89400A +24Y User Training (dedicated)

Baseband, IF Network/Spectrum/Impedance Analyzer, 10 Hz to 500 MHz/10 Hz to 500 MHz/100 kHz to 500 MHz

HP 4395A

- Full-vector network and spectrum measurement and analysis
- Wide dynamic range network measurement with fast sweep speeds
- ±0.05 dB /±0.3° dynamic magnitude/phase accuracy
- Extremely fast narrowband spectrum measurement
- Impedance analysis option and test kit available
- –145 dBm/Hz sensitivity for spectrum analysis
- Built-in HP Instrument BASIC for easy test automation
- Time-gated spectrum analysis option
- Color TFT display and built-in disk drive/RAM disk



HP 4395A

HP 4395A Network/Spectrum/Impedance Analyzer

The HP 4395A provides excellent vector network, spectrum and optional impedance measurements for audio, baseband, HF, VHF, and IF applications. Gain, phase, group delay, distortion, spurious, CN ratio, and noise measurements often required for evaluating components and circuits can be measured using one instrument. When combined with a test set, the HP 4395A provides reflection measurements, such as return loss, and SWR, and S parameters. As a vector network analyzer, the HP 4395A operates from 10 Hz to 500 MHz with 1 mHz resolution and its integrated synthesized source provides –50 to +15 dBm of output power with 0.1 dB resolution. The dynamic magnitude and phase accuracy are ±0.05 dB and ±0.3° so that it can accurately measure gain and group delay flatness, which are becoming more important in modern electronics systems.

As a spectrum analyzer, the HP 4395A operates from 10 Hz to 500 MHz with resolution bandwidths (RBWs) spanning 1 Hz to 1 MHz in a 1-3-10 steps. A fully-synthesized local oscillator allows stable and accurate frequency analysis. Direct A/D conversion (no LOG amplifier is used) results in ±0.8 dB level accuracy (@50 MHz –20 dBm). Noise sidebands fall below –110 dBc/Hz @ 100 kHz offset from carriers, while sensitivity is –145 dBm/Hz at 10 MHz.

Extremely Fast Spectrum Measurement

The HP 4395A features Fast Fourier Transform (FFT) digital-signal-processing (DSP) technique for 20 to 100 times faster narrowband spectrum measurement than swept-tuned spectrum analyzers. The stepped FFT is performed for all RBW settings. For example, with 100 Hz RBW and 100 kHz span, the HP 4395A has a sweep time of 300 ms, while swept-tuned spectrum analyzers take a few tens of seconds. The stepped FFT can greatly improve the efficiency of narrowband spectrum measurement.

Impedance Measurement Function and RF Impedance Test Kit

A full-featured impedance measurement function (useful for quick-check general-purpose impedance applications) can be added to the HP 4395A by adding Option 010 and the HP 43961A RF impedance test kit. Covering from 100 kHz to 500 MHz, impedance parameters |Z|, θ, C, L, Q, D, and more, are directly measured and displayed on the TFT color display. The basic impedance measurement accuracy is 3%. An APC-7® connector is mounted on this kit for easy connection to an appropriate impedance test fixture. A wide variety of HP fixtures can be used with this test kit, including the surface-mount-device (SMD) fixtures used with the HP 4291A RF impedance/material analyzer. The Option 001 DC source is useful in applying DC voltage to the device up to 40 V.

HP 4395A Specifications Summary

Network Measurement

Frequency Characteristics
Range: 10 Hz to 500 MHz
Resolution: 1 mHz
Accuracy: < ±5.5 ppm (Option 1D5: < ±0.13 ppm)

Output Characteristics
Power Range: –50 to +15 dBm
Resolution: 0.1 dB
Level Accuracy: ±1.0 dB @ 0 dBm, 50 MHz

Receiver Characteristics
Frequency Range: 10 Hz to 500 MHz
Noise Level (referenced to full scale input level, 23 ±5° C):
–85 dB (typical) @ 10 Hz ≤ f <100 Hz, IFBW=2 Hz
–85 dB @ 100 Hz ≤ f <100 kHz, IFBW=10 Hz
(–115 + f/100 MHz) dB @ 100 kHz ≤ f, IFBW=10 Hz

IF Bandwidth (Hz)**:** 2, 10, 30, 100, 300, 1k, 3k, 10k, 30k

Dynamic Accuracy

Input Level (relative to full scale input level –10 dB)	Dynamic Accuracy Frequency ≥100 Hz
Magnitude Dynamic Accuracy	
0 dB ≥ input level ≥ –10 dB	±0.4 dB
–10 dB > input level ≥ –60 dB	±0.05 dB
–60 dB > input level ≥ –80 dB	±0.3 dB
–80 dB > input level ≥ –100dB	±3 dB
Phase Dynamic Accuracy	
0 dB ≥ input level ≥ –10 dB	±3°
–10 dB > input level –60 dB	±0.3°
–60 dB > input level –80 dB	±1.8°
–80 dB > input level –100dB	±18°

@ R port input level=full scale input level –10 dB, IFBW=10 Hz, 23 ±5° C

Spectrum Measurement

Frequency Characteristics
Frequency Range: 10 Hz to 500 MHz

Frequency Reference
Accuracy: < ±5.5 ppm (Option 1D5: < ±0.13 ppm)
Resolution Bandwidth (RBW)
Range: 1 Hz to 1 MHz, 1-3-10 step @ span >0
3k, 5k, 10k, 20k, 40k, 100k, 200k, 400k, 800k, 1.5 M, 3 M, 5 MHz @ span=0
Selectivity (60 dB/3 dB)**:** <3 @ span >0

Noise Sidebands
Offset
1 kHz –97 dBc/Hz
10 kHz –97 dBc/Hz
100 kHz –110 dBc/Hz
1 MHz –110 dBc/Hz

Displayed Average Noise Level
Frequency
1 kHz ≤ f < 100 kHz –120 dBm/Hz
100 kHz ≤ f < 10 MHz –133 dBm/Hz
10 MHz ≤ f (–145 + f/100 MHz) dBm/Hz

Spurious Response
Second Harmonic Distortion: –70 dBc @ –16 dB full scale
Third-Order Intermodulation Distortion: –70 dBc @ –16 dB full scale
Other Spurious: –70 dBc @ –16 dBc full scale

Scale Fidelity
±0.05 dB @ 0 to –30 dB from full scale input level –10 dB

Impedance Measurement (Option 010)

Measurement Parameters: |Z|, θz, |Y|, θy, R, X, G, B, Cp, Cs, Lp, Ls, Rp, Rs, D, Q, |Γ|, θγ, Γx, Γy
Frequency Range: 100 kHz to 500 MHz
Measurement Port: APC-7 on the HP 43961A Test Kit
Source Level at Measurement Port: –56 to +9 dBm @ 50 Ω
Calibration: OPEN/SHORT/LOAD calibration,
OPEN/SHORT/LOAD compensation on test fixtures, port extension
Accuracy (Supplemental Performance Characteristics)**:**
± 3% basic accuracy @ 23 ±5° C, after OPEN/SHORT/LOAD calibration

General Characteristics

Full Scale Input Level

Attenuator setting (dB)	Full Scale Input Level Network	Spectrum
0	–10 dBm	–20 dBm
10	0 dBm	–10 dBm
20	+10 dBm	0 dBm
30	+20 dBm	+10 dBm
40	+30 dBm	+20 dBm
50	+30 dBm	+30 dBm

Option 001 DC Voltage/Current Source
Voltage Range: –40 V to + 40 V
Current Range: –20 MA to –100 mA, 20 MA to 100 mA
Operating Temperature/Humidity
Disk Drive Non-Operating Condition: 0° to 40° C, 15% to 95% RH
Disk Drive Operating Condition: 10° to 40° C, 15% to 80% RH
Storage Temperature/Humidity: –20° to 60° C, 15% to 95% RH
Power Requirement: 100/120/220/240 V ±10%, 47 to 66 Hz, 300 VA max.
Weight: 21 kg (typical)
Size: 425 mm W x 235 mm H x 553 mm D

Key Literature

HP 4395A/96B Awareness Brochure, p/n 5965-9374E
HP 4395A Technical Data (Spec Sheet), p/n 5965-9340E

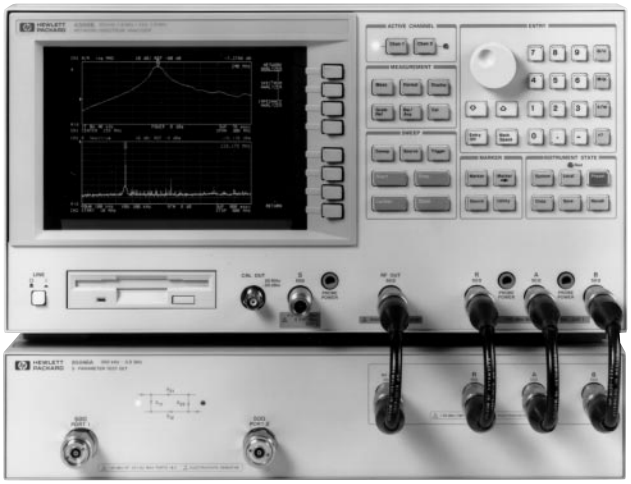
Ordering Information

HP 4395A Network/Spectrum/Impedance Analyzer
Opt 001 Add DC Source
Opt 010 Add Impedance Measurement Function
(Requires HP 43961A)
Opt 1A2 Delete Keyboard
Opt 1D5 Add High Stability Frequency Reference
Opt 1D6 Add Time-Gated Spectrum Analysis
Opt 1D7 50 Ω to 75 Ω Minimum Loss Pad
HP 87511A 50 Ω S-Parameter Test Sets
HP 87511B 75 Ω S-Parameter Test Sets
HP 87512A 50 Ω Transmission/Reflection Test Kits
HP 87512B 75 Ω Transmission/Reflection Test Kits
HP 43961B RF Impedance Test Kit (add test fixture listed below)
HP 16191A Side Electrode SMD Test Fixture
HP 16192A Parallel Electrode SMD Test Fixture
HP 16193A Small Side Electrode SMD Test Fixture
HP 16092A Spring Clip Test Fixture

RF Network/Spectrum/Impedance Analyzer, 100 kHz to 1.8 GHz/2 Hz to 1.8 GHz/100 kHz to 1.8 GHz

HP 4396B

- Full-vector network and spectrum measurement and analysis
- Wide dynamic range network measurement with fast sweep speeds
- ±0.05 dB/±0.3˚ C dynamic magnitude/phase accuracy
- Extremely fast narrowband spectrum measurement
- Impedance analysis option and test kit available
- ±1.0 dB level accuracy for spectrum analysis
- –150 dBm/Hz sensitivity for spectrum analysis
- Built-in HP Instrument BASIC for easy test automation
- Time-gated spectrum analysis option
- Color TFT display and built-in disk drive/RAM disk



HP 4396B with HP 85046A

4

HP 4396B RF Network/Spectrum Impedance Analyzer

The HP 4396B provides excellent RF vector network, spectrum, and optional impedance measurements for lab and production applications. Gain, phase, group delay, distortion, spurious, CN, and noise measurements often required for evaluating components and circuits can be measured using one instrument. When combined with a test set, the HP 4396B provides reflection measurements, such as return loss, and SWR, and S parameters. As a vector network analyzer, the HP 4396B operates from 100 kHz to 1.8 GHz with 1 mHz resolution and its integrated synthesized source provides –60 to +20 dBm of output power with 0.1 dB resolution. The dynamic magnitude and phase accuracy are ±0.05 dB and ±0.3˚ so that it can accurately measure gain and group delay flatness, which are becoming more important in modern electronics systems.

As a spectrum analyzer, the HP 4396B operates from 2 Hz to 1.8 GHz with resolution bandwidths (RBWs) spanning 1 Hz to 3 MHz in a 1-3-10 sequence. A fully-synthesized local oscillator allows stable and accurate frequency analysis. Direct A/D conversion (no LOG amplifier is used) results in ±1.0 dB overall level accuracy. Noise sidebands fall below –105 dBc/Hz offset 10 kHz from carriers below 1 GHz, while sensitivity is –150 dBm/Hz at 10 MHz and –147 dBm/Hz at 1 GHz. In addition, with two independent display channels available, you can simultaneously view network and spectrum (or transmission and reflection) characteristics of the device under test in split-screen format. For example, an amplifier's frequency response (network measurement) and distortion (spectrum measurement) can be shown at the same time.

Extremely Fast Spectrum Measurement

The HP 4396B features a stepped Fast Fourier Transform (FFT) digital-signal-processing (DSP) technique for 20 to 100 times faster narrowband spectrum measurement than swept-tuned spectrum analyzers. The stepped FFT is performed when the resolution bandwidth (RBW) is set at 3 kHz or below. For example, with a 30 Hz RBW and 10 kHz span, the HP 4396B has a sweep time of 400 ms, while swept-tuned spectrum analyzers take a few tens of seconds. The stepped FFT can greatly improve the efficiency of narrowband spectrum measurement such as frequency tuning of a VCO or CN measurements.

Time-Gated Spectrum Analysis

With Option 1D6, the HP 4396B offers time-gated spectrum analysis capability to capture and measure repetitive burst signals in video, disk drives, communication equipment, and more. The minimum gate length is 2μ sec so that even narrow-burst signals can be analyzed.

Impedance Measurement Function and RF Impedance Test Kit

A full-featured impedance measurement function (useful for quick-check general-purpose impedance applications) can be added to the HP 4396B by adding Option 010 and the HP 43961A RF impedance test kit. Covering from 100 kHz to 1.8 GHz, impedance parameters |Z|, θ, C, L, Q, D, and more, are directly measured and displayed. The basic impedance accuracy (typical value) is 3%. The HP 43961A RF impedance test kit is designed for the HP 4396B and is required to utilize the features of Option 010. An APC-7® connector is mounted on this kit for easy connection to an appropriate impedance test figure. A wide variety of HP fixtures can be used with the test kit, including the new surface-mount-device (SMD) fixtures used with the new HP 4291A RF impedance/material analyzer. For higher accuracy, complete impedance analysis over the widest impedance ranges, and temperature effects evaluation, the HP 4291A impedance/material analyzer is recommended. See page 344–345.

HP 4396B Specifications Summary

Network Measurement

Frequency Characteristics
Range: 100 kHz to 1.8 GHz
Resolution: 1 mHz
Accuracy: <±5.5 ppm (Option 1D5: <±0.13 ppm)

Output Characteristics
Power Range: –60 to +20 dBm
Resolution: 0.1 dB
Level Accuracy: ±0.5 dB

Receiver Characteristics
Frequency Range: 100 kHz to 1.8 GHz
Noise Level (10 Hz IFBW, ≥10 MHz, f=frequency in GHz):
< (–125+3 x f) dBm (A, B inputs);
< (–100+3 x f) dBm (R input)
Full Scale Input Level: –5 dBm (A, B), +20 dBm (R)
IF Bandwidth (Hz): 10, 30, 100, 300, 1k, 3k, 10k, 40k

Dynamic Accuracy

Input level (relative to full scale input level)	
Magnitude Dynamic Accuracy	
0 dB	<±0.3 dB
–10 to –70 dB	<±0.05 dB
–80 dB	<±0.1 dB
–90 dB	<±0.3 dB
–100 dB	<±1.0 dB
–110 dB	<±0.7 dB typical
–120 dB	<±2.3 dB typical
Phase Dynamic Accuracy	
0 dB	<±3°
–10 dB	<±0.6°
–20 to –70 dB	<±0.3°
–80 dB	<±0.7°
–90 dB	<±2°
–100 dB	<±7°
–110 dB	<±8° typical
–120 dB	<±25° typical

@ 23 ± 5° C, IFBW 10 Hz, R input= –35 dBm

Measurement Throughput Summary (IFBW 40 kHz, ms)

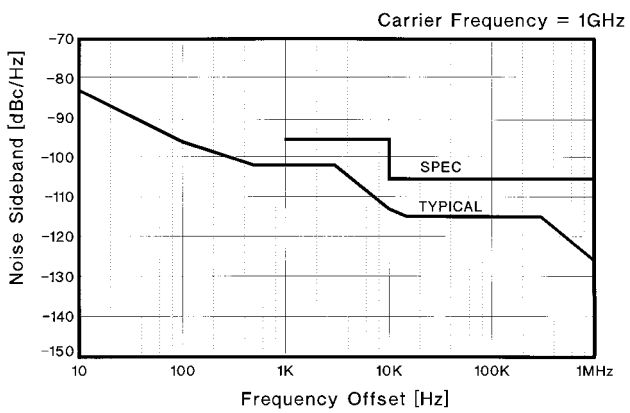
Measurement (with THRU Cal)	Number of points 51	201	401	801
(1) Magnitude	62	138	239	443
(2) Magnitude and phase	84	227	417	798

Spectrum Measurement

Frequency Characteristics
Frequency Range: 2 Hz to 1.8 GHz

Frequency Reference
Accuracy: <±5.5 ppm (Option 1D5: <±0.13 ppm)
Resolution Bandwidth (RBW)
Range: 1 Hz to 3 MHz, 1-3-10 step
Selectivity (60 dB/3 dB): RBW ≥10 kHz: <10; RBW ≤3 kHz: <3

Noise Sidebands



Noise sidebands normalized to 1 Hz RBW versus offset from carrier (typical)

Displayed Average Noise Level
(@ frequency ≥10 MHz, ref. level ≤–40 dBtm, att.=0 dBm):
< (–150 + 3f (GHz)) dBm/Hz
Spurious Response
Second Harmonic Distortion (@ ≥10 MHz, –35 dBm mixer input):
< –70 dBc
Third-Order Intermodulation Distortion (@ ≥10 MHz, –30 dBm, separation >20 kHz): < –75 dBc
Other Spurious (@ –30 dBm mixer input, offset ≥1 kHz): < –70 dBc
Scale Fidelity: ±0.05 dB @ 0 to –30 dB from ref. level

Impedance Measurement (Option 010)

Measurement Parameters: |Z|, θz, |Y|, θy, R, X, G, B, Cp, Cs, Lp, Ls, Rp, Rs, D, Q, |Γ|, θγ, Γx, Γy
Frequency Range: 100 kHz to 1.8 GHz
Measurement Port: APC-7 on the HP 43961A Test Kit
Source Level at RF out: –60 to +20 dBm (6 dB lower at 43961A port)
DC Bias: ±40 V (20 mA maximum). A 2 kΩ ±5% internal resistor is used for dc bias current limitation. An external dc bias source is required.
Connector: BNC (f) on HP 43961A.
Calibration: OPEN(0 S)/SHORT (0 Ω/LOAD(50 Ω) calibration, OPEN/SHORT/LOAD compensation on test fixtures, port extension compensation
Accuracy (Supplemental Performance Characteristics):
3% basic accuracy at 23° ±5° C, after OPEN/SHORT/LOAD calibration

General Characteristics

Operating Temperature/Humidity: 0° C to 40° C, 15% < RH <95%
Storage Temperature: –20° to 60° C
Power Requirement: 90 to 132 V, 198 V to 264 V, 47 to 63 Hz, 300 VA max.
Weight: 21.5 kg (47.4 lb) typical
Size: 425 mm W x 235 mm H x 553 mm D

Key Literature

HP's Family of Combination Analyzers, p/n 5965-9374E
HP 4396B 1.8 GHz Network/Spectrum Analyzer Technical Data, p/n 5965-6311E

Ordering Information

HP 4396B RF Network/Spectrum/Impedance Analyzer
Opt 1A2 Delete keyboard
Opt 1D5 High-Stability Frequency Reference
Opt 1D6 Time-Gated Spectrum Analysis
Opt 1D7 50 Ω to 75 Ω Spectrum Input Impedance Conversion
Opt 010 Impedance Measurement Function (Requires HP 43961A)
HP 85046A 50 Ω S-Parameter Test Sets
HP 85046B 75 Ω S-Parameter Test Sets
HP 87512A 50 Ω Transmission/Reflection Test Kits
HP 87512B 75 Ω Transmission/Reflection Test Kits
HP 43961A RF Impedance Test Kit (add test fixtures listed below)
HP 16191A Side Electrode SMD fixture (dc to 2 GHz)
HP 16192A Parallel Electrode SMD fixture (dc to 2 GHz)
HP 16193A Small Side Electrode SMD fixture (dc to 2 GHz)
HP 16092A Spring-Clip Fixture (dc to 500 MHz)

HP 43961A

HP 43961A RF Impedance Test Kit

4

The HP 43961A RF Impedance Test Kit provides the capability to measure impedance parameters of 1-port devices with the HP 4395A Option 010 (100 kHz to 500 MHz) or the HP 4396B Option 010 (100 kHz to 1.8 GHz). The test port of the HP 43961A is a 7-mm connector and can be used with the HP 16191A, HP 16192A, or HP 16193A test fixture. The HP 43961A includes OPEN/SHORT/LOAD calibration standards.

Frequency Range: 100 kHz to 1.8 GHz (100 kHz to 500 MHz with HP 4395A)
Measurement Parameters: |Z|, |Y|, θ, R, X, G, B, Cp, Cs, Lp, Ls, Rp, Rs, D, Q, |Γ|

HP 87511A

HP 87511A/B S-Parameter Test Sets

The HP 87511A/B S-Parameter Test Sets provide the capability to measure S-parameters of 2-port devices from 100 kHz to 500 MHz with an HP network analyzer. The test ports of the HP 87511A are 50 Ω precision 7-mm connectors (Option 001: type N(f)), and the test ports of the HP 87511B are 75 Ω type N(f) connectors. Calibration kits are not included.

Frequency Range: 100 kHz to 500 MHz
Test Port Impedance: HP 87511A, 50 Ω; HP 87511B, 75 Ω

	HP 87511A	HP 87511B
Directivity		
100 kHz to 300 kHz	30 dB	30 dB
300 kHz to 200 MHz	40 dB	33 dB
200 MHz to 500 MHz	35 dB	33 dB
Nominal Insertion Loss		
RF IN to port 1, 2	13 dB	19 dB
RF IN to R, A, B	19 dB	31 dB

Size: 432 mm W x 90 mm H x 495 mm D
Weight: Approx. 5.7 kg

HP 87512A

HP 87512A/B Transmission/Reflection Test Kits

The 87512A/B Transmission/Reflection Test Kits provide the capability to measure the reflection and transmission characteristics of 50 or 75 Ω devices up to 2 GHz with an HP network analyzer. The test port of the HP 87512A is a 50 Ω type N(f) connector, and the test port of the HP 87512B is a 75 Ω type N(f) connector. The HP 87512A/B include precision SHORT/LOAD termination for calibration.

Frequency Range: DC to 2 GHz
Test Port Impedance: HP 87512A, 50 Ω; HP 87512B, 75 Ω
Equivalent Directivity: 40 dB (typical)
Insertion Loss: 10 dB ± 1 dB

HP 41800A

HP 41800A Active Probe

The HP 41800A Active Probe provides high input impedance from 5 Hz to 500 MHz. The HP 41800A is a valuable tool when used with a network and spectrum analyzer for circuit signal analysis.

Specifications

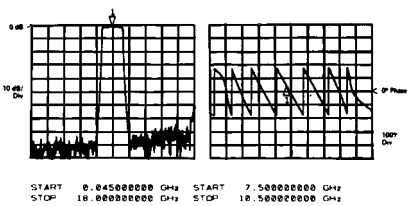
Bandwidth: 5 Hz to 500 MHz
Output Connector: 50 Ω type N male
Input R,C (typical):100 k Ω, 3 pF (probe alone);
1 MΩ, 1 pF (with 10:1, 100:1 divider)
Frequency Response relative to 50 MHz: ±1 dB @ 50 Hz to 200 MHz
Average Noise Level: 10 nV/$\sqrt{\text{Hz}}$ @ ≥300 kHz
Second Harmonic Distortion (typical): <–50 dBc @ 20 dBm (250 MHz) input
Third-Order Intermodulation Distortion (typical): <–70 dBc @ –26 dBm two signal input
1 dB Gain Compression: >+3 dBm input @ 500 MHz

Why Network Analysis?

Characterizing the behavior of linear networks that will be stimulated by arbitrary signals and interfaced with a variety of other networks is a fundamental problem in both synthesis and test processes. For example, the engineer designing a multi-component network must predict with some certainty the final network performance from knowledge of the individual components. Similarly, a production manager must know allowable tolerances on the products manufactured and whether the final products meet the specified tolerances. Network analysis offers a solution to these problems through complete description of linear network behavior in the frequency domain. Additionally, some network analyzers offer the capability to transform measurement data, taken in the frequency domain, to the time domain, providing further insight into the behavior of linear networks.

Network analysis accomplishes the description of both active and passive networks by creating a data model of such component parameters as impedances and transfer functions. However, these parameters not only vary as a function of frequency but are also complex variables in that they have both magnitude and phase. Swept network analyzers now measure magnitude and phase (the total complex quantity) as a function of frequency with less difficulty than conventional CW measurements. Impedance and transfer functions then can be displayed conveniently on a swept CRT, or peripherals such as a printer and/or a plotter.

Thus, network analysis satisfies the engineering need to characterize the behavior of linear networks quickly, accurately, and completely over broad frequency ranges. Hewlett-Packard manufactures a full line of scalar network analyzers (magnitude only) and vector network analyzers (both magnitude and phase).



45 MHz to 18 GHz measurement of magnitude and phase in a single sweep.

What is Network Analysis?

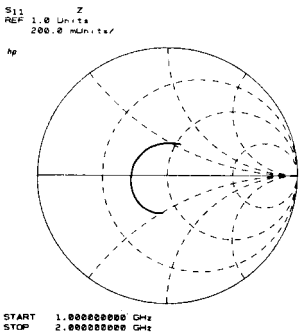
Network analysis is the process of creating a data model of the transfer and/or impedance characteristics of a linear network through stimulus-response testing over the frequency range of interest. All network analyzers in the HP product line operate according to this definition.

At frequencies above 1 MHz, lumped elements actually become "circuits" consisting of the basic elements plus parasitics like stray capacitance, lead inductance, and unknown absorptive losses. Since parasitics depend on the individual device and its construction, they are almost impossible to predict. Above 1 GHz component geometries are comparable to a signal wavelength, intensifying the variance in circuit behavior due to device construction.

Network analysis is generally limited to the definition of linear networks. Since linearity constrains networks stimulated by a sine wave to produce a sine-wave output, sine-wave testing is an ideal method for characterizing magnitude and phase response as a function of frequency. For non-linear measurements, refer to the sections on spectrum analyzers, wave analyzers (signal analyzers) and vector modulation products in this catalog.

Network Analyzers

Hewlett-Packard network analyzers are instruments that measure transfer and/or impedance functions of linear networks through sine-wave testing. A network analyzer system accomplishes these measurements by configuring its various components around the device-under-test. The first requirement of the measurement system is a sine-wave signal source to stimulate the device-under-test. Since transfer and impedence functions are ratios of various voltages and currents, a means of separating the appropriate signals from the measurement ports of the device-under-test is required. Finally, the network analyzer itself must detect the separated signals, form the desired signal ratios, and display the results.



Input impedance of microcircuit amplifier is read directly with Smith Chart overlay for Polar Display.

Signal Sources and Signal Separation

In the general case, any sine-wave source meeting the network analyzer's specifications can be used to stimulate the device-under-test. If the analyzer is capable of swept measurements, great economies in time can be achieved by stimulating the device-under-test with a sweep oscillator or synthesized sweeper. This allows quick and easy characterization of devices over broad frequency ranges.

At high frequencies the problem of signal separation usually involves traveling waves on transmission lines and becomes correspondingly more difficult. Hewlett-Packard manufactures test sets applicable for separating the appropriate traveling waves in a variety of high-frequency measurements.

Broadband and Narrowband Detection

After the desired signals have been obtained from the test set, they must be detected by the network analyzer; HP network analyzers can use one of two detection methods. Broadband detection accepts the full-frequency spectrum of the input signal while narrow-band detection involves tuned receivers that convert CW or swept-RF signals to a constant-IF signal. There are certain advantages to each detection scheme.

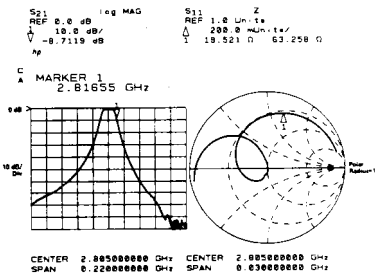
Scalar analyzers usually employ broadband detection techniques. Broadband detection reduces instrument cost by eliminating the IF section required by narrowband analyzers but sacrifices noise and harmonic rejection. However, noise is not a factor in many applications. Finally, broadband systems can make measurements where the input and output signals are not of the same frequency, as in the measurement of the insertion loss of mixers and frequency doublers.

Vector network analyzers normally employ narrow band detection techniques. Narrowband detection makes a more sensitive low noise detection of the constant IF possible. This allows increased accuracy and dynamic range for frequency selective measurements (as compared to broadband systems).

Some newer scalar and vector network analyzers employ both broadband and narrowband detection. The detection method is selectable by the user so that device measurements can be optimized.

Signal Processing and Display

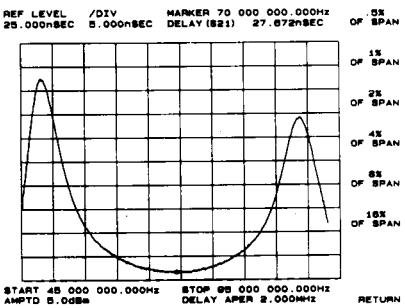
Once the RF has been detected, the network analyzer must process the detected signals and display the measured quantities. All HP network analyzers are multi-channel receivers utilizing a reference channel and at least one test channel; absolute signal levels in the channels, relative signal level (ratios) between the channels, or relative phase difference between channels can be measured, depending on the analyzer.



Simultaneous measurement of transmission response and passband reflection coefficient.

Relative ratio measurements are usually made in dB, which is the log ratio of an unknown signal (Test Channel) with a chosen reference signal (Reference Channel). This allows the full dynamic range of the instrumentation to be used in measuring variations of both high and low level circuit responses. For example, 0 dB implies the two signal levels have a ratio of unity while ± 20 dB implies a 10:1 voltage ratio between two signals.

All network analyzer phase measurements are relative measurements with the reference channel signal considered to have zero phase. The analyzer then measures the phase difference of the test channel with respect to the reference channel.



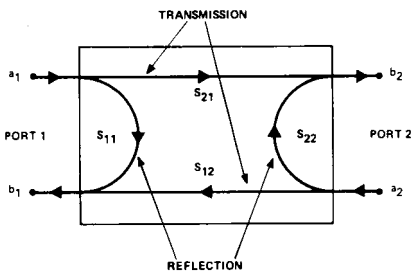
Direct measurement of group delay with digital readout at marker.

Phase information complements amplitude data in the measurement of low frequency parameters. Phase is more sensitive to network behavior and it is a required component of complex impedance and transfer functions.

Phase data is also required to measure delay distortion or group delay of networks. Delay distortion occurs when different frequency components of a complex waveform experience nonlinear phase shifts as they are transmitted through a network. Group delay is a measure of this distortion and is defined as:

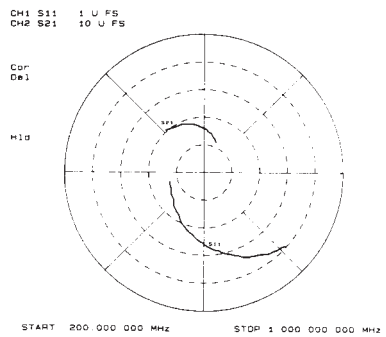
$$Tg = \frac{-d\Theta}{d\omega}$$

An alternative method for measuring phase distortion is deviation from linear phase or differential phase. Deviations from linear phase can be measured by introducing enough electrical length in the network analyzer's reference channel to linearize a device's phase shift.



S-parameter model for a two-port linear network.

Scattering parameters, or S-parameters, were developed to characterize linear networks at high frequencies. S-parameters define the ratios of reflected and transmitted traveling waves measured at the network ports. A two-port device is modeled with S-parameters in Figure 5. S_{11} which is the complex reflection coefficient at port 1 and is the ratio of b_1/a_1, if $a_2 = 0$ (port 2 terminated in its characteristic impedance). S_{21} is the complex transmission coefficient from port 1 to port 2, b_2/a_1, if $a_2 = 0$. The "a" and "b" signals represent the amplitude and phase of the incident and emerging or reflected traveling waves. By reversing the ports and terminating port 1 in its characteristic impedance, S_{22} and S_{12} can be similarly defined.



Simultaneous measurement of transistor S-parameters.

Additional Capabilities

Precision design work and manufacturing tolerances demand highly-accurate measurements, but most errors in network measurements are complex quantities that vary as a function of frequency. By characterizing and virtually removing these systematic errors, measurement accuracies are improved by several orders of magnitude. Hewlett-Packard now offers network analyzers with built-in, high-speed computational hardware that can perform the complex mathematics required for sophisticated error correction.

Computer-controlled network analyzers can be programmed to set up and make many measurements automatically. The measurement process is further accelerated by the computer's ability to store, transform, summarize, and output data in a variety of formats to a number of peripherals. These capabilities make the computer-controlled network analyzer ideal for both computer-aided design or automatic production testing. Several products have built-in automation features, including sequencing and HP Instrument BASIC.

Network Analyzer Selection Guide

HP Model	Frequency range	Source	Measurement capabilities
HP 35670A Dynamic Signal Analyzer (page 544)	122 µHz to 102.4 kHz (2 channel) 122 µHz to 51.2 kHz (4 channel)	Swept and fixed sine, random (white and pink) noise, burst random, chirp, burst and periodic chirp, and arbitrary waveform	Transfer functions–magnitude/phase, curve fit, spectrum analysis, octave analysis, order domain spectrum analysis, order tracking, histogram analysis. HP-IB programmable.
HP 35665A Dual-Channel Dynamic Signal Analyzer (page 542)	122 µHz to 51.2 kHz	Swept and fixed sine chirp, random, burst random, and arbitrary waveform	Transfer functions–magnitude/phase, 20-pole/20-zero curve fitter, frequency-response synthesis, time domain functions, and spectrum analysis. HP-IB programmable.
HP E5100A/B Network Analyzer (page 267)	10 kHz to 300 MHz	Integrated synthesized source	Transfer functions–magnitude/phase, insertion loss/gain, group delay, attenuation. Impedance-magnitude/phase. Electrical delay. HP IBASIC capability. Built-in 3 ½-in flexible disk (DOS format). HP-IB capability.
HP 8751A Network Analyzer (page 270)	5 Hz to 500 MHz	Integrated synthesized source	Transfer functions–magnitude/phase, insertion loss/gain, attenuation, gain compression, S-parameters, electrical length, group delay, deviation for linear phase. Impedance-magnitude/phase, return loss, r + jx. Full accuracy enhancement. HP Instrument BASIC capability. Built-in 3½-in flexible disk (LIF/DOS format). HP-IB capability.
HP 4395A Network/Spectrum/ Impedance Analyzer (page 254)	10 Hz to 500 MHz (network) 100 kHz to 500 MHz (impedance)	Integrated synthesized source	Transfer functions–magnitude/phase, insertion loss/gain, attenuation, S-parameters, group delay, return loss, r+jx. Impedance-magnitude/ phase. Electrical delay. Spectrum analysis. Complex impedance and HP Instrument BASIC optional. Built-in 3 ½-in flexible disk (LIF/DOS format). HP-IB programmable.
HP 8711C/8712C HP 8713C/8714C RF Economy Network Analyzer (page 271)	300 kHz to 1.3 GHz (8711C, 8712C) 300 kHz to 3 GHz (8713C, 8714C)	Integrated synthesized source, T/R test set and receiver	Transmission/reflection measurements. Phase (8712C, 8714C). 50 Ω and 75 Ω measurements. HP Instrument BASIC (IBASIC). Narrowband/broadband receivers. Internal calibration, averaging, limit testing, internal disk, and storage registers. AM delay. LAN.VGA output. HP-IB programmable.
HP 4396A Network/Spectrum/ Impedance Analyzer (page 256)	100 kHz to 1.8 GHz (network) 2 Hz to 1.8 GHz (spectrum) 100 kHz to 1.8 GHz (impedance)	Synthesized source	Transfer functions–magnitude/phase, insertion loss/gain, attenuation, S-parameters, group delay, return loss, r + jx. Impedance-magnitude/ phase. Electrical delay. Spectrum analysis. Complex impedance and HP Instrument BASIC optional. Built-in 3½-in flexible disk (LIF/DOS format). HP-IB programmable.
HP 8752C Network Analyzer (page 275)	300 kHz to 1.3/3.0/6.0 GHz	Integrated synthesized source, transmission/reflection test set, and receiver	Transfer functions–magnitude/phase, insertion loss/gain, attenuation, gain compression, electrical length, group delay, deviation from linear phase. Impedance-magnitude/phase, return loss, r + jx, accuracy enhancement, time domain capability. HP-IB programmable.
HP 8753D Network Analyzer (page 277)	30 kHz to 3/6 GHz	Integrated synthesized source, S-parameter test set, and receiver	Transfer functions–magnitude/phase, insertion loss/gain, attenuation, gain compression, 4 simultaneous S-parameter display, electrical length, group delay, deviation from linear phase. Impedance-magnitude/phase, return loss, r + jx. Full accuracy enhancement. Time domain capability. Harmonic measurement capability. Sequencing. VGA output. HP-IB programmable.
HP 8719D/8720D/8722D Network Analyzers (page 282)	50 MHz to 13.5 GHz (8719D) 50 MHz to 20 GHz (8720D) 50 MHz to 40 GHz (8722D)	Integrated synthesized source (1 Hz resolution optional)	Transfer functions–magnitude/phase, insertion loss/gain, attenuation, S-parameters, electrical length, group delay, deviation from linear phase. Impedance-magnitude/phase, return loss, r + jx. Full accuracy enhancement. Time domain capability. HP-IB programmable.
HP 8510 Series Network Analyzers (page 285)	45 MHz to 110 GHz (SS-SC)	HP 8360 Series Synthesized Sweepers	Transfer functions–magnitude/phase, insertion loss/gain, attenuation, S-parameters, electrical length, group delay, deviation from linear phase, impedance, return loss, r + jx. Active device characterization. Full accuracy enhancement. Time domain capability. HP-IB programmable.
HP 8757D/E Scalar Network Analyzers (page 262)	10 MHz to 110 GHz	HP 83751A/83752A Synthesized Sweepers HP 8360 Series Synthesized Sweepers	Scalar transmission/reflection measurements, 50 Ω coax measurements 10 MHz to 50 GHz, waveguide measurements 26.5 to 110 GHz, open/short averaging, normalization, averaging, limit testing, storage registers. HP-IB programmable.

Vector Voltmeter

HP Model	Frequency range	Source	Measurement capabilities
HP 8508A Vector Voltmeter (page 284)	0.1 MHz to 1 GHz 0.3 MHz to 2 GHz	None	Voltage, impedance, transfer functions, phase and amplitude, HP-IB programmable.

HP 8757D/E

- 75 dB dynamic range
- Optional power calibrator
- 40 dB directivity bridges
- 40 GHz in coax, 110 GHz in waveguide
- Buffered plotter/printer output
- External disk and internal register save/recall
- Built-in limit testing
- Color display

HP 8757E and HP 8757D Option 001

4

HP 8757D/E Scalar Network Analyzers

Measure insertion loss, gain, return loss, SWR, and power quickly and accurately with either the HP 8757D or HP 8757E scalar network analyzers. With high-performance detectors and directional bridges, and a companion HP source and digital plotter, the HP 8757D and 8757E become the basis of a complete measurement system with superb performance.

A Choice of Two Analyzers

For an economical measurement solution, choose the HP 8757E scalar network analyzer. The HP 8757E features three detector inputs and two independent display channels, allowing simultaneous ratioed or nonratioed measurement of your device's transmission and reflection characteristics, 75 dB dynamic range (+20 to –55 dBm) for measuring high-rejection devices, and a choice between ac (square wave modulated) or dc detection techniques. The internal plotter/printer buffer allows you to send your measurement data directly to a plotter and then proceed to the next measurement, typically in less than five seconds. The HP 8757E includes a user-friendly interface, and menu-driven, direct-access softkeys, which simplify its operation.

When your application demands maximum system versatility, choose the HP 8757D scalar network analyzer. It offers all of the performance of the HP 8757E, plus more standard features, better measurement speed, limit testing, external disk save/recall, and a color display. Limit testing reduces test time by letting the analyzer make quick and objective pass/fail decisions. External disk save/recall allows your measurement state to be preconfigured by an engineer or skilled specialist and then automatically recalled by production technicians. The result is reduced set-up time and greater test integrity at each production station. The precision color display simplifies the separation of measurement information while providing a pleasant display for the technician.

Increase Absolute Power Measurement Accuracy

For near power meter measurement accuracy, configure a system that includes the HP 8757D Option 002 and the HP 85037 series precision detectors. Option 002 on the HP 8757D adds an internal power calibrator used to characterize the HP 85037 series detectors' accuracy versus power. In addition, each HP 85037 series precision detector incorporates a dual-diode detector to improve power measurement accuracy when harmonics are present, plus internal frequency correction factors, read by the HP 8757D, for more accurate power versus frequency measurements. The result is a system optimized for swept absolute power measurements.

Systems from 10 MHz to 110 GHz

You can conveniently obtain a 20 GHz coaxial measurement system by ordering the HP 8757XC (10 MHz to 20 GHz) scalar measurement system. Or, you can configure your own system to 50 GHz in coax or to 110 GHz in waveguide.

The HP 83750 series synthesized sweeper family offers the accuracy and performance of a synthesized source at an affordable price. The HP 8350 series sweepers offer the benefits of a modular system with choices of source frequency range and output power. When you test narrowband, frequency-selective devices, choose a synthesized sweeper from the HP 8360 series or an HP 8340B. These sweepers provide excellent frequency stability and up to 1 Hz frequency resolution.

Feature	HP 8757D	HP 8757E
Display	Color	Monochrome
Display channels	4	2
Detector inputs	3 standard 4 with Option 001	3
Dynamic range	75 dB	75 dB
AC/DC detection mode	Yes	Yes
Measurement points:		
Selectable values	101, 201, 401, 801, 1601	101, 201, 401
Channels displayed	3 or 4 2 1	1 or 2
Max. points per channel	401 801 1601	401
Plotter/printer buffer	Yes	Yes
Noise figure display capability*	Yes	Yes
External disk save/recall	Yes	No
Internal save/recall registers	9	9
Limit testing (channels 1 and 2)	Yes	No
Adaptive normalization	Yes	No
Cursor search functions	Max., Min., bandwidth, n dB	Max., Min.
SWR display mode	Yes	Yes
Non-standard sweep mode	Yes	Yes
Auxiliary voltage display mode	Yes	Yes
Optional power calibrator	Yes	No
Compatible with HP 85037 series precision detectors	Yes	No

* Product Note 8970 B/S-4, HP Literature 5959-8742

Key Literature

HP 8757D/E Scalar Network Analyzers Brochure, p/n 5091-2469E
HP 8757D/E Scalar Network Analyzers Technical Data, p/n 5091-2471E

System Accuracy

Transmission Loss or Gain Measurement Accuracy

Transmission loss or gain measurements are made relative to a 0 dB reference point established at calibration. Transmission measurement uncertainty = dynamic power accuracy + mismatch uncertainty.

Dynamic power accuracy is the measurement uncertainty due to the change in power level between calibration and the measurement. Mismatch uncertainty is the uncertainty due to reflections in the measurement setup. The frequency response errors of the source, detectors, bridge, and power splitter are removed via calibration.

Transmission Measurement Uncertainty Examples
Assumptions:
- Measurement frequency = 10 GHz
- DUT input/output SWR = 1.5
- Change in power after calibration <30 dB (+0 to –30 dBm range)

Uncertainty component	HP 85037B precision detector	HP 85025E detector
Dynamic accuracy (±dB)	0.11	0.40
Mismatch (±dB)	0.45	0.33
Uncertainty Total (±dB)	0.56	0.73

HP 85037 Series Precision Detectors (ac/dc)

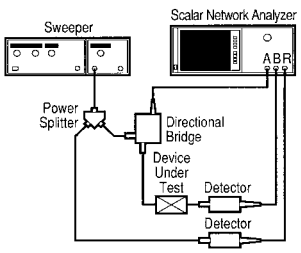
The HP 85037 series precision detectors are designed specifically for operation with the HP 8757D scalar network analyzer and may be used in either ac or dc detection modes. These dual diode detectors contain internal frequency correction factors in an internal EE PROM (read automatically by the HP 8757D) for improved measurement accuracy versus frequency. When used in conjunction with the HP 8757D's internal power calibrator (Option 002), these detectors provide the maximum absolute power measurement accuracy. The HP 85037 series detectors are not compatible with the HP 8757E, 8757A, 8756A, or 8755.

Absolute Power Measurement Uncertainty Examples
Assumptions:
- Measurement frequency = 10 GHz
- DUT input/output SWR = 1.5
- Measured power = 0 dBm

Uncertainty component	HP 85037B detector	HP 85025E detector
Absolute power accuracy at 50 MHz (±dB)	0.11	0.40
Frequency response (±dB)	0.18	0.50
Mismatch (±dB)	0.18	0.10
Uncertainty Total (±dB)	0.47	1.00

Reflection Measurement Accuracy

Uncertainties due to calibration error and the frequency response of the source, detectors, and bridges are removed via open/short averaging. The remaining uncertainties are primarily the sum of directivity uncertainty, effective source match uncertainty, and dynamic power accuracy. See Technical Data Sheet for further information.



Basic scalar coaxial system configured for ratio reflection and transmission measurements.

Precision Detector Summary, HP 85037 Series For use with the HP 8757D in either ac or dc detection modes

Model	Frequency range	Connector type	Dynamic range	Frequency	Return loss	Frequency response	Power (at 50 MHz)	Dynamic accuracy[4]	Absolute accuracy[5]
HP 85037A[1]	10 MHz to 18 GHz	Type-N (m) 7 mm[2]	ac mode +20 to –55 dBm dc mode +20 to –50 dBm	0.01 to 0.04 GHz 0.04 to 18.0 GHz	10 dB 20 dB	±0.35 dB ±0.18 dB	20 dBm 10 dBm –30 dBm –50 dBm	±0.25 dB ±0.11 dB ±0.11 dB ±0.85 dB	±0.25 dB ±0.11 dB ±0.11 dB ±0.85 dB
HP 85037B[1]	10 MHz to 26.5 GHz	3.5 mm (m)	ac mode +20 to–55 dBm dc mode +20 to –50 dBm	0.01 to 0.04 GHz 0.04 to 18.0 GHz 18 to 26.5 GHz	10 dB 20 dB 18 dB	±0.35 dB ±0.18 dB ±0.22 dB	20 dBm 10 dBm –30 dBm –50 dBm	±0.25 dB ±0.11 dB ±0.11 dB ±0.85 dB	±0.25 dB ±0.11 dB ±0.11 dB ±0.85 dB

HP 85025 and 85026 Series Detectors (ac/dc)

The HP 85025 and 85026 series detectors are designed specifically for operation with the HP 8757 scalar network analyzer and are not compatible with either the HP 8756 or the 8755. The HP 85025/26 detectors detect either a modulated (ac) or an unmodulated (dc) microwave signal.

HP 85025C Detector Adapters

The HP 85025C adapter matches the scalar analyzer display to most standard crystal, silicon, and gallium arsenide detectors. This enables the user to operate up to 110 GHz with the HP 8757 and 8756. The HP 85025C detector adapter is designed for use with the HP 8757 only, and can operate in either ac or dc detection modes.

Coaxial Detector Summary, HP 85025 Series For use with the HP 8757 only in either ac or dc detection modes

Model	Frequency range	Connector type	Dynamic range	Frequency	Return loss	Frequency response	Power (at 50 Mhz)	Dynamic accuracy[4]	Absolute accuracy[5]
HP 85025A[3]	10 MHz to 18 GHz	Type-N (m) 7 mm[2]	ac mode +16 to –55 dBm dc mode +16 to –50 dBm	0.01 to 0.04 GHz 0.04 to 4 GHz 4 to 18 GHz	10 dB 20 dB 17 dB	±0.8 dB ±0.5 dB ±0.5 dB	16 dBm 6 dBm –35 dBm –50 dBm	±0.8 dB ±0.4 dB ±0.4 dB ±1.3 dB	±0.8 dB ±0.4 dB ±0.4 dB ±1.3 dB
HP 85025B[3]	10 MHz to 26.5 GHz	3.5 mm (m)	ac mode +16 to –55 dBm dc mode +16 to –50 dBm	0.01 to 0.04 GHz 0.04 to 4 GHz 4 to 18 GHz 18 to 26.5 GHz	10 dB 20 dB 17 dB 12 dB	±0.8 dB ±0.5 dB ±0.5 dB ±2.0 dB	16 dBm 6 dBm –35 dBm –50 dBm	±0.8 dB ±0.4 dB ±0.4 dB ±1.3 dB	±0.8 dB ±0.4 dB ±0.4 dB ±1.3 dB
HP 85025D[3]	10 MHz to 50 GHz	2.4 mm (m)	ac mode +16 to –55 dBm dc mode +16 to –50 dBm	0.01 to 0.1 GHz 0.1 to 20 GHz 20 to 26.5 GHz 26.5 to 40 GHz 40 to 50 GHz	10 dB 20 dB 20 dB 15 dB 9 dB	±0.8 dB ±0.5 dB ±1.0 dB ±2.5 dB ±3.0 dB	16 dBm 6 dBm –35 dBm –50 dBm	±1.0 dB ±0.4 dB ±0.4 dB ±1.3 dB	±1.0 dB ±0.4 dB ±0.4 dB ±1.3 dB
HP 85025E[3]	10 MHz to 26.5 GHz	3.5 mm (m)	ac mode +16 to –55 dBm dc mode +16 to –50 dBm	0.01 to 0.1 GHz 0.1 to 18 GHz 18 to 25 GHz 25 to 26.5 GHz	10 dB 25 dB 25 dB 23 dB	±0.8 dB ±0.5 dB ±0.5 dB ±1.4 dB	16 dBm 6 dBm –35 dBm –50 dBm	±1.0 dB ±0.4 dB ±0.4 dB ±1.3 dB	±1.0 dB ±0.4 dB ±0.4 dB ±1.3 dB

HP R85026A
HP Q85026A
HP U85026A
HP 85027A
HP 85027B
HP 85027C
HP 85027D
HP 85027E

HP 8757D Option 002 Power Calibrator

The HP 8757D's internal power calibrator provides a 50 MHz reference standard for characterizing the absolute power accuracy and dynamic power accuracy of the HP 85037 series precision detectors.
Frequency: 50 MHz ±0.2 MHz
Accuracy at 0 dBm: ±0.05 dB
Linearity: (over any 10 dB range)
±0.08 dB (+20 to +10 dBm)
±0.04 (+10 to –30 dBm)
±0.06 (–30 to –50 dBm)

Waveguide Detectors and Detector Adapters Summary For use with the HP 8757 only in either ac or dc detection modes

Model	Frequency range	Connector type	Dynamic range	Return loss	Frequency response	Dynamic accuracy
HP R85026A[1]	26.5 to 40 GHz	WR-28	+10 to –50 dBm (ac mode) +10 to –45 dBm (dc mode)	12 dB	±1.5 dB	±(0.3 dB + 0.03 dB/dB)
HP Q85026A[1]	33 to 50 GHz	WR-22	+10 to –50 dBm (ac mode) +10 to –45 dBm (dc mode)	12 dB	±2.0 dB	±(0.3 dB + 0.03 dB/dB)
HP U85026A	40 to 60 GHz	WR-19	+10 to –50 dBm (ac mode) +10 to –45 dBm (dc mode)	12 dB	±2.0 dB	±(0.3 dB + 0.03 dB/dB)
HP 85025C Option K57[3]	50 to 75 GHz	WR-15	+10 to –45 dBm (typical)	9.5 dB (typical)	—	—
HP 85025C Option K71[3]	75 to 110 GHz	WR-10	+10 to –45 dBm (typical)	9.5 dB (typical)	—	—
HP 85025C[1]	[2]	SMA (m)	[2]	[2]	[2]	[2]

[1]The HP 85025 and 85026 series detectors and the HP 85025C detector adapter require HP 8757A firmware revision 2.0 or higher. To upgrade previous revisions, order the HP 11614A firmware enhancement.
[2]Depends upon the particular detector being used.
[3]Must be used with the HP 85025C detector adapter.

HP 85027 Series Directional Bridges (ac/dc)

The HP 85027 series directional bridges are designed to operate with either the HP 8757 in ac or dc detection modes or with the HP 8756 or 8755 in ac detection mode. These bridges offer high directivity, excellent test port match, and a measurement range of up to 50 GHz in coax.

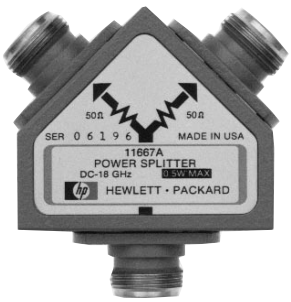
Directional Bridge Summary For use with the HP 8757 in ac or dc detection mode or with the 8756 or 8755 in ac detection mode only

Model	Frequency range	Nominal impedance	Connector–input	Connector–test port	Frequency	Directivity (dB)	Frequency	Test port match (SWR)
HP 85027A	10 MHz to 18 GHz	50 Ω	Type-N (f)	7 mm	0.01 to 18 GHz	40 dB	0.01 to 8.4 GHz 8.4 to 12.4 GHz 12.4 to 18 GHz	<1.15 <1.25 <1.43
HP 85027B	10 MHz to 26.5 GHz	50 Ω	3.5 mm (f)	3.5 mm (f)	0.01 to 20 GHz 20 to 26.5 GHz	40 dB 36 dB	0.01 to 8.4 GHz 8.4 to 20 GHz 20 to 26.5 GHz	<1.15 <1.43 <1.78
HP 85027C	10 MHz to 18 GHz	50 Ω	Type-N (f)	Type-N (f)	0.01 to 12.4 GHz 12.4 to 18 GHz	36 dB 34 dB	0.01 to 8.4 GHz 8.4 to 12.4 GHz 12.4 to 18 GHz	<1.15 <1.25 <1.43
HP 85027D	10 MHz to 50 GHz	50 Ω	2.4 mm (f)	2.4 mm (m)	0.01 to 20 GHz 20 to 26.5 GHz 26.5 to 40 GHz 40 to 50 GHz	36 dB 32 dB 30 dB 25 dB	0.01 to 16 GHz 16 to 30 GHz 30 to 40 GHz 40 to 50 GHz	<1.18 <1.27 <1.57 typically <2.00
HP 85027E	10 MHz to 26.5 GHz	50 Ω	3.5 mm (f)	3.5 mm (m)	0.01 to 20 GHz 20 to 26.5 GHz	40 dB 36 dB	0.01 to 8.4 GHz 8.4 to 20 GHz 20 to 26.5 GHz	<1.15 <1.43 <1.78

[1]The HP 85037A/B specifications are applicable when used with the HP 8757D scalar network analyzer. The absolute power accuracy and dynamic power accuracy specifications apply after a calibration via the HP 8757D Option 002's internal power calibrator.
[2]Option 001 changes to a 7-mm connector.
[3]The HP 85025 and 85026 series detectors and the HP 85025C detector adapter require HP 8757A firmware revision 2.0 or higher. To upgrade previous revisions, order the HP 11614A firmware enhancement.
[4]Dynamic accuracy refers to measurement accuracy as power varies (in dB) from a 0 dBm reference. 25° ±5°C, 50 MHz.
[5]DC mode, 25° ±5° C.

HP 11679A

HP 85022A



HP 11667A

HP 11667C

HP 11668A High-Pass Filter

The HP 11668A high-pass filter accessory is recommended when making measurements on active devices that have gain below 50 MHz. Use of the HP 11668A, placed after the HP 11665B, reduces the modulator drive feedthrough from 8 mV to 1 mV and prevents possible amplifier saturation. Use of the HP 11668A filter is not necessary for passive measurements since the feedthrough from the HP 11665B is –65 dBm and causes no degradation in system performance.

Frequency Range: 50 MHz to 18 GHz

	Insertion Loss	Return Loss
50 to 100 MHz	≤2.5 dB	≥12 dB
100 MHz to 8 GHz	≤1.0 dB	≥16 dB
8 to 12 GHz	≤1.0 dB	≥14 dB
12 to 18 GHz	≤1.5 dB	≥14 dB

Max. Input: +27 dBm
Connectors: Type-N female and male
Weight: Net, 0.13 kg (5 oz); shipping, 0.28 kg (10 oz)

HP 11679A/B Extension Cables

Function: These cables extend the distance between the scalar network analyzer and the detector or bridge to a maximum of 200 feet without degradation of performance.

HP 11679A: 7.6 m (25 ft) extension cable
HP 11679B: 61 m (200 ft) extension cable

HP 85022A System Cable Kit

The HP 85022A contains all the BNC and HP-IB cables to connect an HP 8350B sweep oscillator (or the HP 8360 series, HP 83750, or 83751 synthesized sweepers), an HP series 300 computer, and a printer to the HP 8757 or 8756. This kit contains three one-meter HP-IB cables (HP 10833A), three two-foot BNC (m-m) cables (HP 11170B), and one four-foot BNC (m-m) cable (HP 11170C).

BNC Impedance: 50 Ω
Weight: Net, 0.5 kg (1.2 lb); shipping, 1.2 kg (2.9 lb)

HP 8757D/E Upgrade Kits

Increase your analyzer's measurement capability and performance with an HP 8757 upgrade kit. Upgrade kits are available for the HP 8757D and 8757E.

The HP 86383C upgrade kit allows you to add the fourth detector input to your HP 8757D (86383C Option 001) and/or the internal power calibrator (HP 86383C Option 002). Installation is not included with this kit.

HP 11636A/B Power Dividers

The HP 11636A/B power dividers/combiners are recommended when making wideband comparison measurements without ratioing, and in fault location measurements with the HP 8757/85016.

HP 11665B Modulator

Function: Absorptive on-off modulator designed for and powered by the HP 8757, 8756, or 8755 scalar network analyzers

Frequency range	Return loss on and off	Insertion loss on	off
15 to 40 MHz	≥10 dB	≤7.0 dB	≥35 dB
40 MHz to 4 GHz	≥15 dB	≤3.2 dB	≥35 dB
4 to 8 GHz	≥12 dB	≤4.3 dB	≥45 dB
8 to 12.4 GHz	≥8 dB	≤3.8 dB	≥40 dB
12.4 to 18 GHz	≥8 dB	≤5.0 dB	≥45 dB

HP 11852B 50 Ω/75 Ω Minimum-Loss Pad

The HP 11852B is a low SWR minimum-loss pad required between 75 Ω devices and 50 Ω sources and detectors. For more information, see page 280.

HP 11667A/B/C Power Splitters

The HP 11667A/B/C power splitters are recommended when making wideband ratio measurements using the HP 8757, 8756, or 8755 scalar network analyzer. These two-resistor type splitters provide excellent output SWR at the auxiliary arm when used for source leveling or ratio measurement applications. The tracking between output arms over a frequency range from dc to 50 GHz allows wideband measurements to be made with a minimum of uncertainty.

Frequency Range
- **HP 11667A:** DC to 18 GHz
- **HP 11667B:** DC to 26.5 GHz
- **HP 11667C:** DC to 50 GHz

Impedance: 50 Ω nominal
Insertion Loss
- **HP 11667A/B:** 6 dB nominal
- **HP 11667C:** 8.5 dB nominal

Max. Input Power: +27 dBm
Connectors
- **HP 11667A:** N-female on all ports
- **HP 11667B:** 3.5-mm female on all ports
- **HP 11667C:** 2.4-mm female on all ports

The HP 8757 scalar network analyzer is ordered with multiple line items to give you maximum flexibility in specifying a system that meets your needs. Consult your local Hewlett-Packard sales office if you would like assistance.

Ordering Information

Complete Measurement System
HP 8757XC 20 GHz Coaxial Synthesized Scalar System
Includes:
HP 8757D Scalar Network Analyzer
HP 83752A Synthesized Sweeper
HP 85022A Cable Kit
- **Opt 001** Adds Fourth Detector Input to Analyzer
- **Opt 002** Adds 50 MHz Calibrator to Analyzer
- **Opt 1E1** Adds 70 dB Step Attenuator to Source
- **Opt 1E5** Adds High-Stability Timebase to Source
- **Opt 1ED** Adds Type-N Connector to Source
- **Opt 57E** Substitutes HP 8757E Analyzer
- **Opt 51A** Substitutes HP 83751A Source (2 to 20 GHz)
- **Opt 51B** Substitutes HP 83751B Source (2 to 20 GHz, high power)
- **Opt 52B** Substitutes HP 83752B Source (0.01 to 20 GHz, high power)

Analyzer
HP 8757D Scalar Network Analyzer
- **Opt 001** Fourth Detector Input
- **Opt 002** Internal Power Calibrator
- **Opt 802** HP 9122C Disk Drive and an HP 10833A HP-IB cable
- **Opt W03*** 90-Day On-Site Warranty Conversion
- **Opt W30** Two-Year Extended Service
- **Opt 1BN** MIL-STD-45662A Calibration Certificate
- **Opt 1BP** MIL-STD-45662A Calibration with Test Data

HP 8757E Scalar Network Analyzer
- **Opt 1BP** MIL-STD-45662A Calibration with Test Data

Sweepers
Choose the HP 83752A/B synthesized sweepers for applications from 10 MHz to 20 GHz, the HP 8360 series or 8340B synthesized sweepers for measurements up to 50 GHz in coax or 110 GHz in waveguide.

Precision Detectors
HP 85037A 0.01 to 18 GHz, Type-N(m)
- **Opt 001** 7-mm Connector

HP 85037B 0.01 to 26.5 GHz, 3.5 mm(m)

Directional Bridges
HP 85027A 0.01 to 18 GHz, 7 mm, 50 Ω
HP 85027B 0.01 to 26.5 GHz, 3.5 mm (f), 50 Ω
HP 85027C 0.01 to 18 GHz, Type-N (f), 50 Ω
HP 85027D 0.01 to 50 GHz, 2.4 mm (m), 50 Ω
HP 85027E 0.01 to 26.5 GHz, 3.5 mm (m), 50 Ω

Detectors
HP 85025A 0.01 to 18 GHz, Type-N (m)
- **Opt 001** 7-mm Connector

HP 85025B 0.01 to 26.5 GHz, 3.5 mm (m)
HP 85025D 0.01 to 50 GHz, 2.4 mm (m)
HP 85025E 0.01 to 26.5 GHz, 3.5 mm (m)
HP R85026A 26.5 to 40 GHz, WR-28 Waveguide
HP Q85026A 33 to 50 GHz, WR-22 Waveguide
HP U85026A 40 to 60 GHz, WR-19 Waveguide
HP 85025C Detector Adapter

Filter Kits
HP 11668A High-Pass Filter Kit

System Cable Kit
HP 85022A System Cable Kit

Recommended Accessories
Printer
HP 660C DeskJet (HP C2164A)

HP-IB/Centronics Bus Converter
US/Canada Version (ITEL 45CHVUB)
International Version (ITEL 45CHVEB)

Optional Accessories
(For ratio and/or modulation measurements)
HP 11636A Power Divider dc to 18 GHz
HP 11636B Power Divider dc to 26.5 GHz
HP 11665B Modulator
HP 11667A Power Splitter dc to 18 GHz
- **Opt 001** N-male on Input Port; N-female on Output Ports
- **Opt 002** N-female on Input Port; 7 mm on Output Ports

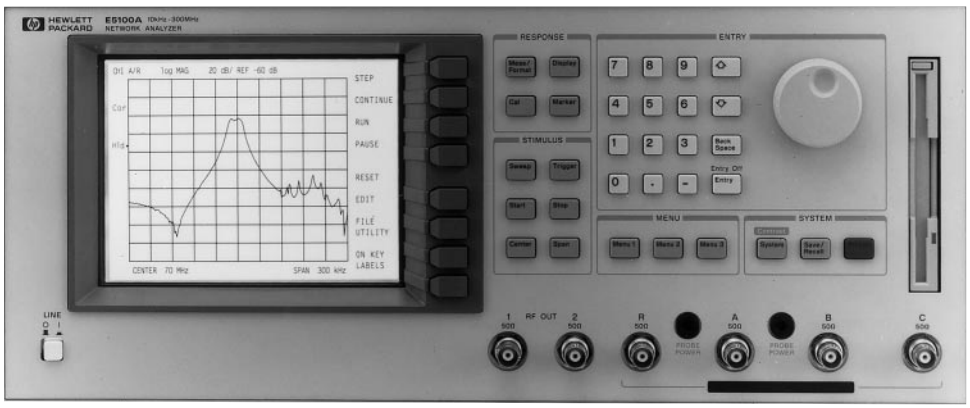
HP 11667B Power Splitter dc to 26.5 GHz
HP 11667C Power Splitter dc to 50 GHz
HP 11679A Detector Extension Cable, 7.6 m (25 ft)
HP 11679B Detector Extension Cable, 61 m (200 ft)
HP 11852B 50 to 75 Ω Minimum Loss Pad

Upgrade Kits
HP 86383C Upgrade Kit for HP 8757D
- **Opt 001** Adds Fourth Detector Input
- **Opt 002** Adds Internal Power Calibrator

*Only where available.

HP E5100A
HP E5100B

- 10 kHz to 300 MHz
- 0.04 ms/point measurement speed
- Fine resolution IFBW
- List sweep function
- Stable measurements
- High-speed evaluation using the waveform analysis commands
- Evaporation Monitoring Function (Option)
- Phase Tracking Function (Option)
- Supports active probes (Option)
- HP Instrument BASIC for easy automation



HP E5100A/B

HP E5100A/B Network Analyzers

The HP E5100A/B network analyzer is a 10 kHz to 300 MHz network analyzer best fitted for production lines of electronic component manufacturers, especially resonator and filter manufacturers, who require extra-high throughput.

The HP E5100A/B improves production line productivity with its fast measurement speed (fastest sweep speed is 0.04 ms/point), fast waveform analysis commands, and speedier processor. It provides faster measurements with lower fluctuations because of its low-noise performance and fine selection IFBW.

HP E5100A

HP E5100A is a versatile network analyzer with many functions and options to fit your needs with a minimum investment. During final tests, both precision and high speed are required for better yield and better productivity. The HP E5100A makes high-quality and high-speed tests with its fine IFBW selection and low-noise circuitry. Its convenient analysis and processing functions improve the productivity of the final test processes.

HP E5100B

The HP E5100B is best for in-process testing of filters and resonators. The requirement of in-process testing is different from that of final tests; they need fast measurements and low price. The HP E5100B has the same measurement quality and speed as the HP 5100A, but has reduced functionality. The HP E5100B reduces production costs and is a valuable tool for in-process testing.

Model	HP E5100A	HP E5100B
Number of receivers	1 to 4	1 or 2
Number of points per sweep	1 to 1601	1 to 401
List sweep capability	yes	no
Dynamic range	120 dB	100 dB

Specifications

Source Characteristics

Frequency
Range: 10 kHz to 300 MHz
Resolution: 1 mHz
Accuracy: ±20 ppm, ±1 ppm (option)

Output
Power range (at SINGLE): –48 to +22 dBm (option), –9 to +11 dBm (standard)
Resolution: 0.1 dB

Receiver Characteristics

Frequency Range: 10 kHz to 300 MHz
IFBW: 10 Hz to 30 kHz (1, 1.5, 2, 3, 4, 5, 8 steps)
Input Impedance (nominal): 50 Ω (std.), 50 Ω /1M Ω , 30 pF (option)
Dynamic Range: >120 dB (IFBW = 1 kHz)
Dynamic Accuracy: ±0.05 dB, ±0.03 deg
Measurement Speed: 0.04 ms/point (IFBW = 30 kHz, ramp-sweep)

General Characteristics

Measurement Parameters: Gain (Amplitude Ratio), Phase, Group-Delay, Amplitude, Gain-Phase, Gain-Delay Impedance, Admittance
Display: 6.3-inch monochrome LCD, 640 x 480 dots
Programming: HP Instrument BASIC
Mass Storage: FDD and internal non-volatile memory
Parallel I/O Port: TTL, 16-bit output, 8-bit input/output (standard)
Size: 425 mm W x 177 mm H x 425 mm D
Weight: Net, 12 kg (typical); shipping, 17 kg (typical)

Key Literature

HP E5100A/B Network Analyzer Product Overview, p/n 5963-3991E
HP E5100A/B Technical Specifications, p/n 5963-5560E

HP E5100A/B Accessories

HP 41901A SMD PI-Network Test Fixture

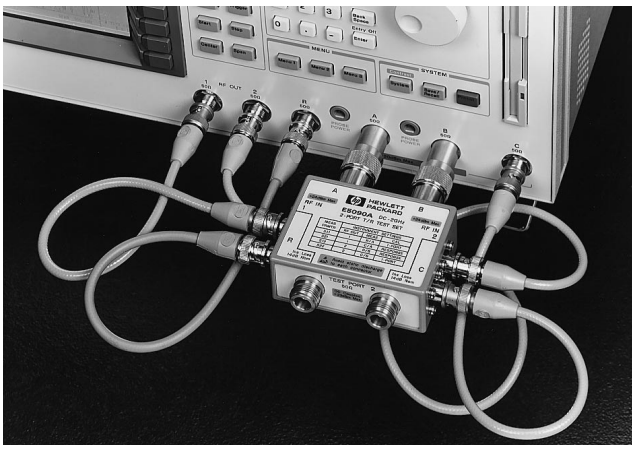
The HP 41901A SMD PI-network test fixture produces the capability to measure surface-mount crystal resonator using the HP E5100A/B or the HP 87510A. Attachment kit (option) is required for measurement. The frequency range of the HP 41901A is 1 MHz to 300 MHz.

Ordering Information

HP E5100A Network Analyzer
- **Opt 100** 1Receiver, Port A
- **Opt 200** 2 Receivers, Ports R and A
- **Opt 300** 3 Receivers, Ports R, A and B
- **Opt 400** 4 Receivers, Ports R, A, B and C
- **Opt 600** PI-Network Test Ready Package
  Note: Option 002, 200 and 010 are included. PI-network test fixture is not included.
  Note: Choose one Option from 100 to 600.
- **Opt 001** One RF OUT port
- **Opt 002** Two RF OUT ports, built-in power splitter
- **Opt 003** Two RF OUT ports, switched single output
  Note: Choose one Option from 001 to 003. Option 003 cannot be ordered with Option 101 or 301.
- **Opt 101** 50 Ω/1 MΩ selectable input on Port A
- **Opt 102** Type-N input connector on Port A
  Note: Options 101 and 102 are for Options 100 and 200 only. Option 101 cannot be ordered with Option 003.
- **Opt 301** 50 Ω/1 MΩ selectable inputs on Ports A and B
- **Opt 302** Type-N input connector on Ports Aand B
  Note: Options 301 and 302 are for Options 300 and 400 only. Option 301 cannot be ordered with Option 003.
- **Opt 010** Extended Output Power Range, –48 to +22 dBm
- **Opt 022** Evaporation Monitoring Function
- **Opt 023** Phase Tracking Function
- **Opt 030** Color LCD Display
- **Opt 1D5** High-Stability Frequency Reference
- **Opt 005** Parallel I/O mode A
- **Opt 006** Parallel I/O mode B
- **Opt 007** Opto-isolated Parallel I/O
  Note: 24-bit parallel I/O is furnished, select only one of Options 005, 006, 007, or choose none.
- **Opt UKR** Delete HP Instrument BASIC
- **Opt 1F0** Add DIN Keyboard
- **Opt UK6** Commercial Calibration Certificate with Test Data

HP E5090A 2-Port Transmission/Reflection Test Kit

The HP E5090A 2-port transmission/reflection test kit provides the capability to measure transmission and reflection characteristics of two port device in either direction with a single connection. The HP E5090A is test set for the HP E5100A with Options 003, 010, 302, and 400. The frequency range of the HP E5090A is dc to 2 GHz.



HP E5100B Network Analyzer
- **Opt 100** 1 Receiver, Port A
- **Opt 200** 2 Receivers, Ports R and A
  Note: Must choose either Option 100 or 200.
- **Opt 001** Single RF OUT port
- **Opt 002** Dual RF OUT ports, built-in power splitter
  Note: Must choose either Option 001 or 002.
- **Opt 010** Extended output power range, –48 to +22 dBm
- **Opt 022** Evaporation Monitoring Function
- **Opt 030** Color LCD Display
- **Opt 101** 50 Ω/1 MΩ selectable input, Port A
- **Opt 102** Type-N input connector, Port A
- **Opt 1D5** High-Stability Frequency Reference
- **Opt 005** Parallel I/O mode A
- **Opt 006** Parallel I/O mode B
- **Opt 007** Opto-isolated Parallel I/O
  Note: 24-bit parallel I/O is furnished, select only one of Options 005, 006, 007, or choose none.
- **Opt UKR** Delete HP Instrument BASIC
- **Opt 1F0** Add DIN Keyboard
- **Opt UK6** Commercial Calibration Certificate with Test Data

HP E5100U Upgrade Kit for HP E5100A/B
- **Opt 010** Retrofit Kit for Opt 010
- **Opt 022** Retrofit Kit for Opt 022
- **Opt 023** Retrofit Kit for Opt 023
  Note: E5100A only
- **Opt 090** Expand NOP to 1601
  Note: E5100A only
- **Opt UK6** Commercial Calibration Certificate with Test Data

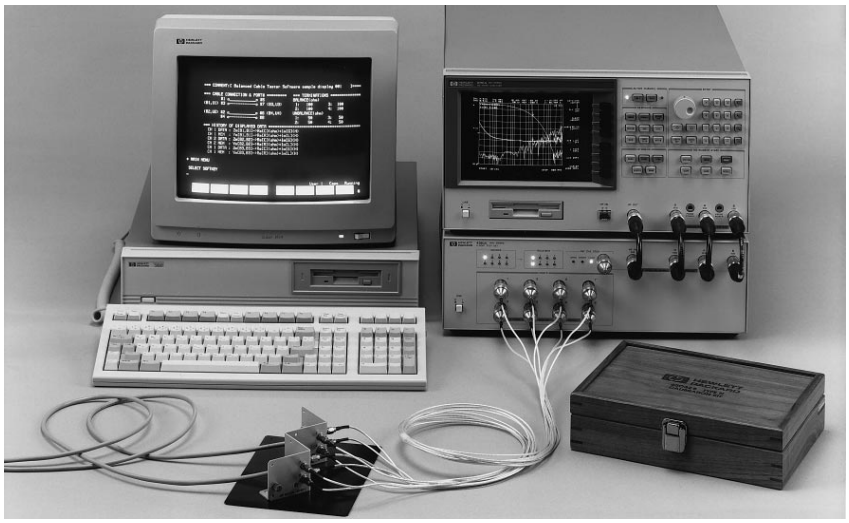
Accessories

HP 41800A Active Probe
HP 41802A 1-MΩ Input Adapter
HP 41900A PI-Network Test Fixture
- **Opt 001** Adapter Kit for Load Capacitor

HP 41901A SMD PI-Network Test Fixture
- **Opt 001** to 006 Attachment Kit

HP E5090A 2-Port Transmission/Reflection Test Kit
HP 11850C 50 Ω Three-Way Power Splitter

- For characterization of high performance LAN components
- 10 kHz to 500 MHz without BALUN transformers
- Any LAN UTP/STP characteristic impedance
- Single connection provides full parameter set
- Balanced and unbalanced parameters



HP 4380S

HP 4380S RF Balanced Cable Test System

The HP 4380S system simplifies research and development and engineering characterization of balanced cable and connecting hardware up to 500 MHz. The system makes balanced and unbalanced measurements on unshielded twisted pair (UTP) or shielded twisted pair (STP) cables and related components with wide ranges of characteristic impedance values. These cables and related hardware are normally used for high data-rate transmission and/or EIA/TIA 568 category 5 (or greater) LAN applications.

BALUN Errors and Problems Eliminated

By employing the modal decomposition method, "ideal" balanced-to-unbalanced transformers (BALUNs) are realized by mathematical calculation. Problems associated with physical BALUNs are eliminated, simplifying and improving measurements, while offering new levels of test flexibility. The HP 4380S can make high-quality measurements up to 500 MHz, where BALUN transformers typically degrade measurement performance or are unusable at these frequencies. In addition, BALUN transformers are usually limited to about 3 decades of frequency range. For wider frequency ranges, two or more separate BALUNS are often required. The HP 4380S can make wide-frequency-range tests from 10 kHz to 500 MHz with just one setup.

All Characteristics with One Setup

The HP 4380S calculates all the DUT characteristics from one set of S-parameter measurement data, using a single cable connection. This eliminates data-correlation or degradation problems sometimes encountered with multiple connections and BALUN configurations.

In addition, the HP 4380S derives "from balance to unbalance" or "from unbalance to balance" characteristics sometimes necessary for engineering evaluation. These parameters are often difficult or impossible to obtain using other techniques.

Basic System Configuration

The HP 4380S system consists of the following major elements:

- HP 8751 A 500 MHz network analyzer
- HP 4380A 8-port S-parameter test set
- HP 4380A Option 001 or 002 cable test software (HP BASIC) and accessories package
- Compatible controller supporting HP BASIC version 6.2 or greater and an HP-IB interface

Contact your local Hewlett-Packard Test & Measurement sales specialist to discuss custom configurations to meet special testing requirements.

Specifications

Frequency Range: 10 kHz to 500 MHz
Number of Pairs: For near-end parameters only: 4 pairs
For near- and far-end parameters: 2 pairs

Measurement Parameters
Balanced
Characteristic impedance (Zc)
Insertion loss (attenuation)
Near-end crosstalk (NEXT)
Input impedance (Zin)
Far-end crosstalk (FEXT)
Return loss
Unbalanced
Characteristic impedance (Zc)
Input impedance (Zin)
Return loss
Insertion loss (attenuation)
Near-end crosstalk (NEXT)
Far-end crosstalk (FEXT)
Balanced-to-unbalanced
Return loss
Differential mode rejection ratio (DMRR)
Near-end crosstalk (NEXT)
Far-end crosstalk (FEXT)
Unbalanced-to-balanced
Return loss
Common mode rejection ratio (CMRR)
Near-end crosstalk (NEXT)
Far-end crosstalk (FEXT)

Key Literature

HP 4380S RF Balanced Cable Evaluation Test System
Product Overview, p/n 5963-3612E

Ordering Information

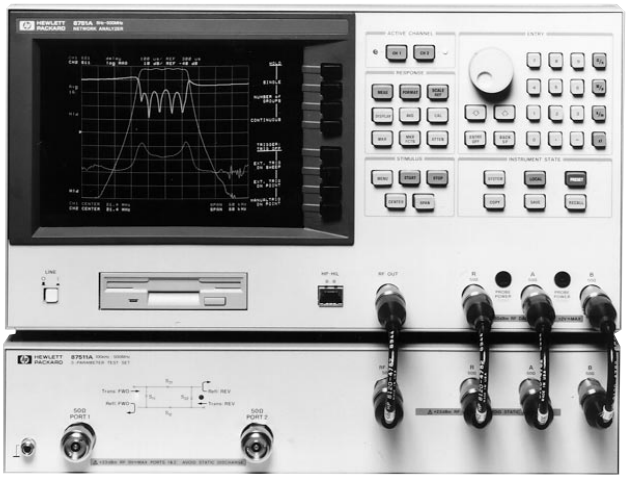
HP 4380S RF Balanced Cable Test System
HP 8751A Network Analyzer
HP 4380A 8-port Test Set
Opt 002 Cable Test Accessories and Software for PC
HP 85033D 3.5-mm Calibration Kit
Opt 001 Delete 7-mm Adapter
HP 10833B HP-IB (2 m)
External PC with Windows 95, HP-Basic for Windows and HP-IB Interface

Network Analyzers

270 Baseband, IF and RF Network Analyzer, 5 Hz to 500 MHz

HP 8751A

- 5 Hz to 500 MHz
- ±0.02 dB, ±0.12° dynamic accuracy
- 0.001 Hz, 0.001 dB, 0.001 degree, 10 ps resolution
- Full 2-port and interpolative calibration
- Conjugate matching analysis
- Built-in 1.44 MB disk drive for save/recall
- Crisp color display
- 10 updates of 201 sweep points per second
- 0.4 ms/point fast list sweep (IFBW = 4 kHz)
- Up to 4 traces simultaneous measurement/display
- Eight active trace markers per channel
- HP Instrument BASIC for customization
- HP 41802A 1 MΩ input adapter
- List sweep for efficient measurement



HP 8751A with HP 87511A

4 HP 8751A Network Analyzer

The HP 8751A network analyzer is a high-throughput instrument with lab precision that covers 5 Hz to 500 MHz. The HP 8751A provides resolution of 0.001 Hz, 0.001 dB, 0.001 degree, and 10 ps for characterizing the linear behavior of either passive or active networks, devices, or components in the lab and the production test areas. The built-in 1.44 MB disk drive is for direct save/recall of instrument state, calibration data, and application programs for your customization. Dedicated 50/74 Ω S-parameter test sets, 50/75 Ω T/R test kits, and the 1 M Ω input adaptors are all available.

Specifications

Source

Frequency Characteristics
Range: 5 Hz to 500 MHz
Resolution: 1 mHz
Accuracy: ± 20 ppm, ± 1.0 ppm (Option 001)
Stability: ± 2.5 x 10^{-9}/8 hours (typical 23±5° C with Option 001)

Output Characteristics

Power Range: –50 to + 15 dBm
Resolution: 0.1 dB
Flatness: ±2.0 dB @ 5 Hz ≤ freq. ≤ 500 MHz (23 ±5° C, +0 dBm, relative to 50 MHz)
Level Accuracy: ±0.5dB (50 MHz, 0 dBm)
Level Linearity: ± 0.5dB @ output level ≥ –35dBm; ±1.5dB @ output level < –35dBm (50 MHz, relative to 0 dBm)
Impedance: 50 Ω

Receiver

Frequency Range: 5 Hz to 500 MHz
Input Range: 0 dBm @ ATT = 20 dB; –20 dBm @ ATT = 0 dB
IF Bandwidth: 2 Hz, 20 Hz, 200Hz, 1 kHz, 4 kHz
Noise Level: –130 dBm @ IFBW=20 Hz, ATT=0 dB, frequency ≥100 kHz
Maximum Input Level: 0 dBm
Impedance: 50 Ω
Crosstalk: <–100 dB
Dynamic Accuracy: ±0.02 dB, ± 0.12° (input level –10 to –50 dB, 20 Hz IFBW)

Delay Characteristics

Aperture Frequency: 0.5 to 20%
Display Range: 10 ps to 500 s
Accuracy: (Phase accuracy)/(360 x aperature)
Size: 425 mm W x 235 mm H x 553 mm D (16.75 in x 9.25 in x 21.77 in)
Weight: 28 kg (61.6 lb)

Key Literature

HP 8751A Network Analyzer Data Sheet, p/n 5952-2370

Ordering Information

HP 8751A Network Analyzer
- **Opt 001** High-Stability Frequency Reference
- **Opt 002** HP Instrument BASIC and 1 MB RAM
- **Opt 907** Front Handle Kit
- **Opt 908** Rackmount Kit
- **Opt 909** Rack Flange and Handle Kit
- **Opt 910** Extra Operating Manual
- **Opt 915** Add Service Manual

HP 87511A 50 Ω S-Parameter Test Set*
- **Opt 001** N-Type Port

HP 87511B 75 Ω S-Parameter Test Set*
- **Options (common for the HP 87511A/B)**
- **Opt 907** Front Handle Kit
- **Opt 908** Rackmount Kit
- **Opt 909** Rack Flange and Handle Kit
- **Opt 910** Extra Operating Manual

HP 87512A 50 Ω Transmission/Reflection Test Kit*
HP 87512B 75 Ω Transmission/Reflection Test Kit*
HP 41802A 1 MΩ Input Adaptor
HP 41800A Active Probe

*See above literature for details.

- 300 kHz to 3 GHz (1.3 GHz in HP 8711C and HP 8712C)
- TCP/IP-compliant Ethertwist LAN interface
- Internal 3.5-inch disk drive (LIF/DOS formats)
- Narrowband and broadband detection
- "Real-time" sweep speed (50 ms/sweep)
- Integrated transmission/reflection test set
- Synthesized 1 Hz resolution source
- 2, 6, 12 port switching test sets available
- Internal HP Instrument BASIC (IBASIC)
- 100 dB of system dynamic range
- AM delay, fault location and SRL measurements

HP 8711C
HP 8712C
HP 8713C
HP 8714C

RF Economy Network Analyzers

The HP 8711C family of RF economy network analyzers provide speed, accuracy, and measurement versatility in a compact, integrated instrument for high-volume RF component manufacturing, inspection, and maintenance. An integrated synthesized source and transmission/reflection test set enable complete swept frequency characterization of RF components with a single connection. For testing narrowband devices, the internal synthesized source provides a fast (50 ms/sweep), stable (1 Hz resolution) stimulus. Calculate and display specified device characteristics in real time. Eight markers per channel, marker search, tracking, bandwidth, and a variety of math functions speed component testing.

The optional TCP/IP-compliant Ethertwist LAN interface provides fast, simultaneous distribution of new test parameters, test line limits, and custom interfaces to all test instruments on your production line. LAN capability helps gather test data from every station for trends analysis and quality improvements.

The instrument has a large, 9-inch instrument display, or use a VGA-compatible color monitor for enhanced visibility. Display formats include linear and log magnitude, group delay, phase (models HP 8712C and 8714C), SWR, polar, Smith chart, and real and imaginary. For 75 ohm measurements, dBV/dBmV/dBμV formats also available.

For testing linear and nonlinear components of RF systems, sensitive receivers have both narrowband and broadband detection. Broadband detection allows characterization of frequency-translation devices, while narrowband detection provides more than 100 dB of dynamic range for testing high-rejection, narrowband devices. Calibrated external scalar detectors measure external DUTs and amplitude modulation delay. Power sweep enables testing of amplifier gain compression. A built-in, LIF/DOS format, 3.5-inch disk drive allows unlimited storage of instrument states, data calibration and measurement, and data transfer from your LAN.

Designed for Manufacturing

The HP RF economy network analyzers are designed for high-volume manufacturing and have the speed, and automation features, to reduce test times—and cost—per test. The LAN capability, large VGA, easy-to-understand interface, and internal store and recall of complete instrument states all save time and reduce operator errors.

With LAN capability, R&D and manufacturing departments can readily share and analyze data. Identify pass/fail trends by material and lot number and stations that require calibration. Investigate productivity by variables you select. Create and distribute new test definitions reliably and instantly, plus gain an overview of production, inventory turns, and cost per test. Literally hundreds of instrument states can be programmed for a variety of uses. Up to seven instrument states can be quickly recalled with a single softkey or optional footswitch for hands-free switching. HP's "Fast-Recall" switching can be accomplished in milliseconds so you don't have to change measurement parameters manually.

Powerful marker-search functions speed final test of components by calculating and displaying in real-time-specified device characteristics (maximum/mininum and a 3-dB bandwidth gain slope and flatness), along with measurement data.

Bar-coding capability lets you efficiently track and document individual device performance. With the IBASIC option, correlate test station and operator data with the performance data of every device, before it leaves your facility.

HP 8711C
HP 8712C
HP 8713C
HP 8714C
HP 87075C
HP 8730A
HP 87030A

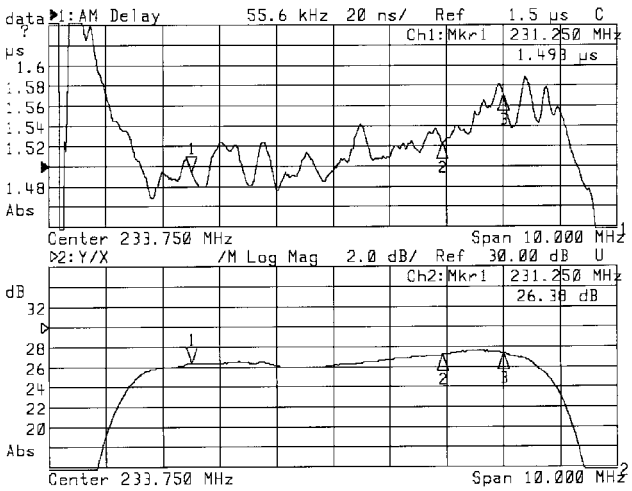
HP 8711C and HP 8713C

These two members of the family offer economical magnitude measurements. They are low-cost RF component test systems with an excellent price for performance to lower your production costs and increase your competitiveness. The HP 8711C has a frequency range of 300 kHz to 1.3 GHz, while the HP 8713C has a frequency range of 300 kHz to 3 GHz.

Optional AM delay allows measurement of delay through frequency-translating devices. Two independent display channels can measure and display two measurements, such as reflection and transmission, in a variety of useful formats.

AM Delay

Delay is an important measure of the nonlinearity of a device's phase response versus frequency. Amplitude modulation delay can measure delay in frequency-translating devices where phase differential will not work. The analyzer measures delay using two calibrated external scalar detectors, the HP 86200B or 86201B.



HP 8712C and HP 8714C

These two members of the RF economy network analyzer family offer higher-performance RF vector measurement capabilities, including phase, complex impedance, and linear group delay. When combined with optional amplitude modulation (AM) delay, these products satisfy your most demanding RF measurement needs. The HP 8712C has a frequency range of 300 kHz to 1.3 GHz, while the HP 8714C has a frequency range of 300 kHz to 3 GHz.

Two independent display channels can simultaneously measure and display two measurements, such as reflection and delay, in a variety of useful formats including complex impedance and SWR, on rectangular, polar, or Smith charts.

Comprehensive, Fast Cable Test

When cable does not meet specifications, it is an expensive problem for manufacturers, installers, and maintainers. Option 100 fully tests cables that may have been invisibly damaged through shipment and verifies manufacturer's data.

Option 100 is easy to use and lowers your cost per test with faster, less error-prone measurements of loss, impedance, structural return loss (SRL), and fault location.

SRL is the ratio of incident to the reflected signal, giving the reflection coefficient referenced to the cable's impedance. Periodic disturbances that can cause SRL are usually created by manufacturing or reel-handling incidents. Too small by themselves to cause problems, reflections from each incident can sum coherently. This causes significant reflections at a frequency with a wavelength corresponding to the disturbance spacing, times two. Option 100 also gives you the capability to utilize a known short cable length and determine velocity factor and cable loss per 100 feet. Option 100's multibump correction automatically compensates for multiple reflections from cable faults or connectors that cause inaccurate measurement of subsequent faults.

HP offers optional 50- and 75-ohm 10-, 15- and 30-foot low-loss, phase-stable cables, and a complete selection of calibration kits.

HP 87075C Multiport Test Set

NEW

The HP 87075C multiport test set allows the complete characterization of multiport devices with a two-port network analyzer. The HP 87075C has a frequency range of 300 kHz to 1.3 GHz and operates with 75-ohm HP 8711C, 8712C, 8713C, and 8714C network analyzers. Three options allow you to choose the number of ports that best fit your needs—either 2, 6, or 12 ports.

The test set provides switching capability for the measurement ports, and tests all desired signal paths, with only one connection to the device-under-test. Now multiport device manufacturers can decrease tune and test time, reduce operator fatigue, misconnection rates, and reduce the wear on cables, fixtures and connectors.

In addition to basic switching capability, the HP 87075C gives you specified performance at the test port. The test set is shipped with a factory-complete installation (default) calibration, which includes calibration of all measurement ports. You can use this default calibration, or complete your own installation calibration.

In between "installation" calibrations, the instrument can quickly "on-line" calibrate (SelfCal) the measurement ports using internal transfer standards. The network analyzer's firmware automatically controls the SelfCal process. SelfCal quickly brings the system to the same accuracy level as the installation calibration. The SelfCal capability reduces calibration times by a factor of 20.

HP 8730A/87030A Tuner Analyzer

The HP 8730A is an economical tuner-test solution from Hewlett-Packard that brings unprecedented levels of throughput, accuracy, and reliability to your tuner manufacturing line. The HP 8730A tuner test system includes a fast and accurate analyzer with an integrated RF source, along with all of the necessary bias supplies and control signals for complete tuner alignment and verification. The analyzer is capable of testing both analog and digitally-controlled tuners and the synthesized source provides precise frequencies—within 1 Hz. The HP 8730's accuracy gives you new confidence that you are making high-quality, repeatable measurements which will improve your product yields.

Calibration Kits

Accuracy enhancement removes systematic errors by measuring known devices (standards) over the frequency range of interest. Kits for the RF economy network analyzer family contain standards to characterize these errors.

HP 85032E 50 Ω Type-N Economy Calibration Kit

The HP 85032E contains 50 Ω type-N standards to calibrate network analyzers to measure devices with 50 Ω type-N connectors. Standards include a fixed termination, open circuit, and short circuit.

HP 85033D 3.5-mm Calibration Kit

The HP 85033D contains 50 Ω 3.5-mm standards to calibrate network analyzers to measure devices with 50 Ω 3.5-mm connectors. Standards include a fixed termination, open circuit, and short circuit.

HP 85036E 75 Ω Type-N Economy Calibration Kit

The HP 85036E contains 75 Ω type-N standards to calibrate network analyzers to measure devices with 75 Ω type-N connectors. Standards include a fixed termination, open circuit, and short circuit.

HP 85039B 75 Ω Type-F Calibration Kit NEW

The HP 85039B contains 75 Ω type-F standards, both male and female, to calibrate network analyzers for measurements of common broadband and CATV components with 75 Ω type-F connectors. Standards include a fixed load, open circuit, and short circuit. The following adapters are also included: type-F (f-f), type-F (m-m), type-N (f) to type-F (m) and type-N (m) to type-F (f). A complete male set of standards (fixed-load, open, short) and (m-m) adapter can be ordered as HP 85039B Option 00M, and a complete female set as HP 85039B Option 00F.

Additional type-F adapters available: type-F (m) to type-N (m) (85039-60010), type-F (m) to type-F (f) (85039-60012), and type-F (f) to type-N (f) (85039-60014).

Specifications Summary

	HP 8711/12	HP 8713/14
Source Characteristics		
Frequency Range		
Min. frequency	300 kHz	300 kHz
Max. frequency	1.3 GHz	3.0 GHz
Resolution	1 Hz	1 Hz
Accuracy	<5 ppm	<5 ppm
Output Characteristics		
Power Range (standard)		
<1000 MHz	0 to 16 dBm	–5 to 10 dBm
>1000 MHz	0 to 13 dBm	–5 to 10 dBm
With Attenuator		
<1000 MHz	–60 to 13 dBm	–60 to 7 dBm
>1000 MHz	–60 to 10 dBm	–60 to 7 dBm
With 75 Ω	reduces output by 3 dB	
With Group Delay	reduces output by 3 dB	
Test Port Accuracy and Flatness		
Standard	±1.0 dB	±1.0 dB
Option 1 EC	±1.5 dB	±1.5 dB
Option 1 E1	±2.0 dB	±2.0 dB
Option 1 EC and 1E1	±3.0 dB	±3.0 dB
Signal Purity		
Harmonics	(at +7 dBm)	
<1 MHz	<–20 dBc	<–30 dBc
>1 MHz	<–30 dBc	<–30 dBc

	HP 8711/12	HP 8713/14
Receiver Characteristics		
Frequency Range		
Narrowband	300 kHz to 1.3 GHz	300 kHz to 3.0 GHz
Broadband	10 MHz to 1.3 GHz	10 MHz to 3.0 GHz
Dynamic Range		
Narrowband		
<5 MHz	>60 dB	>80 dB
>5 MHz	>100 dB	>100 dB
Broadband		
Internal	>66 dB	>60 dB
External	>66 dB	>66 dB
Maximum Input		
Narrowband (at 0.8 dBm compression)	10 dBm	10 dBm
Broadband (at 0.5 dBm compression)	16 dBm	16 dBm
Input Damage Level	20 dBm	20 dBm

AM Delay Characteristics
Apertures: 55.56 kHz
Input Amplifier Range: –10 to +13 dBm
Resolution: 0.5 ns
Range: 30 µs (9000 m)
Accuracy: ±4 ns

Test Set Characteristics
Reflection Port Match: 30 dB
Transmission Port Match: 18 dB typical
System Directivity: 40 dB

RF Connectors
Test Ports: All models are available in 50 Ω or 75 Ω type-N (f)

Physical Characteristics
Size: 179 mm H x 425 mm W x 514 mm D (7.0 in x 16.75 in x 20.25 in)
Weight: Net, 20.5 kg (45 lb); shipping, 25 kg (55 lb)

Detectors and Bridges

External detectors (50 Ω and 75 Ω) and bridges are available for remote device measurements and amplitude modulation delay measurements.

HP 86200B 50 Ω Scalar Detector
An external scalar detector for use when measuring external 50 Ω devices.

HP 86201B 75 Ω Scalar Detector
An external scalar detector for use when measuring external 75 Ω devices.

HP 86205A 50 Ω Bridge
An external directional bridge that offers high directivity and excellent port match and is designed for 50 Ω device measurements.

HP 86207A 75 Ω Bridge
An external directional bridge that offers high directivity and excellent port match and is designed for 75 Ω device measurements.

Upgrading Kits

The following upgrade kits add optional measurement capability to existing HP RF economy network analyzers.

HP 86223B Attenuator Upgrade Kit
Provides the necessary components to retrofit an HP RF economy network analyzer with a 60 dB step attenuator (Option 1E1). Includes installation at an HP service center. Also available as HP p/n 08711-60067.

HP 86224C IBASIC Upgrade Kit
Provides the necessary components to retrofit an RF economy network analyzer with BASIC capabilities (Option 1C2). Includes installation at an HP service center. Also available as HP p/n 08711-60164.

HP 86221B AM Delay Upgrade Kit, 50 Ω
Provides the necessary components to retrofit an RF economy network analyzer with AM delay capabilities (Option 1DA). Includes installation at an HP service center.

HP 86225B AM Delay Upgrade Kit, 75 Ω
Provides the necessary components to retrofit an RF economy network analyzer with AM delay capabilities (Option 1DB). Includes installation at an HP service center.

HP 86228C FL/SRL Upgrade Kit
Does not include transport case.

HP 86227C LAN Upgrade Kit
Adds TCP/IP compliant LAN interface.

HP 86226C Firmware Upgrade Kit
Upgrade to the latest revision of firmware.

HP C1405B DIN Keyboard
PC keyboard to enhance editing capability (Option 1CL).

Test Port Cables

Replacement test port cables are available as HP part numbers. One economy cable is standard for the RF economy network analyzers.
HP 8120-6469 Economy Cable; Type-N, 50 Ω (included with RF ENAs)
HP 8120-4781 Precision Cable; Type-N, 50 Ω
HP 8120-6468 Economy Cable; Type-N, 75 Ω (included with RF ENAs, Option lEC)
HP 8120-2408 Precision Cable; Type-N, 75 Ω

Ordering Information

HP 8711C Network Analyzer
HP 8712C Network Analyzer
HP 8713C Network Analyzer
HP 8714C Network Analyzer
- **Opt 1EC** 75 Ω System Impedance
- **Opt 1E1** 60 dB Attenuator
- **Opt 1C2** IBASIC Capability
- **Opt 1DA** 50 Ω AM Delay
- **Opt 1DB** 75 Ω AM Delay
- **Opt 1CL** DIN Keyboard
- **Opt 1CM** Rackmount
- **Opt 100** Fault Location/SRL
- **Opt 101** Transportable Operating Case plus Fault Location/SRL
- **Opt 1F7** LAN Interface

HP 85075C Multiport Test Sets
- **Opt 002** 2 ports
- **Opt 004** 4 ports
- **Opt 012** 12 ports

HP 86223B Attenuator Upgrade Kit
HP 86224C IBASIC Upgrade Kit
HP 86221B AM Delay Upgrade Kit 50 Ω
HP 86225B AM Delay Upgrade Kit 75 Ω
HP 86228C FL/SRL Upgrade Kit
HP 86227C LAN Upgrade Kit
HP 86226C Firmware Upgrade Kit
HP C1405B DIN Keyboard
HP 8730A Tuner Analyzer
- **Opt 1C2** IBASIC Capability
- **Opt 1F7** LAN Interface
- **Opt 1CM** Rackmount Kit
- **Opt 1CL** DIN Keyboard

HP 87030 Tuner Test Set
- **Opt 1CM** Rackmount Kit

HP 86226T TV Tuner Firmware Upgrade Kit
HP 85032E Type-N Calibration Kit, 50 Ω
HP 85036E Type-N Calibration Kit, 75 Ω
HP 85033D 3.5-mm Calibration Kit
HP 85039B 75 Ω Type-F Calibration Kit
- **Opt 00F** Female Standards Set
- **Opt 00M** Male Standards Set

HP 11853A Type-N Accessory Kit, 50 Ω
HP 11854A BNC Accessory Kit, 50 Ω
HP 11855A Type-N Accessory Kit, 75 Ω
HP 11856A BNC Accessory Kit, 75 Ω
HP 86211A Type-F Accessory Kit, 75 Ω
HP 86200B 50 Ω Scalar Detector
HP 86201 B 75 Ω Scalar Detector
HP 86205A 50 Ω Bridge
HP 86207A 75 Ω Bridge
HP 8120-1839 BNC Test Port Cable, 50 Ω
HP 5063-0061 BNC Test Port Cable, 75 Ω
HP 8120-4781 Type-N Cable, 50 Ω
HP 8120-2408 Type-N Cable, 75 Ω
HP 86217A Type-N 50 Ω Cable, male/male
- **Opt 10** 10 ft.
- **Opt 15** 15 ft.
- **Opt 30** 30 ft.

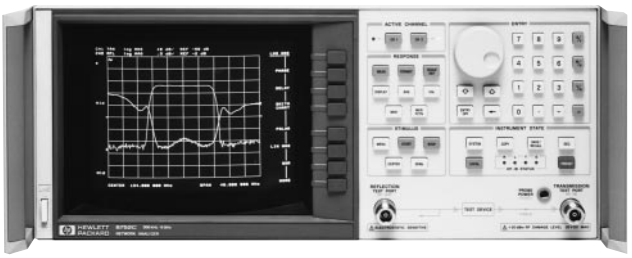
HP 86217B Type-N 50 Ω Cable, male/female
- **Opt 10** 10 ft.
- **Opt 15** 15 ft.
- **Opt 30** 30 ft.

HP 86218A Type-N 75 Ω Cable, male/male
- **Opt 10** 10 ft.
- **Opt 15** 15 ft.
- **Opt 30** 30 ft.

HP 86218B Type-N 75 Ω Cable, male/female
- **Opt 10** 10 ft.
- **Opt 15** 15 ft.
- **Opt 30** 30 ft.

HP 1250-2713 Feed Thru, female/female
HP 9211-2656 Transit Case

- 300 kHz to 1.3, 3, or 6 GHz
- Integrated 1 Hz resolution synthesized source
- Integrated transmission/reflection test set
- 50 Ω or 75 Ω system impedance
- Direct save/recall to an external disk drive
- Test sequence function for repetitive test procedures
- Up to 110 dB of dynamic range
- Group delay and deviation from linear phase
- Superb uncorrected performance



HP 8752C

HP 8752C RF Network Analyzer

The new HP 8752C RF network analyzer provides simple and complete vector network measurements in a compact, fully-integrated RF network analyzer. Characterize your RF components and networks accurately and economically with the HP 8752C RF network analyzer in the 300 kHz to 1.3, 3, or 6 GHz frequency range. Integration of the swept synthesized source, test set, and receiver results in a network analyzer that is easy to set up and use, which is ideal for service, incoming inspection, production, and final test measurements.

The integrated synthesized source provides measurement port power level of +5 to –20 dBm with linear, log, list, power, and CW sweep types. A new built-in step attenuator (Option 004) gives an improved power range of +10 to –85 dBm for testing power sensitive devices such as amplifiers. The sensitive tuned receivers provide up to 110 dB of dynamic range.

With two independent display channels available, you can simultaneously measure the reflection and transmission characteristics of the device-under-test on the crisp color display. Data can be displayed in log magnitude, linear magnitude, SWR, phase, group delay, polar, real, or Smith chart formats. The easy-to-use softkey measurement functions allow you to quickly measure the desired characteristic of your device-under-test.

Designed for Manufacturing

The productivity features of the HP 8752C increase your throughput in production. The test sequence function provides rapid and consistent execution of complex, repetitive tests with a single keystroke. In sequencing mode, you make the measurement once from the front panel and the instrument automatically saves the keystrokes without an external computer.

The HP 8752C offers excellent uncorrected performance, allowing simple and accurate measurements of your device-under-test without the need for measurement calibration. New productivity enhancements are faster CPU clock rate, DOS format for disk output, and expanded nonvolatile memory of 512 KB. Other helpful features include a plot/print buffer, limit testing, arbitrary frequency testing, and marker tracking functions. Up to four onscreen markers per channel are available for hardcopy outputs or for tuning at specific frequencies.

Time-Domain Analysis

The HP 8752C with Option 010 has the capability of displaying the time domain response of a network, obtained by computing the inverse Fourier transform of the frequency-domain response. Two time-domain modes are offered with the HP 8752C. The low-pass mode provides traditional time domain reflectometer (TDR) measurement capability and gives the response of a mathematically simulated step or impulse response. The bandpass mode, which has only the impulse stimulus, provides the time domain response of frequency-selective devices such as SAW filters and antennas.

Specifications Summary

Source

Frequency Characteristics

Range: 300 kHz to 1.3 GHz (std.); 300 kHz to 3 GHz (Option 003); 300 kHz to 6 GHz (Option 006)
Resolution: 1 Hz
Accuracy: ±10 ppm at 25° ± 5° C

Output Characteristics

Power Range: –20 to +5 dBm (std), –85 to +10 dBm (Option 004), –85 to +8 dBm (Option 004 and 075)
Resolution: 0.05 dB
Level Accuracy: ±1 dB
Level Linearity relative to–5 dBm output level:
(–20 to –15 dBm) ±0.5 dB;
(–15 to 0 dBm) ±0.2 dB;
(0 to +5 dBm) ±0.5 dB

Receiver

Frequency Range: 300 kHz to 1.3 GHz (std.), 300 kHz to 3 GHz (Option 003), 300 kHz to 6 GHz (Option 006)
Noise Level: (typical)
Reflection: –75 dBm (3 kHz IF BW), –85 dBm (10 Hz IF BW)
Transmission:
–90 dBm (3 kHz IF BW), –110 dBm (10 Hz IF BW) [300 kHz to 3 GHz];
–85 dBm (3 kHz IF BW), –105 dBm (10 Hz IF BW) [3 to 6 GHz]
Damage Level: 20 dBm or 25 Vdc (Option 006: 20 dBm or 25 Vdc at reflection port, 20 dBm or 10 Vdc at transmission port)
Crosstalk: 100 dB, 300 kHz to 1.3 GHz; 100 dB (97 dB Option 075), 1.3 to 3 GHz; 90 dB, 3 to 6 GHz

Group Delay Characteristics

Range: 1/(2 x minimum aperture)
Aperture: Frequency span/(no. of points –1), up to 20% of frequency span
Accuracy (in seconds): (phase accuracy (in degrees)/(360 x aperture in Hz)

RF Connectors

Test Ports: 50 Ω type-N (female); 75 Ω type-N (female) (Option 075)

Physical Characteristics

Size: 425 mm W x 178 mm H x 508 mm D (16.75 in x 7.0 in x 20.0 in)
Weight: Net, 25 kg (56 lb); shipping, 28 kg (63 lb)

Upgrade Kits

(Serial number of 8752C must be specified when ordering these kits.)

HP 11885A 3 GHz Frequency Upgrade Kit
The HP 11885A upgrade kit adds Option 003 to extend the operating frequency range of the HP 8752C from 1.3 GHz to 3 GHz. Installation at an HP service center is included.

HP 85019C Time-Domain Upgrade Kit
The HP 85019C upgrade kit adds time-domain analysis capability (Option 010) to an existing HP 8752C network analyzer. This kit is user installable. Installation at local HP service center is not included.

HP 11884D 6 GHz Upgrade Kit for HP 8752C
Includes installation at a local HP service center. Not for use with HP 8752C Option 075.

HP p/n 08752-60019 Step Attenuator Retrofit Kit

Accessories

HP 11878A 3.5-mm Adapter Kit
The HP 11878A adapter kit provides the RF components generally required when an SMA or 3.5-mm device needs to be measured with the HP 8752C standard type-N configuration. The kit includes four type-N to 3.5-mm adapters for both male and female connectors.
HP 11853A 50 Ω Type-N Accessory Kit
The HP 11853A accessory kit furnishes the RF components required for measurement of devices with 50 Ω type-N connectors.
HP 11854A 50 Ω BNC Accessory Kit
The HP 11854A accessory kit furnishes the RF components required for measurement of devices with 50 Ω BNC connectors.
HP 11855A 75 Ω Type-N Accessory Kit
The HP 11855A accessory kit furnishes the RF components required for measurement of devices with 75 Ω type-N connectors.
HP 11856A 75 Ω BNC Accessory Kit
The HP 11856A accessory kit furnishes the RF components required for measurement of devices with 75 Ω BNC connectors.
Test Port Cables: Additional or replacement cables (24 in) for the HP 8752C:
HP p/n 8120-4781 Type-N 50 Ω (both connectors male)
HP p/n 8120-2408 Type-N 75 Ω (both connectors male)
HP p/n 8120-2409 Type-N 75 Ω (one male, one female connector)
HP 11852B 50 Ω /75 Ω Minimum Loss Pad
The HP 11852B is a low SWR minimum loss pad required when measurements are made on 75 Ω devices with the HP 8752 network analyzer. Measurements on two port devices require two HP 11852B pads and one 50 Ω type-N barrel.
Frequency Range: dc to 2.0 GHz
Insertion Loss: 5.7 dB
Return Loss: 75 Ω typically >30 dB, 50 Ω typically >26 dB
Connectors: 50 Ω type-N (f) and 75 Ω type-N (m) standard, 50 Ω type-N (m) and 75 Ω type-N (f) Option 004

Calibration Kits

The calibration kits in the HP 8752C family contain precision standards used in accuracy enhancement procedures to characterize the systematic errors of an HP 8752C measurement system. Standards include fixed terminations, open circuits, and short circuits.
HP 85032B 50 Ω Type-N Calibration Kit
Contains precision 50 Ω type-N standards used to calibrate the HP 8752C for measurements of devices with 50 Ω type-N connectors. This kit can also be used to perform system verification. Option 001 removes the precision phase-matched 7 mm to type-N adapters.
HP 85036B 75 Ω Type-N Calibration Kit
Contains precision 75 Ω type-N standards used to calibrate the HP 8752B or 8752C Option 075 for measurements of devices with 75 Ω type-N connectors. This kit also contains 75 Ω type-N adapters and can also be used to perform system verification.
HP 85033D 3.5-mm Calibration Kit
Contains precision 3.5-mm standards used to calibrate the HP 8752C network analyzer for measurements of devices with 3.5-mm or SMA connectors. Option 001 removes the precision phase-matched 7-mm to 3.5-mm adapters.
HP 85039B Type-F Calibration Kit NEW
Contains 75 Ω type-F fixed load, and open and short circuits (both male and female) to calibrate the HP 8752C for measurements of common broadband and CATV components. Also includes type-F f-f and m-m adapters, and type-N to type-F f-m and m-f adapters. A male-only version of the cal kit can be ordered as HP 85039B Option 00M and a female-only version can be ordered as HP 85039B Option 00F.

Ordering Information

HP 8752C Network Analyzer
Opt 003 3 GHz Frequency Extension
Opt 004 Step Attenuator
Opt 006 6 GHz Frequency Extension
Opt 010 Time-Domain Capability
Opt 075 75 Ω Impedance
Opt 802 Add Dual Disk Drive and HP-IB Cable
Opt AFN Add 50 Ω Test Port Cable
Opt AFP Add 75 Ω Test Port Cable
HP 11885A 3 GHz Frequency Upgrade
HP 85019C Time-Domain Upgrade
HP 11884D 6 GHz Upgrade Kit
HP 85032B 50 Ω Type-N Calibration Kit
Opt 001 Deletes 7 mm to Type-N Adapters
HP 85036B 75 Ω Type-N Calibration Kit
HP 85033D 3.5-mm Calibration Kit
HP 85039A Type-F 75 Ω Calibration Kit
HP 11878A 3.5-mm Adapter Kit
HP 11853A 50 Ω Type-N Accessory Kit
HP 11854A 50 Ω BNC Accessory Kit
HP 11855A 75 Ω Type-N Accessory Kit
HP 11856A 75 Ω BNC Accessory Kit
HP 11852B 50 Ω/75 Ω Minimum Loss Pad
Opt 004 50 Ω Type-N (m) and 75 Ω Type-N (f) connectors
HP 8120-4781 50 Ω Type-N Test Port Cable
HP 8120-2408 75 Ω Type-N Test Port Cable
HP 08752-60019 Step Attenuator Retrofit Kit
HP 8120-2409 75 Ω Type-N (m-f) Test Port Cable
HP 85024A High-Frequency Probe

HP 85024A High-Frequency Probe

The HP 85024A high-frequency probe makes it easy to perform in-circuit measurements. An input capacitance of only 0.7 pF shunted by 1 megaohm of resistance permits high-frequency probing without adversely loading the circuit-under-test. Excellent frequency response and unity gain guarantee high accuracy in swept measurements with this probe. High probe sensitivity and low distortion levels allow measurements to be made while taking advantage of the full dynamic range of HP RF analyzers. Spectrum analyzers that supply probe power from the front panel include the HP 8568B, HP 8590 series, HP 8560 series, and the HP 70000 series. RF network analyzers such as the HP 8753E, 8752C, 8751A, 3577A, and 4195A are also directly compatible. You can use the HP 85024A with other instruments by using the HP 1122A probe power supply or any dual ±15 V, 130 mA supply.

HP 85024A

Specifications Summary

Input Capacitance (at 500 MHz): <0.7 pF (nominal)
Input Resistance: 1 MΩ (nominal)
Bandwidth: 300 kHz to 3 GHz (usable to 100 kHz)
Gain (at 500 MHz): 0 dB ±1 dB
Average Noise Level (10 Hz to 10 MHz): <1 mV
Frequency Response: ±1 dB (300 kHz to 1 GHz); +2, –3 dB (1 GHz to 3 GHz)
Input Voltage for 1 dB Compression: 0.3 V peak
Maximum Safe RF Voltage: 1.5 V peak (with 10:1 divider 15 V peak)
Noise Figure (nominal): <50 dB (<100 MHz); <25 dB (100 MHz to 3 GHz)
Distortion (at 0.3 V): <–30 dBc nominal
Includes: Type-N male adapter, 10:1 divider, spare probe tips, (5) 2½-inch ground leads, hook tip, spanner tip, and probe tip nut driver.

- 30 kHz to 6 GHz frequency range
- Integrated S-parameter test set
- Integrated 1-Hz resolution synthesized source
- Optional time-domain and swept-harmonic measurements
- Up to 110 dB of dynamic range
- Group delay and deviation from linear phase
- Save/recall to built-in disk drive
- Built-in accuracy enhancement

HP 8753D

HP 8753D RF Network Analyzer

The HP 8753D RF network analyzer provides affordable excellence in RF network measurement for laboratory and production testing. It has an integrated S-parameter test set for longer-lasting calibrations, exceptional reliability, and improved resistance to electrostatic discharge. The HP 8753D gives you a complete solution for characterizing active or passive networks, devices, or components from 30 kHz to 6 GHz—with a cost savings over the previous model with a test set.

The network analyzer has two independent display channels for simultaneous display of reflection and transmission, magnitude and phase, or time-domain and swept-frequency measurements. Easy-to-use softkeys let you access measurement functions quickly, and you can view results in overlay or split-screen format on the crisp color display.

Maximum Versatility and Performance

An integrated, synthesized source provides up to 10 mW of output power (100 mW for Option 011), 1 Hz frequency resolution, and linear, log, list, power, and CW sweep types. Three tuned receivers allow independent power measurements or simultaneous ratio measurements over a wide dynamic range of 105 dB at 6 GHz (with Option 006 frequency extension) or 110 dB at 3 GHz (standard). The integrated test set allows you to measure transmission and reflection characteristics of a device to 6 GHz without a frequency doubler.

TRL*/LRM*[1] calibration has been added for convenient, accurate measurements in noncoaxial environments. A high-stability frequency reference, Option 1D5, improves the frequency accuracy of measurements on high-Q devices such as SAW resonators or dielectric resonance filters. For configuration flexibility, Option 011 deletes the built-in test set so that you can select your own. The HP 8753D Option 011 works with the HP 85046A/B, 85047A, and other test sets.

Productivity Enhancements

A test-sequence function allows rapid, repeated execution of complex tasks with a single keystroke. In sequencing mode, you make a measurement once from the front panel, and the analyzer stores the keystrokes so that no additional programming is required. You can also use a test sequence to control external devices through the parallel port.

Other productivity enhancements include a built-in disk drive supporting LIF and DOS formats, a faster CPU clock rate, non-volatile memory of 512 KB, serial and parallel interfaces, a DIN keyboard interface, and a real-time clock for time-stamping of printouts and files. Limit testing, arbitrary frequency testing, and marker tracking functions are included. Segmented calibration and interpolative error correction allow you to apply vector accuracy enhancement over a subset of the analyzer's calibrated frequency range.

Nonlinear Device Testing

For nonlinear device characterization, Option 002 adds harmonic measurement capability. Swept second- and third-harmonic levels of an amplifier can be displayed directly or in dBc. With the press of a button, you can measure harmonics down to –40 dBc. Power meter calibration provides leveled absolute power to devices that are sensitive to absolute input or output levels. The HP 8753D automatically controls an HP 436A, 437B, or 438A power meter to set the power anywhere in the test configuration with power meter accuracy. The analyzer also performs mixer tracking and conversion loss measurements. Both fixed and swept IF measurements can be made.

Time-Domain Analysis

With Option 010, you can view responses in the time domain. The analyzer computes the inverse FFT of the frequency-domain data to display the reflection or transmission coefficient versus time. Two time-domain analysis modes enable you to view the step or impulse response of your device, or to remove unwanted responses such as connector mismatch using gating.

[1] TRL* and LRM* are three-sampler implementations of the through-reflect-line and line-reflect-match calibration techniques.

Specifications Summary

Test Set
Integrated S-parameter with complete forward and reverse measurements in 50 Ω (standard) or 75 Ω (Option 075). External test sets supported with Option 011.

Test Port Output
Frequency Characteristics
Range: 30 kHz to 3 GHz (std.);
30 kHz to 6 GHz (Option 006);
300 kHz to 3 GHz (Option 011);
30 kHz to 6 GHz (Option 011, 006)
Resolution: 1 Hz
Accuracy: ±10 ppm at 25 °C ± 5 °C
Output Characteristics
Power Range: –85 to 10 dBm
Resolution: 0.05 dB
Sweep Range: 25 dB
Level Accuracy: ±1.0 dB relative to 0 dBm output level
Level Linearity: (–15 to +5 dBm) ±0.2 dB typical 30 kHz to 300 kHz;
(+5 to +10 dBm) ±0.5 dB typical 30 kHz to 300 kHz
Impedance: 50 Ω
2nd Harmonic: <–25 dBc at +10 dBm (16 MHz to 3 GHz)
3rd Harmonic: <–25 dBc at +10 dBm (16 MHz to 2 GHz)
Nonharmonic Spurious (typical)
Mixer-Related: <–30 dBc at +10 dBm

Test Port Input Characteristics
Frequency Range: 30 kHz to 3 GHz (std.);
30 kHz to 6 GHz (Option 006)
Average Noise Level
3 kHz BW: –82 dBm (< –3 GHz), –77 dBm (3 to 6 GHz)
10 Hz BW: –102 dBm (< –3 GHz), –97 dBm (3 to 6 GHz)
Maximum Input Level: +10 dBm
Damage Level: +26 dBm or 35 Vdc
Impedance: 50 Ω (75 Ω with Option 075)
Harmonics: (Option 002)
2nd Harmonic: <–15 dBc at +8 dBm
3rd Harmonic: <–30 dBc at +8 dBm
Harmonic Measurement Accuracy (25 ± 5 °C):
16 MHz to 3 GHz ± 1 dB;
3 GHz to 6 GHz ± 3 dB (with Option 006)
Harmonic Measurement Dynamic Range
–40 dBc (output= –10 dBm, input < –15 dBm)

Group Delay Characteristics
Range: 1/(2 x minimum aperture)
Aperture (selectable)
Maximum: 20% of frequency span
Minimum: (frequency span)/(no. of pts. –1)
Group Delay Accuracy (in seconds): ± (phase accuracy in degrees)/(360 x aperture in Hz)

Physical Characteristics
Size: 425 mm W x 222 mm H x 508 mm D
(16.75 in x 8.75 in x 20.0 in)
Weight: 34 kg (75 lb) net; 37 kg (82 lb) shipping

Upgrade Kits

Upgrade kits retrofit the latest operating systems or add optional measurement capability to existing HP 8753A/B/C/D network analyzers.

HP 11883A Harmonic Measurements Upgrade
This upgrade kit adds harmonic measurement capability (Option 002) to an HP 8753C/D network analyzer. This kit includes installation at an HP service center.

HP 11884A 6 GHz Receiver Upgrade
This kit extends the operating frequency range of the HP 8753B/C receiver from 3 GHz to 6 GHz. To make transmission/reflection measurements above 3 GHz, the HP 85047A S-parameter test set is required. This kit includes installation at an HP service center.

HP 11884B 6 GHz Upgrade for HP 8753D Standard
This kit extends the operating frequency range of the HP 8753D from 3 GHz to 6 GHz. No additional test set is needed. Includes installation at an HP service center. Not compatible with Option 075 or Option 011.

HP 11884C 6 GHz Upgrade for HP 8753D Option 011
This kit extends the operating frequency range of the HP 8753D Option 011 from 3 GHz to 6 GHz. Includes installation at an HP service center. Not compatible with Option 075.

HP 85019B Time-Domain Upgrade Kit
This upgrade kit adds time-domain analysis capability (Option 010) to an existing HP 8753C/D network analyzer. This kit is user-installable.

S-Parameter Test Sets

The S-parameter test sets provide the capability to measure reflection and transmission characteristics (including S-parameters) of two port devices in either direction with a single connection. The test sets are controlled from the analyzer and include programmable step attenuators. These test sets are used with the HP 8753A/B/C or the HP 8753D Option 011 only.

HP 85046A/B S-Parameter Test Sets

The HP 85046A/B test sets provide the capability to simultaneously measure the transmission and reflection characteristics of 50 and 75 ohm devices, respectively.

Specifications Summary

	HP 85046A	HP 85046B
Impedance	50 Ω	75 Ω
Frequency Range	300 kHz to 3 GHz	300 kHz to 2 GHz
Directivity	35 dB to 1.3 GHz 30 dB to 3.0 GHz	35 dB to 1.3 GHz 30 dB to 2.0 GHz
Typical Tracking		
Transmission Magnitude, Phase [1,2,3]		
0.3 MHz to 2.0 MHz	±1.5 dB, ±20°	±1.5 dB, ±20°
2.0 MHz to F_{max}	±1.5 dB, ±10°	±1.5 dB, ±10°
Reflection Magnitude, Phase [1,2,3]		
0.3 MHz to 2.0 MHz	±1.5 dB, ±25°	±1.5 dB, ±25°
2.0 MHz to F_{max}	±1.5 dB, ±10°	±1.5 dB, ±10°
Effective Source Match[3] **(test ports)**		
0.3 MHz to 2.0 MHz	14 dB	14 dB
2.0 MHz to 1.3 GHz	20 dB	17 dB
2.0 MHz to F_{max}	16 dB	16 dB
RF Connectors		
Test Ports	Precision 7 mm	75 Ω type-N (female)
All Others	50 Ω Type-N (female)	50 Ω Type-N (female)

Includes: Four 190-mm (7.5 in) cables with Type-N (male) connectors for connection to the HP 8753. One HP 8753 test set interconnect cable.

Physical Characteristics
Size: 426 mm W x 90 mm H x 508 mm D (16.75 in x 3.5 in x 20 in)
Weight: Net, 6.8 kg (15 lb); shipping, 9.1 kg (20 lb)

[1] Degrees, specified as deviation from linear phase.
[2] F_{max} is the upper frequency limit of the associated test set.
[3] Can be improved through accuracy enhancement.

HP 85047A S-Parameter Test Set

The HP 85047A test set includes a frequency doubler that can be switched in to measure 3 MHz to 6 GHz in a single sweep or switched out to measure 300 kHz to 3 GHz in a single sweep. The HP 8753B/C controls the frequency doubler. (The HP 8753D Option 006 and 011 with built-in 6 GHz source does not use the frequency doubler.) Option 006 (6 GHz receiver) is required to activate the HP 85047A.

Specifications Summary

Impedance: 50 Ω
Frequency Ranges: 300 kHz to 3 GHz; 3 MHz to 6 GHz;
300 kHz to 6 GHz (HP 8753D Option 006 and 011)
Directivity: 300 kHz to 1.3 GHz: 35 dB;
1.3 GHz to 3 GHz: 30 dB; 3 GHz to 6 GHz: 25 dB
Typical Tracking
Transmission Magnitude, Phase:
300 kHz to 3 GHz: ±1.5 dB, ±10°;
3 GHz to 6 GHz: +0.5, – 2.5 dB, ±20°
Reflection Magnitude, Phase:
300 kHz to 3 GHz: ±1.5 dB, ±10°;
3 GHz to 6 GHz: ±1.5 dB, ±20°
Effective Source Match: 300 kHz to 1.3 GHz: 20 dB;
1.3 GHz to 3 GHz: 16 dB; 3 GHz to 6 GHz: 14 dB
RF Connectors
Test Ports: Precision 7 mm
All Others: 50 Ω Type-N (female)
Includes: Four 190 mm (7.5 in) cables with Type-N (male) connectors for connection to the HP 8753, one HP 8753 test set interconnect cable.

Physical Characteristics
Size: 426 mm W x 90 mm H x 508 mm D (16.75 in x 3.5 in x 20 in)
Weight: Net, 10 kg (22 lb); shipping, 15 kg (33 lb)

Solid-State Switching

Solid-state switching allows for simultaneous measurement of forward and reverse parameters and continuous update of all four S-parameters as required for two-port error correction (used to achieve best possible measurement accuracy). Option 009 replaces the standard solid-state RF test port switch with a mechanical RF switch. HP 8753 system specifications for standard and Option 009 test sets are identical. Nominal insertion loss of the solid-state switch is less than 2 dB (at 3 GHz) or 3 dB (at 6 GHz), relative to a mechanical switch.

HP 86389A/B Solid-State Switch Upgrade Kits

The HP 86389A/B kits retrofit any existing HP 85046A/B and HP 85047A S-parameter test set by replacing the mechanical RF test port switch with a solid-state RF switch. This solid-state switch allows for simultaneous measurement of forward and reverse parameters and continuous measurement of all four S-parameters (required for two-port error correction).

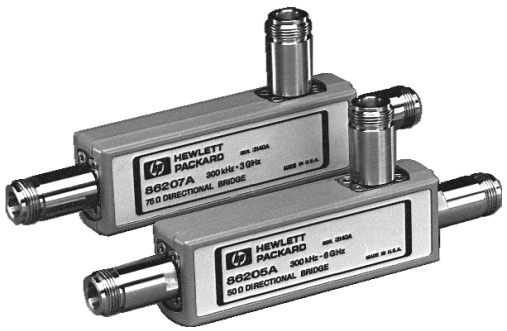
The HP 86389A retrofits HP 85046A/B test sets, and the HP 86389B retrofits HP 85047A test sets. HP 8753C network analyzers with firmware revision 4.0 or higher support solid-state test sets.

Special Test Sets

HP 8753D Option K36 Duplexer Test Adapter enables single-connection error corrected measurement of return loss at Tx, Rx, and Ant ports, and insertion loss from Tx-to-Ant, Ant-to-Tx, Rx-to-Ant, and Ant-to-Rx ports.

For applications requiring Tx-to-Rx and Rx-to-Tx measurements, Option K39 three-port test set is recommended.

Contact HP for technical specifications and information about additional special options.



HP 86205A/86207A

Accessories

HP 86205A/86207A RF Bridges

The HP 86205A/86207A high directivity RF bridges offer unparalleled performance in a variety of general-purpose applications. They are ideal for accurate reflection measurements and signal leveling applications.

Specifications Summary

	HP 86205A	HP 86207A
Impedance	50 Ω	75 Ω
Freq. Range	300 kHz to 6 GHz	300 kHz to 3 GHz
Directivity	30 dB, 0.3 MHz to 5 MHz 40 dB, 5 MHz to 2 GHz 30 dB, 2 GHz to 3 GHz 20 dB, 3 GHz to 5 GHz (typ.) 16 dB, 5 GHz to 6 GHz (typ.)	30 dB, 0.3 MHz to 5 MHz 40 dB, 5 MHz to 1.3 GHz 35 dB, 1.3 GHz to 2 GHz 30 dB, 2 GHz to 3 GHz
Coupling Factor	(< 3 GHz) 16.0 dB, + 0.15 dB/GHz (> 3 GHz) 16.5 dB, – 0.20 dB/GHz	
Insertion Loss	1.5 dB, + 0.1 dB/GHz	
Maximum Input	25 dBm	
RF Connectors	50 Ω Type-N (female)	75 Ω Type-N (female)

Physical Characteristics
Size: 93 mm H x 160 mm W x 23 mm D (3.7 in x 6.3 in x 1 in)
Weight: Net, 0.57 kg (1.3 lb); shipping, 1.8 kg (4 lb)

HP 11850C/D Three-Way Power Splitters

Specifications Summary

	HP 11850C	HP 11850D
Impedance	50 Ω	75 Ω
Frequency Range	DC to 3 GHz	DC to 2 GHz
Tracking	±0.25 dB, ±3°	±0.2 dB, ± 2.5°
Equivalent Source Match	30 dB at 1.3 GHz	30 dB at 1.3 GHz
(ratio or leveling)	20 dB at 3 GHz	20 dB at 3 GHz
Nominal Insertion Loss	9.5 dB + 1 dB/GHz	7.8 dB
Input Port Match		
DC to 1.3 GHz	20 dB	20 dB
1.3 GHz to F_{max}[1]	10 dB	10 dB
RF Connectors		
RF Input: (female)	50 Ω Type-N	50 Ω Type-N
All Others: (female)	50 Ω Type-N	75 Ω Type-N

[1] F_{max} is the upper frequency limit of the associated power splitter.

HP 11851B RF Cable Kit

This kit includes three 610-mm (24-in) 50 Ω cables phase matched to 4° at 1.3 GHz and one cable 860 mm (34-in). Connectors are type-N (male).

HP 11852B 50 Ω /75 Ω Minimum Loss Pad

The HP 11852B is a low SWR minimum loss pad required for measurements on 75 Ω devices with the HP 8753C/D.
Frequency Range: DC to 2.0 GHz
Insertion Loss: 5.7 dB
Return Loss: 75 Ω typically ≥ 30 dB, 50 Ω typically ≥ 26 dB
Maximum Input Power: 250 mW (+24 dBm)
RF Connectors: 50 Ω type-N (f) and 75 Ω type-N (m) standard, 50 Ω type-N (m) and 75 Ω type-N (f) Option 004

Type-N Accessory Kits

Each kit contains a type-N (female) short, a type-N (male) short, two type-N (male) barrels, two type-N (female) barrels, and a storage case.

HP 11853A 50 Ω Type-N Accessory Kit

The HP 11853A accessory kit furnishes the RF components required for measurement of devices with 50 Ω type-N connectors using the HP 11850C, 85044A, 85046A, or 85047A.

HP 11855A 75 Ω Type-N Accessory Kit

The HP 11855A accessory kit furnishes the RF components required for measurement of devices with 75 Ω type-N connectors using the HP 11850D, 85044B, or 85046B. This kit also contains a 75 Ω type-N (male) termination.

BNC Accessory Kits

The BNC accessory kit contains two type-N (male) to BNC (female) adapters, two type-N (male) to BNC (male) adapters, two type-N (female) to BNC (female) adapters, two type-N (female) to BNC (male) adapters, a BNC (male) short, and a storage case.

HP 11854A 50 Ω BNC Accessory Kit

The HP 11854A accessory kit furnishes the RF components required for measurement of devices with 50 Ω BNC connectors using the HP 11850C, 85044A, 85046A, or 85047A.

HP 11856A 75 Ω BNC Accessory Kit

The HP 11856A furnishes RF components required for measurement of devices with 75 Ω BNC connectors using the HP 11850D, 85044B, or 85046B. This kit also contains a 75 Ω BNC (male) termination.

Test Port Cables

HP 11857D 50 Ω APC-7 Test Port Cables

The HP 11857D includes two precision 61-cm (24-in) cables, phase matched to 2° at 1.3 GHz for use with the HP 8753D, 85046A or 85047A S-parameter test sets. Connectors are 50 Ω APC-7.

HP 11857B 75 Ω Type-N Test Port Cables

The HP 11857B includes two precision 61-cm (24-in) cables, phase matched to 2° at 1.3 GHz for use with the HP 8753D Option 075 or HP 85046B S-parameter test set. One cable has 75 Ω type-N (male) connectors on both ends; the other has one type-N (male) and one type-N (female) connector.

HP 85043D System Cabinet

The HP 85043D system cabinet has been ergonomically-designed specifically for the HP 8753 and the HP 85046A/B or 85047A S-parameter test sets. The 132-cm (52-in) system cabinet includes a bookcase, a drawer, and a convenient work surface.

Transit Cases

HP offers a complete line of sturdy transit cases that protect your instrument from shock, vibration, moisture, impact, and contamination, providing a secure enclosure for shipping. Model 9211-2657 fits the HP 8753D and model 9211-2656 fits the HP 8752C.

Calibration Kits

The calibration kits in the HP 8753 family contain precision standards used in accuracy enhancement procedures to characterize the systematic errors of an HP 8753 measurement system.

HP 85031B 7-mm Calibration Kit

The HP 85031B calibration kit contains a set of precision 7-mm fixed terminations, and a one-piece open/short circuit used to calibrate the HP 8753 and its 50 Ω test sets for measurement of devices with precision 7-mm connectors. This kit is specified 300 kHz to 6 GHz.

HP 85032B 50 Ω Type-N Calibration Kit

The HP 85032B calibration kit contains precision 50 Ω type-N standards used to calibrate the HP 8753 and its 50 Ω test sets for measurement of devices with 50 Ω type-N connectors. Precision phase-matched 7-mm to 50 Ω type-N adapters are included for accurate measurements of non-insertable devices. Standards include fixed terminations, open circuits, and short circuits in both sexes. This kit is specified from dc to 6 GHz.

HP 85032E 50 Ω Type-N Economy Calibration Kit

The HP 85032E calibration kit contains a type-N (m) fixed termination and a one-piece type-N (m) open/short circuit. The kit is specified from dc to 6 GHz.

HP 85033D 3.5-mm Calibration Kit

The HP 85033D calibration kit contains fixed loads and open and short circuits in both sexes to calibrate the HP 8753 and 50 Ω test sets for measurement of devices with precision 3.5-mm and SMA connectors. Phase-matched 7-mm to 3.5-mm adapters for male and female connectors are included for use with 7-mm test port cables. This kit is specified from dc to 6 GHz.

HP 85036B 75 Ω Type-N Calibration Kit

The HP 85036B calibration kit contains precision 75 Ω type-N standards used to calibrate the HP 8753 and its 75 Ω test sets for measurement of devices with 75 Ω type-N connectors. Standards include fixed terminations, open circuits, and short circuits in both sexes. Precision phase-matched adapters are included for accurate measurements of non-insertable devices. This kit is specified from dc to 3 GHz.

HP 85039B Type-F Calibration Kit NEW

The HP 85039B contains 75 Ω type-F calibration standards, both male and female, to calibrate the HP 8753D for measurements of common broadband and CATV components. Standards include a fixed load, open circuit, and short circuit. The following adapters are also included: type-F (f-f), type-F (m-m), type-N (f) to type-F (m) and type-N (m) to type-F (f). A complete male set of standards (fixed load, open, short) and (m-m) adapter can be ordered as HP 85039B Option 00M and a complete female set as HP 85039B Option 00F.

Additional type-F adapters available: type-F (m) to type-N (m) (85039-60010), type-F (m) to type-F (f) (85039-60012), and type-F (f) to type-N (f) (85039-60014).

HP 85060 Series Electronic Calibration Modules and Control Unit

This series provides electronic calibration (ECal) capability for the HP 8753D. The usual calibration kit standards are replaced by two solid-state calibration modules that can be programmed by a control unit to present many different impedances to the test ports. A full two-port calibration can be done with a single connection in just a few minutes, with less chance for error and less wear on connectors. ECal requires an HP 85060C electronic calibration control unit and HP 85060 series calibration modules of the appropriate connector type.

Verification Kits

Measuring known devices, other than the calibration standards, is a convenient way of verifying that the HP 8753 measurement system is operating properly.

HP 85029B 7-mm Verification Kit

The HP 85029B verification kit contains a set of precision 7-mm devices, with data traceable to NIST, used to verify the calibrated performance of an HP 8753A/B/C/D/ measurement system. The devices have precision 7-mm connectors and include a 20-dB pad, a 50-dB pad, and a mismatch attenuator. The verification process requires only an HP 85031B calibration kit and an HP 85029B verification kit.

Option 001 is intended solely for use with the HP 8702B lightwave component analyzer. Option 001 adds verification data that is compatible with the HP 8702B.

Ordering Information

HP 8753D Network Analyzer, 30 kHz to 3 GHz
Integrated network analyzer with built-in color display, S-parameter test set, disk drive, and 30 kHz to 3 GHz synthesized source. Standard 50 Ω version has two 7-mm test ports.
- **Opt 002** Harmonic Measurement Capability
- **Opt 006** 6 GHz Frequency Extension
- **Opt 010** Time-Domain Capability
- **Opt 011** Delete Built-in Test Set
- **Opt 075** 75 Ω Impedance
- **Opt 1D5** High-Stability Frequency Reference

HP 85047A 50 Ω S-Parameter Test Set—6 GHz
- **Opt 009** Mechanical Test Port Switch
- **Opt 913** Rackmount Kit (5062-4069)

HP 85046A 50 Ω S-Parameter Test Set—3 GHz
- **Opt 009** Mechanical Test Port Switch
- **Opt 913** Rackmount Kit (5062-4069)

HP 85046B 75 Ω S-Parameter Test Set—300 kHz–2 GHz
- **Opt 009** Mechanical Test Port Switch
- **Opt 913** Rackmount Kit (5062-4069)

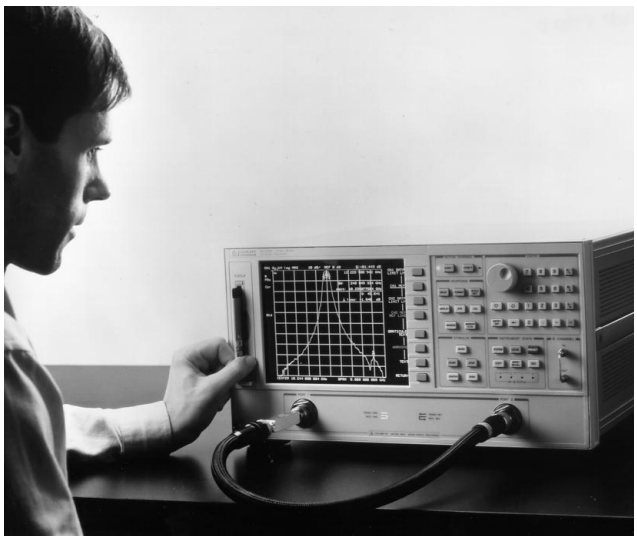
HP 85029B Precision 7-mm Verification Kit
- **Opt 001** Data for HP 8702B

HP 85031B Precision 7-mm Calibration Kit
HP 85032B 50 Ω Type-N Calibration Kit
HP 85032E 50 Ω Type-N Economy Calibration Kit
HP 85033D 3.5-mm Calibration Kit
HP 85036B 75 Ω Type-N Calibration Kit
HP 85039A Type-F Calibration Kit
HP 85060C Electronic Calibration Control Unit
HP 85060 Series Electronic Calibration Modules
HP 85043D System Rack
HP 11883A Harmonic Measurements (Option 002) Upgrade
HP 11884A 6 GHz Receiver (Option 006) Upgrade
HP 11884B 6 GHz (Option 006) Upgrade Kit for HP 8753D
HP 11884C 6 GHz (Option 006) Upgrade Kit for HP 8753D Option 011
HP 85019B Time Domain (Option 010) Upgrade
HP 86389A Solid-State Switch Upgrade Kit (for HP 85046A/B Test Sets)
HP 86389B Solid-State Switch Upgrade Kit (for HP 85047A Test Sets)
HP 86205A 50 Ω Bridge
HP 86207A 75 Ω Bridge
HP 8753D
- **Opt K36** Duplexer Test Adapter
- **Opt K39** Three-Port Test Set Adapter

HP 11850C 50 Ω Power Splitter
HP 11850D 75 Ω Power Splitter
HP 11851B 50 Ω/Type-N RF Cable Kit
HP 11852B 50 Ω/75 Ω Minimum Loss Pad
HP 11853A 50 Ω Type-N Accessory Kit
HP 11854A 50 Ω BNC Accessory Kit
HP 11855A 75 Ω Type-N Accessory Kit
HP 11856A 75 Ω BNC Accessory Kit
HP 11857B 75 Ω Type-N Test Port Extension Cables
HP 11857D 50 Ω APC-7 Test Port Extension Cables

HP 8719D
HP 8720D
HP 8722D

- 50 MHz to 13.5, 20, or 40 GHz frequency coverage
- Fast-sweeping, built-in synthesized source
- Integrated solid-state switching S-parameter test set
- Vector receiver, error correction, time domain
- Direct save/recall from built-in 3.5-inch floppy disk drive
- Up to 105 dB dynamic range



HP 8720D provides flexibility, performance, and ease of use to solve your toughest device measurement problems.

HP 8720D Series Microwave Network Analyzers

The HP 8719D, 8720D and 8722D vector network analyzers (VNAs) offer built-in source, receiver, and S-parameter test set covering frequencies from 50 MHz to 13.5, 20 or 40 GHz. With their built-in 3.5-inch disk drive and serial/parallel ports, you'll benefit from improved data handling, in addition to higher accuracy, faster sweep speed, and built-in test sequencing automation. Compact, economical, and easy to use, the 8720D family provides accurate, fast tests of microwave filters, amplifiers, mixers, multiport devices and cables in coaxial and non-coaxial environments, such as waveguide, in-fixture and on-wafer. The HP 8720 family is an ideal choice for cost- and space-conscious engineers in research and development, manufacturing, incoming inspection, or quality assurance.

Affordable Analyzers with Outstanding Performance

Despite their affordable price, the HP 8720 series network analyzers offer remarkable performance. The integrated source is fully synthesized, even while sweeping, and provides stability and accuracy within 10 ppm (typical). Yet the sweep rate is extremely fast: measurement update times are typically about 1 ms per point. Frequency resolution is 1 Hz standard for accurate measurements of narrowband or long-delay devices.

The tuned receivers with variable bandwidth IF filters provide up to 105 dB of dynamic range. A built-in, solid-state switching test set measures both forward and reverse parameters with a single connection, and provides continuous updating of all four S-parameters as required for two-port error correction.

Two independent channels can simultaneously display two measurements, such as reflection and transmission responses. The receiver detects both magnitude and phase, and displays results in a variety of useful formats, including group delay, deviation from linear phase, complex impedance or admittance, and SWR on rectangular, polar or Smith charts.

Built-in vector accuracy enhancement provides excellent error-corrected accuracy in all common coaxial connectors. A user kit supports user-defined standards, and allows calibration in waveguide (including effects of dispersion).

Powerful Features for Active Devices

With +5 dBm at their test ports, the HP 8719D and 8720D have plenty of power for testing amplifiers. Option 007 provides 5 dB more output power by replacing the solid-state transfer switch with a mechanical switch (although Option 007 does not provide continuous updating of all four S-parameters). For sensitive small-signal devices, the built-in step attenuator can cut power back to –70 dBm. Absolute power levels can be set accurately anywhere in the system, using the power meter calibration feature. Power-sweep capability and power resolution of 0.01 dB make it easy to test the gain-compression characteristics of active components. A new sweep mode controls power during retrace for safe testing of AGC amplifiers.

In-Fixture and On-Wafer Device Characterization

Use TRL*/LRM* calibration to minimize fixture errors for measuring noncoaxial devices (such as microstrip). Combine the network analyzer with a wafer probing station in order to measure devices while still on the wafer. For even better accuracy, Option 400 adds a fourth sampler and TRL/LRM calibration. Electronic port extensions and gating are also available to enhance accuracy.

Time Domain and Fault Location

Time domain capability (Option 010) computes and displays the response versus time or distance (instead of frequency) of the device under test. Use time domain to locate and quantify individual faults or discontinuities in a network. Apply the gating feature to remove the effects of unwanted reflections (separated in time), then view the device under test's true response versus frequency.

Productivity Features

Limit-test capability makes pass/fail decisions quantitative and decisive, allowing faster tuning and more consistent testing.

Fast two-port tuning mode speeds up 12-term error correction by allowing the user to specify a number of forward sweeps to take before updating the reverse sweep.

To document results without a computer, the copy feature sends the entire display to a compatible plotter or printer using the HP-IB, serial, or parallel interface. A built-in buffer controls the peripheral while you continue with the next measurement.

Up to five markers per channel can be used to annotate trace features or search and track values with marker functions.

With save/recall capability, you can define and save test configurations, then recall identical conditions later, and align or test each device under test consistently. Use up to 31 internal nonvolatile memory registers, or save/recall directly to an internal 3.5-inch floppy disk drive.

Automate repeated tasks with test sequencing. Create test sequences with automatic keystroke recording, then repeat the measurements with a single keystroke. No programming expertise is needed. You can also use test sequencing to control external devices such as part handlers through the parallel port.

Adapter Removal Calibration

This feature, adopted from the 8510, provides greater accuracy for measuring non-insertable devices, such as devices with the same sex connectors on both ports or different connector types on ports 1 and 2. Adapter-removal calibration effectively removes the errors from the adapter that must be used during a non-insertable calibration to make a "thru" connection between the test ports. For customers with older versions of the HP 8719D, 8720D, or 8722D, this capability can be obtained with a firmware upgrade (p/n 08720-60168). Other key features included in the new firmware are S2P format data output files and a wider IF bandwidth. S2P format is convenient, easy-to-read, and compatible with CAD programs, including HP EEsofs Libra, Touchstone, and jOmega. A wider 3.7 kHz IF bandwidth has been added to provide 15 to 20 percent faster measurements than the previous 3 kHz bandwidth, with only minor increases in trace noise and noise floor.

Key Literature

HP 8719D, 8720D, 8722D Microwave Vector Network Analyzers
Brochure, p/n 5964-6419E
HP 8719D, 8720D, 8722D Network Analyzers
Technical Specifications, p/n 5964-9133E
HP 8719D, 8720D, 8722D Network Analyzers
Configuration Guide, p/n 5964-9130E

Flexible Configuration for Applications

Option 007 replaces the standard solid-state transfer switch with a mechanical switch to provide 5 dB more power at the test port, and 5 dB more dynamic range. The mechanical transfer switch does not provide continuous updating of all 4 S-parameters for full two-port calibration.
Option 010 adds time-domain capability, which allow fault location and gating of fixture responses.
Option 012 provides direct sampler access, enabling the user to eliminate coupler loss and increase sensitivity by 16 dB. Option 012 allows filter rejection measurements to greater than –120 dB and allows insertion of attenuation between coupler and sampler. By using separate transmit and receive antennae, Option 012 can improve signal-to-noise in free-space measurements.
Option 085 is a high-power S-parameter test set modification allowing device test up to +43 dBm (20 watts) input and output. It deletes the bias tees, replaces the solid-state switch with a mechanical switch, and adds internal attenuators.
Option 089 offers a frequency offset mode for simple mixer conversion loss measurements without the need for a reference mixer.
Option 1D5 adds a high-stability frequency reference to improve measurement accuracy of narrowband or high Q devices.
Option 400 adds a fourth sampler to the receiver and improves TRL calibration accuracy for in-fixture and on-wafer applications.
DX models are pre-configured systems that are ideal for noncoaxial applications. They combine a standard network analyzer with Options 400, 010, 012, and 1D5 at a value price.

Accessories

Configure a complete measurement system with test port cables, calibration kits, verification kits, and adapters. Waveguide calibration kits are available in X, P (Ku), K, and R (Ka) bands, covering 8.2 to 40 GHz. The HP 8720 family of network analyzers uses the same precision calibration standards and rugged, flexible cables as the industry standard HP 8510.

Software Enhances Measurement Capability

Measure the dielectric properties of materials quickly and non-destructively with the HP 85070B dielectric probe kit (including software). For greater accuracy and flexibility, use the HP 85071B materials measurement software, for samples loaded into waveguide or coaxial fixtures, and for free space measurements.

Specifications Summary

Data applies at 23°± 3°C. See product literature for more complete specifications and for total measurement uncertainty after error correction.

	HP 8719D	HP 8720D	HP 8722D
Minimum Frequency	50 MHz	50 MHz	50 MHz
Maximum Frequency	13.5 GHz	20 GHz	40 GHz
Frequency Resolution	1 Hz	1 Hz	1 Hz
Frequency Accuracy	10 ppm	10 ppm	10 ppm
Max. Source Power (std)	+5 dBm	+5 dBm	–5 dBm, < 20 GHz –10 dBm, 20 to 40 GHz
With Option 007	+10 dBm	+10 dBm	0 dBm, < 20 GHz –5 dBm, 20 to 40 GHz
Min. Source Power (std)	–70 dBm	–70 dBm	–75 dBm
With Option 007	–65 dBm	–65 dBm	–70 dBm
Power Resolution	0.01 dB	0.01 dB	0.01 dB
Power Flatness	± 1.5 dB	± 1.5 dB	± 2 dB
Power Sweep Range	20 dB	20 dB	15 dB
System Dynamic Range (>2 GHz)	100 dB	100 dB	82 to 93 dB
With Option 007	105 dB	105 dB	86 to 98 dB
Test Port Connector	3.5 mm	3.5 mm	2.4 mm

Measurement Rate (typical, 201-point sweep): < 2 ms/point (1-port cal) to < 5 ms/point (full 2-port cal)
HP-IB Functions: SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT0, C0, C1, C10, E2
Size: 222 mm H x 425 mm W x 457 mm D (8.75 in x 16.750 in x 18.00 in)
Weight: Net, 25 kg (54 lb); shipping, 28 kg (61 lb)

Ordering Information

HP 8719D Network Analyzer, 50 MHz to 13.5 GHz
HP 8720D Network Analyzer, 50 MHz to 20 GHz
HP 8722D Network Analyzer, 50 MHz to 40 GHz
The following options apply to all three network analyzers:
- **Opt 007** Mechanical Transfer Switch
- **Opt 010** Time Domain Capability
- **Opt 012** Direct Sampler Access
- **Opt 085** High-Power Test Set
- **Opt 089** Frequency Offset Mode
- **Opt 1D5** High-Stability Frequency Reference
- **Opt 400** Four-Sampler Test Set
- **Opt 1CM** Rackmount Kit
- **Opt 1CP** Rackmount and Handle Kit
- **Opt W08** Convert 1-yr. on-site to 3-yr. return to HP warranty

The DX models are pre-configured systems for noncoaxial applications that include Options 400, 010, 012, and 1D5 at a value price.
HP 8719DX Network Analyzer, 50 MHz to 13.5 GHz
HP 8720DX Network Analyzer, 50 MHz to 20 GHz
HP 8722DX Network Analyzer, 50 MHz to 40 GHz
The following options apply to all three network analyzers:
- **Opt 089** Frequency Offset Mode
- **Opt 1CM** Rackmount Kit
- **Opt 1CP** Rackmount and Handle Kit
- **Opt W08** Convert 1-yr. on-site to 3-yr. return to HP warranty

HP 85070B High-Temperature Dielectric Probe Kit
HP 85071B Materials Measurement Software

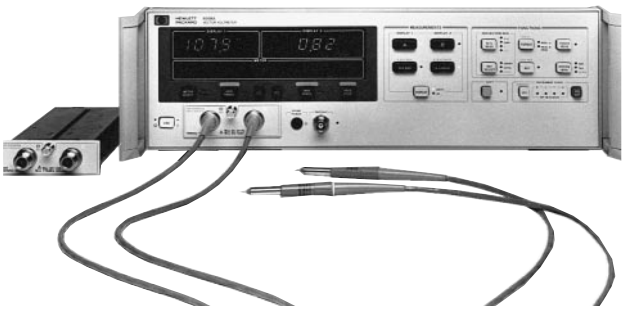
Upgrades and Retrofit Kits

To add options to an HP 8720D family analyzer after initial purchase, order model number HP 8719DU, 8720DU, or 8722DU with the option(s) you want to retrofit. All "DU" upgrade/retrofit kits include installation at an HP service center.
HP 8719DU Upgrade Kits for HP 8719D
HP 8720DU Upgrade Kits for HP 8720D
HP 8722DU Upgrade Kits for HP 8722D
The following options are available for all three models:
- **Opt 007** Add Mechanical Transfer Switch
- **Opt 010** Add Time Domain Capability
- **Opt 012** Add Direct Sampler Access
- **Opt 085** Add High-Power Test Capability
- **Opt 089** Add Frequency Offset Mode
- **Opt 1D5** Add High-Stability Frequency Reference
- **Opt 400** Add Four-Sampler Test Set

The following upgrades are only available for the specified models:
HP 8719DU Opt 020 Upgrades HP 8719D to HP 8720D
HP 8719DU Opt 040 Upgrades HP 8719D to HP 8722D
HP 8720DU Opt 040 Upgrades HP 8720D to HP 8722D
The following kits offer upgrades for older HP 8720 family network analyzers. Installation is NOT included unless stated otherwise.(Do not order these for the HP 8720D family.)
HP 86384A Solid-State Switch Retrofit Kit (HP 8719C)
HP 86384B Solid-State Switch Retrofit Kit (HP 8720C)
HP 86384C Solid-State Switch Retrofit Kit (HP 8722C)
HP 86382B Upgrade HP 8719C to HP 8720C; incl. installation
HP 86382C Upgrade HP 8720C to HP 8722C; incl. installation
HP 86380A Add Time Domain; includes installation
HP 86381A Add 1 Hz Frequency Resolution; incl. installation
HP 08720-60024 High Forward Dynamic Range
HP 08720-60168 Firmware Upgrade
HP 1540-1695 Operating Case
HP 9211-2657 Transit Case

HP 8508A
HP 85081B
HP 85082A
HP 11570A

- RF voltage and phase measurements
- 100 kHz to 1 GHz high-impedance probe inputs
- 300 kHz to 2 GHz 50 Ω inputs



HP 8508A Option 001

HP 8508A Vector Voltmeter

The HP8508A vector voltmeter is a fully-automatic tuned receiver that makes RF voltage and phase measurements easy. The narrowband measuring technique gives a dynamic range of over 90 dB and a sensitivity of 10 μV to trace even the smallest signal. The vector voltmeter also measures the difference between the two input channels with at least 0.1 degree resolution over a full +180 to –180 degree range, so it can be used for another complete set of measurements—such as electrical length, phase distortion, or impedance. The standard unit is supplied with the HP 85081B input module, which has two high-impedance probe inputs that operate from 100 kHz to 1 GHz. Its ability to store reference and use it in later measurements means individual circuit sections can be characterized and adjusted independently. Any CW source can be used as a stimulus—even a source that is part of the device being tested—so measurements can be made under normal operating conditions. To adapt the probe inputs for measurements in a 50 Ω environment, the HP 11570A accessory kit provides two HP 11536A probe tees, an HP 11549A power splitter, and two HP 908A 50 Ω terminations. Option 050 is supplied with the HP 85082A input module. Its 50 Ω inputs operate from 300 kHz to 2 GHz, and provide the accuracy and dynamic range to make measurements on active and passive components.

HP 8508A with HP 85081B High-Impedance Input Module Specifications

Frequency Range: 100 kHz to 1 GHz (300 kHz to 2 GHz[1])
Maximum Input: 2 V peak ac (+16 dBm[1]), ±50 Vdc
A- (ref) Channel Minimum: 10 mV (–47 dBm[1]), 100 kHz to 300 kHz 1mV (–47 dBm[1]), 300 kHz to 3 MHz 300 μV, 3 MHz to 1 GHz (–57 dBm, 3 MHz to 2 GHz[1])
B-Channel Noise Level: 10 μV (–87 dBm[1])
Input Crosstalk: >100 dB, 1 MHz to 500 MHz > 80 dB, 500 MHz to 1 GHz (>70 dB, 1 GHz to 2 GHz[1])

Magnitude Accuracy

Absolute Accuracy (A,B 100 mV, 15° to 30°C)	+1/–1.5 dB, 100 kHz to 300 kHz ±.5 dB, 300 kHz to 1 MHz ±.3 dB, 1 MHz to 100 MHz ±.6 dB, 100 MHz to 300 MHz ±1 dB, 300 MHz to 1 GHz (±1 dB, 300 MHz to 1.5 GHz[1]) (+1/–2 dB, 1.5 GHz to 2 GHz[1])
Ratio Accuracy (A,B 100 mV, 15° to 30° C)	±1 dB, 100 kHz to 300 kHz ±.4 dB, 300 kHz to 1 MHz ±.2 dB, 1 MHz to 100 MHz ±.4 dB, 100 MHz to 300 MHz ±.6 dB, 300 MHz to 1 GHz (±.6 dB, 300 MHz to 1.5 GHz[1]) (±1 dB, 1.5 GHz to 2 GHz[1])
Phase Accuracy (A,B 100 mV, 15° to 30° C)	±4, 300 kHz to 1 MHz ±1, 1 MHz to 100 MHz ±4, 100 MHz to 300 MHz ±6, 300 MHz to 1 GHz (±6, 300 MHz to 1.5 GHz[1]) (±12, 1.5 GHz to 2 GHz[1])

[1]Specifications apply to HP 85082A 50 Ω input module only.

Search and Lock Time: Lockup (within one range): 40 ms, frequencies up to 3 MHz; 20 ms, frequencies greater than 3 MHz

General: HP 8508A only

Power: 100, 120, 220 or 240 V +5%/–10%, 48 to 440 Hz, 40 VA
Size: 425.5 mm W x 133 mm H x 473.3 mm D (16.75 in x 5.25 in x 18.65 in)
Option 001: 524.5 mm W x 158.8 mm H x 524.5 mm D (19.75 in x 6.25 in x 20.65 in)
Weight: net, 8.1 kg (18 lb); shipping, 11 kg (24 lb).
Option 001: net, 9.4 kg (21 lb); shipping 12.5 kg (28 lb).

HP 11570A Accessory Kit

50 Ω Tees: For monitoring signals on 50 Ω transmission line. Kit contains two 50 Ω tees, both with type-N female connectors.
50 Ω Power Splitter: All connectors type-N female
HP 908A 50 Ω Termination: For terminating 50 Ω coaxial systems in their characteristic impedance. Kit contains two 50 Ω terminations, both with type-N male connectors.
HP 11512A Short: Type-N male

Ordering Information

HP 8508A Vector Voltmeter (includes HP 85081B)
  Opt 001 Bail Handle and Front Protective Cover
  Opt 801 Two each HP 11576A 10:1 Divider and HP 10216A Isolators
HP 85081B Input Module (100 kHz to 1 GHz, high-impedance probe inputs)
HP 85082A Input Module (300 kHz to 2 GHz, 50 Ω Type-N inputs)
HP 11570A Accessory Kit (for measurement of 50 Ω systems with standard HP 8508A and 70138A)

- 45 MHz to 110 GHz frequency range
- Real-time error-corrected measurements
- 60 dB effective directivity and source match
- Up to 100 dB dynamic range
- 0.001 dB, 0.01 degree, 0.01 ns measurement resolution
- Time-domain analysis

HP 8510 Series Microwave Network Analyzers

The HP 8510 Series Microwave Vector Network Analyzers provide a complete solution for characterizing the linear behavior of either active or passive networks over the 45 MHz to 50 GHz frequency range. A complete system consists of the HP 8510C network analyzer, an S-parameter test set, and a compatible RF source. The HP 8510E (45 MHz to 20 GHz) is an unracked system. The HP 8510SX (45 MHz to 26.5 GHz) and the HP 85107B (45 MHz to 50 GHz) systems are fully integrated in an HP 85043C system rack, tested, and verified at the factory prior to shipment. They come with a one year on-site warranty. For millimeter wave measurements the HP 8510XF (45 MHz to 110 GHz) and HP 85106D (Q, U, V, and W band) are available. For pulse measurements the HP 85108A (2 GHz to 20 GHz, specials 0.5 to 20 GHz, and 2 GHz to 50 GHz) and HP 85108L (45 MHz to 2 GHz) are available. For compatible lightwave products, see page 428.

HP 8510C Network Analyzer

At the heart of the system is the HP 8510C vector network analyzer. Measurement results can be displayed on a large color CRT on one of two independent, yet identical, channels. The channels may be displayed individually, or simultaneously, with results presented in either log/linear magnitude, phase, or group delay format on rectangular or polar coordinates. Direct measurement of impedance is possible with the Smith chart format.

Real-Time Error Correction

The HP 8510's built-in, high-speed computer provides the capability to characterize and effectively remove the impact of systematic errors through accuracy enhancement techniques. Effective directivity and source match can be improved to as much as 60 dB. The data processing speed of the system is such that a fully error-corrected, 401 point trace of data is updated in under one second. This virtual "real-time" display of error-corrected data means that you can easily adjust your test device while it's being measured, with the assurance that you are viewing the data at the highest possible accuracy.

Time-Domain Analysis

The HP 8510 (with Option 010) has the capability of displaying the time-domain response of a network, obtained by computing the Inverse Fourier Transform of the frequency-domain response. The time-domain response displays the reflection coefficient of the network versus time, which displays the magnitude and location of each individual discontinuity, or else the transmission coefficient versus time, which displays each individual transmission path.

Pulsed-RF Measurement Capability

For the measurement of pulsed-RF devices, the HP 8510C can be equipped with wideband IF detectors (Option 008). When configured with a compatible test set (HP 85110A/L), the system can measure pulse widths as narrow as 1 μs on devices with output power up to 20 W (CW) [50 W (CW) for the HP 85110L]. Measurement formats include magnitude and phase versus frequency or time (pulse profile).

Test Sets

The test set is the system component that determines the frequency range of the system and is the main contributor to system specifications. Depending on the test set used, up to 100 dB of dynamic range is available. The precision IF processing and detection system contributes as little as ±0.05 dB and ±0.5 degree measurement uncertainty at a level of 50 dB below the reference. Meaningful resolutions of 0.001 dB, 0.01 degree, and 0.01 ns are easily available. Refer to page 286 for more information.

RF Sources

The recommended system sources for the HP 8510C are the HP 83621B (20 GHz), 83631B (26.5 GHz), and 83651B (50 GHz). These sources provide 1 Hz frequency resolution, stepped CW, phase-locked narrowband sweeps, and fully-synthesized start frequencies for broadband ramp sweeps. Other models of the HP 8360 series synthesized sweeper, the HP 8340 series synthesized sweeper, and HP 8350B series sweep oscillators, are also compatible with the HP 8510C.

System Software

HP 85161B Measurement Automation Software

The HP 85161B measurement automation software leads the operator through the measurement sequence one step at a time, from system setup and calibration, to device measurement and hardcopy output. Complete measurement configurations can be saved to disk for later recall. Also, data printout formats can be customized by the operator.

The HP 85161B software is designed for use with a PC running HP Basic Rev 6.3 or higher under Windows (3.1/95/NT), or HP 9000 Series 200 or 300 computers and Basic Operating System 5.0 or later.

Key Literature

HP 8510 Systems Solutions Brochure, p/n 5965-8837E
HP 8510C Family Network Analyzer Technical Data, p/n 5091-8484E
HP 8510C Family Network Analyzer Configuration Guide, p/n 5091-8967E
HP 8360 B/L Series Synthesized Sweeper Technical Data, p/n 5964-6062E

Ordering Information

HP 8510C Microwave Vector Network Analyzer
Opt 008 Pulsed-RF Measurement Capability
Opt 010 Time-Domain Capability
HP 85043C System Rack Kit
HP 85161B Measurement Automation Software

S-Parameter Test Sets

Several S-parameter test sets are available for the HP 8510C network analyzer for broadband coaxial measurements from 45 MHz to 50 GHz. The HP 8514B, 8515A, and 8517B test sets have an architecture that develops a separate reference channel for each incident port. RF switching is done with a built-in electronic switch. For active device measurements, the test sets include the ability to apply dc bias (external) to the test port center conductors. Also available are two 90 dB step attenuators (60 dB in the HP 8517B) which allow control of the port 1 and port 2 signal levels.

Pulsed-RF Measurement Test Sets

The HP 85110A/L test sets are specially configured for operation in pulsed-RF measurement systems (HP 85108). Four 90 dB step attenuators protect each input of the fundamentally-mixed down converter to allow measurement of test devices with output power of 20 watts CW or 50 watts CW (HP 85110L). Special options are available to 50 GHz.

Coaxial Test Set General Information

	HP 8514B	HP 8515A	HP 8517B	HP 85110A	HP 85110L
Frequency range (GHz)	0.045 to 20	0.045 to 26.50	0.045 to 50	2 to 20[2]	0.045 to 2
Test ports (port 1 or 2) Nominal operating power level (dBm)	2 to –6	–5 to –25	+2 to –29 +5 to –16[1]	0 to –3	0
Test ports (port 1 or 2) Max. power in (CW)	+20 dBm	+2 dBm	+13 dBm	+43 dBm (20 W)	+47 dBm (50 W)
Test port connector type	3.5 mm (m)	3.5 mm (m)	2.4 mm (m)	3.5 mm (m)	7 mm

[1]HP 8517B Option 007
[2]Special test sets options are available from 0.5 to 20 GHz and 2 to 50 GHz

Frequency Converters

With the HP 8511A (26.5 GHz) and 8511B (50 GHz) frequency converters, the HP 8510 becomes a general-purpose four-channel magnitude/phase receiver. Add your own power splitters for transmission measurements, and bridges or directional couplers for reflection measurements. Since one input is used for system phase-lock, the other three inputs are available for measurements of multi-port devices, subsystems, and antennas. All four inputs have precision 3.5 mm (HP 8511A) or 2.4 mm (HP 8511B) connectors.

Multiple Test Set Operation

A single HP 8510C system may be configured with two test sets. In this configuration the test sets have different addresses, and the user may select between them from the front panel of the HP 8510 without reconnections. This capability is useful, for example, when combining a microwave coaxial test set with a millimeter-wave test set in the same HP 8510 system or in manufacturing to increase throughput, one test set can be used to make a measurement while a device is being connected to a second test set.

IF switching (Option 001): In the multiple test set configuration, the 20 MHz IF signal is daisy-chained from the test sets to the HP 8510. This capability requires test set Option 001 in one of the two test sets.

The RF signal must be routed to the desired test set using a coaxial RF switch and an HP 11713A switch driver. The switch driver is controlled automatically by the HP 8510C over the HP 8510 system interface bus.

Ordering Information

HP 8511A Frequency Converter
HP 8511B Frequency Converter
HP 8514B S-Parameter Test Set
HP 8515A S-Parameter Test Set
HP 8517B S-Parameter Test Set
HP 85110A Pulsed-RF S-Parameter Test Set
HP 85110L Pulsed-RF S-Parameter Test Set
HP 85105A Millimeter-Wave Controller

Key Literature

HP 8510 Systems Solutions Brochure, p/n 5965-8837E
HP 8510C Family Network Analyzer Technical Data, p/n 5091-8484E
HP 8510C Family Network Analyzer Configuration Guide, p/n 5091-8967E

Test Port Cables and Adapters

Test port cables and adapter sets are available for various connector types. The cable/adapter configurations are described below. All cables are designed with one end that connects directly to the special rugged ports of the network analyzer test set, and one end that connects to the device-under-test.

Special test port adapter sets are also available to convert the rugged ports of the network analyzer test set to the desired connector interface. Each kit contains two adapters, one male and one female.

Both the cables and the special adapters have one special female connector which is designed to connect directly to the 3.5 mm test port (2.4 mm for HP 8517B and 8722C). This side of the cable or adapter can only be connected to the test set port, and cannot be mated to a standard 3.5 mm (or 2.4 mm) male connector. The male test set ports, however, can be mated to a standard 3.5 mm (or 2.4 mm) female connector.

Choose one of the configurations shown:

For HP 8719D/8720D Network Analyzer or HP 8514B/8515A Test Sets (3.5 mm test port)

	Cable/adapters	Connector type (on device side of cables/adapter)
For 3.5 mm devices	HP 85131C Semi-rigid Cable HP 85131E Flexible Cable HP 85130D Adapter Set	3.5 mm (f) 3.5 mm (f) 3.5 mm (m and f)
For 7 mm devices	HP 85132C Semi-rigid Cable HP 85132E Flexible Cable HP 85130B Adapter Set	7 mm 7 mm 7 mm
For Type-N devices	Use 7-mm cables and the 7 mm-to-Type-N adapters included in the HP 85054B/D calibration kit. HP 85130C Adapter Set	Type-N (m and f)

For HP 8722D Network Analyzer or HP 8517B Test Set (2.4 mm test port)

	Cable/adapters	Connector type (on device side of cables/adapter)
For 2.4 mm devices	HP 85133C Semi-rigid Cable HP 85133E Flexible Cable HP 85130G Adapter Set	2.4 mm (f) 2.4 mm (f) 2.4 mm (m and f)
For 3.5 mm devices	HP 85134C Semi-rigid Cable HP 85134E Flexible Cable HP 85130F Adapter Set	3.5 mm (f) 3.5 mm (f) 3.5 mm (m and f)
For 7 mm devices	HP 85135C Semi-rigid Cable HP 85135E Flexible Cable HP 85130E Adapter Set	7 mm 7 mm 7 mm

For HP 8719D/8720D Network Analyzer or HP 8514B/8515A Test Sets (3.5 mm test port)

	Cable set	Connector type (on device side of cables/adapter)
For 3.5 mm devices	HP 85131D Semi-rigid Cable Set or HP 85131F Flexible Cable Set	3.5 mm (one male, one female) 3.5 mm (one male, one female)
For 7 mm devices	HP 85132D Semi-rigid Cable Set HP 85132F Flexible Cable Set	7 mm 7 mm
For Type-N devices	Use 7-mm cables and the 7 mm-to-Type-N adapters in the HP 85054B/D calibration kit.	

For HP 8722D Network Analyzer or HP 8517B Test Set (2.4 mm test port)

	Cable set	Connector type (on device side of cables/adapters)
For 2.4 mm devices	HP 85133D Semi-rigid Cable Set or HP 85133F Flexible Cable Set	2.4 mm (m, f) 2.4 mm (m, f)
For 3.5 mm devices	HP 85134D Semi-rigid Cable Set or HP 85134F Flexible Cable Set	3.5 mm (m, f) 3.5 mm (m, f)
For 7 mm devices	HP 85135D Semi-rigid Cable Set or HP 85135F Flexible Cable Set	7 mm 7 mm

For HP 8510XF Systems (1.0 mm test port connectors)

Cables/Adapters	Connector Type
HP 11500I 1.0 mm test port cable	1.0 mm (m-m) (240 mm long)
HP 11500J 1.0 mm test port cable	1.0 mm (m-f) (240 mm long)
HP 11920A Adapters	1.0 (m-m) series adapters
HP 11920B Adapters	1.0 (f-f) series adapters
HP 11920C Adapters	1.0 (m-f) series adapters
HP V281C Adapter	1.0 mm (f) to V-band waveguide
HP V281D Adapter	1.0 mm (m) to V-band waveguide
HP W281C Adapter	1.0 mm (f) to W-band waveguide
HP W281D Adapter	1.0 mm (m) to W-band waveguide

Microwave Network Analyzer Accessories

Microwave accessories for the HP 8720D and the HP 8510C series network analyzers include calibration kits, verification kits, cables, and adapters for 7-mm, 3.5-mm, Type-N, 2.4-mm, 1.85-mm, and 1-mm coaxial, WR-90, WR-62, WR-42, and WR-28 waveguide. Millimeter-wave accessories for the HP 8510C series network analyzers include WR-22, WR-29, WR-15, and WR-10 waveguide connector interfaces. The standards used in the 3.5-mm, Type-N, and 2.4-mm kits use precision, slotless connectors (PSC-3.5, PSC-N, and PSC-2.4).

Calibration Kits

Error-correction procedures require that the systematic errors in the measurement system be characterized by measuring known devices (standards) on the system over the frequency range of interest. HP offers two types of calibration kits: mechanical and electronic.

Electronic Calibration (ECal) System

The electronic calibration system consists of a control unit and a connector specific calibration module. ECal modules are used as transfer standards. Electronic calibrations have the fewest connections and least operator interaction, while providing extremely repeatable measurements. Using the insertable ECal module with precision adapters, a non-insertable calibration can be performed with two additional connections. Or, for greater convenience, non-insertable ECal modules are available. Operation of the ECal system is through the network analyzer front panel or through HP-IB programming.

HP 85060C Electronic Calibration Control Unit

The HP 85060C electronic calibration control unit interfaces with the HP 8510B/C, 8719C/D, 8720C/D, 8722C/D, and 8753C/D network analyzers via HP-IB. The control unit provides various communication lines and temperature control for the ECal module.

Electronic Calibration Kits

The ECal kit requires an HP 85060C control unit for operation. Each standard calibration kit contains the two-port calibration module and a torque wrench for proper connection. Options are available to add a lowband module to the kit, and to change the sex of the connectors of the module.

Mechanical Calibration Kits

All network analyzer mechanical calibration kits contain precision standard devices to characterize the systematic errors of the HP 8720 series or 8510C network analyzer system.

Each mechanical calibration kit also contains adapters to change the sex of the test port and a torque wrench for proper connection. Each kit contains standards definitions on disk for the HP 8510C. (These definitions are already included in the HP 8720 series.)

Verification Kits

Measuring known devices, other than the calibration standards, is a straightforward way of verifying that the network analyzer system is operating properly. HP offers verification kits that include precision airlines, mismatch airlines, and precision fixed attenuators. Traceable measurement data is shipped with each kit on disk.

Verification kits may be recertified by Hewlett-Packard. This recertification includes a new measurement of all standards, as well as new data and uncertainties. Certification in compliance with MIL-STD-45662A is also available.

Verification Kit Summary

Verification kit	Connector type	Frequency range (GHz)
85051B	7 mm	0.045 to 18
85053B	3.5 mm	0.045 to 26.5
85055A	Type-N	0.045 to 18
85057B	2.4 mm	0.045 to 50
R11645A	WR-28	26.5 to 40
Q11645A	WR-22	33 to 50
U11645A	WR-19	40 to 60
V11645A	WR-15	50 to 75
W11645A	WR-10	75 to 110

Mechanical Calibration Kits

Calibration kit	Connector type	Frequency range (GHz)
85050B	7 mm	0.045 to 18
85050C	7 mm	0.045 to 18
85050D	7 mm	0.045 to 18
85052B	3.5 mm	0.045 to 26.5
85052C	3.5 mm	0.045 to 26.5
85052D	3.5 mm	0.045 to 26.5
85054B	Type-N	0.045 to 18
85054D	Type-N	0.045 to 18
85056A	2.4 mm	0.045 to 50
85056D	2.4 mm	0.045 to 50
85056K	2.92 mm	0.045 to 40
85058D	1.85 mm	0.045 to 65
85059A	1.0 mm	0.045 to 110
X11644A	WR-90	8.2 to 12.4
P11644A	WR-62	12.4 to 18.0
K11644A	WR-42	18.0 to 26.5
R11644A	WR-28	26.5 to 40
Q11644A	WR-22	33 to 50
U11644A	WR-19	40 to 60
V11644A	WR-15	50 to 75
W11644A	WR-10	75 to 110

Electronic Calibration Modules

Calibration kit	Connector type	Frequency range (GHz)	Description/contents
85060A	7 mm	1 to 18	One two-port ECal module and collet remover
Opt 001	7 mm	0.045 to 2	Adds lowband ECal module
85060C	—	—	Control unit
Opt 001	—	—	Control unit with front panel connectors
85062A	3.5 mm (m-f)	1 to 26.5	One two-port ECal module and m-m and f-f adapters
Opt 001	3.5 mm (m-f)	0.045 to 2	Adds lowband ECal module
Opt 00F	3.5 mm (f-f)		Changes connectors to f-f
Opt 00M	3.5 mm (m-m)		Changes connectors to m-m
85064A	Type-N (m-f)	1 to 18	One two-port ECal module
Opt 001	Type-N (m-f)	0.045 to 2	Adds lowband ECal module
Opt 00F	Type-N (f-f)		Changes connectors to f-f
Opt 00M	Type-N (m-m)		Changes connectors to m-m

4

The HP 8510C system can easily be configured for making measurements at millimeter-wave frequencies. Hewlett-Packard offers two fully integrated systems for making millimeter measurements in coax, waveguide and on-wafer. The HP 8510XF is a single-connection, single-sweep, 45 MHz to 110 GHz network analyzer system. This system is designed for on-wafer and coaxial (1.0 mm) measurements. The HP 85106D offers hardware for configuring systems in the 33 to 50 GHz, 40 to 60 GHz, 50 to 75 GHz, and 75 to 110 GHz waveguide bands. These systems are fully integrated, tested and verified at the factory prior to shipment. System installation at your facility and one year, on-site service are included at no additional cost.

HP 8510XF Single Connection, Single-Sweep, .045 to 110 GHz Network Analyzer System

NEW

Covering a broadband frequency range in millimeter-wave has been virtually impossible due to the frequency limitations of each waveguide band. The recent development from Hewlett-Packard of a broadband connector, coaxial calibration kit and directional couplers allows broadband devices to be measured over a wide frequency range, 45 MHz to 110 GHz, in one frequency sweep. All frequency band switching is performed internally by the HP 8510C, making it extremely convenient when measuring broadband devices on-wafer or in coax.

The HP 8510XF systems have been designed to measure broadband devices to 110 GHz in coax (1.0 mm) or on-wafer, fully calibrated, in a single sweep. By building on the HP 8510C network analyzer, the HP 8510XF provides excellent measurement performance in frequency coverage, dynamic range and measurement accuracy.

Broadband calibration improves productivity

By performing a broadband calibration, from 45 MHz to 110 GHz, you are able to make measurements over the entire frequency range. Productivity is improved because you no longer need to connect, and disconnect banded coaxial test sets or waveguide modules as your measurements move from one frequency band to the next. In addition, the system was designed with the user in mind, making it suitable for both first-time and experienced users with minimal system training.

Convenient on-wafer calibration and measurements with 1.0 mm wafer probe

The HP 8510XF system is designed for convenient on-wafer measurements. You no longer have to struggle with waveguide connection. The new test heads are especially designed to mount on the probe stations. A short, flexible 1.0 mm coaxial cable connects the test head to the wafer probe tip. Mounting the test heads on the probe station allows the test heads to move with the wafer probe tips so that there is no relative movement between the two. This configuration eliminates cable flexing and improves measurement performance.

Probing equipment and accessories are available from Cascade Microtech Inc., Beaverton, Oregon, USA.

Millimeter-wave measurements made in 1.0 mm coax

With the recent development and availability of the Hewlett-Packard designed 1.0 mm coaxial connectors and calibration kits, you can now make fully error-corrected measurements to 110 GHz. Measurements made in 1.0 mm coax deliver uncompromised performance with improved productivity, as compared to making measurements in waveguide. The 1.0 mm connector is a sturdy, long life, precision connector that will provide repeatable connections. It has been accepted as a worldwide standard by the IEEE and IEC (the published standards are forthcoming).

There is no longer a need to struggle with waveguide; the measurement setup for 1.0 mm coax is configured with the test heads placed close to the device-under-test (DUT). You simply connect the short, flexible 1.0 mm coax cables between the test heads and your DUT. This configuration allows maximum flexibility while minimizing cable losses at 110 GHz.

Upgrade your current HP 8510 system to grow your measurement capability

Your HP 8510-based system can be upgraded to an HP 8510XF to meet your new design and test challenges. HP offers pre-configured upgrades for your standard HP 85107B, 85106C/D and 85109C systems. Upgrades include hardware and firmware and are installed on-site. Customized upgrades are also available for other HP 8510 systems. Calibration kits and cables must be purchased separately.

Millimeter subsystems available to protect your investments

If you have an HP 8510C and the appropriate sources, you can upgrade your HP 8510 by simply selecting one of the two millimeter subsystems that are available. Each subsystem includes a millimeter controller, two test heads and two base units.

Key Literature

HP 8510 System Solutions Brochure, p/n 5965-8837E
HP 8510C Family Network Analyzer Technical Data, p/n 5091-8484E
HP 8510C Family Network Analyzer Configuration Guide, p/n 5091-8967E
HP 8510XF Family, Single-Sweep Systems Product Overview, p/n 5965-9888E

Ordering Information

Complete HP 8510XF Systems
HP E7340A Single-Connection, Single-Sweep Network Analyzer System (2 to 85 GHz)
Opt 005 Extend Low Frequency to 45 MHz
HP E7350A Single-Connection, Single-Sweep Network Analyzer System (2 to 110 GHz)
Opt 005 Extend Low Frequency to 45 MHz

HP 85106D Millimeter-Wave Network Analyzer Subsystem

The HP 85106D millimeter-wave network analyzer subsystem includes an HP 8510C network analyzer, an HP 85105A millimeter-wave controller, an HP 83621B synthesized source as the RF, and an HP 83621B synthesized source as the LO, all mounted in a single bay rack with extendable worksurface.

Two HP 85104A series test set modules are required to complete the system. With these configurations, both forward and reverse measurements can be made with a single connection to the device under test. The greatest convenience and highest accuracy is assured through the TRL (through-reflect-line) calibration technique. Precision calibration kits and verification kits are also available for these waveguide bands.

The HP 85106D can be configured as a combination microwave/millimeter-wave S-parameter system with Option 001. This option adds an HP 8517B microwave test set, 50 GHz source (HP 83651B), HP 85133F test port return cable set, HP 85056A calibration kit, and appropriate cabling for convenient switching between millimeter-wave operation and microwave operation with no re-connections required.

HP 85108A/L Pulsed-RF Network Analyzer Systems

High Power Device Characterization

The HP 8510C can be configured for convenient single-connection, multiple-measurements of high-volume, high-power, and pulsed testing of IF, RF, and microwave frequency ranges. By pulsing the RF, the average power through the device is reduced, thereby reducing thermal effects on the device and making accurate characterization possible. These systems also include on-site installation, and a one-year, on-site warranty to ensure that the systems remain up and running.

HP 85108A Pulsed-RF Network Analyzer System

The HP 85108A is a factory-integrated system that provides the entire instrument configuration required to make pulsed-RF measurements from 2 to 20 GHz. Special options are available to add frequency coverage to 50 GHz.

The system is built around the HP 8510C with the pulsed-RF measurement option (Option 008) already installed. The system also includes the HP 85110A S-parameter test set. HP 83622B and HP 83624B synthesized sweepers provide, respectively, the RF and LO signals needed to operate the fundamentally mixed test set.

HP 85108L Pulsed-RF Network Analyzer System

The HP 85108L with the HP 85110L pulsed-RF test set provides improvements to pulsed-RF network analysis in many areas, but specifically extends the frequency coverage down to 45 MHz and up to 2 GHz. Special options are available to extend the upper frequency. The HP 85108L system is built around the same HP 8510C and includes two HP 83620B Option H80 synthesizers. The system is optimized for component testing in applications such as cellular, direct broadcast satellite, and VHF/UHF.

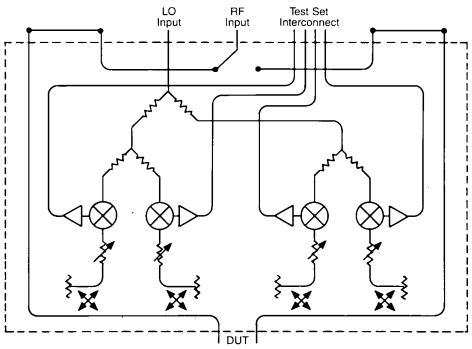
The HP 85110L has excellent pulsed-RF and CW performance with system dynamic range greater than 70 dB when using the wideband detectors and better than 95 dB when using the standard narrowband detectors. Both detectors are included in the HP 85108 systems.

HP 8510C Option 008

The HP 8510C pulsed-RF measurement capability (Option 008) consists of an additional receiver subsystem for the HP 8510. This pulsed-RF measurement capability, which exists in parallel with the standard HP 8510C operation, provides you with the ability to measure and display the relative magnitude and phase shift of the component as a function of time with equivalent bandwidth of 1.5 MHz. This allows the evaluation of the dynamic pulsed-RF characteristics for pulse widths down to 1 microsecond. Using the repetitive sampling method, point-to-point display resolution of 100 ns is available.

High Power CW or Pulsed-RF Measurements

An HP 85110A or 85110L S-parameter test set is a required system component for the HP 8510C pulsed-RF measurement capability. The figure below shows a simplified block diagram of this test set.



The block diagram provides some distinct advantages, whether using the HP 8510C for pulsed-RF or standard S-parameter measurements. Because of the coupler-based measurement path and attenuators, the test set can handle high powers, up to 20 W (HP 85110A) or 50 W (HP 85110L) CW.

Key to the pulse performance of the test sets are the fundamental mixers used to provide the low noise IF necessary to make accurate, pulsed-RF measurements with the pulsed-RF receiver subsystem. Two external synthesizers act as the RF and LO sources for the four-channel downconverter. This approach eliminates the need to dedicate one channel for phase-lock, making full two-port, pulsed-RF S-parameter measurements available. Also, the internal pulse modulator of the RF synthesizer can be used to pulse the device-under-test.

The connections available on the rear panel provide access to the measurement path, making it easy to configure test systems that use a single measurement connection for making multiple types of measurements such as spectrum analysis, noise figure, and load-pull. Special versions of the HP 85110A and 85110L test sets are available for even higher power applications or other frequency ranges.

To Upgrade an Existing HP 8510C System for Pulsed-RF Measurements

Your existing HP 8510 system can be upgraded to perform pulsed-RF measurements. This upgrade can be performed on-site or integrated into a full system at the factory.

Key Literature

HP 8510 System Solutions Brochure, p/n 5965-8837E
HP 8510C Family Network Analyzer Technical Data, p/n 5091-8484E
HP 8510C Family Network Analyzer Configuration Guide, p/n 5091-8967E
HP 85108 Series Network Analyzer Systems Data Sheet, p/n 5091-8965E

Ordering Information

HP 85108A Pulsed-RF Network Analyzer System
HP 85108L Pulsed-RF Network Analyzer System
Opt 010 Add Time-Domain Capability to HP 8510C (applies to both HP 85108A and 85108L)
HP 85106D Millimeter-Wave Network Analyzer Subsystem
Opt 001 Add Microwave Test Set (HP 8517B), 50 GHz Source (HP 83651B), and 2.4 mm Accessories
Opt 007 High Dynamic Range Configuration (to 50 GHz)
Opt 010 Add Time-Domain Capability to HP 8510C

For more information, including custom configurations, contact your local Hewlett-Packard sales office.

HP 8990A
HP 8991A
HP 8992A
HP 84812A
HP 84813A
HP 84814A
HP 84815A

HP 8991A

HP 84815A, HP 81814A, HP 84813A, HP 84812A (left to right)

HP 8990A and HP 8991A Peak Power Analyzers HP 8992A Digital Video Power Analyzer

Complete Pulse Power Characterization

The HP 8990A and HP 8991A peak power analyzers provide complete and accurate characterization of today's complex pulsed signals. They are capable of performing seven automatic timing measurements (rise time, fall time, pulse width, PRI, PRF, duty cycle, and delay) and five automatic power measurements (peak power, average power, pulse top/base amplitude, and overshoot) with push-button ease. Front-panel operation is intuitive and straightforward. Data entries can be typed in or made with the front-panel knob; automatic measurements are made with simple keystrokes.

The HP 8990A and 8991A offer two sensor channels plus two external triggering/oscilloscope channels, allowing the simultaneous measurement of modulating signals and detected power envelopes. Powerful measurement and display routines put you in control of your most demanding pulse applications. Measurement statistics, high-speed/high-sensitivity triggering, amplitude and time markers, dual-timebase windowing, measurement limit test, waveform storage, and waveform math are some of the new capabilities featured in the HP 8990A and 8991A.

The HP 8990A is optimized for linear display applications, and better rise/fall times than the HP 8991A. The HP 8991A is optimized for log display applications, providing higher resolution power measurements and improved power accuracy (when used with the HP 84815A sensor) than the HP 8990A. In addition, the HP 8991A is priced significantly less than the HP 8990A.

The peak power analyzers are compatible with the HP 84812/13A/14A/15A peak power sensors. These sensors give you outstanding measurement accuracy in demanding situations and include automatic temperature sensing and correction. The HP 8992 digital video power analyzer is very important for digital transmission applications. The HP 8992A's ability to characterize random peak power events make it possible to monitor receiver headroom and digital modulation quality.

HP 8990A, 8991A, and 8992A Specifications

Sensor Inputs (Channels 1 and 4)
Frequency Range: 20 MHz to 40 GHz, sensor dependent

	HP 8990A			HP 8991A/92A	
Power measurement range	–32 to +20 dBm			–33 to +20 dBm	
Rise/fall time	**Power dBm**	**Video BW**	**Tr/Tf**	**Video BW**	**Tr/Tf**
	0 to +20	150 MHz	<5 ns	High	<10 ns
	–16 to 0	150 MHz	<6 ns	Low	<1 μs
	–26 to –16	500 kHz	<1 μs	CW	<100 μs
	–32 to –26	8 kHz	<80 μs		
Instrumentation uncertainty (including noise and offset)	±(3.5% +(0.07 μW/signal power) x 100%)			±(0.07+1/(signal power in dBm+26)) dB (high bandwidth) ±(0.07+1.3/(signal power in dBm +33) dB (low, CW bandwidth) ±0. 07 dB, –15 to +20 dBm (using HP 84815A sensor and 50 MHz, 0 dBm reference source)	

Note: Rise/fall times limited to <45 ns with HP 84815 sensor

Max. Pulse Repetition Rate: 100 MHz externally triggered, 1 MHz internally triggered
Video Inputs (Channels 2 and 3)
Bandwidth: dc-coupled: dc to 100 MHz (repetitive); dc to 1 MHz (single shot). ac-coupled: 10 Hz to 100 MHz (repetitive); 10 Hz to 1 MHz (single shot).
Rise Time: <5 ns (HP 8990A) <10 ns (HP 8991A)
Vertical Sensitivity: 100 mV/div to 500 mV/div
Vertical Gain Accuracy: ±1.5%
Available Offset Range: ±20 Vdc, ±10 Vac
Time Base
Range: 2 ns/div to 5 s/div in 1-2-5 sequence
Resolution: 100 ps
Accuracy: 0.005%
General Characteristics
Power Requirements: Voltage: 90 to 132 or 198 to 264 Vac; 48 to 66 Hz. Power: 250 VA max
HP-IB Codes: SH1, AH1, T5, L4, SR1, RL1, PP1, DC1, DT1, C0, E2
Size: 422 mm W x 194 mm H x 366 mm D (16.62 in x 7.65 in x 14.4 in)
Weight: Net, 12.8 kg (28 lb); shipping, 20.1 kg (44 lb)

HP 84812A/13A/14A/15A Specifications

Frequency Range: HP 84812A: 500 MHz to 18 GHz
HP 84813A: 500 MHz to 26.5 GHz
HP 84814A: 500 MHz to 40 GHz
HP 84815A: 20 MHz to 18 GHz
Power Range: Dependent upon analyzer used. See specifications table for HP 8990A/91A/92A.
Sensor Input SWR (reflection coefficient):
50 MHz to 18 GHz: 1.25 (0.11)
6 to 18 GHz: 1.30 (0.13) (HP 84815A only)
18 GHz to 26.5 GHz: 1.35 (0.15)
26.5 GHz to 40 GHz: 1.60 (0.23)
Sensor Calibration Uncertainty:

Frequency	RSS uncertainty
< 4 GHz	±3.6%
< 12 GHz	±3.8%
< 18 GHz	±4.3%
< 26.5 GHz	±5.5%
< 40 GHz	±6.5%

Connector Type: HP 84812A, HP 84815A: Type-N (m); HP 84813A: APC-3.5 mm (m); HP 84814A: 2.4 mm (m)
General Characteristics
Size: HP 84812A, HP 84815A: 37 mm W x 27 mm H x 137 mm D (1.45 in x 1.05 in x 5.4 in)
HP 84813A, HP 84814A: 37 mm W x 27 mm H x 127 mm D (1.45 in x 1.05 in x 5.0 in)
Weight: Net, 0.29 kg (0.64 lb); shipping, 0.64 kg (1.4 lb)

Ordering Information

HP 8990A Peak Power Analyzer
Opt 001 Deletes Channel 4
Opt W30 Extended Repair Service (see page 584)
HP 8991A Peak Power Analyzer
HP 8992A Digital Video Power Analyzer
Opt 001 Deletes Channel 4
Opt W30 Extended Repair Service
HP 84812A Peak Power Sensor
HP 84813A Peak Power Sensor
HP 84814A Peak Power Sensor
HP 84815A Peak Power Sensor
Opt W30 Extended Repair Service (see page 584)

- Fast measurement speed (up to 200 readings per second with the 441A, and 100 readings per second with the 442A, over the HP-IB, with ECP-series sensors)
- Speed improvement of x2 using the HP 8480-series power sensor (compared to HP 437B)
- Code-compatible with the HP 437B (EPM-441A)
- Operates with the new ECP-series plus all HP 8480 series power sensors
- No range-switching delays with HP 8480-series sensors (over a 50 dB range), and only one fast-range switch point with ECP-series sensors (over a 90 dB range)
- High-resolution LCD display with backlighting for a wide viewing angle of data
- Same height and width as the HP 437B (EPM-441A), HP 438A (EPM-442A)
- Conformity to CE and CSA standards

HP EPM-441A and HP EPM-442A

HP EPM-441A Single-Channel Power Meter NEW

The HP EPM-441A is a low-cost, high-performance, single-channel, programmable power meter. It is fully compatible with the HP 8480 series of power sensors and the ECP series of power sensors. Depending upon which sensor is used, the HP EPM 441A can measure from –70 dBm to +44 dBm at frequencies from 100 kHz to 110 GHz. Designed for bench and automatic test equipment (ATE) use, the EPM-441A makes fast (up to 200 readings per second with ECP series sensors), accurate and repeatable power measurements.

The EPM-441A power meter has a high-resolution LCD display with LED backlighting and contrast control. This allows users to see the power readings from a distance, at a wide viewing angle and in a variety of lighting conditions. The user interface is easy to learn and use, with hardkeys for the most frequently used functions, and softkey menus to simplify instrument configuration for different applications. Ten instrument configurations can be saved and recalled, reducing the need to repeat setup sequences.

Because the EPM-441A power meter is designed to be code-compatible with the previous-generation HP 437B power meter, a user's investment in automatic-test procedures, software generation and verification is protected.

Front and rear panel bumpers protect the EPM-441A from everyday knocks. The meter weighs only 4 kg (9lbs), and a bail handle makes it easy to carry.

HP EPM-442A Dual-Channel Power Meter NEW

The HP EPM-442A is a low-cost, high-performance, dual-channel, programmable power meter. It is fully compatible with the HP 8480 series of power sensors and the new ECP series of power sensors. Depending upon which sensor is used, the HP EPM-442A can measure from –70 dBm to +44 dBm at frequencies from 100 kHz to 110 GHz.

Designed for bench and automatic test equipment use (ATE), the EPM-442A makes fast (up to 100 readings per second with ECP series sensors), accurate and repeatable power measurements. The HP EPM-442A is a true dual-channel power meter, which means that you get two simultaneous power readings on the display.

The EPM-442A power meter has a high-resolution LCD display with LED backlighting and contrast control. This allows users to see the power readings from a distance, at a wide viewing angle and in a variety of lighting conditions. Users can display both the digital and analog types of readout on the meter's split screen facility. The analog peaking meter allows users to make accurate adjustments.

The user interface is easy to learn and use, with hardkeys for the most frequently used functions, and softkey menus to simplify instrument configuration for different applications. Difference (A-B, B-A) and ratio (A/B, B/A) functions are provided, and ten instrument configurations can be saved and recalled, reducing the need to repeat setup sequences.

Because the EPM-442A power meter is the same height (88.5 mm /3.5 in) and width (212.6 mm/8.5 in) as the HP 438A, this makes them easy to substitute into rackmount automatic-test-equipment systems.

Instrumentation absolute accuracy for both the EPM-441A/442A is specified at ± 0.02 dB in logarithmic mode and ± 0.5% in linear mode, which makes the EPM family of power meters a negligible part of the overall measurement uncertainty.

Specifications

Frequency Range: 100 kHz to 50 GHz and 75 GHz to 110 GHz, sensor dependent
Power Range: –70 dBm to +44 dBm (100 pW to 25 W), sensor dependent
Power Sensors: Compatible with all HP 8480 series and HP ECP series sensors
Single Sensor Dynamic Range:
90 dB maximum (HP ECP series sensors)
50 dB maximum (HP 8480 series sensors)
Display Units:
Absolute: Watts or dBm
Relative: Percent or dB
Display Resolution: Selectable resolution of 1.0, 0.1, 0.01, and 0.001 dB in log mode, or 1 to 4 digits in linear mode
Default Resolution: 0.01 dB in log mode, 3 digits in linear mode

Accuracy
Instrumentation
Absolute: ± 0.02 dB (log) or ± 0.5% (linear). Add the corresponding power sensor linearity percentage
Relative: ± 0.04 dB (log) or ± 1.0% (linear). Add the corresponding power sensor linearity percentage

Power Reference
Power Output: 1.00 mW (0.0 dBm). Factory set to ± 0.7%, traceable to the U.S. National Institute of Standards and Technology (NIST)
Accuracy: ± 1.2% worst case (± 0.9% rss) for one year

Key Literature

EPM Power Meters and E-Series Power Sensors
Technical Specifications, p/n 5965-6382E
EPM Power Meters and E-Series Power Sensors
Brochure, p/n 5965-6380E
RF and Microwave Power Products Selection Guide,
p/n 5965-6629E
EPM Power Meters and E-Series Power Sensors
Configuration Guide, p/n 5965-6381E
Fundamentals of RF and Microwave Power Measurements
Application Note 64-1A, p/n 5965-6630E

Ordering Information

HP EPM-441A E4418A Power Meter
HP EPM-442A E4419A Power Meter
Opt 002 Supplies rear-panel sensor input (power reference calibrator is on front panel)
Opt 003 Supplies rear-panel sensor input (power reference calibrator is on rear panel)
Opt 004 Deletes the HP 11730A sensor cable
Opt 908 Supplies a one-instrument rackmount kit
Opt 909 Supplies a two-instrument rackmount kit
Opt 1BN Supplies ANSI/NCSL Z540-1-1994 Certificate of Calibration (supersedes MIL-STD-45662B)
Opt 1BP Supplies ANSI/NCSL Z540-1-1994 Certificate of Calibration with data (supersedes MIL-STD-45662B)
Opt UK6 Supplies commercial calibration certificate with test data

Power Meter, Peak Power Meters, Peak Power Sensor

HP 8900C
HP 8900D
HP 70100A
HP E1416A
HP 84811A

HP 70100A

HP E1416A

HP 70100A and E1416A MMS and VXI Power Meters

The HP 70100A is a full-featured single-channel power meter module for the modular measurement system (see page 72). It has all the capability of the HP 437B power meter in a one-eighth rack-width module. The HP 70100A features the same modern and flexible feature set as the HP 437B, the same state-of-the-art accuracy, and is also fully compatible with the HP 8480 series of power sensors. The HP E1416A power meter is a VXI version of the HP 70100A.

HP 70100A, and E1416A Specifications

Frequency Range: 100 kHz to 110 GHz, sensor dependent
Power Range: –70 to +44 dBm (100 pW to 25 W), sensor dependent
Power Sensors: Compatible with all HP 8480 series power sensors
Dynamic Range: 50 dB in 10 dB steps
Display Units: Absolute: watts, dBm; relative: percent, dB
Resolution: Selectable resolution of 0.1, 0.01, and 0.001 dB in logarithmic mode; or 1% and 0.01% of full scale in linear mode

Accuracy
Instrumentation: ±0.02 dB or ±0.5%
In REL Mode: ±0.02 dB or ±0.5% within measurement range; ±0.04 dB or 1% outside measurement range
Zero Set: ±0.5% of full scale on most sensitive range

Power Reference
Power Output: 100 mW, factory-set to ±0.7%, traceable to US National Institute of Standards and Technology
Accuracy: ±1.2% worst case (±0.9% RSS) for 1 year

Key Literature

RF and Microwave Power Products Selection Guide, p/n 5965-6629E

Ordering Information

HP 70100A Power Meter Module
- **Opt 003** Moves Reference Oscillator from Front to Rear Panel
- **Opt 004** Deletes the HP 11730A Power Sensor Cable
- **Opt 005** Deletes Reference Oscillator
- **Opt W30** Extended Repair Service (see page 584)

HP E1416A Power Meter C-Size VXI
- **Opt 004** Delete Sensor Cable
- **Opt 915** Service Support Kit
- **Opt 916** Additional User's Manual
- **Opt W01** 3 Year Return-to-HP to 1 Year On-site Warranty
- **Opt W32** 3 Year Customer Return Calibration Service
- **Opt W34** 3 Year Customer Return Standards Compliant Calibration Service
- **Opt W50** 5 Year Return Repair Service
- **Opt W52** 5 Year Customer Return Calibration Service
- **Opt W54** 5 Year Customer Return Standards Compliant Calibration Service

HP 8900C

HP 8900D

HP 8900C/D Peak Power Meters

The HP 8900C and 8900D peak power meters directly display the peak power of RF pulses over a 100 MHz to 18 GHz frequency range. Measurements can be made on pulses with widths from 1 µs (100 ns in compare mode) to CW, and repetition rates from 100 Hz (0 Hz in compare mode) to 100 kHz.

The HP 8900C is an economical analog meter calibrated in watts and dBm. The analog display with its large, easy-to-read scale makes it simple to peak or null pulsed power systems. The HP 8900D has a high-resolution 3½-digit digital display calibrated in watts. The direct reading display and range annunciators make the digital version a good choice for production and field applications where unambiguous or frequent readings are required.

HP 84811A Peak Power Sensor

The HP 84811A peak power sensor works with the HP 8900C/D peak power meters to measure the peak power of RF pulses. It is supplied with a 4-foot flexible cable to easily reach the pulse source being measured. The HP 84811A also conveniently detaches from the meter for storage, recalibration, or replacement.

HP 8900C/D Peak Power Meters Specifications

Frequency Range: 100 MHz to 18 GHz
Dynamic Range: 20 dB (0 to +20 dBm)
- **HP 8900C:** 4 ranges of 3, 10, 30, and 100 mW full scale
- **HP 8900D:** 2 ranges of 10 and 100 mW full scale

Pulse Response:
- **Direct Mode**
  - **Pulse Width:** 1 µs to CW
  - **Repetition Rate:** 100 Hz to 100 kHz
- **Compare Mode**
  - **Pulse Width:** 100 ns (typical) limited by rise-time specification
  - **Repetition Rate:** 0 to 100 kHz
- **Rise Time:** 75 ns
- **Fall Time:** 125 ns (as measured on video output)

Power Consumption: 100 and 120 Vac +5, –10%, 48 to 66 Hz and 360 to 440 Hz; 220 and 240 Vac +5, –10%, 48 to 66 Hz

Meter accuracy	CW	Pulse	Transfer accuracy CW to pulse
Direct	±0.2 dB	±0.35 dB	±0.2 dB
Compare	±0.2 dB	±0.25 dB	±0.1 dB

HP 84811A Peak Power Sensor Specifications

Power Range: 0 to +20 dBm (1 mW to 100 mW)
Frequency Range: 100 MHz to 18 GHz
SWR: 100 MHz to 12 GHz <1.5. 12 GHz to 18 GHz <2.0
Maximum Peak Power: +24 dBm (250 mW) for 5 minutes
Connector Type: Type-N (male)
Calibration Accuracy: (+10° to +40° C), ±0.7 dB 0.1 to 12 GHz, ±1.0 dB to 18 GHz. 0° to 10° C and 40° to 55° C: add ±0.2 dB

Key Literature

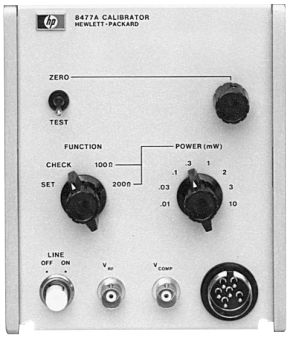
HP 8900C/D Peak Power Meters and HP 84811A Peak Power Sensor Technical Data, p/n 5952-8258

Ordering Information

HP 8900C Analog Peak Power Meter
HP 8900D Digital Peak Power Meter
- **Opt W30** Extended Repair Service (for HP 8900C/D) (see page 584)
- **Opt W32** Calibration Service (see page 584)

HP 84811A Peak Power Sensor
- **Opt W30** Extended Repair Service (see page 584)
- **Opt W32** Calibration Service (see page 584)

HP 432A



HP 8477A

HP Thermistor Mounts

HP 432A Power Meter

- High accuracy—no thermoelectric error: High accuracy over a wide temperature range is featured on the HP 432A power meter. By measuring the output voltage of the thermistor bridges and computing the corresponding power, even higher accuracy of ±0.2 percent ±0.5 µW can be obtained. Accuracy can be maintained on even the most sensitive range because the error due to thermoelectric effect is reduced to a negligible level.
- Calibrated mounts: Each thermistor mount is furnished with data stating the calibration factor and effective efficiency at various frequencies across the operating range. For easy and accurate power measurements, the front panel of the HP 432A has a calibration-factor control, calibrated in one-percent steps from 88 percent to 100 percent, that compensates for losses in the mount and eliminates the need for calculation.
- Instrument type: Automatic, self-balancing power meter for use with temperature-compensated thermistor sensor.

Specifications (Partial)

Power Range: 7 ranges with full-scale readings of 10, 30, 100, and 300 µW, 1, 3, and 10 mW; also calibrated in dBm from –20 dBm to +10 dBm full scale in 5 dB steps
Noise: Less than 0.25% of full scale peak (typical)
Response Time: At recorder output, 35 ms time constant (typical)
Fine Zero: Automatic, operated by front-panel switch
Zero Carryover: Less than 0.50% of full scale when zeroed on most sensitive range
Meter: Taut-band suspension, individually calibrated, mirror-backed scales. Milliwatt scale more than 108 mm (4.25 in) long
Calibration Factor Control: 13-position switch normalizes meter reading to account for thermistor sensor calibration factor. Range 100% to 88% in 1% steps.
Thermistor Sensor: Thermistor sensors are required for operation of the HP 432A. For microwave sensors HP 478A, 8478B, and 486 series, see next column.
Recorder Output: Proportional to indicated power with 1 volt corresponding to full scale. 1 kΩ output impedance.
BCD Output: 8, 4, 2, 1 code: "1" positive. TTL compatible logic. Operates with HP 5150A, Option 002 (BCD) digital recorder.
Power Consumption: 115 or 230 Vac ±10%, 50 to 400 Hz, 1.5 watts
Size: 130 mm W x 155 mm H x 279 mm D (5.2 in x 6.1 in x 11.0 in)
Weight: Net, 2.3 kg (5.5 lb); shipping, 4.6 kg (10 lb)

HP 8477A Power Meter Calibrator

The HP 8477A power meter calibrator is specifically designed for use with the HP 432A power meter. It allows you to verify full-scale meter readings on all ranges, and meter tracking. Simply connect three cables between the power meter and calibrator; no charts or additional instruments are required.

Power: 115 or 230 Vac ±10%, 50 to 400 Hz, 3 watts

Temperature-Compensated Thermistor Mounts

High efficiency and good radio frequency (RF) match are characteristic of the HP 478A and 8478B coaxial and 486A series waveguide thermistor mounts. Used in conjunction with the HP 432A power meter, they provide high accuracy even in routine power measurements. These thermistor mounts are temperature compensated for low drift, even in the presence of thermal shocks, permitting measurement of microwave power as low as one microwatt. Each mount contains data showing calibration factor and effective efficiency at six frequencies, directly traceable to the U.S. National Institute Standards and Technology at those frequencies where NIST provides calibration service.

HP 486A, 478A, 8478B Specifications

HP model	Frequency range, GHz	Maximum SWR
478A	10 MHz to 10 GHz	1.75, 10 to 25 MHz 1.3, 25 MHz to 7 GHz 1.5, 7 to 10 GHz
8478B[1]	10 MHz to 18 GHz	1.75, 10 to 30 MHz 1.35, 30 to 100 MHz 1.1, 0.1 to 1 GHz 1.35, 1 to 12.4 GHz 1.6, 12.4 to 18 GHz
X486A	8.20 to 12.4	1.5
P486A	12.4 to 18.0	1.5
K486A	18.0 to 26.5	2.0
R486A	26.5 to 40.0	2.0

[1] Option 011: Furnished with APC-7 RF connector

Ordering Information

HP 432A Power Meter
Opt 001 Rechargeable battery installed, provides up to 20 hours of continuous operation (HP 432A only)
Opt 002 Input connector placed on rear panel in parallel with front
Opt 003 Input connector on rear panel only
Opt 009 3.1 m (10 ft) Cable for 100 Ω or 200 Ω Sensor
Opt 010 6.1 m (20 ft) Cable for 100 Ω or 200 Ω Sensor
Opt 011 15.2 m (50 ft) Cable for 100 Ω or 200 Ω Sensor
Opt 012 30.5 m (100 ft) Cable for 100 Ω or 200 Ω Sensor
Opt 013 61 m (200 ft) Cable for 100 Ω or 200 Ω Sensor
Opt 100 100 Vac Operation, 48 to 66 Hz
Opt 910 Extra Operating and Service Manual (HP432A: p/n 00432-90009)
Opt W30 Extended Repair Service (see page 584)
Opt W32 Calibration Service (see page 584)
HP 8477A Power Meter Calibrator
Opt W30 Extended Repair Service (see page 584)
Opt W32 Calibration Service (see page 584)

HP ECP Power Sensor Family

HP ECP-E18A
HP ECP-E26A

- Operates with the new EPM-441A and 442A power meters
- Wide dynamic range sensors (–70 dBm to +20 dBm)
- Fast measurement speed (up to 200 readings per second, over the HP-IB, with the EPM-441A power meter)
- Calibration factors stored in EEPROM

HP ECP Series Power Sensors

HP ECP-Series Power Sensors

NEW

The ECP series power sensors, comprising the ECP-E18A (10 MHz to 18 GHz) and ECP-E26A (50 MHz to 26.5 GHz) are wide dynamic range (–70 dBm to +20 dBm) CW sensors and only operate with the EPM-441A and 442A power meters.

Some of the new performance features provided by the HP ECP series sensor and HP EPM power meter combination are fast measurement speed (up to 200 readings per second with the EPM-441A single-1–1 channel power meter), 90 dB dynamic range (–70 dBm to +20 dBm) and sensor calibration factors stored in EEPROM.

Specifications

Wide Dynamic Range CW Sensors:
100 pW to 100 mW (–70 dBm to +20 dBm)
Zero Set (digital settability of zero)**:** ECP-E18A and E26A: ±50 pW.
This applies to a ZERO performed when the sensor input is not connected to the POWER REF.

HP ECP-E18A

Frequency Range	Maximum SWR	Maximum Power	Connector Type
10 MHz to 18 GHz	10 MHz to 30 MHz: 1.34 30 MHz to 10 GHz: 1.22 10 GHz to 18 GHz: 1.27	200 mW (+23 dBm)	N (m)

HP ECP-E26A

Frequency Range	Maximum SWR	Maximum Power	Connector Type
50 MHz to 26.5 GHz	50 MHz to 2 GHz: 1.25 2 GHz to 18 GHz: 1.21 18 GHz to 26.5 GHz: 1.26	200 mW (+23 dBm)	APC-3.5 mm (m)

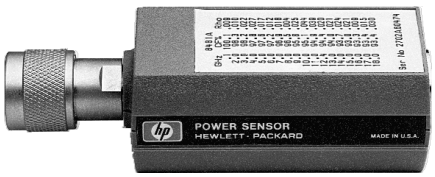
Power
100 pW to 10 mW (–70 dBm to +10 dBm)**:**
Temperature: (25° C ± 5° C): ±4%; (0 to 55° C): ±8%
10 mW to 100 mW (+10 dBm to +20 dBm)**:**
Temperature: (25° C ± 5° C): ±5.5%; (0 to 55° C): ±11%
Size
ECP-E18A: 130 mm L x 38 mm W x 30 mm H (5.1 in x 1.5 in x 1.2 in)
ECP-E26A: 102 mm L x 38 mm W x 30 mm H (4 in x 1.5 in x 1.2 in)
Weight
ECP-E18A: 0.47 kg (1.04 lb)
ECP-E26A: 0.45 kg (1.0 lb)

Key Literature

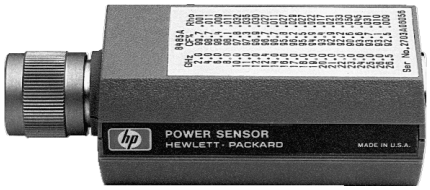
EPM Power Meters and E-Series Power Sensors Technical Specifications, p/n 5965-6382E
EPM Power Meters and E-Series Power Sensors Brochure, p/n 5965-6380E
Power Products Selection Guide, p/n 5965-6629E
EPM Power Meters and E-Series Power Sensors Configuration Guide, p/n 5965-6381E
Fundamentals of RF and Microwave Power Measurements Application Note 64-1A, p/n 5965-6630E

Ordering Information

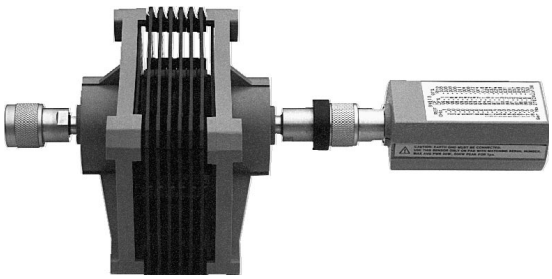
HP ECP-E18A E4412A Power Sensor (10 MHz to 18 GHz)
HP ECP-E26A E4413A Power Sensor (50 MHz to 26.5 GHz)
Opt 0B1 Extra Operation and Service Guide
Opt 1BN MIL-STD-45662A Certification of Calibration
Opt ABD German Operation and Service Guide
Opt ABE Spanish Operation and Service Guide
Opt ABF French Operation and Service Guide
Opt ABJ Japanese Operation and Service Guide
Opt ABZ Italian Operation and Service Guide



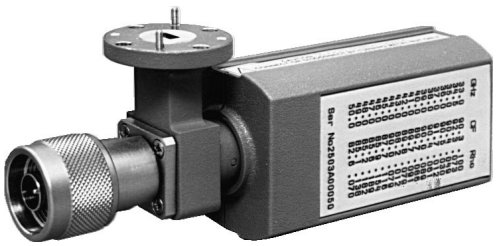
HP 8481A



HP 8485A



HP 8481A



HP Q8485A

HP 8480 Power Sensor Family

The HP 8480 power sensors are designed for use with the EPM-441A, EPM-442A, HP 435B, 436A, 437B, 438A, 70100A and E1416A power meters. These thermocouple and diode power sensors provide extraordinary accuracy, stability, and SWR over a wide range of frequencies (100 kHz to 110 GHz) and power levels (–70 to +44 dBm).

Best SWR in the Industry

Mismatch uncertainty is usually the largest single source of error in power measurements. The HP 8480 power sensor family gives you extremely low SWR even at mm-wave frequencies. For example, the HP W8486A power sensor has a specified SWR of less than 1.08:1 over its entire 75 to 110 GHz frequency range. This low SWR translates into minimum mismatch uncertainty and optimum measurement accuracy.

Accurate Calibration and Traceability

Each power sensor in the HP 8480 family is individually calibrated and traceable to the U.S. National Institute of Standards and Technology (NIST, formerly NBS). The uncertainty in this calibration factor is your link to NIST. The cal factor measurement system used by HP Standards Lab provides you with minimum cal factor uncertainty.

True-RMS Reading Sensors

HP high-sensitivity diode power sensors (HP 8481D/85D/86D/87D) are always operated inside the square-law region. This means that the sensor will act as a true-RMS reading device over its entire –70 to –20 dBm dynamic range. The benefit to you: HP sensors provide you with accurate readings even if your test signal is subjected to multi-tone environments, modulated carriers, or carriers with high harmonics.

Millimeter-Wave Sensor Calibration

A 50 MHz calibration port is included in HP waveguide power sensors for calibration with the power meter. This calibration provides traceability to NIST at millimeter-wave frequencies, and it eliminates the uncertainties due to temperature changes and the variance in making measurements with different meter/sensor combinations.

Accurate Accessories Included

With HP power sensors, you can start making measurements right away. No more hunting around for attenuators or adapters. HP sensors include all the accessories you need to optimize accuracy and save time.

HP 11683A Range Calibrator

The HP 11683A range calibrator is specifically designed for use with the EPM-441A, EPM-442A, HP 435B, 436A, 437B, 438A, 70100A and E1416A power meters. It allows verification of full-scale meter readings on all ranges, as well as meter tracking. Simply connect the cable between the power meter and calibrator. The CAL ADJ control on the power meter is used to set the meter to full scale on the 1 mW range. The calibrator and meter are then stepped through the other ranges verifying accuracy within ±1 percent plus noise and drift. The HP 11683A also has a polarity switch that tests the auto-zero circuit. The HP 11683A is not HP-IB compatible.

HP 11683A Range Calibrator Specifications

Calibration Functions: Outputs corresponding to meter readings of 3, 10, 30, 100, and 300 µW; 1, 3, 10, 30, and 100 mW
Calibration Uncertainty: ±0.25% in all ranges
Power: 100, 120, 220, or 240 Vac + 5%, –10%, 48 –440 Hz, less than10 V · A
Size: 133 mm W x 89 mm H x 216 mm D (5.25 in x 3.5 in x 8.5 in)
Weight: Net, 1.13 kg (2.5 lb); shipping, 1.9 kg (4.2 lb)

HP 11730A-F Power Sensor Cables

The HP 11730 series power sensor cables are for use with the EPM-441A, EPM-442A, HP 435B, 436A, 437B, 438A, 70100A and E1416A power meters and the ECP-series and HP 8480 series of power sensors. These cables are designed to reduce RFI effects on low power readings with an improved shielding design in the cable itself. Cables may be ordered individually or in pairs in any combination desired for single- and dual-channel measurements.

The HP 11730A cable is the standard cable for the EPM-441A, EPM-442A (2 cables shipped), HP 435B, 436A, 437B, 438A (2 cables shipped), 70100A and E1416A power meters. To order a nonstandard cable, select Option 004 for the meter in question, and order the desired cable from below.

Key Literature

Thermocouple and Diode Power Sensor Family Brochure, p/n 5959-8751

Ordering Information

HP 11683A Range Calibrator
HP 11730A 1.5 Meter (5 ft) Sensor Cable
HP 11730B 3.0 Meter (10 ft) Sensor Cable
HP 11730C 6.1 Meter (20 ft) Sensor Cable
HP 11730D 15.2 Meter (50 ft) Sensor Cable
HP 11730E 30.5 Meter (100 ft) Sensor Cable
HP 11730F 61.0 Meter (200 ft) Sensor Cable

HP 8480 Series Specifications

HP model	Frequency range	Maximum SWR	Power linearity[1]	Maximum power	Connector type	Weight
25 Watt Sensors 1 mW to 25 W (0 to +44 dBm)						
8481B	10 MHz to 18 GHz	10 MHz to 2 GHz: 1.10 2 to 12.4 GHz: 1.18 12.4 to 18 GHz: 1.28	+35 to +44 dBm; ±4%	0° to 35° C: 30 W avg[2] 35° to 55° C: 25 W avg 0.01 to 5.8 GHz: 500 W pk	Type-N(m)	Net 0.8 kg (1.75 lb) Shipping 1.5 kg (3.25 lb)
8482B	100 kHz to 4.2 GHz	100 kHz to 2 GHz: 1.10 2 to 4.2 GHz: 1.18		5.8 to 18 GHz: 125 W pk 500 W-µs per pulse	Type-N(m)	
3 Watt Sensors 100 µW to 3 W (–10 to +35 dBm)						
8481H	10 MHz to 18 GHz	10 MHz to 8 GHz: 1.20 8 to 12.4 GHz: 1.25 12.4 to 18 GHz: 1.30	+25 to +35 dBm; ±5%	3.5 W avg, 100 W pk 100 W-µs per pulse	Type-N(m)	Net 0.2 kg (0.38 lb) Shipping 0.5 kg (1 lb)
8482H	100 kHz to 4.2 GHz	100 kHz to 4.2 GHz: 1.20			Type-N(m)	
100 mW Sensors 1 µW to 100 mW (–30 to +20 dBm)						
8485A	50 MHz to 26.5 GHz	50 to 100 MHz: 1.15 100 MHz to 2 GHz: 1.10 2 to 2.4 GHz: 1.15 12.4 to 18 GHz: 1.20 18 to 26.5 GHz: 1.25	+10 to +20 dBm; +2, –4%	300 m W avg, 15 W pk 30 W-µs per pulse	APC-3.5 mm (m)	Net 0.2 kg (0.38 lb) Shipping 0.5 kg (1 lb)
Option 033	50 MHz to 33 GHz	26.5 to 33 GHz: 1.40				
8481A	10 MHz to 18 GHz	10 to 30 MHz: 1.40 30 to 50 MHz: 1.18 50 MHz to 2 GHz: 1.10 2 to 12.4 GHz: 1.18 12.4 to 18 GHz: 1.28			Type-N(m)	
8482A	100 kHz to 4.2 GHz	100 to 300 kHz: 1.60 0.3 to 1 MHz: 1.20 1 MHz to 2 GHz: 1.10 2 to 4.2 GHz: 1.30			Type-N(m)	
8483A (75 Ω)	100 kHz to 2 GHz	100 to 600 kHz: 1.80 600 kHz to 2 GHz: 1.18		300 mW avg, 10 W pk	Type-N(m) 75 Ω	
R8486A	26.5 to 40 GHz	1.4	+10 to +20 dBm; +2, –4%	300 mW avg, 15 W pk 30 W-µs per pulse	Waveguide Flange UG-599/U	Net 0.26 kg (0.53 lb) Shipping 0.66 kg (1.3 lb)
Q8486A	33 to 50 GHz	1.5			Waveguide Flange UG-383/U	
W8486A	75 to 110 GHz	1.08	+1, –3%	200 mW avg 40 W peak	Waveguide Flange UG-387/U	Net 0.4 kg (0.9 lb) Shipping 1.0 kg (2.1 lb)
8487A	50 MHz to 50 GHz	50 to 100 MHz: 1.15 100 MHz to 2 GHz: 1.10 2 to 12.4 GHz: 1.15 12.4 to 18 GHz: 1.20 18 to 26.5 GHz: 1.25 26.5 to 40 GHz: 1.30 40 to 50 GHz: 1.50	+10 to +20 dBm; +2,– 4%	300 mW avg, 15 W pk 30 W-µs per pulse	2.4 mm (m)	Net 0.14 kg (0.28 lb) Shipping 0.5 kg (1 lb)
High Sensitivity Sensors 100 pW to 10 µW (–70 to –20 dBm)						
8481D[3,4]	10 MHz to 18 GHz	10 to 30 MHz: 1.40 30 MHz to 4 GHz: 1.15 4 to 10 GHz: 1.20 10 to 15 GHz: 1.30 15 to 18 GHz: 1.35	–30 to –20 dBm; ±1%	100 mW avg 100 mW pk	Type-N(m)	Net 0.18 kg (0.41 lb) Shipping 0.9 kg (2 lb)
8485D[3]	50 MHz to 26.5 GHz	0.05 to 0.1 GHz: 1.19 0.1 to 4 GHz: 1.15 4 to 12 GHz: 1.19 12 to 18 GHz: 1.25 18 to 26.5 GHz: 1.29	–30 to –20 dBm; ±2%	100 mW avg 100 mW pk	APC-3.5 mm (m)	Net 0.2 kg (0.38 lb) Shipping 0.5 kg (1 lb)
Option 033	50 MHz to 33 GHz	26.5 to 33 GHz: 1.35				
8487D[3]	50 MHz to 50 GHz	0.05 to 0.1 GHz: 1.19 0.1 to 2 GHz: 1.15 2 to 12.4 GHz: 1.20 12.4 to 18 GHz: 1.29 18 to 34 GHz: 1.37 34 to 40 GHz: 1.61 40 to 50 GHz: 1.89	–30 to –20 dBm; ±2%	100 mW pk 100 mW avg	2.4 mm (m)	Shipping 0.5 kg (1 lb) Net 0.2 kg (0.38 lb)
R8486D[3]	26.5 to 40 GHz	1.4	–30 to –25 dBm; ±3%	100 mW avg or pk 40 Vdc max	Waveguide Flange UG-599/U	Net 0.26 kg (0.53 lb) Shipping 0.66 kg (1.3 lb)
Q8486D[3]	33 to 50 GHz	1.4	–25 to –20 dBm; ±5%		Waveguide Flange UG-383/U	

[1] Negligible deviation except for those power ranges noted.
[2] For pulses greater than 30 W the maximum average power (P_a) is limited by the energy per pulse (E) in W – µs according to P_a=30-0.02E.
[3] Includes HP 11708A 30 dB attenuator for calibrating against a 0 dBm, 50 MHz power reference. HP 11708A is factory set to 30 dB ±0.05 dB at 50 MHz, traceable to NIST. SWR <1.05 at 50 MHz.
[4] This sensor directly replaces the popular HP 8484A power sensor.

- 10 to 1600 MHz (2047 MHz with Option 020)
- Accurate and simple, swept or CW measurements
- Second-stage correction
- Noise figure and gain display
- Calibrated display on oscilloscope, recorder, or plotter
- Powerful special-function enhancements

HP 8970B

HP 8970B Noise Figure Meter

With the HP 8970B noise figure meter, noise figure measurements are easy, accurate, and repeatable. Automatic second-stage correction makes accurate noise figure readings possible even for low-gain devices. The HP 8970B's dynamic range allows gain measurements of at least 40 dB (higher in some cases) or loss measurements to –20 dB, with no external attenuation or amplification. The HP 8970B can store up to four Excess Noise Ratio (ENR) noise source calibration tables. It also properly interpolates ENR values at each measurement frequency.

Microprocessor and Controller Functions

The HP 8970B takes the mystery out of noise figure measurements. It uses a microprocessor to make the calculations and corrections necessary for truly accurate, convenient, and flexible noise figure measurements. The meter also controls external local oscillators (such as the HP 8370 series synthesizers, the HP 8340 or HP 8360 series synthesized sweepers, or the HP 8350 sweep oscillator) and the HP 8971C noise figure test set. This makes accurate, broadband microwave measurements of amplifiers, mixers, and transistors as simple as RF measurements.

Virtually all of the HP 8970B's front-panel keys and functions are accessible over HP-IB, Hewlett Packard's enhanced version of IEEE-488. The noise figure meter has an independent system interface bus (SIB) to control the HP 8971C and local oscillator. This additional bus frees you from having to write computer code to control an instrument on the SIB (such as the local oscillator) when used in an automated setup. Pass-through capability allows other instrument controllers to send messages through the noise figure meter to any other instrument on the SIB.

Simple Calibration and Second-Stage Correction

Noise figure measurement accuracy is enhanced because the meter measures its own noise figure (and that of the rest of the measurement system) at up to 181 points. It stores this information, interpolates where necessary, and corrects for it when displaying the device under test noise figure. It also measures the test device gain.

Display

The HP 8970B's front-panel LEDs display frequency, gain, and noise figure. Rear-panel BNC connectors allow swept display of noise figure and gain versus frequency on an oscilloscope or x-y recorder. You can also have the noise figure and gain vs. frequency display sent to a digital plotter over the HP 8970B's system interface bus. All display modes are easily and accurately scaled to the desired resolution from the meter's front panel. The swept oscilloscope display allows you to optimize your test device in real time for both noise figure and gain. You can easily change the noise figure display from noise figure to effective noise temperature (Te) or Y factor.

Front Panel and Special Functions

The HP 8970B front-panel keys control number entry, calibration, and measurement. STORE, RECALL, and SEQ keys allow up to nine front-panel settings to be stored and sequenced automatically or manually to save setup time. Smoothing INCREASE and DECREASE keys are used to average up to 512 readings before display. This increases accuracy and eliminates display flicker.

For those who need greater measurement power than that provided by the HP 8970B's simple front panel, more than 200 special functions can be selected by pressing a numerical code and a special function key. Two examples are hot-cold measurements and automatic compensation for losses at the input of the test device. One of the special functions is a catalog that quickly shows you the current special functions being used. Three pull-out cards serve as a mini-reference manual for the instrument. They include most of the special functions, the HP-IB formats and codes, error messages, and typical measurement setups.

HP 8970B Partial Specifications

(See Technical Data Sheet p/n 5091-6049E for complete specifications.)
Noise Figure (Gain) Measurement Range: 0 to 30 dB (–20 to at least 40 dB)
Noise Figure (Gain) Instrumentation Uncertainty: ± 0.1 dB for 0° to 55° C (±.15 dB)
Noise Figure Resolution: 0.01 dB (0.001 dB over HP-IB)
Gain Resolution: 0.01 dB (0.001 dB over HP-IB)
Frequency Range: Tunable from 10 to 1600 MHz (2047 MHz with Option 020)
Tuning Accuracy (from 10° to 40° C): ± (1 MHz + 1% of frequency), 6 MHz maximum
Frequency Resolution: 1 MHz
Noise Figure (for input power levels below –60 dBm): <7 dB + 0.003 dB/MHz
Maximum Operating Input Power: –10 dBm
Maximum Net External Gain: >65 dB between noise HP 8970B RF input
Noise Source Drive: 28.0 ± 0.1 V
Operating Temperature: 0° to 55° C
Storage Temperature: – 55° to 75° C
Power: 100, 120, 220, or 240 V (+ 5%, – 10%); 48 to 66 Hz; 150 VA maximum
Size: 425 mm W x 143 mm H x 476 mm D (16.75 in x 5.68 in x 18.38 in)
Weight: net, 15.5 kg (34 lb); shipping, 18.5 kg (40 lb)

Key Literature

HP 8970B, 8970S/V, 8971C Noise Figure Measurement Products
Technical Data, p/n 5091-6049E

Noise Figure Meters

Noise Figure Measurement System

HP 8970S
HP 8970V
HP 8971C

HP 8970S/V

- 10 MHz to 26.5 GHz
- Fully specified system
- Removes double-sideband inaccuracies
- As easy to operate as the HP 8970B

HP 8971C

HP 8970S/V Microwave Noise Figure Measurement Systems

The HP 8970S/V systems remove the burden of designing, building, and supporting a microwave noise figure measurement system. You can now spend your time designing and building products, not test systems.

Each system consists of the HP 8970B noise figure meter, the HP 8971C noise figure test set, and a synthesized local oscillator. The HP 8970V system, which operates 10 MHz to 20 GHz, uses the HP 83711A synthesized CW generator as its local oscillator. The HP 8970S allows you to select the LO from the list below. Frequency operation depends on the LO selected, but can be configured to measure 10 MHz to 26.5 GHz with the HP 83630B synthesized sweeper. The HP 8971C with Option 001 is recommended for operation above 20 GHz.

The HP 8970B acts as the controller, so all system operation is transparent to the user. To ensure specified performance, the HP 8970S/V systems are given specifications just like an RF noise figure meter (i.e., the HP 8970B).

HP 8970S/V Partial Specifications

(See HP 8970S/V Technical Data for complete specifications.)
Frequency Range:
HP 8970S: 10 MHz to 26.5 GHz
HP 8970V: 10 MHz to 20 GHz
Noise Figure Measurement Range: 0 to 30 dB
Noise Figure Instrumentation Uncertainty (for a 14 to 16 dB ENR noise source in a 10° to 40° C environment and for device under test noise figure plus gain greater than 10 dB):
10 MHz to 18 GHz: ±0.2 dB (plus typical drift of ±0.015 dB/° C)
18 to 26.5 GHz: ±0.4 dB (plus typical drift of ±0.08 dB/° C)
Gain Instrumentation Uncertainty: ±0.28 dB (plus typical drift of ±0.05 dB/° C), 10 MHz to 18 GHz; ±0.07 dB/° C, 18 to 26.5 GHz
Noise Figure (maximum):
10 to 30 MHz: 18 dB
30 to 100 MHz: 13 dB
0.1 to 12 GHz: 10 dB
12 to 18 GHz: 11.5 dB
18 to 26.5 GHz: 14 dB
Input SWR: 10 MHz to 18 GHz: 2.25; 18 to 26.5 GHz: 2.7
Recommended Local Oscillators: HP 8671B, 8672A, 8673B/C/E/G, 8340B, 8341B, 83620A, 83622A, 83640A, 83630A, 83711B, 83712B, 83731B, 83732B, 83751A, and 83752A

HP 8971C Noise Figure Test Set

The HP 8971C noise figure test set brings the simplicity of double-sideband measurements and the accuracy of single-sideband measurements together in one package. Careful design and high-performance components, including a stable YIG filter, allow broadband single-sideband measurements from 10 MHz to 26.5 GHz with a single calibration and sweep. A low-noise preamplifier built into the noise figure test set lowers the second-stage noise figure, thereby reducing a major source of measurement uncertainty.

Measurement modes in the HP 8970B allow for double downconversion using the HP 8971C as the second downconverter. These modes can be used for millimeter-wave measurements of amplifiers and transistors and measurements of receivers and mixers with IFs above 1.6 GHz.

HP 8971C Partial Specifications

(See HP 8971C Technical Data for complete specifications.)
Frequency Range: 10 MHz to 26.5 GHz
Input SWR: 10 MHz to 18 GHz: 2.25; 18 to 26.5 GHz: 2.7
Image and Odd-Harmonic Rejection: 20 dB
Accessories Supplied:
One LO-to-HP 8971C cable, SMA(female), 300 mm
One HP 8971C-to-HP 8970B cable, Type-N (male), 190 mm
One Type-N (male)-to-SMA (male) adapter
Two HP-IB cables, 0.5 m

Key Literature

HP 8970B, 8970S/V, 8971C Noise Figure Measurement Products Technical Data, p/n 5091-6049E

HP 346A, 346B, 346C

HP 346A/B/C Broadband Noise Sources

The ideal companion to HP's noise figure meter and systems is the HP 346 family of noise sources. Since they are broadband (10 MHz to either 18 or 26.5 GHz), they eliminate the necessity for several sources at different frequency bands. Each source has individually-calibrated ENR values at specific frequencies. The calibration is printed on its label (see illustration) for easy loading into the HP 8970B. The low SWR of each noise source reduces a major source of measurement uncertainty—reflections of test signals. In addition, the variety of available connectors reduces the need for degrading accuracy with connector adapters.

The HP 346 family of noise sources are designed for a broad range of measurement applications. The HP 346C covers the broadest frequency range—10 MHz to 26.5 GHz. The HP 346B's high ENR, low SWR, and variety of connectors make it a general-purpose noise source. The HP 346A is designed especially for accurate characterization of input-impedance-sensitive devices (like GaAsFETs and many UHF amplifiers). Its very small change in reflection coefficient (<0.01) from ON to OFF minimizes errors when measuring noise figure and gain as a function of input impedance.

HP 346A/B/C Partial Specifications

(See Technical Data Sheet for complete specifications.)
Frequency Range:
HP 346A/B: 10 MHz to 18 GHz
HP 346C: 10 MHz to 26.5 GHz
Excess Noise Ratio (ENR) Limits:
HP 346A: 5 to 7 dB
HP 346B: 14 to 16 dB
HP 346C: 12 to 16 dB (10 MHz to 12 GHz) and
14 to 17 dB (12.0 to 26.5 GHz)
Maximum SWR (reflection coefficient) On and Off:
HP 346A/B: 10 to 30 MHz – 1.3 (0.13); 30 to 5000 MHz – 1.15 (0.07);
5 to 18 GHz – 1.25 (0.11)
HP 346C: 10 MHz to 18 GHz – 1.25 (0.11); 18 to 26.5 GHz – 1.35 (0.15)
Power Required: 28 ±1 Vdc
Size: 21 mm W x 140 mm H x 30 mm D (0.8 in x 5.5 in x 1.2 in)
Weight: net, 0.108 kg (3.5 oz); shipping, 0.5 kg (1 lb)
Standard Connector: APC-3.5 (male)

HP 346C Option K01 Broadband Noise Source

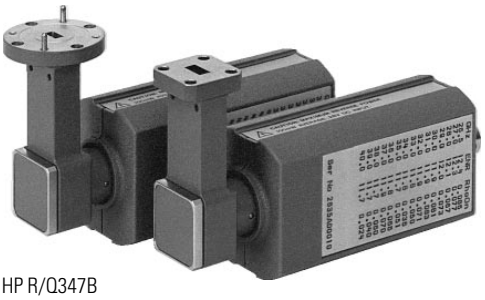
This coaxial noise source features coverage from 1 to 50 GHz with the 2.4-mm coaxial connector. ENR is nominally 20 dB at 1 GHz and 7 dB at 50 GHz. Contact Hewlett-Packard for technical specifications.

HP 346B Option H01 High ENR Noise Source

The HP 346B Option H01 has high ENR (21 dB typical), suitable for measuring high noise figure devices. Contact Hewlett-Packard for technical specifications.

HP 346B Option H42 DBS Noise Source

The 346B Option H42 was developed especially to test low noise block converters (LNB) used for Direct Broadcast Satellite (DBS). WR75 waveguide output, 5 dB ENR, low ENR calibration uncertainty, and low SWR improve the noise figure measurement accuracy of DBS LNBs. Contact HP for technical specifications.



HP R/Q347B

HP R347B and Q347B Noise Sources Partial Specifications

(See Technical Data Sheet for complete specifications.)
Frequency Range:
HP R347B: 26.5 to 40 GHz
HP Q347B: 33 to 50 GHz
Excess Noise Ratio (ENR) Range:
HP R347B: 10 to 13 dB
HP Q347B: 10 to 13 dB (33 to 42 GHz); 6 to 12.5 dB (42 to 50 GHz)
Maximum SWR (reflection coefficient):
HP R347B: <1.42 (0.17)
HP Q347B: <1.57 (0.22)

Key Literature

HP 346A/B/C Broadband Noise Sources Technical Data,
p/n 5953-6452

Ordering Information

HP 8970B Noise Figure Meter
- **Opt 020** 2047 MHz Upper Frequency
- **Opt 907** Front-Panel Handle Kit (5061-9689)
- **Opt 908** Rackmounting Flange Kit (5061-9677)
- **Opt 909** Both Options 907 and 908 (5061-9683)

Opt 915 Service Manual (08970-90023)
Opt 916 Additional Operating Manual (08970-90048)
- **Opt 700** External Mate Translator
- **Opt W30** Extended Repair Service
- **Opt W32** Calibration Service

HP 8971C Noise Figure Test Set
- **Opt 001** Add L.O. Power Amplifier
- **Opt 002** Delete RF Preamplifier
- **Opt 907** Front-Panel Handle Kit (5062-3988)

HP 8970S Noise Figure Measurement System
HP 8970V Noise Figure Measurement System
(10 MHz to 20 GHz)
- **Opt W30** Extended Repair Service
- **Opt W32** Calibration Service

HP 346A Noise Source
- **Opt 001** Type-N (male) Connector
- **Opt 002** APC-7 Connector
- **Opt 004** Type-N (female) Connector
- **Opt 910** Extra Operating Manual
- **Opt W30** Extended Repair Service
- **Opt W32** Calibration Service

HP 346B Noise Source
- **Opt 001** Type-N (male) Connector
- **Opt 002** APC-7 Connector
- **Opt 004** Type-N (female) Connector
- **Opt H01** High ENR
- **Opt H42** DBS Noise Source
- **Opt 910** Extra Operating Manual
- **Opt W30** Extended Repair Service
- **Opt W32** Calibration Service

HP 346C Noise Source
- **Opt 910** Extra Operating Manual
- **Opt W30** Extended Repair Service
- **Opt W32** Calibration Service

HP 346C Opt K01 Noise Source
HP R347B Noise Source
HP Q347B Noise Source

Amplifiers

Microwave System Amplifiers

Various Models

- Ultra broadband to 50 GHz
- Up to 1 watt output power
- Compact size

HP Microwave System Amplifiers

Use these amplifiers to increase output power from microwave sources and to increase test system measurement speed with improved dynamic range. Drive a variety of narrowband travelling wave tubes with a single driver solution that is highly reliable and low in cost to maintain year after year. With excellent noise figure relative to its broad bandwidth and high gain, these amplifiers can make significant improvement to system noise figure. By using feedback to an external source ALC input, system designers can level output power at the test port, negating the effects of post sweeper reflections and losses. Place power where you need it with a remotely-locatable dc power supply. The amplifier and the power supply are provided with a 2-m dc bias cable.

Specifications (+20° to +30° C)

HP Model	Frequency (GHz)	Power out Psat (dBm)	Power out P1dBC (dBm)	Gain dB (min)	Noise figure (dB typ.)	Detected output	DC bias volt/amp	RF connectors (Input/Output)
83006A	0.01 to 26.5	+18 typ. 0.01 to 10 +16 typ. 10 to 20 +14 typ. 20 to 26.5	+13, 0.01 to 20 +10, 20 to 26.5	20	13, 0.01 to 0.1 GHz 8, 0.1 to 18 GHz 13, 18 to 26.5 GHz	No	+12 V at 450 mA –12 V at 50 mA	3.5 mm (f)
83017A	0.5 to 26.5	+20 typ. 0.5 to 20 +15 typ. 20 to 26.5	+18, 0.5 to 20 GHz +13, 20 to 26.5	25	8, 0.5 to 18 GHz 13, 18 to 26.5 GHz	Yes	+12 V at 700 mA –12 V at 50 mA	3.5 mm (f)
83018A	2 to 26.5	+24, 2 to 20 GHz +21, 20 to 26.5 GHz	+22, 2 to 20 GHz +17, 20 to 26.5 GHz	27, 2 to 20 GHz 23, 20 to 26.5 GHz	10, 2 to 20 GHz 13, 20 to 26.5 GHz	Yes	+12 V at 2 A –12 V at 50 mA	3.5 mm (f)
83020A	2 to 26.5	+30, 2 to 20 GHz +30, 20 to 26.5 GHz*	+28, 2 to 20 GHz +28, 20 to 26.5 GHz*	30, 2 to 20 GHz 27, 20 to 26.5 GHz	10, 2 to 20 GHz 13, 20 to 26.5 GHz	Yes	+15 V at 3.2 A –15 V at 50 mA	3.5 mm (f)
83050A	2 to 50	+20, 2 to 40 GHz +19, 40 to 50 GHz**	+15, 2 to 40 GHz +13, 40 to 50 GHz	21	6, 2 to 26.5 GHz 10, 26.5 to 50 GHz	No	+12 V at 830 mA –12 V at 50 mA	2.4 mm (f)
83051A	0.045 to 50	+12, .045 to 45 GHz +10, 45 to 50 GHz	+8, .045 to 45 GHz +6, 45 to 50 GHz	23	12, 0.045 to 2 GHz 6, 2 to 26.5 GHz 10, 26.5 to 50 GHz	No	+12 V at 425 mA –12 V at 50 mA	2.4 mm (f)
87405A	0.01 to 3	+26 typ.	+4	22-27 min./max.	6.5, 0.01 to 2 GHz 7.5, 2 to 3 GHz	No	+15 V at 80 mA	N (f)/N (m)
87415A	2 to 8	+26 typ.	+23	25	13	No	+12 V at 900 mA	SMA (f)

* –0.7 dB/GHz (20<f<26.5)
** 19 dBm –0.2 dB/GHz (40<f<50)

Size:
HP 83006A, 83017A, 83050A, 83051A, 87415A: 132 mm L x 103 mm W x 45 mm H (4 in x 1.8 in x 5.2 in)
HP 83018A: 212 mm L x 114 mm W x 76 mm H (4.5 in x 3 in x 8.3 in)
HP 83020A: 275 mm L x 202 mm W x 87 mm H (8 in x 3.4 in x 10.8 in)
HP 87405A: 125 mm L x 28 mm W x 28 mm H (4.9 in x 1.1 in x 1.1 in)

Weight:
HP 83006A, 83017A, 83050A, 83051A, 87415A: .64 kg (1.4 lb);
HP 83018A: 1.8 kg (4 lb); **HP 83020A:** 3.9 kg (8.5 lb);
HP 87405A: .27 kg (0.6 lb)

Bias Cable:
2-m cable with a connector on one end and bare wires on the other, shipped with the amplifiers below
HP 83006A, 83017A, 83018A, 83050A, 83051A, 87415A:
HP p/n 83006-60004
HP 83020A: HP p/n 83020-60004
2-m cables to connect between amplifier and power supplies, shipped with power supplies below
HP 87421A: HP p/n 83006-60005
HP 87422A: HP p/n 87422-60001, 83006-60005

HP power supply	AC Input voltage	DC Output voltage/current	Output power	Size (H,W,D)
HP 87421A	100 to 240 VAC 50/60 Hz	+12 V at 2.0 A, –12 V at 200 mA	25 W max	57 mm, 114 mm, 176 mm 2.3 in, 4.5 in, 6.9 in
HP 87422A	100 to 240 VAC 50/60 Hz	+15 V at 3.3 A, –15 V at 50 mA +12 V at 2.0 A, –12 V at 200 mA	70 W max	86 mm, 202 mm, 276 mm 3.4 in, 8.0 in, 10.9 in

Key Literature

New *RF & Microwave Test Accessories Catalog,* p/n 5964-9527E

HP 8347A
HP 8447A
HP 8447D
HP 8349B
HP 8449B
HP 8348A

HP 8347A and HP 8447A/D Amplifiers

Specifications Summary

	HP 8347A RF Amplifier	HP 8447A Preamplifier	HP 8447D Preamplifier
Frequency range	100 kHz to 3 GHz	0.1 to 400 MHz	100 kHz to 1.3 GHz
Typical 3 dB bandwidth	—	50 kHz to 700 MHz	75 kHz to 1.7 GHz
Maximum leveled output power	≥ +20 dBm	—	—
Output power leveling range	(≥300 kHz): +2 to +20 dBm	—	—
Gain (mean, per channel)	≥25 dB	20 dB ± 1.0 dB at 10 MHz (20° to 30° C)	>25 dB (20° to 30° C)
Gain flatness across full frequency range	Internally leveled, ±300 kHz: ±1.5 dB	±1.8 dB (0° to 55° C) ±0.7 dB (20° to 30° C) characteristic	±1.5 dB
Noise figure	10 MHz to 3 GHz: 15 dB Below 10 MHz: 20 dB	<7 dB	<8.5 dB
Output power for 1 dB gain compression	+22 dBm	> +6 dBm	> +7 dBm typical
Third-order intercept	+30 dBm	—	—
Harmonic distortion	(at +20 dBm output) Internal level off (ALC off): ≤–25 dBc Internal level on (ALC on): ≤–20 dBc	–32 dB for 0 dBm output	–30 dB for 0 dBm output (typical)
Maximum input for minimum internally leveled output	–14 dBm	—	—
Output for <–60 dB harmonic distortion		–25 dBm (characteristic)	–30 dBm
VSWR	2.0: 1 input 1.5: 1 output internally leveled 2.0: 1 output unleveled below 2 GHz 3.0: 1 output unleveled 2 GHz to 3 GHz	<1.7	<2.0 input <2.2 output 1 to 1300 MHz
Reverse isolation	60 dB	>30 dB	>40 dB
Maximum dc voltage output	—	±10 V	±10 V
Size	213 mm W x 102 mm H x 298 mm D (8.4 in x 4.0 in x 11.8 in)	130 mm W x 85.8 mm H x 261 mm D (5.1 in x 3.4 in x 8.5 in)	130 mm W x 85.8 mm H x 216 mm D (5.1 in x 3.4 in x 8.5 in)
Weight	Net, 4 kg (8 lb); Shipping, 5 kg (11 lb)	Net, 1.56 kg (3.4 lb); Shipping, 2.3 kg (5.1 lb)	Net, 1.56 kg (3.4 lb); Shipping, 2.3 kg (5.1 lb)
Power requirements	—	110 or 230 Vac + 10%, 48 to 440 Hz, 15 W	110 or 230 Vac + 10%, 48 to 440 Hz, 15 W
Options available		**Option 001:** Dual-channel amp, BNC (f) connectors	**Option 001:** Dual-channel amp, BNC (f) connectors **Option 010:** Single-channel amp, Type-N (f) connectors **Option 011:** Dual-channel amp, Type-N (f) connectors

Key Literature

HP 8346A, 8347A, 8348A, 8349A Amplifiers Technical Data, p/n 5091-0370E

Ordering Information

HP 8347A RF Amplifier
HP 8447A Preamplifier
HP 8447D Preamplifier

HP 8348A Microwave Preamplifier

Specifications

Frequency Range: 2.0 to 26.5 GHz
Maximum Output Power (at 0 dBm input):
1.0 to 2.0 GHz: ≥+20 dBm (typical)
2.0 to 20.0 GHz:≥+25 dBm
20.0 to 26.5 GHz: ≥+23 dBm
Power Flatness (at 0 dBm input): ±4 dB (typical)
Minimum Small Signal Gain (at –15 dBm input):
1.0 to 2.0 GHz: ≥20 dB (typical)
2.0 to 20.0 GHz: ≥25 dB
20.0 to 26.5 GHz: ≥23 dB

Spectral Purity
Harmonics (typical, at maximum specified output power):
1.0 to 2.0 GHz: <–20 dBc
2.0 to 26.5 GHz: >–15 dBc
Third-Order Intercept
2.0 to 20.0 GHz: +36 dBm, nominal
20.0 to 26.5 GHz: +31 dBm, nominal
Maximum Continuous Input
Microwave power:+22 dBm
DC voltage:±10 V
Input and Output Impedence: 50 Ω, nominal
Input SWR: 3:1 (typical)
Output SWR (typical):
1.0 to 2.0 GHz: 6:1
2.0 to 20.0 GHz: 4.5:1
20.0 to 26.5 GHz: 2:1
Reverse Isolation: >50 dB (typical)
Noise Figure (typical):
1.0 to 20 GHz: <10 dB
20 to 26.5 GHz: <13 dB

Pulse Transmission Capability
Rise/Fall Time: <5 ns (typical)
Delay Time: <5 ns (typical)

General
Input and Output Connectors: 3.5 mm male
Power Requirement: 50 to 400 Hz, 100, 120, 200, or 240 volts ac (±10%); 85 VA maximum
Size: 133 mm H x 214 mm W x 366 mm D (5.2 in x 8.4 in x 14.4 in)
Weight: Net, 7 kg (15 lb); shipping, 14 kg (31 lb)

Ordering Information

HP 8348A 2 to 26.5 GHz Microwave Preamplifier

HP 8349B Microwave Amplifier

Frequency Specifications

Frequency Range: 2 to 20 GHz

Output and Input Specifications (25° C ± 5° C)

Minimum Output Power (at +5 dBm input)

Frequency Range (HGz)	Output Leveled	Output Unleveled
2.0 to 18.6	19 dBm (80 mW)	20 dBm (100 mW)
18.6 to 20.0	17 dBm (50 mW)	18 dBm (63 mW)

1 dB Compression Point: +21 dBm, nominal
Power Flatness (leveled): ±1.25 dB
Minimum Small Signal Gain (at –5 dBm input):
2.0 to 18.6 GHz: 15 dB
18.6 to 20.0 GHz: 13 dB
Noise Figure: <13 dB, typical
Input and Output Impedence: 50 Ω, nominal

VSWR

Frequency Range (GHz)	Input	Output Leveled	Output Unleveled (typical)
2.0 to 5.0	≤2.8	≤2.5	≤4.8
5.0 to 11.0	≤2.8	≤2.5	≤3.8
11.0 to 18.0	≤2.8	≤2.5	≤3.2
18.0 to 20.0*	≤2.8	≤2.5	≤3.2

*VSWR from 18.0 to 20.0 GHz is typical

Maximum Continuous Input, to the Input or Output Ports:
+27 dBm (RF), ±10 Vdc

Spectral Purity
Harmonics (at +20 dBm output): 2.0 to 11.0 GHz: <–20 dBc;
11.0 to 20.0 GHz: <–30 dBc typical
Non-Harmonic Spurious: ≤–55 dBc
Third-Order Intercept: +33 dBm, nominal

Pulse Transmission Capability
Rise/Fall Time: <10 ns typical

General
Reverse Isolation: >50 dB, typical
RF Input and Output Connectors: Type-N female
Size: 214 mm W x 133 mm H x 366 mm D (8.36 in x 5.2 x 13.6 in)
Weight: Net, 7 kg (15 lb); shipping, 14 kg (31 lb)

Ordering Information

HP 8349B 2 to 20 GHz Microwave Amplifier
Opt 001 Rear Panel RF Input/Output
Opt 002 Rear Panel RF Input w/Front Panel RF Output
Opt W30 Extended Repair Service (see page 584)

HP 8449B Preamplifier

Specifications

Frequency range	1.0 to 26.5 GHz		
Gain (mean, per channel)	≥ 26 dB (20° to 30° C)		
Gain flatness across full freq. range	1 to 26.5 GHz ± 4.5 dB (0° to 55° C); 2 to 22 GHz ± 2.4 dB (20° to 30° C)		
Noise figure	**Band**	**Typical**	
	1.0 to 12.7 GHz	≤8.5 dB	7 dB
	12.7 to 22.0 GHz	12.5 dB	9 dB
	22.0 to 26.5 GHz	≤14.5 dB	12 dB
Output power for 1 dB gain compression	≤+7 dBm (characteristic)		
Harmonic distortion	–30 dB for 0 dBm output (characteristic)		
Output for <–60 dB harmonic distortion	–30 dBm (characteristic)		
VSWR	**Input**	1.0 to 2.0 GHz	2.0:1
		2.0 to 12.5 GHz	1.5:1
		12.5 to 26.5 GHz	2.0:1
	Output	1.0 to 26.5 GHz	2.0:1
Reverse isolation	>75 dB		
Maximum dc voltage	±20 V		

Displayed average noise level, 0 dB atten. (characteristic)

HP 8563E (1 Hz RBW)	HP 8566B (10 Hz RBW)
1.0 to 6.46 GHz, –165 dBm	1.0 to 2.5 GHz, –55 dBm
5.86 to 13.0 GHz, –163 dBm	2.0 to 5.8 GHz, –154 dBm
12.4 to 26.5 GHz, –160 dBm	5.8 to 12.5 GHz, –150 dBm
	12.5 to 18.6 GHz, –144 dBm
	18.6 to 22 GHz, –140 dBm

Size: 213 mm W x 102 mm H x 297 mm D (8.4 in x 4.0 in x 11.7 in)
Weight: Net, 4 kg (8.8 lb) nominal
Power: 100, 120, 220, or 240 V, ±10%; 47 to 63 Hz

Ordering Information

HP 8449B 1 to 26.5 GHz Preamplifier
Opt 907 Front Handle Kit
Opt 908 Rackmount Kit (half-rack width)

HP 87130A

HP 11713A Attenuator/Switch Driver

The HP 11713A attenuator/switch driver provides simple HP-IB control of up to ten, 24 Vdc solenoid-activated switch or attenuator sections. The HP 11713A supplies 24 Vdc common and ten pairs of current sinking contacts to achieve control of up to ten relays. Each HP 11713A is supplied with two plug-in drive cables to simplify connection to programmable attenuators.

HP 70611A Attenuator/Switch Driver for MMS

The HP 70611A is a one-slot MMS module capable of driving up to 248 electromechanical switches or attenuator switch sections. The HP 70611A is MSIB, SCPI, and HP-IB compatible. In addition to being programmable, the HP 70611A features an extremely user-friendly manual interface via any MMS display unit. The highlight of the manual interface is the operator's ability to customize groups of switch control lines and their settings, then identify these switch settings with user-defined alphanumeric labels. In this manner, end users of the HP 70611A can define custom menus with their own identification labels for simplified manual control.

The HP 70611A can store up to 256 user-defined labeled paths. Path definitions can be stored in non-volatile EEROM. Groups of paths can be stored in directories for easy access to similar path commands. The HP 70612A/C and 70613A/C offer compatible capacity with built-in RF switches. (Configurations vary and custom configurations are available.)

HP 87130A Attenuator/Switch Driver

The HP 87130A is a 3.5-inch, full rack width attenuator/switch driver capable of driving up to 248 electromechanical switch or attenuator sections. The HP 87130A is controlled over HP-IB via Standard Commands for Programmable Instruments (SCPI) commands. The HP 87130A has been designed for use in both ATE switching systems and computer-controlled bench top applications.

The HP 87130A is electronically identical to the HP 70611A and shares its performance characteristics, with the exception of the manual control method. The HP 87130A has no front panel controls. Manual control of the HP 87130A is realized through its ITG driver and a computer controller. The HP 87130A can drive 31 switch or attenuator sections directly, and up to an additional 217 switches via seven additional HP 84940A driver cards.

HP E1368A, E1369A and E1370A VXI Attenuator/Switch Drivers

HP's VXI family of instrumentation includes modules for microwave switching and attenuation control up to 18.0 GHz. HP E1368A contains three factory-installed SPDT switches such as the HP 8762B which features all-port termination, dc to 18.0 GHz. HP E1369A is identical to the HP E1368A except the switches are not included. This allows user-substitution of HP 8763 or HP 8764 transfer switches. HP E1370A allows the user to customize the internal configuration for HP 8766 series multi-port switches or HP 8494/95/96/97 step attenuators.

HP 84940A Switch Driver and HP 84941A Distribution Card

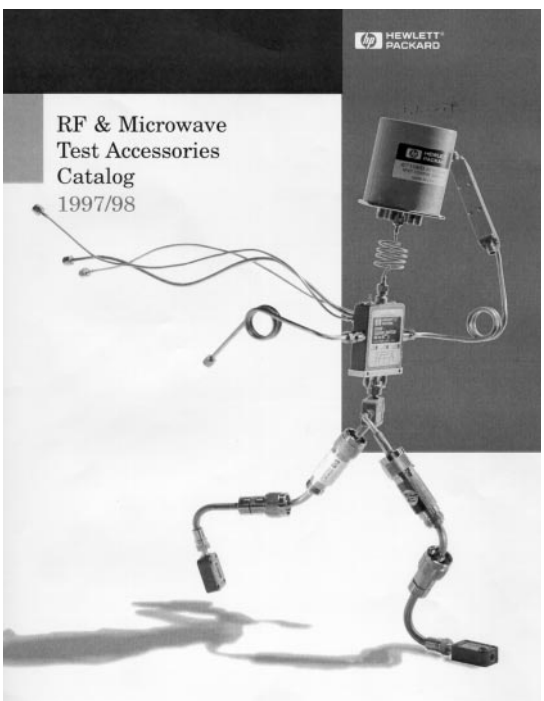
The HP 84940A is an expansion driver card for the HP 70611/12/13 family of MMS attenuator/switch drivers and the HP 87130A attenuator/switch driver. The HP 84940A has been designed for incorporation into large interfaces located remotely from their controller. A single HP 84940A can control up to 31 switches when located up to 150 feet (45 m) from an HP 70611/12/13 or HP 87130A. The physical interconnection to the switches or attenuators is realized via 31 four-pin output connectors, which permit quick connection and disconnection of the switches or attenuators.

Key Literature

New *RF & Microwave Test Accessories Catalog,* p/n 5964-9527E

Ordering Information

HP 11713A Attenuator/Switch Driver
HP 11717A Attenuator/Switch Driver Rack Support Shelf
HP 11761A; HP 8765 to **HP 11713A** Adapter Cable
HP 11764A; HP 84904/6/7 to **HP 11713A** Adapter Cable
HP 11764B; HP 84904/6/7 5-ft Ribbon Cable with 10-pin DIP Connector
HP 44476B Microwave Switch Module for HP 3488A (Holds up to two HP 8762/3/4 Option 011 Switches)
HP 70611A MMS Switch Driver
HP 84940A Attenuator/Switch Driver Expansion Card
HP 84941A Distribution Expansion Card
HP 87130A Attenuator/Switch Driver
HP E1368A 18 GHz Microwave Switch
HP E1369A Microwave Switch Driver
HP E1370A Microwave Switch/Step Attenuator Driver



RF & Microwave Test Accessories Catalog

The complete catalog of HP's microwave accessories—from adapters to waveguides and everything between, it's all here. Amplifiers, detectors, filters, step and fixed attenuators, switches and switch drivers—the entire HP product line, with all the technical specs.

To receive your free copy in the U.S., call 800-452-4844 and ask for the new *RF & Microwave Test Accessories Catalog,* p/n 5964-9527E, contact your local HP representative, or order on the World Wide Web (http://www.hp.com/go/tmcatalogs).

HP 8761
HP 8762
HP 8763
HP 8764
HP 8765
Series

HP Coaxial Switches

HP coaxial switches feature low SWR, low insertion loss, and excellent isolation. HP offers a broad line of coaxial switches, covering up to 40 GHz, for use in test and measurement applications. All switches use magnetically-latched solenoids and break-before-make RF contacts for test simplicity.

HP 8761 Series

HP 8761A/B is a SPDT switch which operates up to 18 GHz. Each port features six connector options plus 50 Ω termination for design flexibility. These switches offer exceptional repeatability of 0.03 dB over 1 million switching cycles.

HP 8762 Series

HP 8762A/B/C switches operate up to 26.5 GHz. These switches offer exceptional repeatability of 0.03 dB over 1 million switching cycles. They provide exceptional isolation of 90 dB to 18 GHz and all-port switched terminations, so that all ports maintain a 50 Ω match. Internal loads are rated at 1 watt average (100 W peak, 10 μsec pulse width). Control voltage options T15 and T24 are compatible with TTL/5 V CMOS drive circuitry. Another model, HP 8762F is designed for 75 Ω transmission lines, making it valuable for commercial communication applications up to 4 GHz.

HP 8763 Series

HP 8763A/B/C switches operate up to 26.5 GHz. These switches offer exceptional repeatability of 0.03 dB over 1 million switching cycles. They are preferred for transfer applications because of their compact design. Transfer switches are used to automatically insert or remove a test component from a signal path. Because of their excellent isolation, they can also be used as the intersection (crosspoint) switch in full-access matrix switching applications. One port is internally terminated. Options T15 and T24 are available for TTL/5 V CMOS compatibility.

HP 8764 Series

HP 8764A/B/C switches are available in three models up to 26.5 GHz. These switches offer exceptional repeatability of 0.03 dB over 1 million switching cycles. These switches are similar to the HP 8763, but with the internal termination replaced with a fifth port. The fifth port can be utilized for signal path reversal or as a calibration port. Options T15 and T24 offer TTL/5V CMOS compatibility.

HP 8765 Series

HP 8765A/B/C/D/F are available in four models up to 40 GHz, as well as a 75 Ω model to 4 GHz. These SPDT switches offer exceptional repeatability of 0.03 dB over 5 million switching cycles. Unlike the HP 8762 switches, they do not have internal, switched RF loads or dc current interrupts. Coil voltage options cover the complete range from 5 Vdc to 24 Vdc. Since the coils are not interrupted, the coil voltage may be continuous or may be switched off after 15 ms.

The standard HP 8765 comes with ribbon cables and standard printed circuit board 0.025-inch connector for convenient assembly. The ribbon cable also connects with the HP 11761A Cable/Adapter which permits direct connection to the HP 11713A Attenuator/Switch Driver. The HP 8765 can also be driven by the HP 87130A driver, but position monitoring and reporting are not available. Optional solder terminals are available.

Key Literature

New *RF & Microwave Test Accessories Catalog,* p/n 5964-9527E

Ordering Information

HP 8761A/B Coaxial Switches
Specify voltage and connectors (including built-in 50 Ω terminations) by alphabetic suffix on the switch model number and the appropriate 3-digit option number. Specify all connectors.
HP 8761A 12 to 15 V Supply Voltage
HP 8761B 24 to 30 V Supply Voltage
Connector Options (Port 1, Port 2, Port C):

Option Code	Connector Type
0	Type-N(f)
1	Type-N(m)
2	APC-7 w/threaded sleeve
3	APC-7 w/coupling nut
4	APC-7 for UT-250 coax
5	SMA(f)
6	SMA(m)
7	50 Ω termination

HP 8762, HP 8763, HP 8764 Coaxial Switches
Specify the frequency and voltage by the alphabetic suffix and option number. The standard model has 24 V supply voltage.
HP 8762A SPDT, DC to 4 GHz
HP 8762B SPDT, DC to 18 GHz
HP 8762C SPDT, DC to 26.5 GHz
HP 8762F SPDT, DC to 4 GHz, 75 Ω
HP 8763A 4-Port, DC to 4 GHz
HP 8763B 4-Port, DC to 18 GHz
HP 8763C 4-Port, DC to 26.5 GHz
HP 8764A 5-Port, DC to 4 GHz
HP 8764B 5-Port, DC to 18 GHz
HP 8764C 5-Port, DC to 26.5 GHz
Opt 011 5 Vdc Supply Voltage
Opt 015 15 Vdc Supply Voltage
Opt T15 TTL/5 V CMOS Compatible Logic with 15 Vdc Supply Voltage
Opt T24 TTL/5 V CMOS Compatible Logic with 24 Vdc Supply Voltage
Opt UK6 Commercial Calibration Test Data with Certificate
Opt UKS Commercial Calibration Certificate
HP 8765 Coaxial Switches
A voltage option must be ordered with the switch. Specify frequency, voltage, dc connectors, and ribbon cable extension options by alphabetic suffix and option number.
HP 8765A SPDT, DC to 4 GHz
HP 8765B SPDT, DC to 20 GHz
HP 8765C SPDT, DC to 26.5 GHz
HP 8765D SPDT, DC to 40 GHz
HP 8765F SPDT, DC to 4 GHz, 75 Ω
Opt 005 5 Vdc Supply Voltage
Opt 010 10 Vdc Supply Voltage
Opt 015 15 Vdc Supply Voltage
Opt 024 24 Vdc Supply Voltage
Opt 100 Solder Terminals
Opt 108 8-in Ribbon Cable Extension
Opt 116 16-in Ribbon Cable Extension
Opt 292 2.92 mm (f) Connector**
Opt UK6 Commercial Calibration Test Data with Certificate* (HP 8765A/B/C/D only)
Opt UKS Commercial Calibration Certificate

*8765D Option 292 and 8765F do not have Option UK6.
**Option 292 available for 8765D only.

HP 8761–5 Series Specifications

HP Model	Frequency Range (GHz)	SWR 50 Ω Nominal	Insertion Loss	Isolation	Switching Speed	Repeat-ability[2]	Life[3]	RF Connectors	Dimensions W x H x D (mm)	Shipping Weight (g)
8761A SPDT Unterminated	dc to 18	<1.2 to 12.4 GHz <1.25 to 18 GHz	<0.5 dB to 12.4 GHz <0.8 dB to 18 GHz	>50 dB to 12.4 GHz >45 dB to 18 GHz	35 to 50 mS	0.03 dB	1 x 10^6	See table on page XXX	38 x 41 x 38	300
8761B SPDT Unterminated	dc to 18	<1.2 to 12.4 GHz <1.25 to 18 GHz	<0.5 dB to 12.4 GHz <0.8 dB to 18 GHz	>50 dB to 12.4 GHz >45 dB to 18 GHz	35 to 50 mS	0.03 dB	1 x 10^6	See table on page XXX	38 x 41 x 38	300
8762A SPDT Terminated	dc to 4	<1.1 to 2 GHz <1.2 to 4 GHz	<0.2 db to 2 GHz <0.25 dB to 4 GHz	>100 dB to 4 GHz	<30 mS	0.03 dB	1 x 10^6	SMA (f)	53 x 14 x 54	220
8762B SPDT Terminated	dc to 18	<1.10 to 2 GHz <1.2 to 12.4 GHz <1.3 to 18 GHz	<0.2 dB to 2 GHz <0.5 dB to 18 GHz	>90 dB to 18 GHz	<30 mS	0.03 dB	1 x 10^6	SMA (f)	53 x 14 x 54	220
8762C SPDT Terminated	dc to 26.5	<1.15 to 2 GHz <1.25 to 12.4 GHz <1.4 to 18 GHz <1.8 to 26.5 GHz	<0.25 dB to 2 GHz <0.5 dB to 18 GHz <1.25 dB to 26.5 GHz	>90 dB to 18 GHz >50 dB to 26.5 GHz	<30 mS	0.03 dB	1 x 10^6	3.5 mm (f)	53 x 14 x 54	220
8762F SPDT, 75 Ω Terminated	dc to 4	<1.15 to 1 GHz <1.3 to 4 GHz	<0.4 dB to 4 GHz	>100 dB to 4 GHz	<30 mS	0.03 dB	1 x 10^6	75 Ω, SMB (m	53 x 14 x 54	300
8763A Transfer Terminated	dc to 4	<1.1 to 2 GHz 1.2 to 4 GHz	<0.2 dB to 2 GHz <0.25 dB to 4 GHz	>100 dB to 4 GHz	<30 mS	0.03 dB	1 x 10^6	SMA (f)	53 x 14 x 54	220
8763B Transfer Terminated	dc to 18	<1.10 to 2 GHz <1.2 to 12.4 GHz <1.3 to 18 GHz	<0.2 dB to 2 GHz <0.5 dB to 18 GHz	>90 dB to 18 GHz	<30 mS	0.03 dB	1 x 10^6	SMA (f)	53 x 14 x 54	220
8763C Transfer Terminated	dc to 26.5	<1.15 to 2 GHz <1.25 to 12.4 GHz <1.4 to 18 GHz <1.8 to 26.5 GHz	<0.25 dB to 2 GHz <0.5 dB to 18 GHz <1.25 to 26.5 GHz	>90 dB to 18 GHz >50 dB to 26.5 GHz	<30 mS	0.03 dB	1 x 10^6	3.5 mm (f)	53 x 14 x 54	220
8764A Transfer Unterminated	dc to 4	<1.1 to 2 GHz <1.2 to 4 GHz	<0.2 dB to 2 GHz <0.25 dB to 4 GHz	>100 dB to 4 GHz	<30 mS	0.03 dB	1 x 10^6	SMA (f)	53 x 14 x 54	220
8764B Transfer Unterminated	dc to 18	<1.10 to 2 GHz <1.2 to 12.4 GHz <1.3 to 18 GHz	<0.2 dB to 2 GHz <0.5 dB to 18 GHz	>90 dB to 18 GHz	<30 mS	0.03 dB	1 x 10^6	SMA (f)	53 x 14 x 54	220
8764C Transfer Unterminated	dc to 26.5	<1.15 to 2 GHz <1.25 to 12.4 GHz <1.4 to 18 GHz <1.8 to 26.5 GHz	<0.25 dB to 2 GHz <0.5 dB to 18 GHz <1.25 dB to 26.5 GHz	>90 dB to 18 GHz >50 dB to 26.5 GHz	<30 mS	0.03 dB	1 x 10^6	3.5 mm (f)	53 x 14 x 54	220
8765A SPDT Unterminated	dc to 4	<1.2 to 4 GHz	0.2 +0.025 f (GHz) max <0.2 to 4 GHz[1]	>120 dB to 4 GHz	<15 mS	0.03 dB	5 x 10^6	SMA (f)	33 x 14 x 45	200
8765B SPDT Unterminated	dc to 20	<1.2 to 4 GHz <1.35 to 12.4 GHz <1.45 to 18 GHz <1.7 to 20 GHz	0.2 +0.025 f (GHz) max <0.2 to 4 GHz[1] <0.5 to 20 GHz[1]	>120 dB to 4 GHz >90 dB to 20 GHz	<15 mS	0.03 dB	5 x 10^6	SMA (f)	33 x 14 x 45	200
8765C SPDT Unterminated	dc to 26.5	<1.25 to 4 GHz <1.45 to 18 GHz <1.7 to 26.5 GHz	0.25 +0.027 f (GHz) max <0.2 to 4 GHz[1] <0.5 to 20 GHz[1] <0.7 to 26.5 GHz[1]	>120 dB to 4 GHz >90 dB to 20 GHz >60 dB to 26.5 GHz	<15 mS	0.03 dB	5 x 10^6	3.5 mm (f)	33 x 14 x 45	200
8765D SPDT Unterminated	dc to 40	<1.25 to 4 GHz <1.45 to 26.5 GHz <1.7 to 40 GHz	0.2 +0.23 f (GHz) max <0.2 to 4 GHz[1] <0.5 to 20 GHz[1] <0.7 to 26.5 GHz[1] 0.75 + .023 f (GHz) max <1.0 to 40 GHz1	>120 dB to 4 GHz >90 dB to 20 GHz >60 dB to 26.5 GHz >50 dB to 40 GHz	<15 mS	0.03 dB	5 x 10^6	2.4 mm (f) 2.92 mm (f) Option 292	33 x 14 x 45	200
8765F SPDT, 75 Ω Unterminated	dc to 4	<1.15 to 1 GHz <1.20 to 4 GHz	<0.18 dB to 1 GHz <0.24 dB to 2 GHz <0.40 dB to 4 GHz	>100 dB to 1 GHz >90 dB to 4 GHz	<15 mS	0.03 dB	5 x 10^6	75 Ω, SMB (m	33 x 14 x 45	200

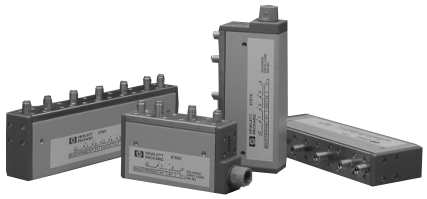
[1] Typical insertion loss
[2] Measured at 25°C
[3] Cycles per section minimum

RF & Microwave Test Accessories

Switching Solutions–Multiport Coaxial Switches

HP 87406B

HP 87204B



HP 8766

Matrix Switches–High Performance, Terminated

HP 87406/606 Series

The HP 87406B and 87606B 6-port, coaxial matrix switches will provide a valuable tool for 3x3, 2x4, and 1x5 configurations. These high performance matrix switches offer excellent repeatability and life greater than 5 million cycles. The HP 87406B, 87606B operate from dc to 20 GHz with excellent isolation, VSWR < 2.0:1, and with an input power of 1 W avg./50 W peak (10 μs max). The standard HP 87406B/606B provide a 16-pin connector while Option 100 provides solder terminals. Option T24 is available which provides internal circuits that are compatible with external TTL/5 V CMOS digital ICs.

Multiport–High Performance, Terminated

HP 87104/106 and HP 87204/206 Series

HP 87104A/B/C and 87106A/B/C multiport switches are available in 3 models up to 26.5 GHz. These switches offer exceptional repeatability of 0.03 dB over 5 million switching cycles. HP 87104 is a Single-Pole-4-throw (SP4T) and HP 87106 is a SP6T function. Both switches have internal solid-state logic which automatically programs the non-used ports to a matched load when any one port is programmed to "on". This relieves the user from having to provide external logic drive pulses.

HP 87204A/B/C and 87206A/B/C switches are fully equivalent to models HP 87104/06 in their RF switching performance. However, their drive circuits are primarily designed to work with the HP 87130A/11760A switch drivers. These switches do not provide independent position indicators. The standard HP 87204/06 provides a 16-pin connector while Option 100 provides solder terminals.

Multiport–Low Profile, Unterminated

HP 8766/67/68/69K Series

HP 8766/67/68/69K series switches are modified versions of the HP 8494/95/96/97 series step attenuators (dc–26.5 GHz) for applications requiring a single-pole, 3-throw, 4-throw, 5-throw or 6-throw coaxial switch. The switch ports are unterminated. These switches offer exceptional repeatability of 0.03 dB over 5 million switching cycles. The switches are available with several optional cables and connectors to make them compatible with standard 14-pin DIP sockets. Isolation and insertion loss vary with frequency, and depend upon the port selected.

Key Literature

New *RF & Microwave Test Accessories Catalog,* p/n 5964-9527E

Ordering Information

HP 87104A SP4T, DC to 4 GHz
HP 87104B SP4T, DC to 20 GHz
HP 87104C SP4T, DC to 26.5 GHz
HP 87106A SP6T, DC to 4 GHz
HP 87106B SP6T, DC to 20 GHz
HP 87106C SP6T, DC to 26.5 GHz
HP 87204A* SP4T, DC to 4 GHz
HP 87204B* SP4T, DC to 20 GHz
HP 87204C* SP4T, DC to 26.5 GHz
HP 87206A* SP6T, DC to 4 GHz
HP 87206B* SP6T, DC to 20 GHz
HP 87206C* SP6T, DC to 26.5 GHz
HP 87406B SP6T, DC to 20 GHz NEW
HP 87606B SP6T, DC to 20 GHz NEW
- **Opt 100** Solder Terminals
- **Opt T24** TTL/5 V CMOS Compatible Logic
- **Opt T00**** Solder Terminals to Replace Ribbon Cable TTL/5V CMOS compatability
- **Opt UK6** Commercial Calibration Test Data with Certificate
- **Opt UKS** Commercial Calibration Certificate

HP 8766K, HP 8767K, HP 8768K, HP 8769K Coaxial Switches
Specify RF connectors (and frequency), supply voltages, dc connectors by option number. Standard unit is 24 Vdc, 3.5–mm (f) RF connectors (dc to 26.5 GHz), and Viking-type dc connector.
HP 8766K SP3T Multi-Port Switch
HP 8767K SP4T Multi-Port Switch
HP 8768K SP5T Multi-Port Switch
HP 8769K SP6T Multi-Port Switch
- **Opt 002** Replace 3.5 mm (f) w/ SMA (m) Connectors
- **Opt 008** 8-inch Ribbon Cable w/DIP Connector
- **Opt 011** 5 Vdc Supply Voltages
- **Opt 015** 15 Vdc Supply Voltages
- **Opt 016** 16-inch Ribbon Cable w/DIP Connector
- **Opt UK6** Commercial Calibration Test Data with Certificate
- **Opt UKS** Commercial Calibration Certificate

*Provides sensing capability with 87130A and 70611A
**HP 87406B only

HP 87104/6 Series, 87204/6, 87406B/606B, 8766/7/8/9 Series Specifications

HP Model	Frequency Range (GHz)	SWR (50 Ω Nominal)	Insertion Loss (db)	Isolation (db)	Switching Time (max)	Repeat-ability*	Life (min.)	RF Connectors	Dimensions W x H x D (mm)	Shipping Weight (g)
87104A/204A SP4T	dc to 4	<1.2 to 4 GHz	0.3 + .015 x f (GHz)	>100 to 4 GHz	15 ms	0.03 dB	5,000,000 cycles	SMA(f)	57 x 74 x 57	360
87104B/204B SP4T	dc to 20	<1.2 to 4 GHz <1.35 to 12.4 GHz <1.45 to 18 GHz <1.7 to 20 GHz	0.3 + .015 x f (GHz)	>100 to 12 GHz >70 at 20 GHz	15 ms	0.03 dB	5,000,000 cycles	SMA(f)	57 x 74 x 57	360
87104C/204C SP4T	dc to 26.5	<1.7 to 20 to 26.5 GHz	0.3 + .015 x f (GHz)	>65 db 20 to 26.5 GHz	15 ms	0.03 dB	5,000,000 cycles	SMA(f)	57 x 74 x 57	360
87106A/206A SP6T	dc to 4	<1.2 to 4 GHz	0.3 + .015 x f (GHz)	>100 to 4GHz	15 ms	0.03 dB	5,000,000 cycles	SMA(f)	57 x 74 x 57	380
87106B/206B SP6T	dc to 20	<1.2 to 4 GHz <1.35 to 12.4 GHz <1.45 to 18 GHz <1.7 to 20 GHz	0.3 + .015 x f (GHz)	>100 to 12 GHz >70 at 20 GHz	15 ms	0.03 dB	5,000,000 cycles	SMA(f)	57 x 74 x 57	380
87106C/206C SP6T	dc to 26.5	<1.7 to 20 to 26.5 GHz	0.3 + .015 x f (GHz)	>65 db 20 to 26.5 GHz	15 ms	0.03 dB	5,000,000 cycles	SMA(f)	57 x 74 x 57	380
87406B/606B NEW	dc to 20	<1.21 to 4 <1.35 to 10 <1.5 to 15 <1.7 to 18 <1.9 to 20	0.34 + 0.033 x f (GHz)	<100 to 12 GHz <80 to 15 GHz <70 to 20 GHz	15 ms	0.03	5,000,000 cycles	SMA (f)	57 x 74 x 57	380
8766K SP3T	dc to 26.5 or dc to 18 for Option 002	<1.3 to 8 GHz <1.5 to 12.4 GHz <1.6 to 18 GHz <1.8 to 26.5 GHz	Port 1: 0.2 dB + 0.05 dB/GHz Port 2: 0.2 dB + 0.06 dB/GHz Port 3: 0.2 dB + 0.08 dB/GHz Port 4: 0.25 dB + 0.095 dB/GHz Port 5: 0.25 dB + 0.108 dB/GHz Port 6: 0.25 dB + 0.12 dB/GHz	Consult Technical Data Sheet	20 ms	0.03 dB	5,000,000 cycles	3.5 mm (f)	45 x 23 x 82	178
8767K SP4T	dc to 26.5 or dc to 18 for Option 002	<1.3 to 8 GHz <1.5 to 12.4 GHz <1.6 to 18 GHz <1.8 to 26.5 GHz			20 ms	0.03 dB	5,000,000 cycles	3.5 mm (f)	45 x 23 x 105	235
8768K SP5T	dc to 26.5 or dc to 18 for Option 002	<1.3 to 8 GHz <1.5 to 12.4 GHz <1.6 to 18 GHz <1.8 to 26.5 GHz			20 ms	0.03 dB	5,000,000 cycles	3.5 mm (f)	45 x 23 x 133	292
8769K SP6T	dc to 26.5 or dc to 18 for Option 002	<1.3 to 8 GHz <1.55 to 12.4 GHz <1.8 to 18 GHz <2.05 to 26.5 GHz			20 ms	0.03 dB	5,000,000 cycles	3.5 mm (f)	45 x 23 x 160	349

*Measured at 25° C

HP 84904K
HP 84906K
HP 84907K
HP 84904L
HP 84906L
HP 84907L

HP 84904/6/7K and L

High-Performance Programmable Step Attenuators—dc to 40 GHz

HP 84904K/L (0-11, dB steps)
HP 84906K/L (0-90, dB steps)
HP 84907K/L (0-70, dB steps)

4

The HP 84904/906/907 family of programmable step attenuators offers unmatched attenuation performance to 40 GHz. The K model brings superior accuracy and reliability to 26.5 GHz, while the L model offers unparalleled performance to 40 GHz.

HP step attenuators consist of 3 or 4 cascaded sections of specific attenuation values, e.g., 1, 2, 4, 10, 20 and 40 dB. Both families offer the selection, performance, accuracy and reliability expected from HP attenuators: attenuation ranges of 11, 70, or 90 dB, 1 dB and 10 dB step sizes, 5 million cycles per section, better than 0.03 dB repeatability, connector size options, and the choice of male or female connectors. RF connector choices include precision 3.5-mm or 2.92-mm on the 26.5 GHz K model, and precision 2.4-mm or 2.92-mm on the L model. While the 2.92-mm connector format is compatible with both 3.5-mm and SMA connectors, Hewlett-Packard recommends the more rugged 2.4-mm and 3.5-mm connectors.

HP programmable step attenuators feature electromechanical designs which achieve 20 milliseconds switching time, including settling time. The permanent magnet latching allows automatic interruption of the dc drive voltage to cut power consumption and simplify circuit design. They are equipped with 10-pin DIP sockets (m) with interconnect cables available.

Programmable Driver Instruments

Drive options include the HP 11713A and 87130A attenuator/switch drivers, which permit users to easily integrate the attenuator into HP-IB compatible automatic test systems, and the HP 70611 MMS attenuator/switch driver. Cabling options include 8- or 16-inch ribbon cables (HP 11764C/D) with a 10-pin DIP socket (f) and a 14-pin DIP plug for easy connection to standard 14-pin DIP IC sockets, a 5-foot Interconnect Cable (HP 11764A) with 10-pin DIP socket (f), and a "Viking" connector for the HP 11713A driver, and a 5-foot Interconnect Cable (HP 11764B) with a 10-pin DIP socket (f) and bare leads for custom applications. Option 100 series replaces one female connector with a male connector to allow end-to-end connection of 1 dB and 10 dB step attenuators.

Key Literature

New *RF & Microwave Test Accessories Catalog,* p/n 5964-9527E

Ordering Information

Attenuators
HP 84904K 0 to 11 dB, 1 dB steps, 26.5 GHz
HP 84904L 0 to 11 dB, 1 dB steps, 40 GHz
HP 84906K 0 to 90 dB, 10 dB steps, 26.5 GHz
HP 84906L 0 to 90 dB, 10 dB steps, 40 GHz
HP 84907K 0 to 70 dB, 10 dB steps, 26.5 GHz
HP 84907L 0 to 70 dB, 10 dB steps, 40 GHz
Opt 006 Female 2.92-mm Connectors (L models only)
Opt 100 Male 2.4-mm Connector (L models only)
Opt 104 Male 3.5-mm Connector (K models only)
Opt 106 Male 2.92-mm Connector (L models only)
Opt UK6 Commercial Calibration Test Data with Certificate
Opt UKS Commercial Calibration Certificate

Attenuator Accessories
HP 11764A Interconnect Cable with 10-pin Socket (f) to "Viking" Connector for HP 11713A
HP 11764B Interconnect Cable with 10-pin DIP Socket (f) and Bare Leads
HP 11764C Interconnect Cable with 203-mm (8 in) Ribbon Cable, 10-pin DIP Socket, 14-pin DIP Plug
HP 11764D Interconnect Cable with 406-mm (16 in) Ribbon Cable, 10-pin DIP Socket, 14-pin DIP Plug

HP 84904/6/7K/L Specifications

HP Model	Frequency Range (GHz)	Attenuation Range	Maximum SWR Std (Option 006)	Insertion Loss 0 dB Setting	Repeatability[1]	Life[2]	Shipping Weight
84904K	dc to 26.5	0 to 11 dB	1.3 (1.5) to 12.4 GHz	0.8 dB + 0.04 dB/GHz	0.03 dB	5 x 10^6	291 g
84904L	dc to 40	1 dB steps	1.7 (1.9) to 34 GHz 1.8 (2.0) to 40 GHz				(10.3 oz)
84906K	dc to 26.5	0 to 90 dB	1.3 (1.5) to 12.4 GHz	0.8 dB + 0.04 dB/GHz	0.03 dB	5 x 10^6	291 g
		10 dB steps	1.7 (1.9) to 34 GHz				(10.3 oz)
84906L	dc to 40		1.8 (2.0) to 40 GHz				
84907K	dc to 26.5	0 to 70 dB	1.25 (1.4) to 12.4 GH;	0.6 dB + 0.03 dB/GHz	0.03 dB	5 x 10^6	229 g
		10 dB steps	1.5 (1.7) to 34 Gz				(8.1 oz)
84907L	dc to 40		1.7 (1.9) to 40 GHz				

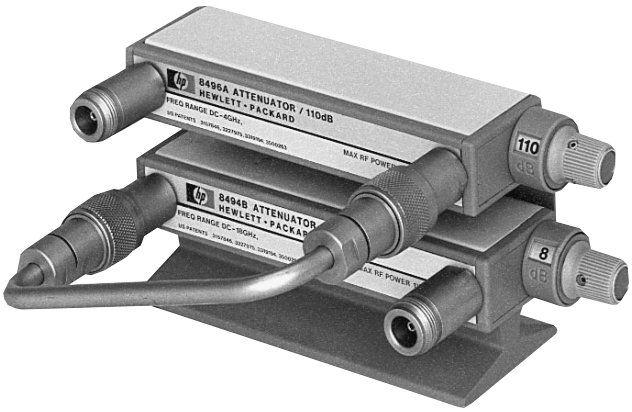
Sensitivity power: dB/watt (temperature dB/° C): 0.001 (0.0001)
Power rating: 1 W ave, 50 W peak, 10 μs max. pulse width
Supply voltage/speed/power: 20 to 30 V / <20 ms / 2.7 W

[1] Measured at 25° C
[2] Cycles per section minimum

Attenuation Accuracy DC to 26.5 GHz	26.5 to 40 GHz
1 dB: 0.4 dB	1 dB: 0.6 dB
2 dB: 0.5 dB	2 dB: 0.6 dB
3 dB: 0.7 dB	3 dB: 0.8 dB
4 dB: 0.7 dB	4 dB: 0.8 dB
5 dB: 0.7 dB	5 dB: 0.8 dB
6 dB: 0.7 dB	6 dB: 0.9 dB
7 dB: 0.8 dB	7 dB: 1.1 dB
8 dB: 0.8 dB	8 dB: 1.1 dB
9 dB: 0.85 dB	9 dB: 1.2 dB
10 dB: 0.9 dB	10 dB: 1.3 dB
11 dB: 1.10 dB	11 dB: 1.5 dB
10 dB: 0.5 dB	10 dB: 0.5 dB
20 dB: 0.6 dB	20 dB: 0.6 dB
30 dB: 0.7 dB	30 dB: 0.7 dB
40 dB: 1.0 dB	40 dB: 1.0 dB
50 dB: 1.2 dB	50 dB: 1.2 dB
60 dB: 1.6 dB	60 dB: 1.6 dB
70 dB: 1.9 dB	70 dB: 1.9 dB
80 dB: 2.7 dB	80 dB: 2.7 dB
90 dB: 2.9 dB	90 dB: 2.9 dB

HP 8495D

HP 8495K



HP 11716A

Programmable and Manual Step Attenuators DC–1000 MHz

Manual

HP 355C (0–12 dB, 1 dB steps)
HP 355D (0–120 dB, 10 dB steps)

Programmable

HP 355E (0–12 dB, 1 dB steps)
HP 355F (0–120 dB, 10 dB steps)

The manual and programmable HP 355 C/D/E/F attenuators offer exceptional attenuation accuracy to 1 GHz; +0.1 dB to 1 kHz, 0.25 dB to 500 MHz, 0.35 to 1 GHz. They feature BNC (f) RF connectors, with optional type-N (Option 001) and TNC (Option 005) also available. To achieve 1 dB steps to 132 dB range, serially connect two attenuators using a standard UG-491A/U BNC (m)-to-BNC (m) adapter. Programmable HP 355 E/F models feature a 7-pin connector (supplied). To protect your transistor driver against transients during the switching cycle, order Option 007 to install a protective diode between each solenoid and driver.

Programmable and Manual Step Attenuators DC–26.5 GHz

HP 8494A/B/G/H (0–11 dB, 1 dB steps)
HP 8495A/B/D/G/H/K (0–70 dB, 10 dB steps)
HP 8496A/B/G/H (0–110 dB, 10 dB steps)
HP 8497K (0–90 dB, 10 dB steps)

The HP 8494/95/96/97 family of step attenuators offer fast, precise signal level control in three frequency ranges, dc to 4 GHz, dc to 18 GHz and dc to 26.5 GHz. They feature exceptional repeatability and reliability in a wide range of frequency, attenuation and connector options.

Attenuation repeatability is specified to be less than 0.03 dB (0.05 dB, 18-26.5 GHz) for 5 million cycles per section. This assures low measurement uncertainty and high user confidence when designed into automatic test systems. Electromechanical step attenuators offer low SWR, low insertion loss and high accuracy required by high-performance test and measurement equipment.

Precision plated leaf-spring contacts remove attenuator sections (miniature tantalum nitride thin-film T-pads on sapphire and alumina substrates) from the signal path. Unique process controls and material selection ensure unmatched life and contact repeatability.

Programmable Models

Miniature drive solenoids in the programmable models keep switching time, including settling, down to less than 20 milliseconds. Once switched, strong permanent magnets hold the solenoids (and attenuation value) in place. Current interrupts automatically disconnect solenoid current, simplifying driver circuit design and minimizing heat dissipation. Programming is done through a 12-pin Viking socket or optional ribbon cables with DIP plugs.

To simplify connecting programmable attenuators to the drive circuit, each unit is supplied with a 5-ft. cable assembly. With an HP 11713A attenuator driver, 87130A attenuator driver, or an HP 70611A driver for MMS-based systems, automatic drive control is easy using the Hewlett-Packard Interface Bus (HP-IB) automated system.

HP 11716A/B/C Attenuator Interconnect Kits

Quickly and conveniently connect 1 dB step and 10 dB step attenuators together to achieve greater dynamic range with 1 dB steps. The 11716A/B/C interconnect kits contain a rigid RF cable, mounting bracket, and necessary hardware to connect any pair of HP 8494/95/96/97 attenuators in series (see photo above). Attenuators must be ordered separately.

Key Literature

New *RF & Microwave Test Accessories Catalog,* p/n 5964-9527E

Ordering Information

HP 11716A Interconnect Kit (Type-N)
HP 11716B Interconnect Kit (APC-7)
HP 11716C Interconnect Kit (SMA)
HP 11717A Attenuator/Switch Rackmount Support Kit

HP 355 Series, 8494/5/6/7 Series Specifications

HP Model (Switching Mode)	Frequency Range (GHz)	Attenuation Range (dB)	Maximum SWR	Insertion Loss @ 0 dB	Attenuation Accuracy	Power Rating, Minimum Life	Solenoid Voltage Speed Power	Size, Shipping Weight	Connector Options
355C (Manual) **355E (Programmable)**	dc to 1	0 to 12 1 dB steps	1.2 to 250 MHz 1.3 to 500 MHz 1.5 to 1 GHz	0.11 dB + 1.39 dB/GHz	±0.1 dB @ 1000 Hz ±0.25 dB: dc to 0.5 GHz ±0.35 dB: dc to 1.0 GHz	0.5 W avg. 350 W peak 0.5 million cycles per section	— 15 to 18 V <65 ms 3.0 W	70 mm W x 67 mm H x 152 mm D (2.75 in x 2.6 in x 6 in) 1.4 kg (3 lb)	BNC (f) See Note 1
355D (Manual) **355F (Programmable)**	dc to 1	0 to 120 10 dB steps	1.2 to 0.25 GHz 1.3 to 0.5 GHz 1.5 to 1 GHz	0.11 dB + 1.39 dB/GHz	±0.3 dB @ 1000 Hz ±1.5 dB to 90 dB, and ±3 dB to 120 dB @ 1 GHz	0.5 W avg. 350 W peak 0.5 million cycles per section	— 15 to 18 V <65 ms 3.0 W	70 mm W x 67 mm H x 152 mm D (2.75 in x 2.6 in x 6 in) 1.4 kg (3 lb)	BNC (f) See Note 1
8494A (Manual) **8494G (Programmable)**	dc to 4	0 to 11 1 dB steps	1.5	0.6 dB + 0.09 dB/GHz	±0.2 dB: 1 to 2 dB ±0.3 dB: 3 to 6 dB ±0.4 dB: 7 to 10 dB ±0.5 dB: 11 dB	1 W avg. 100 W peak 10 μs max. 5 million cycles per section	— 20 to 30 V <20 ms 2.7 W	73 mm W x 43 mm H x 159 mm D (2.9 in x 1.7 in x 6.2 in) 0.9 kg (2 lb) 79 mm W x 43 mm H x 168 mm D (3.1 in x 1.7 in x 6.6 in) 0.9 kg (2 lb)	001 002 003 See Note 2
8494B (Manual) **8494H (Programmable)**	dc to 18	0 to 11 1 dB steps	1.5 to 8 GHz 1.6 to 12.4 GHz 1.9 to 18 GHz	0.6 dB + 0.09 dB/GHz	**dc to 12.4 GHz** ±0.3 dB: 1 to 2 dB ±0.4 dB: 3 to 4 dB ±0.5 dB: 5 to 6 dB ±0.6 dB: 7 to 10 dB ±0.7 dB: 11 dB **dc to 18 GHz** ±0.7 dB: 1 to 5 dB ±0.8 dB: 6 to 9 dB ±0.9 dB: 10 to 11 dB	1 W avg. 100 W peak 10 μs max. 5 million cycles per section	— 20 to 30 V <20 ms 2.7 W	73 mm W x 43 mm H x 159 mm D (2.9 in x 1.7 in x 6.2 in) 0.9 kg (2 lb) 79 mm W x 43 mm H x 168 mm D (3.1 in x 1.7 in x 6.6 in) 0.9 kg (2 lb)	001 002 003 See Note 2
8495A (Manual) **8495G (Programmable)**	dc to 4	0 to 70 10 dB steps	1.35	0.4 dB + 0.07 dB/GHz	±1.7% of setting or 0.4 dB, whichever is greater	1 W avg. 100 W peak 10 μs max. 5 million cycles per section	— 20 to 30 V <20 ms 2.7 W	73 mm W x 43 mm H x 130 mm D (2.9 in x 1.7 in x 5.1 in) 0.9 kg (2 lb) 79 mm W x 43 mm H x 141 mm D (3.1 in x 1.7 in x 5.5 in) 0.9 kg (2 lb)	001 002 003 See Note 2
8495B (Manual) **8495H (Programmable)**	dc to 18	0 to 70 10 dB steps	1.35 to 8 GHz 1.5 to 12.4 GHz 1.7 to 18 GHz	0.4 dB + 0.07 dB/GHz	±3%: dc to 12.4 GHz ±4%: dc to 18 GHz % in dB from atten. setting	1 W avg. 100 W peak 10 μs max. 5 million cycles per section	— 20 to 30 V <20 ms 2.7 W	73 mm W x 43 mm H x 130 mm D (2.9 in x 1.7 in x 5.1 in) 0.9 kg (2 lb) 79 mm W x 43 mm H x 141 mm D (3.1 in x 1.7 in x 5.5 in) 0.9 kg (2 lb)	001 002 003 See Note 2
8495D (Manual) **8495K (Programmable)**	dc to 26.5	0 to 70 10 dB steps	1.25 to 6 GHz 1.45 to 12.4 GHz 1.6 to 18.0 GHz 1.8 to 26.5 GHz	0.5 dB + 0.13 dB/GHz	±0.3 dB at 6 GHz 10 dB attenuation to ±2.8 dB at 26.5 GHz 90 dB attenuation	1 W avg. 100 W peak 10 μs max. 5 million cycles per section	— 20 to 30 V <20 ms 2.7 W	52 mm W x 43 mm H x 159 mm D (2.1 in x 1.7 in x 6.2 in) 0.9 kg (2 lb) 52 mm W x 43 mm H x 168 mm D (2.1 in x 1.7 in x 6.6 in) 0.9 kg (2 lb)	004 3.5 mm See Note 2
8496A (Manual) **8496G (Programmable)**	dc to 4	0 to 110 10 dB steps	1.5	0.6 dB + 0.09 dB/GHz	±1.7% of setting or 0.4 dB, whichever is greater	1 W avg. 100 W peak 10 μs max. 5 million cycles per section	— 20 to 30 V <20 ms 2.7 W	73 mm W x 43 mm H x 159 mm D (2.9 in x 1.7 in x 6.2 in) 0.9 kg (2 lb) 79 mm W x 43 mm H x 168 mm D (3.1 in x 1.7 in x 6.6 in) 0.9 kg (2 lb)	001 002 003 See Note 2
8496B (Manual) **8496H (Programmable)**	dc to 18	0 to 110 10 dB steps	1.5 to 8 GHz 1.6 to 12.4 GHz 1.9 to 18 GHz	0.6 dB + 0.09 dB/GHz	±3%: dc to 12.4 GHz ±4%: dc to 18 GHz % in dB from atten. setting	1 W avg. 100 W peak 10 μs max. 5 million cycles per section	— 20 to 30 V <20 ms 2.7 W	73 mm W x 43 mm H x 159 mm D (2.9 in x 1.7 in x 6.2 in) 0.9 kg (2 lb) 79 mm W x 43 mm H x 168 mm D (3.1 in x 1.7 in x 6.6 in) 0.9 kg (2 lb)	001 002 003 See Note 2
8497K (Programmable)	dc to 26.5	0 to 90 10 dB steps	1.25 to 6 GHz 1.45 to 12.4 GHz 1.6 to 18.0 GHz 1.8 to 26.5 GHz	0.4 dB + 0.09 dB/GHz	±0.3 dB at 6 GHz 10 dB attenuation to ±2.8 dB at 26.5 GHz 90 dB attenuation	1 W avg. 100 W peak 10 μs max. 5 million cycles per section	5 V or 24 V	52 mm W x 43 mm H x 143 mm D (2.1 in x 1.7 in x 5.6 in) 0.9 kg (2 lb)	004 3.5 mm See Note 2

How to Order the HP 8494/5/6/7 Series Attenuators

Each order must include basic model number, suffix letter, and connector option.

Ordering example: HP 8494 **A** Option **001**

4	**A**	**001**
4 (1 dB step, 11 dB max)	**A** (Manual, dc to 4 GHz)	**001** (N female)
5 (10 dB step, 70 dB max)	**B** (Manual, dc to 18 GHz)	**002** (SMA female)
6 (10 dB step, 110 dB max)	**D** (Manual, dc to 26.5 GHz)*	**003** (APC-7)
7 (10 dB step, 90 dB max)	**G** (Programmable, dc to 4 GHz)	**004** (3.5 mm female)*
	H (Programmable, dc to 18 GHz)	
	K (Programmable, dc to 26.5 GHz)*	

*Option 004 is only available on D and K models.

Note 1: 355C/D/E/F connector options (BNC (f) standard):
Option 001 N(f)
Option 005 TNC(f)
Option 007 Transistor protection (355E/F only)
Option UKS Commercial Calibration Certificate

Note 2: 8494/5/6/7 orders must specify connector option. See ordering example.
Option 001 N(f)
Option 002 SMA(f)
Option 003 APC-7
Option 004 3.5 mm (HP 8495D/K, 8497K only)
Option UK6 Commercial Calibration Test Data with Certificate
Option UKS Commercial Calibration Certificate

HP 8490D


HP 8492A

HP 8493A/B/C Series

HP 8498A High Power Attenuator

The HP 8498A Option 030 is designed to meet the needs of high-power attenuation applications in the RF and microwave frequency range. It is a 25-watt average, 30 dB fixed attenuator with a frequency of dc to 18 GHz. The maximum peak power specification is 500 watts (dc to 5.8 GHz) and 125 watts (5.8 to 18 GHz). Available only in a 30 dB version, the unit offers a 1.3 SWR and ±1 dB accuracy at 18 GHz. Large heat-dissipating fins keep the unit cool even under continuous maximum input power conditions.

HP 8491A/B/C, 8492A, 8493A/B/C Fixed Attenuators

Hewlett-Packard coaxial fixed attenuators provide precise attenuation, flat frequency response, and low SWR over broad frequency ranges. Attenuators are available in nominal attenuations of 3 dB and 6 dB, as well as 10 dB increments from 10 dB to 60 dB. These attenuators are swept-frequency tested to ensure they meet specifications at all frequencies. Calibration points are provided on a nameplate chart attached to each unit (except for the HP 8491C).

HP 8490D 50-GHz Fixed Attenuator

Hewlett-Packard coaxial fixed attenuators have been the standard for accurate flat response and low SWR. The HP 8490D offers exceptional performance to 50 GHz using the 2.4-mm connector. Attenuation values available are 3, 6, 10, 20, 30, and 40 dB. Ideally suited for extending the range of sensitive power meters, or for use as calibration standards, these broadband attenuators are manufactured with the same meticulous care as their lower frequency counterparts.

HP 8490D, 8491A/B/C, 8492A, 8493A/B/C, 8498A, Specifications

HP Model	Frequency range (GHz)	SWR (max.)	Input Power (max.)		Attenuation Accuracy (+dB) 3 dB Opt 003	6 dB Opt 006	10 dB Opt 010	20 dB Opt 020	30 dB Opt 030	40 dB Opt 040	50 dB Opt 050	60 dB Opt 060	Connectors
8490D	DC to 50	dc to 26.5 GHz: 1.15 (1.08 Opt 040 only) 26.5 to 40 GHz: 1.25 (1.15 Opt 040 only) 40 to 50 GHz: 1.45 (1.25 Opt 040 only)	2 W avg. 100 W peak	DC to 26.5 26.5 to 50	+0.9 –0.5 +1.8 –0.5	+0.9 –0.6 +1.8 –0.6	+0.9 –0.6 +1.3 –0.6	+1.3 –0.8 +1.7 –0.8	+1.3 –0.8 +1.7 –0.8	+2.5 –1.8 +2.5 –1.8			2.4 mm
8491A 3 to 30 dB 40 to 60 dB	dc to 12.4	1.2 to 8 GHz 1.3 to 12.4 GHz	2 W avg. 100 W peak		0.3	0.3	0.5	0.5	1.0	1.5	1.5	2	N (m,f)
8491B 3 to 30 dB 40 to 60 dB	dc to 18	1.2 to 8 GHz 1.3 to 12.4 GHz 1.5 to 18 GHz	2 W avg. 100 W peak		0.3	0.3 to 12.4 GHz 0.4 to 18 GHz	0.6	0.6 to 12.4 GHz 1.0 to 18 GHz	1.0	1.5	1.5	2	N (m,f)
8491C 3 to 30 dB	dc to 18	1.2 to 8 GHz 1.3 to 12.4 GHz 1.5 to 18 GHz	2 W avg. 100 W peak		0.3 to 12.4 GHz 0.4 to 18 GHz	0.4 to 12.4 GHz 0.5 to 18 GHz	0.6	0.6 to 12.4 GHz 1.0 to 18 GHz	1.0	—	—	—	N (m,f)
8492A 3 to 30 dB 40 to 60 dB	dc to 18	1.15 to 8 GHz 1.25 to 12.4 GHz 1.35 to 18 GHz	2 W avg. 100 W peak		0.3	0.3 to 12.4 GHz 0.4 to 18 GHz	0.6	0.6 to 12.4 GHz 1.0 to 18 GHz	1.0	1.5	1.5	2	APC-7
8493A 3 to 20 dB 30 dB	dc to 12.4	1.2 to 8 GHz 1.3 to 12.4 GHz	2 W avg. 100 W peak		0.3	0.3	0.5	0.5	1.0	—	—	—	SMA (m,f)
8493B 3 to 20 dB 30 dB	dc to 18	1.2 to 8 GHz 1.3 to 12.4 GHz 1.5 to 18 GHz	2 W avg. 100 W peak		+0.3 dB	0.3 to 12.4 GHz 0.4 to 18 GHz	0.6	0.6 to 12.4 GHz 1.0 to 18 GHz	1.0	—	—	—	SMA (m,f)
8493C 3 to 30 dB 40 dB	dc to 26.5	1.1 to 8 GHz 1.15 to 12.4 GHz 1.25 to 26.5 GHz	2 W avg. 100 W peak		0.5 to 18 GHz 1.0 to 26.5 GHz	0.6 0.6	0.3 0.5	0.5 0.6	0.7 1	1.0 1.3	— —	— —	3.5 mm (m,f)
8498A 30 dB	dc to 18	1.15 to 8 GHz 1.25 to 12.4 GHz 1.35 to 18 GHz	25 W avg. 500 W peak (dc to 5.8 GHz) 125 W peak 500 W/ms max. per pulse (5.8 to 18 GHz)		—	—	—	—	1.0	—	—	—	N (m,f)

HP Models	Options UK6/UKS
8491A, 8491B, 8492A,8493A, 8493B, 8493C, 8498A	**Option UK6**-Commercial Calibration Test Data with Certificate **Option UKS**-Commercial Calibration Certificate

HP 11581A, 11582A, 11583A/C Attenuator Sets

A set of four Hewlett-Packard attenuators—3, 6, 10, and 20 dB—are furnished in a handsome walnut accessory case. The HP 11581A set consists of HP 8491A attenuators; the HP 11582A set, HP 8491B attenuators; the HP 11583A set, HP 8492A attenuators; and the HP 11583C set, HP 8493C attenuators. These sets are ideal for calibration labs or where precise knowledge of attenuation and SWR is desired.

Key Literature

New *RF & Microwave Test Accessories Catalog*, p/n 5964-9527E

Ordering Information

HP 11581A 3, 6, 10, 20 dB HP 8491A Set
HP 11582A 3, 6, 10, 20 dB HP 8491B Set
HP 11583A 3, 6, 10, 20 dB HP 8492A Set
HP 11583C 3, 6, 10, 20 dB HP 8493C Set
Opt UK6 Commercial Calibration Test Data with Certificate
Opt UKS Commercial Calibration Certificate

HP 8474 Series

HP 8471D/E

HP 83036C

Low-Barrier Schottky Diode Detectors

HP 423B, HP 8472B, HP 8473B/C

These Low-Barrier Schottky Diode (LBSD) detectors have been widely used for many years in a variety of applications including leveling and power sensing. They offer good performance and ruggedness. Matched pairs (Option 001) offer very good detector tracking. A video load option (Option 002) extends the square-law region to at least 0.1 mW (–10 dBm).

Planar-Doped Barrier Detectors

HP 8471D/E

The HP 8471D/E are economy detectors based on the Planar-Doped Barrier (PDB) diodes. The PDB diodes give them superior frequency response, square-law response, and temperature performance. The HP 8471D has a BNC (m) input connector and a frequency range of 100 kHz to 2 GHz, making it ideal for use in RF and low microwave applications. The HP 8471E has a SMA (m) input connector and a SMC (m) output connector. Its frequency range is 10 MHz to 12 GHz. Both models come standard with a negative polarity output; a positive polarity output can be specified as Option 103.

HP 8473D

The HP 8473D detector was the first gallium arsenide PDB diode introduced. It features broadband performance and excellent flatness vs. frequency, along with superior temperature stability. The HP 8473D is available with a 3.5-mm (m) RF connector and a BNC (f) output connector.

High-Performance Planar-Doped Barrier Detectors

HP 8474B/C/D/E

Utilizing a gallium arsenide PDB diode as the detecting element, these detectors offer superior performance when compared to earlier detector designs. They feature extremely flat frequency response over their entire band of operation (typically better than ±1 dB to 50 GHz) and very good frequency response stability versus temperature. For applications where broadband frequency coverage is not required, octave band options are available in specific bands.

The HP 8474 detectors are available with APC-7 (0.01 to 18 GHz), Type N (0.01 to 18 GHz), 3.5 mm (mates with SMA, 0.01 to 33 GHz), 2.92 mm (0.01 to 40 GHz), or 2.4 mm (0.01 to 50 GHz) connectors. These detectors are offered with options for optimal square-law loads (Option 102) and for positive polarity output (Option 103). Because the unit-to-unit frequency response tracking of these devices is typically better than ±0.3 dB, no matched response option is offered.

Broadband Directional Detector

HP 83036C

The HP 83036C is a broadband microwave power sampler that operates in much the same way as a directional coupler and detector combination. It is composed of a resistive bridge and PDB diode that yields a very broadband device with excellent frequency response, superior temperature response and square-law response characteristics. With a 10 MHz to 26.5 GHz frequency range, a single HP 83036C can be used in many applications where two directional couplers and detectors were once required, such as in broadband power monitoring and source leveling.

The maximum SWR is 1.7 above 50 MHz on both the input and output ports. Directivity of 14 dB matches that of most miniature couplers currently available. The maximum insertion loss is 2.2 dB.

The HP 83036C has been used with great success as the sampling element for external leveling of broadband swept frequency sources. The extended frequency range increases the usable band from 100 MHz to 26 GHz, giving the user full use of the broadband source with external leveling. Other uses include the internal leveling element for sources, and forward/reverse power monitoring.

Key Literature

New *RF & Microwave Test Accessories Catalog,* p/n 5964-9527E

Planar-Doped Barrier Diode Detectors Specifications

HP Model	Freq. Range (GHz)	Freq. Response (dB)	Max. SWR	Low-level Sensitivity	Max. Input (Peak or Average)	Short-term Max. Input (<1 min.)	Opt. 002/102 Optimum Square-Law Load	Opt. 003/103 Positive Polarity Output	Input/ Output Connector
8471D	0.0001 to 2	±0.2 to 1 GHz ±0.4 to 2 GHz	1.23 to 1 GHz 1.46 to 2 GHz	>0.5 mV/μW	100 mW	0.7 W	Yes	Yes	BNC (m) BNC (f)
8471E	0.01 to 12	±0.23 to 4 GHz ±0.6 to 8 GHz ±0.85 to 12 GHz	1.2 to 4 GHz 1.7 to 8 GHz 2.4 to 12 GHz	>0.4 mV/μW	200 mW	0.75 W	No	Yes	SMA (m) SMC (m)
8473D	0.01 to 33	±0.25 to 12.4 GHz ±0.40 to 26.5 GHz ±1.25 to 33 GHz	1.2 to 14 GHz 1.36 to 26.5 GHz 2.96 to 33 GHz	>0.4 mV/μW	200 mW	1 W	Note 1	Note 1	3.5 mm (m) BNC (f)
8474B*	0.01 to 18	±0.35 to 18 GHz	1.3 to 18 GHz	>0.4 mV/μW	200 mW	.75 W	Note 1	Note 1	Type N (m) BNC (f)
8474C*	0.01 to 33	±0.45 to 26.5 GHz ±0.70 to 33 GHz	1.4 to 26.5 GHz 2.2 to 33 GHz	>0.4 mV/μW	200 mW	.75 W	No	Note 1	3.5 mm (m) SMC (m)
8474E*	0.01 to 50	±0.4 to 26.5 GHz ±0.6 to 40 GHz ±1.0 to 50 GHz	1.2 to 26.5 GHz 1.6 to 40 GHz 2.8 to 50 GHz	>0.4 mV/μW	200 mW	.75 W	No	Note 1	2.4 mm (m) SMC (m)

*Octave band options available (see Data Sheet).

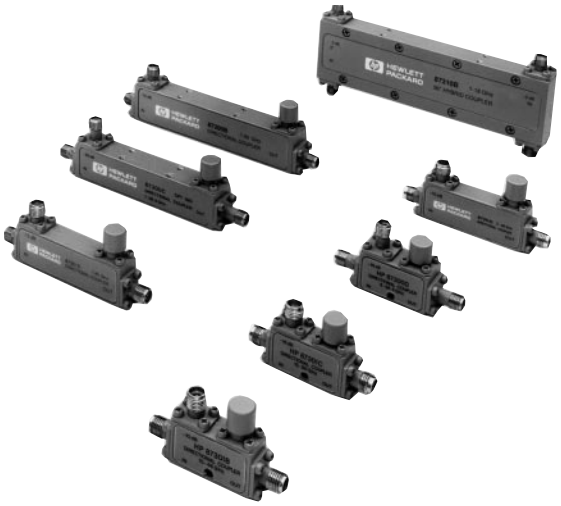
Broadband Directional Detector Specifications

HP Model	Freq. Range (GHz)	Freq. Response (dB)	Max. SWR Input/Output (50 Ω Nom.)	Max. Thru Line Loss (dB)	Low-level Sensitivity	Min. Directivity (dB)	Max. Input (Into 50 Ω Load) w/ 2:1 Source Match	Max. Input (Into Open) w/ 2:1 Source Match	Input/ Output Connector
83036C	0.01 to 26.5	±1.0	1.7	2.2	18 uV/μW	14	32 dBm	21 dBm	3.5 mm (f)

Low-Barrier Schottky Diode Detectors Specifications

HP Model	Freq. Range (GHz)	Freq. Response (dB)	Max. SWR (50 Ω Nom.)	Low-level Sensitivity (mV/μW)	Max. Input (Peak or Average)	Short-term Max. Input (<1 min.)	Matched[2] Response Opt. 001	Optimum Square-law Load[3]	Positive Polarity Output	Input/ Output Connector
423B	0.01 to 12.4	±0.3 to 12.4 GHz	1.15 to 4 GHz 1.3 to 12.4 GHz	>0.5	200 mW	1 W (typical)	±0.2 dB to 12.4 GHz	Opt. 002	Opt. 003	N (m) BNC (f)
8470B **8470B Option 012**	0.01 to 18	±0.3 to 12.4 GHz ±0.5 to 15 GHz ±0.6 to 18 GHz	1.15 to 4 GHz 1.3 to 15 GHz 1.4 to 18 GHz	>0.5	200 mW	1 W (typical)	±0.2 dB to 12.4 GHz ±0.3 to 18 GHz	Opt. 002	Opt. 003	APC-7 BNC (f) N (m) BNC (f)
8472B Option 100	0.01 to 18	±0.3 to 12.4 GHz ±0.5 to 15 GHz ±0.6 to 18 GHz	1.15 to 4.5 GHz 1.35 to 7 GHz 1.5 to 12.4 GHz 1.7 to 18 GHz	>0.5	200 mW	1 W (typical)	±0.2 dB to 12.4 GHz ±0.3 to 18 GHz	Opt. 002	Opt. 003	SMA (m) BNC (f) SMA (m) OSSM (f)
8473B	0.01 to 18	±0.3 to 12.4 GHz ±0.6 to 18 GHz	1.2 to 4 GHz 1.5 to 18 GHz	>0.5	200 mW	1 W (typical)	±0.2 dB to 12.4 GHz ±0.3 to 18 GHz	Opt. 002	Opt. 003	3.5 mm (m) BNC (f)
8473C	0.01 to 26.5	±0.3 to 12.4 GHz ±0.6 to 20 GHz ±1.5 to 26.5 GHz	1.2 to 4 GHz 1.5 to 18 GHz 2.2 to 26.5 GHz	>0.5	200 mW	1 W (typical)	±0.2 dB to 12.4 GHz ±0.3 to 18 GHz ±0.5 to 26.5 GHz	Opt. 002	Opt. 003	3.5 mm (m) BNC (f)

Note:
[1] Available as a special option on request. Consult your HP representative.
[2] Must order a quantity of 2 standards and 2 Option 001s for a pair of detectors with matched frequency response.
[3] Defined as ± 0.5 from ideal square law response.



HP 87300B/C/D, 87301B/C/D, 87310B, 87301E

HP 87300 Series Directional Couplers

This line of compact, broadband directional couplers are ideal for signal monitoring, or when combined with a coaxial detector, for signal leveling. Available in a variety of frequency ranges, they can be matched to specific applications. The HP 8474 series coaxial detectors are recommended if output detection is desired. The HP 87300B is supplied with SMA (f) connectors, the HP 87300C has 3.5-mm (f) connectors, and the HP 87301D has 2.4-mm (f) standard or optional 2.92-mm (f) connectors.

HP 87310B Hybrid Coupler

HP 87310B is a 3 dB hybrid coupler, intended for applications requiring a 90 degree phase difference between output ports. In that sense, it is different from typical power dividers and power splitters, which have matched signal phase at their output ports. The HP 87310B features SMA (f) connectors.

HP 87300 Series Specifications

HP Model	Freq. Range (GHz)	Nominal Coupling & (dB) Variation	Directivity (dB)	Max. SWR	Insertion Loss (dB)
87300B	1 to 20	10 ± 0.5	16	1.35	<1.5
87300C	1 to 26.5	10 ± 1	>14 to 12.4 GHz >12 to 26.5 GHz	1.40	<1.2 to 12.4 <1.7 to 26.5
87300C Opt 020	1 to 26.5	20 ± 1	>14	1.4	<1.2
87300D	6 to 26.5	10 ± 0.5	>13	1.4	<1.3
87301B	10 to 46	10 ± 0.7	>10	1.8	<1.9
87301C	10 to 50	10 ± 0.7	>10	1.8	<1.9
87301D	1 to 40	13 ± 1	>14 to 20 >10 to 40	1.5 to 20 1.7 to 40	<1.2 to 20 <1.9 to 40
87310B	1 to 18	3 ± 0.5	—	1.35	<2.0
87301E	2 to 50	10 ± 1	>13 to 26.5 >10 to 50	1.5 to 26.5 1.8 to 50	<2.0

HP 773D Directional Coupler and HP 772D Dual-Directional Coupler

The HP 772D and 773D are high-performance couplers designed for broadband swept measurements in the 2 to 18 GHz range. The HP 773D is ideal for leveling broadband sources when used with an HP 8474B detector. (See also the HP 83036C directional detector.) For reflectometer applications, the HP 772D is the best coupler to use with HP power sensors and power meters (such as the HP 438A dual power meter). Forward and reverse power measurements on transmitters, components, or other broadband systems are made simpler using the HP 772D. The broadband design allows the use of a single test setup and calibration for tests spanning the entire 2 to 18 GHz frequency range.

HP 772D and HP 773D

HP 775D to 779D Dual-Directional Couplers

The economical HP 775D-778D couplers cover octave frequency spreads of more than 2:1, each centered on one of the important VHF/UHF bands. With their high directivity and mean coupling accuracy of ±0.5 dB, these are ideal couplers in reflectometer applications. The close tracking of the auxiliary arms makes these couplers particularly useful for reflectometers. Power ratings are 50 W average, 500 W peak.

HP 772-779D, 11691D, 11692D Specifications

HP Model	Freq. Range (GHz)	Nominal Coupling (dB)	Max. Coupling Variation (dB)	Min. Directivity (dB)	SWR Primary Line Max. (50 Ω Nom.)
772D	2 to 18	20	±0.9	2 to 12.4: 30 12.4 to 18: 27	2 to 12.4: 1.3 12.4 to 18: 1.4
773D	2 to 18	20	±0.9	2 to 12.4: 30 12.4 to 18: 27	1.3 1.4
775D[1]	0.45 to 0.94	20	±1	40	1.15
776D[1]	0.94 to 1.9	20	±1	40	1.15
777D	1.9 to 4	20	±0.4	30	1.2
778D	0.1 to 2	20	±1.5	0.1 to 1 GHz: 36[2] 1 to 2 GHz: 32[2]	1.1
779D	1.7 to 12.4	20	±0.75	1.7 to 4 GHz: 30 4 to 12.4 GHz: 26	1.2
11691D	2 to 18	20	±1.0	2 to 8 GHz: 30[3] 8 to 18 GHz: 26[3]	1.3 1.4
11692D	2 to 18	20	±1 incident to test port	2 to 8 GHz: 30[3] 8 to 18 GHz: 26[3]	2 to 12.4 GHz: 1.3 12.4 to 18 GHz: 1.4

[1] Maximum auxiliary arm tracking: 0.3 dB for HP 776D; 0.5 dB for HP 777D
[2] 30 dB, 0.1 to 2 GHz, input port
[3] 24 dB with Type-N connector on the test port (11692D) or on the input port (11691D)

Key Literature

New *RF & Microwave Test Accessories Catalog*, p/n 5964-9527E

HP 87302C, 87303C, and 87304C Hybrid Power Dividers

The HP 87302C, 87303C, and 87304C power dividers are compact, hybrid microwave couplers designed for power splitting applications that require minimal insertion loss and high isolation.

The HP 87302C covers the entire 0.5 to 26.5 GHz frequency range with a maximum insertion loss of 1.9 dB. The HP 87303C and 87304C cover the frequency range of 1 to 26.5 GHz and 2 to 26.5 GHz with an even lower insertion loss of 1.6 dB and 1.4 dB, respectively. These hybrid power dividers are excellent for any application requiring low loss power division. They typically exhibit an insertion loss that is 1 to 2 dB lower than an equivalent resistive power divider.

HP Model	Freq. Range (GHz)	Band Segments	Insertion Loss (dB)	Isolation (dB)
HP 87302C	0.5 to 26.5	0.5 to 18 GHz 18 to 26 GHz	1.5 1.9	19 19
HP 87303C	1.0 to 26.5	1.0 to 18 GHz 18 to 26.5 GHz	1.2 1.6	19 21
HP 87304C	2.0 to 26.5	2.0 to 18 GHz 18 to 26.5 GHz	1.1 1.4	19 18

Power Rating: 10 W, CW (2:1 maximum SWR)
Connectors: 3.5 mm (f), SMA compatible

Signal Sources

HP 70340A Module Signal Generator, Brochure
5091-4649E
HP 8370 Series Color Brochure
5963-6614E
ESG Series Technical Specifications
5965-3096E
ESG Series Brochure
5965-9088E

(PN 8350) Reduced Harmonic Distortion Using the Integra TMF-1800H Tracking Filter With the 8350 Sweep Oscillator
5952-9345
(PN 8350-2) Improved Frequency Accuracy
5952-9330
(PN 8360-1) HP 8340/41 to HP 8360 System Conversion Guide
5952-8089
(PN 8360-2) Obtaining Flat Test Port Power with the HP 8360 User Flatness Correction Feature
5952-8090
(PN 8360-3) Generating Scan Modulation Patterns
5091-0226E
(PN 8360-4) Performing Two-Tone Measurements with the HP 8360
5091-0227E
(PN 8642A/B-1) The Benefits and Use of the HP 8642A/B
5953-8453
(PN 8642A/B-2) Using Sweep Functions on the HP 8642A/B
5953-8452
(PN 8644) HP 8644, 8645, 8665A Performance Signal Generator Series
5951-6727
(PN 8644A-1) Phase Noise Measurements with the HP 8644A and 8655A Signal Generators
5951-6729
(PN 8645-1) Agile Operation of the HP 8645A
5951-6711
(PN 8645-2) A Catalog of HP 8645A Information
5951-6712
(PN 8791-1) Product Note Using Dynamic Data with HP 8791 10 FASS
5953-2343
(PN 8791-2) Programming HP FASS with WGL
5963-0988E
(PN 8791-3) Theory of Operation of the HP FASS
5091-4581E
(PN 8791-4) Secure Communications Testing with HP FASS
5952-0507
(PN 8791-5) Tips on External Clock Operation with HP FASS
5952-1901
(PN 8791-6) Jamming Signal Capability of the HP FASS
5952-1903
(PN 8791-7) Spectral Purity of the HP FASS
5952-1058
(PN 8791-8) Survey of Radar Test Applications Using FASS
5952-2847
(PN 8791-9) User Patterns: Your Key to Signal Customization with HP FASS
5091-0243E
(PN 8350-8) Leveling the HP 8350B Sweep Oscillator with an HP 430 Series Power Meter
5954-1507
(PN 8350-9) Improving Output Flatness
5954-8344
(PN E2507B/8A 71910A, 89410A) Noise Power Ratio (NPR) Measurements Using the HP E2407B, E2508A Multi-Format Communication Signal Simulator
5965-8533E
(PN 8648A-2) Servicing and Repairing Pagers using the HP 8648A Option 1EP
5965-1132E
(PN 8780A-1) Introductory Operating Guide to the HP 8780A Vector Signal Generator
5954-6368
(PN 8780A-2) Modulation Solutions RF & Microwave Receivers
5952-1416

Signal Analyzers

Scalar Network Analysis with the **HP 8590** Series Spectrum Analyzers, **HP 85630A** Scalar Transmission/Reflection Measurement Test Set and **HP 85714A** Scalar Measurement Personality
5091-1338E
HP 346B Noise Source Technical Data
5953-6452
HP 3587S Demo Video
5964-9460E/PAL
HP 3587S Product Overview
5964-3631E
HP 3588A Spectrum Analyzer Product Brochure and Technical Data
5952-0605
HP 3589A Product Brochure
5091-1522E
HP 3589A Spectrum/Network Analyzer Technical Data
5091-1400E
HP 71000 Series MMS Spectrum Analyzers
5965-2818E
HP 71209A 26.5 GHz Microwave Spectrum Analyzer Product Overview
5091-2581E
HP 71910A Wide Bandwidth Surveillance Receiver Technical Data
5964-3895E
HP 85719A Noise Figure Measurement Personality and 8590E Option 119 Technical Data
5091-4800E
HP 87405A Preamplifier Technical Data
5091-3661E
HP 89400 Series VSAs Configuration Guide
5964-3630E
HP 89411A 21.4 MHz Downconverter Technical Data
5962-7210E
HP 89450A DMCA Radio Test Application Personality Product Overview
5963-1835E
HP 89451A Radio Test Personality Product Overview
5964-4098E

(PN 8590-2) Time-Gated Spectrum Analysis: New Measurement Fundamentals
5952-3685
(PN 8590EM-1) Electromagnetic Compatibility–Guide to Performing Precompliance Conducted and Radiated Emissions
5964-2151E
(PN 8590E/4Q, 859X) DVB-C Solutions
5965-4991E
(PN) Add Digitized Burst Signal Measurements Capability to HP 8560 E-Series Spectrum Analyzers
5091-5837E
(PN 85719A-1) Maximizing Accuracy in Noise Figure Measurements
5091-4801E
(PN 70000) Series Spectrum Analyzer Programming Code Compatibility to the HP 8566B
5091-2583E
(PN 71910A) Extending Vector Signal Analysis to 26.5 Ghz with 20 MHz Information Bandwidth (71910A, 89400/10A/40A)
5964-3586E
(PN 8902A-2) Accurate Signal Characterization at Millimeter-Wave Frequencies
5953-8436

RF Microwave Measurement System

RF & Microwave Test Accessories Catalog
5964-9527E
HP 4352S VCO/PLL Signal Test System Product Overview
5966-0805E

Network/Spectrum Analyzers

Combining Network and Spectrum Analysis and IBASIC to Improve Device Characterization
5965-7656E
HP 4396B 1.8 GHz Network/Spectrum Analyzer
5965-6311E
Using the HP 4396B for Digital VTR Testing
5965-7658E
Wideband Microwave Spectrum Analysis and Vector Signal Analysis HP 71910A, 71910P, and 89410A, Brochure
5965-7916E

Many of these literature pieces are available at:
http://www.hp.com/go/tmc98

Network Analyzers

17 Fixtures, Test Sets and Accessories for the HP 8751A
5091-1985E
HP 8711/12/13/14C RF Economy Network Analyzers
5965-1459E
HP 8711/12/13/14C RF Economy Network Analyzers Configuration Guide
5965-1461E
HP 8711/12/13/14C RF Economy Network Analyzers Technical Specifications
5965-1464E
HP 4380S RF Balanced Cable Test System Product Overview
5964-2391E
HP 8730A/87030A Tuner Test System, Product Overview
5965-1467E
HP 8751A Network Analyzer Technical Data
5952-2373
HP 87050/75A/B Custom Multiport Test Sets, Product Overview
5964-3830E
HP 8752C RF Network Analyzer Product Overview
5966-0056E
HP 8752C & 8753D RF Network Analyzers, Brochure
5962-8780E
HP 8752 & 8753D Network Analyzers, Technical Specifications
5962-9770E
HP 8753D RF Network Analyzer, Configuring Guide
5962-9771E

(PN 8757-2) V and W Band Millimeter Scalar Measurements Using the HP 8757 Scalar Network Analyzer
5954-8380
(PN 8757-5) Measuring Voltage-Controlled Devices
5954-1537
(PN E5100A/B) Crystal Resonator Measuring Functions of HP E5100A/B Network Analyzer
5965-4972E
(PN 8751A-1) High Accuracy and High-Speed Filter Measurements
5091-0408E
(PN 8720-1) Amplifier Measurements with the HP 8720C
5091-1942E
(PN 8720-2) In-Fixture Measurements with the HP 8720C
5091-1943E
(PN 85108) Isothermal Measurement with HP 85108 Pulsed Bias, Pulsed-RF System
5965-7958E
(PN 8753-5) Mixer Measurements with the HP 8753C and HP 8625A Synthesized RF Sweeper
5091-1100E
(PN 35665A) Controlling an HP-IB System with the HP 35665A Dynamic Signal Analyzer
5091-1678
(PN 35665A-2) PC Control of the HP 35665A Dynamic Signal Analyzer via HP-IB and C
5091-2767E
(PN 35665A-3) Single Plane Balancing with the HP 35665A and HP Instrument Basics
5091-2886E
(PN 35665A-4) MIL-STD-740-1 and -740-2 with the HP 35665A
5091-2943E
(PN 8510-13) Measuring Noninsertable Devices
5956-4373
(PN 8510-14) Using Multiple Test Sets with the HP 8510B
5952-6674
(PN 8510-15) Lightwave Component Measurements
5952-3524
(PN 8510-16) Test Port Power Flatness
5091-0467E
(PN 8510-18) Testing Amplifiers and Active Devices with the HP 5810 Network Analyzer
5963-2352
(PN 8510-6) On-Wafer Measurements Using Cascade Prober
5954-1579
(PN 8510-7) Measuring Chip Capacitors with the HP 8510C Network Analyzers and Inter-Continental Microwave Test Fixtures
5091-5674E
(PN 8510-8A) Applying TRL Cal to Non-coaxial Measurements
5091-3645E
(PN 8753-1) Amplifier Measurements Using the HP 8753 Network Analyzer
5956-4361
(PN 8753-2) Mixer Measurements Using the HP 8753B Network Analyzer
5956-4362
(PN 8753C) Antenna Measurements Using the HP 8753C Network Analyzer
5952-2776
(PN 8753C) Mixer Measurements Using the HP 8753 Network Analyzer
5952-2771
(PN 4380-2) Designing Custom Fixtures for the HP 43805 Balanced Cable Test System
5965-5252E
(PN 4380A) HP 4380A Stand-Alone Control
5964-6792E
(PN 4380S) Testing 4-Pair Balance Cable/ Connectors with the HP 4380S RF Balanced Cable Test System
5963-9535E

Power Meters

Thermocouple and Diode Power Sensor Family Brochure
5959-8751D
HP 70100A Power Meter Modular Measurement System Catalog
5965-2818E
HP EPM-441A/442A Power Meters, ECP-E18A/E26A Power Sensors, Brochure
5965-6380E
HP EPM-441A/442A Power Meters, ECP-E18A/E26A Power Sensors, Technical Data
5965-6382E
HP EPM Power Meters, ECP-Series Power Sensors, Configuration Guide
5965-6381E

Noise Figure Meters

Applications and Operation of the HP 8970B Noise Figure Meter and HP 8790S Microwave Noise Figure Measurement System
5091-6049E
Fundamentals of RF and Microwave Noise Figure Measurements
5952-8255E
HP 346A/B/C Broadband Noise Sources Technical Data
5953-6452E
HP 70875A Noise Figure Meter Personality for MMS Spectrum Analyzers Product Overview
5965-5022E

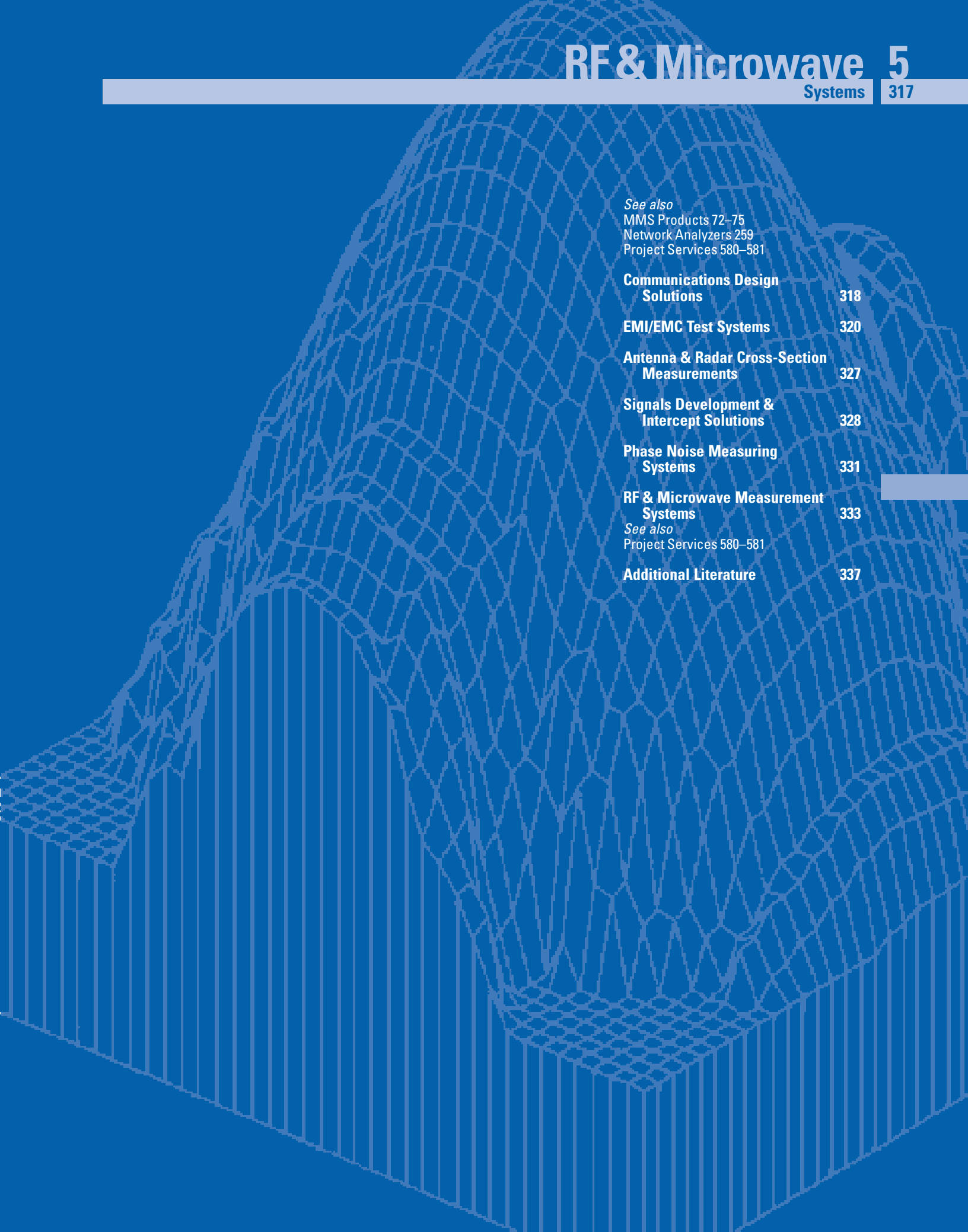
(PN 8970B/S-2) Applications and Operation of the HP 8970B Noise Figure Meter and HP 8970S MW Noise Figure Measurement System
5954-8896
(PN 8970B/S-3) Noise Parameter Measurement Using the HP 8970B Noise Figure Meter and the ATN Model NP4 Noise Parameter Test Set
5952-6639
(PN 8970B/S-4) Displaying HP 8970B Noise Figure Meter Measurements on the HP 8757 Scalar Network Analyzer
5959-8742

RF & Microwave Test Accessories

(PN 8760-1) HP 8760 Series Custom Microwave Switch Matrixes
5959-7860
(PN 8625A) Performing Two-tone Measurements with the HP 8625A
5091-2838E
(PN) ESA-L1500A 1.5 GHz Portable Spectrum Analyzer
5965-6309E

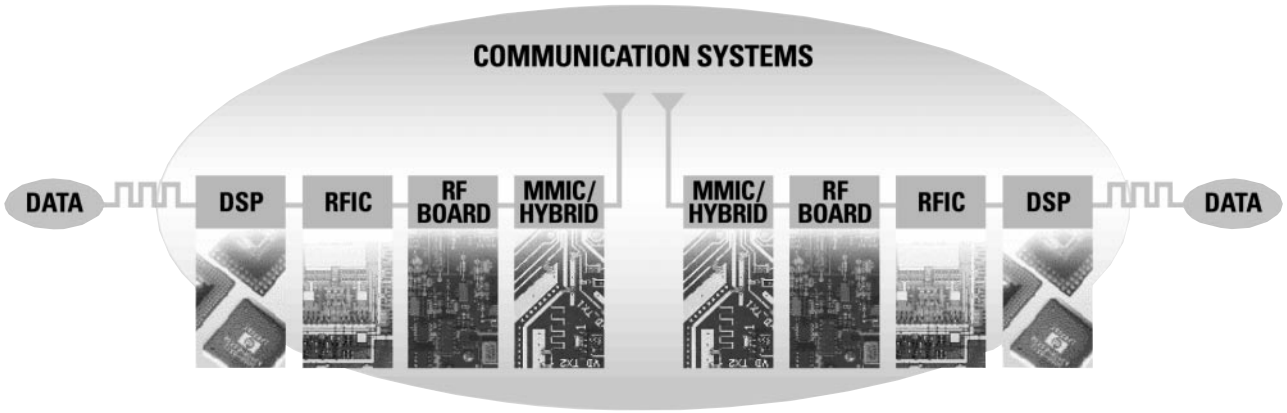
EMI/EMC Testing

Cookbook for EMC Precompliance Measurements
5964-2151E



See also
MMS Products 72–75
Network Analyzers 259
Project Services 580–581

See also
Project Services 580–581



HP Advanced Design System—The First Complete Signal Path Design Solution

The challenge of communications design is to shorten time to market, while making better, smaller, faster products that require less energy consumption. HP EEsof's new Advanced Design System has been developed specifically to simulate the entire communications signal path. This unique solution integrates proven RF, DSP, and electromagnetic simulators into a single, flexible design environment.

Combining Proven Technology with New Innovation

HP EEsof's industry-leading RF design products, MDS and Series IV, provided the foundation for this new software solution. For the first time, all the design technologies offered by the company are available in a single environment: system, circuit, electromagnetic simulation, synthesis, and physical design. The HP Advanced Design System provides new DSP design and synthesis technologies, and significant new design capabilities for RF, microwave, and RFIC, all integrated into one efficient, flexible design solution. The integration and co-simulation of RF and DSP analysis engines is unique in the EDA industry. The integration of multi-discipline design tools into a single environment eliminates the barriers caused by separate processes and allows design teams to reduce errors and save time. This new design environment is available for both PC and UNIX platforms. The PC version can be run on a modern laptop, creating a more flexible design environment.

System Design

The HP Advanced Design System top-level simulation solution, HP Communication System Designer, offers unprecedented speed and accuracy in RF system simulation. The system simulation capability of HP OmniSys has been enhanced with the use of an extremely fast harmonic balance simulator that allows engineers to compute full budget simulations on any RF topology. The software includes measurements for dozens of system-level parameters such as incident power, noise figure, third order products, signal-to-noise ratio (SNR), noise bandwidth, and more. It also offers a way to identify the source of spurious signals. These abilities allow engineers new freedom to experiment with innovative approaches to their designs.

HP Communication System Designer also has a new signal-processing engine that allows processing of data in both vector and matrix form and has over 300 DSP models. Bit error rate (BER) testers that have both monte carlo prediction and a faster variance reduction algorithm are included. Users can make use of advanced post-processing capabilities such as FFT, correlation, cumulative distribution function (CDF), probability distribution function (PDF), and complex math functions. HP System Designer comes with a Matlab interface and has an optional user-friendly C code interface. An optional instrument server is available that lets users link to RF and communication measurement instrumentation. The software also offers an optional library of EIA-compliant antenna and propagation models for GSM, NADC, PHP, and CDMA.

RFIC Design

Circuit simulation technology in the HP Advanced Design System features dramatic enhancements resulting from patented new technologies. The software offers a complete range of integrated RFIC simulation technologies that provide the most efficient and accurate verification of RFIC performance against modern digital wireless standards, such as adjacent channel power ratio (ACPR) and error vector magnitude (EVM) of code division multiple access (CDMA) systems.

This breakthrough software includes new HP high-frequency SPICE, harmonic balance, and HP Circuit Envelope simulation technologies. Tests on the patented new harmonic balance simulation technique have shown speed enhancements from 2 to 100 times and reduction of memory usage by 8 to 15 times, enabling designers to simulate the very large RFIC circuits necessary in today's complex communications systems. HP's patented Circuit Envelope simulation technology, useful for simulation of RFICs with complex digitally-modulated signals such as CDMA, is now available for both PC and UNIX platforms.

Co-simulation of RF and DSP interactions in RFIC chipsets is possible in conjunction with HP DSP Designer, ensuring on-spec performance without costly iteration. Simulate system/DSP behavioral blocks with circuit level blocks, for optimal top-down hierarchical design.

Links to Cadence and Mentor design frameworks are enhanced to allow efficient integration into existing IC design flows.

DSP Design and Synthesis

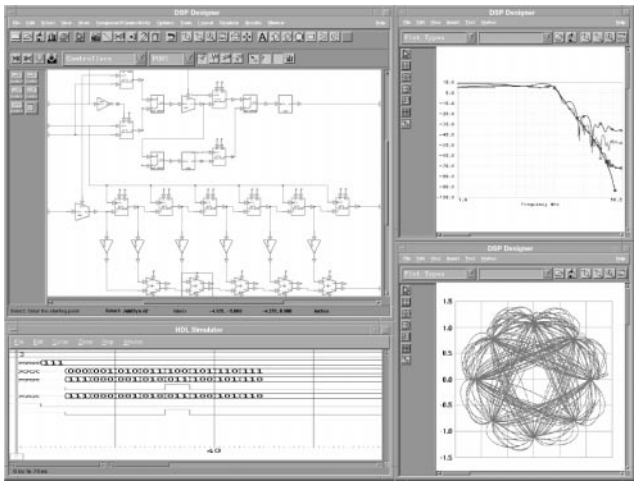
Digital signal processing is a vital part of many communication designs, and the HP Advanced Design System addresses this need with the inclusion of two new DSP tools; HP DSP Designer and HP DSP Synthesis. These two products were developed especially to help DSP design engineers create and evaluate baseband designs.

HP DSP Designer offers the most extensive environment available for communications DSP development and the largest collection of DSP, analog, RF, and digital models to ensure real-world validation. The software includes a block diagram algorithm development environment, DSP filter tool, real-time instrument controller, and powerful data post-processing capability. For the first time digital parameters such as bit width can be included in a simulation with RF parameters such as power amplifier reverse isolation.

HP Ptolemy, new simulation technology from HP EEsof, is built into HP DSP Designer. The technology was developed by merging HP research and technology with the first commercialization of the University of California at Berkeley Ptolemy project, a signal-processing framework renowned for mixing multiple simulation models. This new simulation engine facilitates co-simulation of time, frequency, and data flow technologies and significantly expands the DSP development capability for mixed RF/analog/DSP communications projects. HP is the only EDA vendor to deliver RF/DSP co-simulation capability within a complete design environment.

HP DSP Synthesis offers powerful capabilities to help both DSP and integrated circuit (IC) designers significantly improve productivity and reduce development costs. It includes both behavioral and RTL VHDL/Verilog code generation and simulation capability. The software outputs the hardware description language (HDL) in industry-standard formats for logic synthesis tools.

HP 85122A
HP 85123A
HP 85124A
HP 85190A



DSP Design

The HP 85123A RF Modeling System, left, together with the HP 85190A IC-CAP software, are shown extracting complete nonlinear models for RF active devices.

Microwave and RF Circuit Design

For traditional RF board-level design, the microwave/RF circuit designer benefits from the integration of system, circuit, and electromagnetic simulation, as well as full schematic and layout with library linkages to enterprise-wide PCB systems such as Mentor Board Station. RF board-level and microwave hybrid and MMIC design tools include a DRC with an easy-to-use rules-writing interface and a footprint generator that allows the designer to create footprints graphically without programming and to compile them into AEL macro language. There are also layout enhancements for ground-plane management and better trace handling.

Libraries

Part of the power of HP EEsof's Advanced Design System lies in its extensive active- and passive-device model libraries. Palettes of model data for over 90,000 popular devices from numerous vendors are instantly available for placement within the design. From surface mount technology (SMT) capacitors to behaviorially modeled RFICs, the libraries contain the popular parts needed by today's designers. Our active-device libraries are based on measurement-based, bias dependent transistor models that are backed by years of verification and experience. The SMTs and RFIC devices contain physical layout information as well as electrical data.

A new user library development feature facilitates easy creation of electrical models and custom footprints for in-house and foundry libraries. A new library translator utility translates third-party libraries into HP EEsof format, expediting design transfers from Mentor/Cadence enterprise tools.

Getting the Most from Your Investment

With HP EEsof product support, you receive substantial software upgrades, documentation updates, and support via telephone, fax, email, and the web. Our worldwide technical support services provide assistance to new and advanced users alike.

Key Literature

HP Advanced Design System Brochure, p/n 5965-8978E

Ordering Information

HP Advanced Design System
HP EEsof offers Advanced Design System solutions.
Please call your HP sales representative for
more information.

Additional information on products from HP EEsof can be obtained on the World Wide Web (http://www.hp.com/go/hpeesof).

HP Device Modeling Systems

5

The HP Device Modeling Systems are the first total systems specifically dedicated to active device modeling. They combine parameter extraction and test hardware (HP 85122A for microwave, HP 85123A for RF, or HP 85124A for pulsed modeling) and the HP 85190A IC-CAP modeling software. Industry-standard SPICE models as well as HP EEsof high-frequency models are available for FET, HEMT, BJT, MOS, diode, and thin-film devices.

- Use the HP 8510C or HP 8753C network analyzer for S-parameter measurements and the HP 4142B DC source/monitor for precision DC measurements and bias (custom configurations also available)
- IC-CAP software is compatible with measurement instruments and circuit simulators such as MDS
- Complete modeling solution: delivered fully configured and factory integrated
- Easy to connect and fully compatible with wafer probes from Cascade Microtech or fixtures from Inter-Continental Microwave

IC-CAP software provides the total framework environment in which standard, modified, or fully custom device models may be extracted or generated. Specific models include the HP Root FET and MOS Model Generators, as well as FET, BJT, HEMT, diode, and thin-film models. See page 533 for additional information on IC-CAP.

Ordering Information

HP 85122A Precision Modeling System
HP 85123A RF Modeling System
HP 85124A Pulsed Modeling System
HP 85190A IC-CAP Modeling Suite

Please contact your local HP sales representative for complete details.

Platforms

The circuit and system simulation tools described above are available on a wide range of UNIX workstations and include HP, Sun, DEC, and IBM computers.

HP EEsof also has RF and microwave design solutions for those using PCs. Series IV is available on PCs running under Windows NT and Windows 95. Also, Windows 3.1 versions of Touchstone and Libra are available.

Support

A complete line of support products, which include automatic software updates and telephone technical support, is also available. Please call your HP sales representative for more details.

HP 8542E
HP 8546A

- ±2 dB absolute amplitude accuracy
- Built-in PC/DOS disk drive
- Certified compliant to all CISPR Publication 16-1 recommendations by the BZT**

HP 8542E 2.9 GHz

Fully CISPR 16-1 Compliant

HP-IB

The HP 8542E and HP 8546A EMI receivers make CISPR-based EMI measurements with unprecedented accuracy, speed, and ease of use. These EMI test receivers can be used to check conformance to standards such as CISPR, EN, FCC, VCCI, and VDE.

Most Requested Features

Both receivers incorporate the features most often requested by EMI test engineers:

- Specifications that meet CISPR Publication 16-1* recommendations for making compliance measurements to any civilian EMI measurements standard worldwide
- ±2 dB absolute amplitude accuracy, specified
- Extended frequency coverage to test the newest high-speed ITE equipment
- Traditional receiver features, including automatic overload detection and auto-ranging
- Three tuning modes: manual, stepped, and scanning
- Large, color CRT
- Onscreen limit lines
- Automatic antenna and cable correction for direct comparison of measurement data to limits
- Automatic measurement routines
- Parallel detectors: peak, quasi-peak, and average

Upgrade from Precompliance to Full Compliance Capability

Both the HP 8542E and the HP 8546A consist of two separate sections. The receiver RF section can be purchased as a standalone precompliance tester. The RF filter section can be added later to make the complete EMI compliance receiver.

Flexible Storage of Data and Test Setups

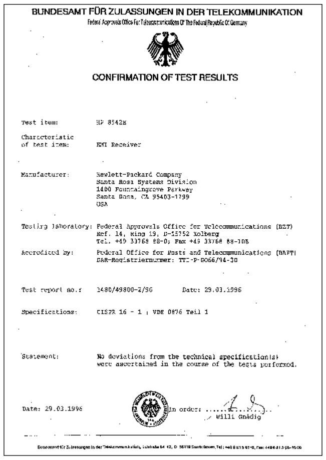
A built-in, PC-formatted floppy disk drive allows test and data files to be stored and recalled. Stored tests can include system configurations, antenna, transducer factors, and cable losses.

The receiver CRT has a powerful dual-window capability. A broad spectrum can be captured in the upper window, and the lower window can be used to examine signals of interest in greater detail.

Report Generation Software is Free

The HP 85878A Report Generator Software is included free with the purchase of an HP 8542E or a HP 8546A. The HP 85878A software can retrieve internal data from the HP 8542E or HP 8546A such as limit lines, stored lists of signals, and external device correction factors (e.g. cables and antennas) and place them into a word processing package. The HP 85878A Report Generator Software also has customizable templates to automatically generate reports for submission to regulatory bodies of countries where the tested product is to be sold.

** BZT is the German federal approvals office for telecommunications.



BUNDESAMT FÜR ZULASSUNGEN IN DER TELEKOMMUNIKATION
Federal Approvals Office For Telecommunications Of The Federal Republic Of Germany

CONFIRMATION OF TEST RESULTS

Test item: HP 8542E

Characteristic of test item: EMI Receiver

Manufacturer: Hewlett-Packard Company
Santa Rosa Systems Division
1400 Fountaingrove Parkway
Santa Rosa, CA 95403-1799
USA

Testing laboratory: Federal Approvals Office for Telecommunications (BZT)
Ref. 14, Ring 19, D-15752 Kolberg
Tel. +49 33768 88-0; Fax +49 33768 88-106

Accredited by: Federal Office for Posts and Telecommunications (BAPT)
DAR-Registriernummer: TTI-P-G066/94-30

Test report no.: 1480/49800-Z/SG Date: 29.03.1996

Specifications: CISPR 16 - 1 ; VDE 0876 Teil 1

Statement: No deviations from the technical specification(s) were ascertained in the course of the tests performed.

Date: 29.03.1996 In order: ....
Willi Gnädig

Measurement Automation

Both receivers work with new PC-based EMI measurement software—the HP 85876B and HP 85875A—to create the most powerful, easiest to use automated solution available for commercial radiated and conducted emission testing.

Specification Summary

Frequency Range: HP 8542E: 9 kHz to 2.9 GHz; HP 8546A: 9 kHz to 6.5 GHz
Frequency Reference
Aging: <±1 x 10^{-7}/year
Temperature Stability: < ±1 x 10^{-8}
Frequency Readout Accuracy: ± (freq. readout x freq. reference error + 20% of IF bandwidth + 100 Hz) conforms to CISPR 16-1
Displayed Average Noise Level (with CISPR bandwidths, 0 dB attenuation) (characteristic)

	Preamp Off	Preamp On
CISPR Band A (200 Hz BW) 9 kHz to 150 kHz	3 to – 27 dBμV	– 9 to – 31 dBμV
CISPR Band B (9 kHz BW) 150 kHz to 30 MHz	– 18 dBμV	– 21 dBμV
CISPR Band C/D (120 kHz BW) 30 MHz to 1 GHz	– 5 dBμV	–10 dBμV
Noise Figure Characteristic 9 kHz to 2.9 GHz 1 GHz to 6 GHz	14 dB 24 dB	10 dB 8 dB
Gain Compression, 1dB (characteristic)	89 dBμV	77 dBμV

Absolute Amplitude Accuracy: 9 kHz to 2.9 GHz: ±2 dB (typical ±1 dB); 2.9 to 6.5 GHz (characteristic): ± 3.0 dB (HP 8546A)
IF Bandwidths
Measurement: 200 Hz, 9 kHz, 120 kHz, 1 MHz, (6 dB, conform to CISPR Publication 16-1)
Diagnostic: 30 Hz to 3 MHz (3 dB) in a 1-3-10 sequence
IF Detectors
Measurement: Peak, quasi-peak, average
Overload: RF, IF
Demodulation: AM, FM
Temperature Range: 0° to +55° C, operating; – 40° to +75° C, storage
Size: 457 mm W x 365 mm H x 645 mm D (18 in x 14.38 in x 25.38 in)
Weight: 48.6 kg (108 lb)

Key Literature

HP 8546A EMI Receiver Technical Data, p/n 5091-8314E
HP 8542E EMI Receiver Technical Data, p/n 5963-0081E

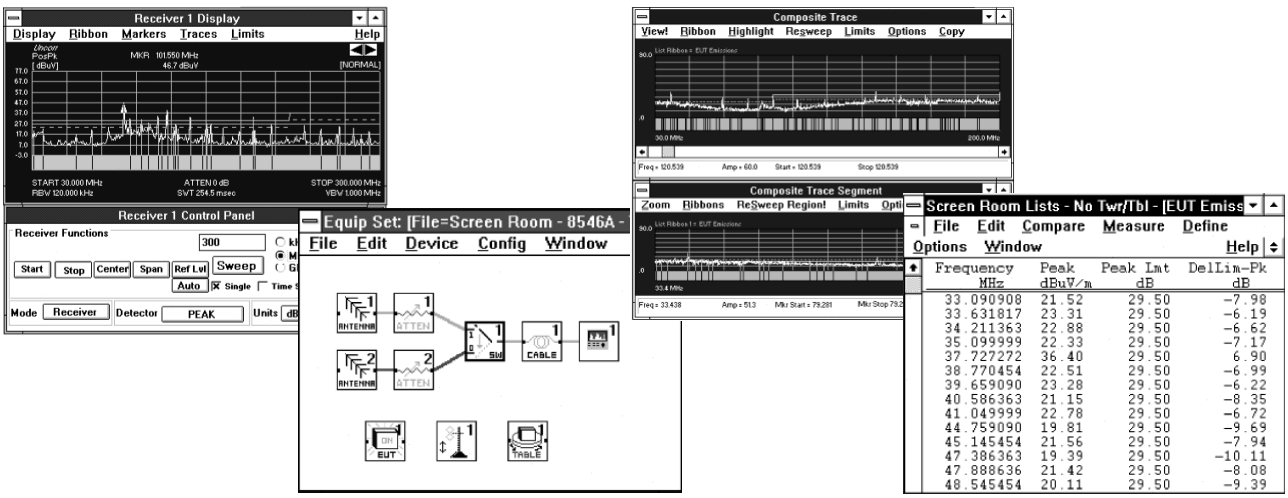
Ordering Information

HP 8542E EMI Receiver (9 kHz to 2.9 GHz)
HP 8546A EMI Receiver (9 kHz to 6.5 GHz)

*CISPR Publication 16 is the Comité International Spécial des Perturbations Radioélectriques specification for radio interface measuring apparatus and measurement methods.

- Software management of EMI measurement process
- PC and Microsoft® Windows format
- Graphical test setup and execution
- Conducted and radiated capability

HP 85875A
HP 85876B



Software That Manages the Entire EMI Measurement Process

A family of PC-based software helps you manage the entire EMI measurement process, from initial setup to final report. HP's Commercial EMI Measurement Software packages provide conducted (HP 85875A) and radiated (HP 85876B) emissions test capability.

Whether you test products for industrial, scientific, medical, or information applications, you will find that these software products meet international EMI test requirements, including FCC Part 15 regulations in the U.S. and the latest European Norms (EN).

Accurate, Simple Test Setup

The HP 85875A and 85876B software runs under Microsoft® Windows on PC-compatible platforms. The HP 85876B has a special graphical interface that allows the test equipment setup to be viewed schematically. You can make equipment changes by simply clicking the mouse.

Icons represent specific test equipment, including receivers, filters, amplifiers, antennas, switches, cables, and equipment-under-test. Calibration data is stored with icons representing specific test equipment. Graphically positioning and interconnecting the equipment icons automatically corrects for an entire measurement path.

Collect Data Easily

The software enables your PC to display and control an EMI receiver. As data points are collected, the software constructs a broad-span display of emission absolute amplitudes. An upper window on the CRT shows the complete measurement span. For better data analysis, a portion of this span may be highlighted and viewed in greater detail in a window below.

Quickly Locate Maximum Emissions

The HP 85876B includes automatic maximization routines that position an antenna tower, antenna polarization, and equipment turntable to find the worst-case radiated emissions. Antenna height and turntable positions are displayed on the PC. Using individual control panels, antenna height and turntable positions can also be controlled manually with the mouse.

A GPIB card is required to control the EMI receiver and other accessories over HP-IB. The GPIB card is available as Option 488.

Powerful Data List Editor

The software collects up to 27 predefined data parameters for each signal encountered during a test. A powerful list editor allows you to organize, view, and manipulate signal data in list formats. Data from different tests can be compared easily and the results saved in a separate list.

Transport Data and Graphics to PC Tools

The software and PC environment allow users to move information to popular spreadsheets and word-processing programs.

5

Computer Compatibility

Operating System
- MS-DOS 5.0 or later
- Microsoft® Windows 3.1 or later
- Microsoft® Windows NT 4.0 (85876B only)
- Microsoft® Windows 95 (85876B only)

Recommended Hardware
- Pentium 90
- 16 MB Free RAM (32 MB Free RAM for Windows NT 4.0)
- SVGA 17-in monitor with graphics accelerator
- 200 MB of free hard disk memory
- 1.44 MB 3.5-inch floppy disk
- Option 488
- GPIB (National Instrument) card

Supported EMI Receivers and Analyzers:
HP 85876B: HP 8542E, 8546A, 85422E, 85462A, 8574B, 8572A, and 8566B/8568B-based systems
HP 85875A: HP 8542E, 8546A, 85422E, 85462A
The HP 85876B is installed standard on CD-ROM, with an option for 3.5-inch disks.

Key Literature

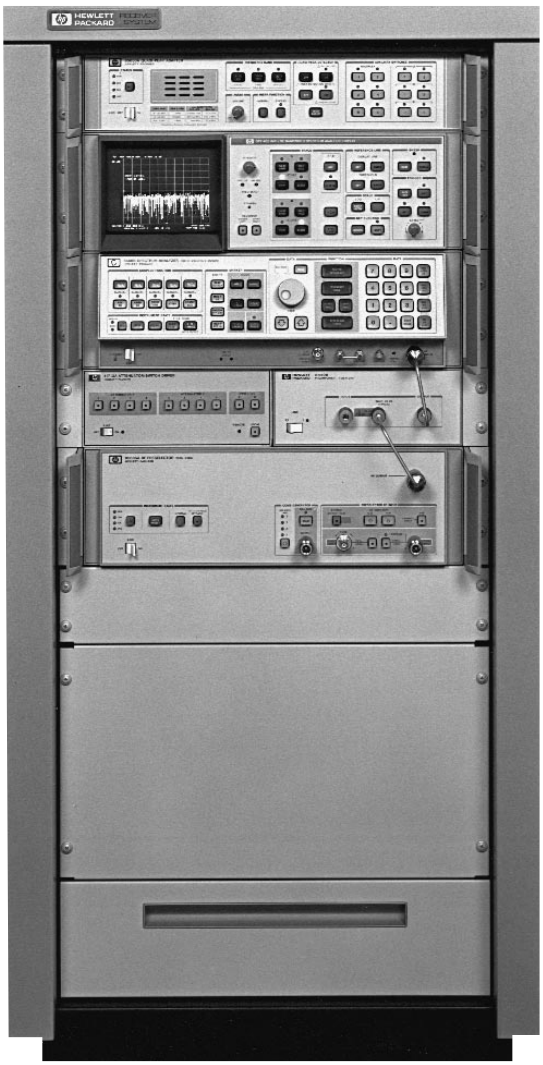
HP 85875A Commercial Conducted EMI Software
Brochure, p/n 5964-1968E
HP 85876B Commercial Radiated EMI Software
Brochure, p/n 5962-9450E

Ordering Information

HP 85875A Commercial Conducted EMI Measurement Software
HP 85876B Commercial Radiated EMI Measurement Software
Options
- **Opt 001** 85876B software installed on 3.5-inch disks
- **Opt 488** GPIB (National Instrument) card for PC
- **Opt 832** Free upgrade from 85876A to 85876B on 3.5-inch disks
- **Opt 835** Free upgrade from 85876A to 85876B on CD-Rom

HP 8571A
HP 8572A
HP 85869A

- Built to CISPR Publication 16* recommendations
- Automatic or manual commercial and military compliance testing
- Diagnostic EMI measurements



HP 8572A

HP 8571A and 8572A Microwave EMI Receivers

These EMI receivers are capable of making your most demanding measurements over a wide (20 Hz to 22 GHz) frequency range. They are specifically designed to make essential military and commercial EMI measurements easily and quickly. The HP 8571A receiver includes an HP 8566B spectrum analyzer with Options 002 and 462, an HP 85685A RF preselector, an HP 11713A attenuator/switch driver, and an HP 8449B Option H02 preamplifier. The HP 8572A includes the same equipment, but adds an HP 85650A quasi-peak adapter for CISPR-based commercial EMI tests. Both receivers are completely configured and verified by Hewlett-Packard and come with an individual calibration sheet to ensure ±2 dB amplitude accuracy. They are shipped in a system cabinet.

HP 85685A RF Preselector

Use the HP 85685A RF preselector as part of your EMI measurement system to provide protection from overload by out-of-band signals. Overload conditions can cause inaccurate amplitude measurements. The RF preselector operates with the HP 8566B, 8567A, and 8568B. Combining the HP 85685A with the HP 8566B forms a system to perform MIL-STD EMI testing. With the addition of the HP 85650A quasi-peak adapter, you will be able to make commercial and MIL-STD emissions measurements to meet European Norms, FCC, and VCCI requirements.

HP 85650A Quasi-Peak Adapter

The quasi-peak adapter is connected to the HP 8566B, 8567A, or 8568B spectrum analyzers to add CISPR filters and detectors. Perform quasi-peak and average measurements by selecting the appropriate filter and detector on the front panel or over the HP-IB. AM and FM demodulation along with a speaker to help discriminate between ambient and DUT signals.

HP 85869PC EMI Measurement Software

The EMI measurement software is a general-purpose program that makes radiated- and conducted-emission measurements automatically up to 22 GHz according to commercial and military regulations. The program works with the HP 8571A, 8572A, and 8574B EMI receivers. It takes advantage of the ability of these receivers to quickly measure wide frequency spans and locate device emissions by using peak detection. For commercial measurements, quasi-peak, and average data can be taken. Save time and effort making MIL-STD measurements by using the software to automatically discriminate between narrowband and broadband signals.

The HP 85869PC has an easy setup procedure, allowing you to design your own tests or to choose from the examples given in the software. These reside in the test library and include MIL-STD, FCC, and EN emission tests.

Computer Compatibility

Minimum Computer Requirements
Display: VGA (15 inch)
RAM: 16 Mbytes
Hard Drive: 5 Mbytes of free space
Floppy Drive: 3.5-inch floppy
Operating System: Microsoft® 3.5-inch DOS 6.2 and Windows 3.1 (also supports Windows 95)
Processor: Intel 486/DX2 (66 MHz)
IEEE-488 Interface: National Instruments AT GPIB
Printer and Plotters: GPIB printers/plotters; printers/plotters supported by Microsoft Windows
Programming Language: HP E2060B HP BASIC for Windows

Key Literature

HP 8571A and HP 8572A Microwave EMI Receivers
Technical Data, p/n 5091-0951E
HP 85869PC EMI Measurement Software, p/n 5965-2885E

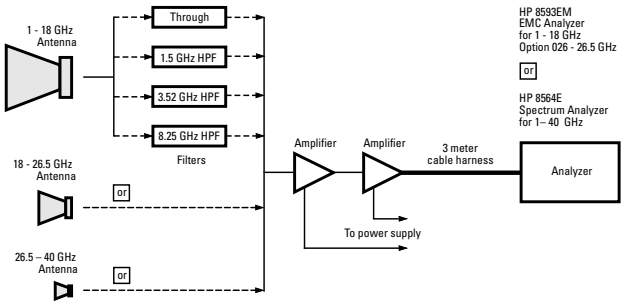
Ordering Information

HP 8571A EMI Receiver (with HP 8566B Option 002 and Option 462 Spectrum Analyzer)
HP 8572A EMI Receiver (with HP 8566B Option 002 and Option 462 Spectrum Analyzer)
HP 85869PC EMI Measurement Software
Opt 832 Upgrade Kit from HP 85869
HP 85685A PF Preselector
Opt 010 Rack Slide Kit
HP 85650A Quasi-Peak Adaptor

*CISPR Publication 16 is the Comité International Spécial des Perturbations Radioélectriques specification for radio interference measuring apparatus and measurement methods.

- Atomatic filter tracking
- Input overload protection
- Low system noise

HP 84125A
HP 84125B
HP 84125C



HP 84125A/B/C Microwave EMI Measurement Systems

The HP 84125 family of systems are designed to measure electromagnetic emissions from intentional and unintentional radiators from 1 to 18 GHz, 26.5 GHz or 40 GHz. Each system is fully integrated and calibrated for measuring products to rigorous FCC regulations, ETSI standards and proposed European EMI standards above 1 GHz. Equipment manufacturers, EMC test laboratories, and regulatory authorities will find the HP 84125 series microwave test systems a valuable addition to their existing EMI measurement capability.

The cart-mounted equipment is connected to a microwave test set with a 3-m low-loss RF cable assembly maximizing the system sensitivity. The functionality of a HP 8593EM or HP 8564E analyzer and the microwave test set is combined using a system down-loadable program (DLP). The system DLP provides softkeys on the analyzer display allowing easy setup of the measurement parameters. The displayed data is automatically corrected for antenna, cable and filter losses, and amplifier gains allowing direct viewing of emissions field strengths in dBµ V/m.

The system test set is designed for tripod mounting, antenna mast mounting or for hand-held use for locating worst-case product emissions. Horn antennas can be interchanged in the HP 84125B and C systems for full frequency coverage from 1 to 26.5 GHz and 1 to 40 GHz. In addition, each system includes three high-pass filters that can be used to block fundamental frequencies when testing intentional radiators. The interchangeable high pass filters block signals below their respective 1.5 GHz, 3.5 GHz and 8.5 cut-off frequencies.

As clock frequencies move higher, you need to be prepared with the right equipment to perform these EMI measurements. The HP 84125 series microwave EMI measurement systems have the frequency range and sensitivity to meet your needs for today and in the future.

Specifications

HP 84125A 1 to 18 GHz Frequency Range
HP 84125B 1 to 26.5 GHz Frequency Range
HP 84125C 1 to 40 GHz Frequency Range

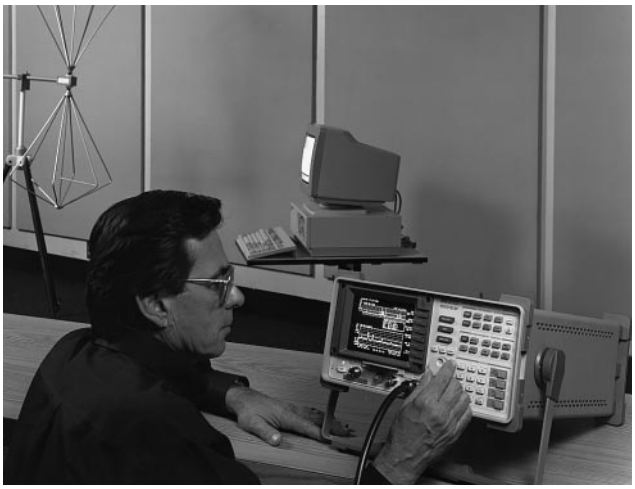
Ordering Information

HP 84125A Microwave EMI Measurement System
HP 84125B Microwave EMI Measurement System
HP 84125C Microwave EMI Measurement System

5

HP 8590EM Series
HP 84100EM
HP 84110EM

HP 8590EM Series EMC Analyzers



HP 8590 Series EMC Analyzers

Whether your industry is information technology, automotive , communication, or medical electronics, you need to evaluate the EMI performance of your designs during the development phase. The HP 8590EM series EMC analyzer allows you to evaluate this performance quickly and easily.

Compare your products' radiated and conducted emissions performance to the following regulatory agency limits:

- EN55011
- EN55014
- EN55022
- FCC Part 15
- VCCI
- VFG

The 8590EM series EMC analyzers have the following functionality and features to speed you through your measurements:

- Complete measurement setups including span and CISPR* bandwidths
- Displays two limits and margins
- Corrections for antenna, cable, and amplifier
- Measure the peak, quasi-peak, and average amplitudes of 239 signals and store the results to the internal list
- The windows feature zooms in on signals while viewing the broad spectrum
- Log frequency sweep to expand signals in lower frequencies. Useful for conducted emissions testing.
- Sort remeasure, mark, and delete signals in the internal list
- Customize and print reports which can include two pages of text, signal list, and graphics
- Standard HP-IB and parallel ports

In addition, you can edit or customize, and store limit lines and correction factors for transducers, cables, or other devices to a RAM card.

The HP 8590EM Series EMC analyzers are offered in the following frequency ranges:
HP 8591EM 9 kHz to 1.8 GHz
HP 8593EM 9 kHz to 22 GHz
HP 8594EM 9 kHz to 2.9 GHz
HP 8595EM 9 kHz to 6.5 GHz
HP 8596EM 9 kHz to 12.8 GHz

The RF performance of the HP 8590EM series EMC analyzers is the same as the HP 8590 E-series spectrum analyzers.

HP 84100EM Design Development System

Identification, isolation, and resolution of problem emissions early in the design process is key to a successful product introduction. With the HP 84100EM design development system, you can easily isolate problem signals using the close field probes supplied with the system. The calibrated probes give very repeatable measurements ensuring that assessments of redesigns will produce meaningful results. The system is based on the HP 8591EM and the HP 11945A close field probe set which covers 9 kHz to 1 GHz.

HP 84110EM Pre-Production Evaluation System

The HP 84110EM has everything you need to perform radiated and conducted emissions measurements on your product. The HP 84110EM system is based on the HP 8591EM which contains a quasi-peak adapter and dual I/O ports (HP-IB and parallel). The system also includes HP 11955A biconical and HP 11956A log periodic antennas, HP 11968C tripod, HP 11966L 10-meter cable, HP 11967D line impedance stabilization network, HP 11947A transient limiter and HP 11945A Option E51 close field probe kit. Also included is the HP 85878A report generator software, a 256 KB RAM card and a ROM card with regulatory limits and transducer factors.

Key Literature

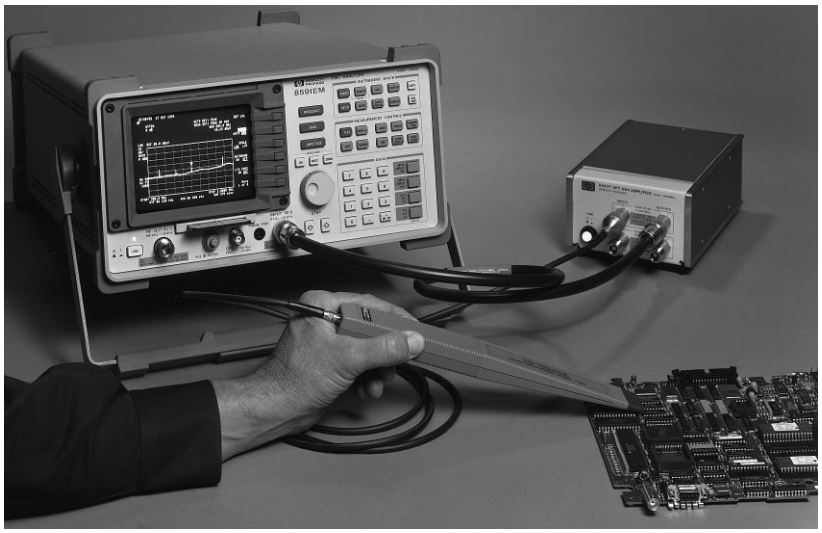
EMC Precompliance Measurement System and Accessories, p/n 5964-6091E
EMC Accessories Catalog, p/n 5952-1791
HP 8590EM Series Product Note 5964-2151E

Ordering Information

HP 84100EM EMC Design Development System
HP 84110EM EMC Pre-Production Evaluation System
Opt 61A adds HP 11961A
HP 8591EM 9 kHz to 1.8 GHz
Opt 010 Tracking Generator
HP 8593EM 9 kHz to 22 GHz
HP 8594EM 9 kHz to 2.9 GHz
HP 8595EM 9 kHz to 6.5 GHz
HP 8596EM 9 kHz to 12.8 GHz
****Opt 010** 9 kHz to 2.9 GHz Tracking Generator

*CISPR Publication 16 is the Comité International Spécial des Perturbations Radioélectriques specification for radio interference measuring apparatus and measurement methods.

** Available on HP 8593EM, 8594EM, 8595EM and 8596EM



HP can show you how to design for electromagnetic capability.

HP 11950X EMC Design Course

"Designing for EMC" is a custom course for engineers who face issues of electromagnetic compatibility. Emphasis is placed on evaluating and solving EMC problems early in the design phase of a product, rather than during final EMC compliance testing. Expert instruction and many demonstrations provide EMC fundamentals, methods of measuring EMC, and principles of incorporating proven EMC design into products.

The course covers the following topics: overview of EMC design, non-conducted coupling, common impedance coupling, radiation from digital circuits, cables, advanced cables, conducted emissions, susceptibility, electrostatic discharge, shielding and diagnostics. The 11-chapter handbook used in the class becomes a permanent reference.

The HP 11950X EMC design course is offered at a fixed fee at the site of your choice. For more information, contact your local HP sales office (listed on page 591).

HP 11940A and 11941A Close-Field Probes and HP 11945A Close-Field Probe Set

These handheld probes are designed to measure magnetic-field radiation from surface currents, slots, cables, and ICs for EMC diagnostic and troubleshooting measurements. Their unique design results in a high level of electric-field rejection. This significantly reduces errors, thus allowing calibrated and repeatable measurements.

The HP 11941A operates from 9 kHz to 30 MHz, the HP 11940A, from 30 MHz to 1 GHz. Five antenna factors appear on each probe for calculating absolute magnetic-field strength (dBµA/m) from the dBµV reading of a spectrum analyzer. Each probe is calibrated and comes with a 2-meter RG-223 coaxial cable, and SMA(f)-to-type-N(m) adapter, and an SMA (f)-to-BNC(m) adapter.

The close field probe set includes both the HP 11940A and 11941A probes for full coverage from 9 kHz to 1 GHz. Option E51 adds the HP 8447F Option H64 dual preamplifier, a 36-inch (914-mm) type-N cable, and a carrying bag for storage and protection of the entire set.

HP 11961A EMI Measurement Software

The HP 11961A EMI measurement software is used with the HP 8590EM series EMC analyzers. The software performs peak, quasi-peak, and average measurements on up to 100 selected signals and sorts and stores the results for report development. The measurements are compared to supplied limits or your own limits. Measurements are corrected for antenna factors, cable loss, and amplifier gains. The software also controls the HP 11960A RF preselector which is used to reduce RF overloading of the EMC analyzer's first mixer.

HP 85878A EMI Report Generator

Link the power of the HP 8590EM series EMC analyzer or HP 8546A/42E EMI receivers to you PC. The advanced features of the HP 85878A enables you to capture and archive measurement results from your EMC analyzer or EMI receiver including the screen, measurement list, log graph, linear graph, correction factors, instrument settings, limit lines and trace information. These items can be cut and pasted, dragged and dropped, or exported to develop comprehensive reports. Using the Word for Windows 7.0 bookmark feature, you can develop reports automatically. Four report templates are supplied. **Check out our website (http://www.hp.com/go/EMC) for a demonstration.**

HP 11960A RF Preselector

Use the HP 11960A to protect against the effects of overload. Without preselection, out-of-band signals can overload the EMC analyzer causing inaccurate measurements. The preselectors filters are designed to filter out the out-of-band signals, reducing the causes of overload. There are eight filters in the 150 kHz to 30 MHz range for conducted emissions measurements where most of the overload problems occur. In the radiated emissions bands above 30 MHz, a thirty dB gain amplifier is supplied to improve overall measurement sensitivity. A switched ten dB attenuator is supplied in radiated band for quick overload checks.

HP 119XX Series Antennas

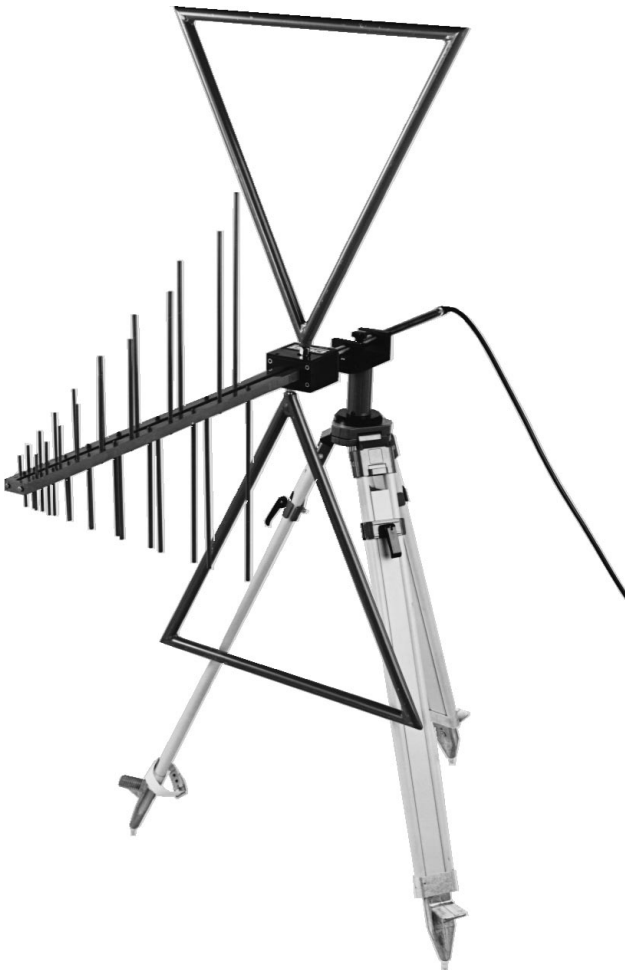
These antennas are individually calibrated and shipped with a calibration certificate showing actual performance data. The series includes the following products:

HP Model		Frequency Range
11955A	Biconical Antenna*	30 to 300 MHz
11956A	Log Periodic Antenna*	200 MHz to 1 GHz
11966A	Active Loop H-Field Antenna	10 kHz to 30 MHz
11966B	Active Rod E-Field Antenna	100 Hz to 50 MHz
11966C	Biconical Antenna	30 to 300 MHz
11966D	Log Periodic Antenna	200 MHz to 1 GHz
11966E	Double-Ridged Waveguide Horn Antenna	1 to 18 GHz
11966F	Conical Log Spiral Antenna	200 MHz to 1 GHz
11966G	Conical Log Spiral Antenna	1 to 10 GHz
11966H	Dipole Antenna Set	28 MHz to 1 GHz
11966I	Double-Ridged Waveguide Horn Antenna	200 MHz to 2 GHz
11966J	Double-Ridged Waveguide Horn Antenna	18 to 40 GHz
11966K	Magnetic Field Pickup Coil	20 Hz to 50 kHz
11966L	Coax Cable, Type-N	10 m
11966M	Coax Cable, BNC	10 m
11966N	Log Periodic Antenna	200 MHz to 5 GHz
11966P	Broadband Antenna	30 MHz to 1 GHz
11947A	Transient Limiter	9 kHz to 20 MHz

Key Literature

EMC Accessories Catalog, p/n 5952-1791
EMC Precompliance Measurement Systems and Accessories, p/n 5964-6091E

* Typical cal factor supplied



HP 11966P Broadband Antenna

HP 11967 Series Current Probes

This series is designed for MIL-STD-461/462 conducted-emission measurements on power and interconnecting leads. Used with 10 µF capacitors, HP p/n 0160-6683.

HP Model	Frequency Range
11967A Current Probe	15 kHz to 50 MHz, dc to 60 Hz powerlines
11967B Current Probe	20 Hz to 2 MHz, dc to 400 Hz powerlines

HP 11967C Line Impedance Stabilization Network

Used for commercial, CISPR-based conducted emission measurements, this single-phase unit meets the requirements of the FCC, VDE, and European Norms for conducted emissions testing. Includes color-coded pin plugs for constructing a power cord to connect with the LISN.

HP 11967D Line Impedance Stabilization Network

Used for commercial conducted measurements. Maximum current 10 amps. Includes options for NEMA, SCHUKO and British power outlet connectors.

HP 11968 Series Positioning Devices

This series includes manually-operated antenna masts and turntables.

HP Model	Description
11968B	Manually-operated antenna-positioning mast
11968C	Non-metallic antenna tripod; minimizes unwanted reflections in the test environment
11968E	Manually-operated turntable

HP 11729-60014 Low-Noise Preamplifier

This amplifier provides the sensitivity needed for MIL-STD-461C CE-06 receiver/transmitter key-up testing. Frequency range is 10 Hz to 25 MHz.

HP 8447F Option H64 Dual Preamplifier

Improve receiver and spectrum analyzer sensitivity for more accurate radiated-emission measurements. This dual preamplifier is ideal for use with the HP 11940A and 11941A close-field probes to detect low-level signals from a device-under-test. Frequency range is 9 kHz to 1.3 GHz.

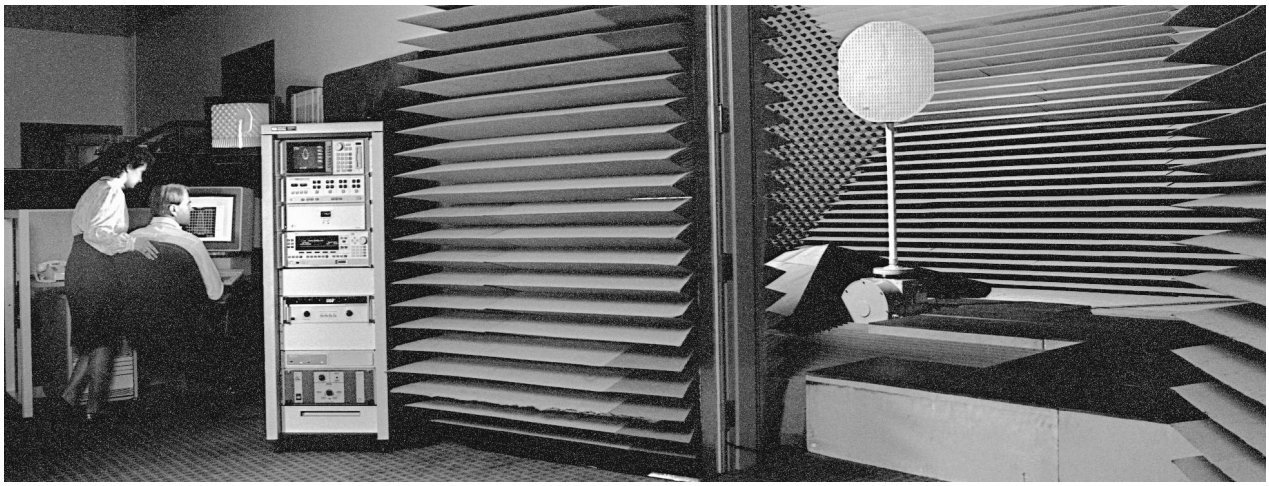
HP 8449B Microwave Preamplifier

This high-gain, low-noise preamplifier adds sensitivity for MIL-STD radiated measurements. Frequency range is 1 to 26.5 GHz (see page 302).

Ordering Information

HP 11950X "Designing for EMC" Course (per site)
HP 11940A Close-Field Probe, 30 MHz to 1 GHz
HP 11941A Close-Field Probe, 9 kHz to 30 MHz
HP 11945A Close-Field Probe Set, 9 kHz to 1 GHz
  Opt 001 Rotary Joints
  Opt 003 Delete Cables and Adapters (2 sets)
  Opt E51 Add HP 8447F Option H64 Preamplifier
  Carrying Bag, 36-in Type-N Cable
HP 11947A Transient Limiter, 9 kHz to 200 MHz
HP 11955A Biconical Antenna*
HP 11956C Log Periodic Antenna*
HP 11960A RF Preselector
HP 11961A EMI Software
HP 11966A Active Loop H-Field Antenna, 10 kHz to 30 MHz
HP 11966B Active Rod E-Field Antenna, 100 to 50 MHz
HP 11966C Biconical Antenna, 30 to 300 MHz
HP 11966D Log Periodic Antenna, 200 MHz to 1 GHz
HP 11966E Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz
HP 11966F Conical Log Spiral Antenna, 200 MHz to 1 GHz
HP 11966G Conical Log Spiral Antenna, 1 to 10 GHz
HP 11966H Dipole Antenna Set, 28 MHz to 1 GHz
HP 11966I Double-Ridged Waveguide Horn Antenna, 200 MHz to 2 GHz
HP 11966J Double-Ridged Waveguide Horn Antenna 18 to 40 GHz
HP 11966K Magnetic Field Pickup Coil, 20 Hz to 50 kHz
HP 11966L Coax Cable, Type-N
HP 11966M Coax Cable, BNC
HP 11966N Log Periodic Antenna, 200 MHz to 5 GHz
HP 11966P Broadband Antenna, 30 MHz to 1 GHz
HP 11967A Current Probe, 15 kHz to 50 MHz
HP 11967A Current Probe, 20 Hz to 2 MHz
HP 11967C Line Impedance Stabilization Network
HP 11967D LISN NEMA Connector
  Opt 001 SCHUKO Connector
  Opt 002 British Connector
HP 11968B Manual Antenna-Positioning Mast
HP 11968C Antenna Tripod
HP 11968E Manual Equipment-Testing Turntable
11729-60014 Low-Noise Preamplifier, 10 Hz to 25 MHz
HP 8447F Option H64 Dual Preamplifier, 9 kHz to 1.3 GHz
HP 8449B Microwave Preamplifier, 1 to 26.5 GHz
HP 85878A Report Generator

*Typical antenna factors supplied



HP 85301B antenna/RCS measurement system in HP's compact test range

- Measurement speeds of up to 5000 points/second
- Fast multiple-channel measurements
- Excellent microwave performance and accuracy
- Manual or automated operation
- Built-in graphical display and analysis capability

HP 85301B/C Antenna, RCS Measurement Systems

Systems Designed for Productivity

Maintaining a competitive edge requires a measurement system with the greatest accuracy, reliability, and productivity available. HP measurement systems provide complete solutions with the excellent performance, accuracy, and features you need. HP also offers complete, dependable system support.

Far-Field Antenna Measurement Systems

A complete antenna measurement solution must have the flexibility to measure a variety of antennas, and it must have features and performance to test the most challenging and complex antennas. The HP 85301B/C antenna measurement systems meet these demanding requirements.

The HP 85301B system includes an HP 8530A microwave receiver and an HP 85310A distributed frequency converter with remote mixers. (The mixers can be located directly at the antenna under test.) This system provides the best microwave performance, measurement sensitivity, and measurement flexibility available. It features broadband coaxial mixers that cover the 2 to 26.5 GHz frequency range and optional coaxial mixers that cover the 0.1 to 50 GHz frequency range. It has the ability to extend frequency coverage to 110 GHz by using the HP 85325A millimeter-wave subsystems.

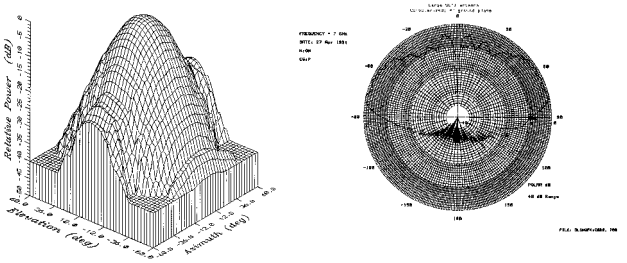
The HP 85301C antenna measurement system includes an HP 8530A microwave receiver with an HP 8511A or HP 8511B frequency converter. It features good microwave performance, an economical price, and broad frequency coverage from 45 MHz to 26.5 or 50 GHz.

Near-Field Antenna Measurement Systems

The HP 85301B/C antenna measurement system is also ideally suited for near-field antenna measurements. Its rapid data acquisition speeds, frequency agility, and fast channel-switching capability make these systems ideal for the demanding requirements imposed by near-field measurement systems. HP can help you configure a near-field measurement system to meet your specific requirements.

Radar Cross-Section Measurement Systems

The HP 85301B/C measurement systems fulfill the demanding needs of RCS measurements. These systems feature broad frequency capability from 45 MHz to 110 GHz; a choice of frequency downconverters; excellent measurement sensitivity and accuracy; and fast frequency agility, data acquisition speeds, and multiple-channel capability. HP instrumentation is meeting the challenges of RCS measurements in hundreds of RCS facilities worldwide.



Typical data available from the measurement systems

HP 8530A Microwave Receiver

The HP 8530A is a fast and accurate microwave receiver designed for both manual and automated antenna measurement and radar cross-section measurement applications. It features fast data acquisition speeds, excellent sensitivity, wide dynamic range, multiple test channels, and fast frequency agility—without compromising measurement accuracy. The receiver provides broad frequency coverage from 45 MHz to 26.5 GHz, with extensions to 110 GHz.

Easy Upgrades for Existing Antenna Ranges

The HP 8530A microwave receiver can be a replacement receiver for existing antenna or RCS range receivers. With the HP 85370A antenna position encoder, the HP 8530A receiver can be interfaced to virtually any positioning system. Also, any HP 8510 network analyzer can be upgraded to an HP 8530A microwave receiver and still retain network analyzer capability. The HP 85395A/B/C kits provide an on-site upgrade of your existing network analyzer. Whether you upgrade one component or a complete system, HP provides the reliable instrumentation you need, and HP's upgrade paths protect your capital investment in your measurement systems.

Customized Systems to Meet Your Requirements

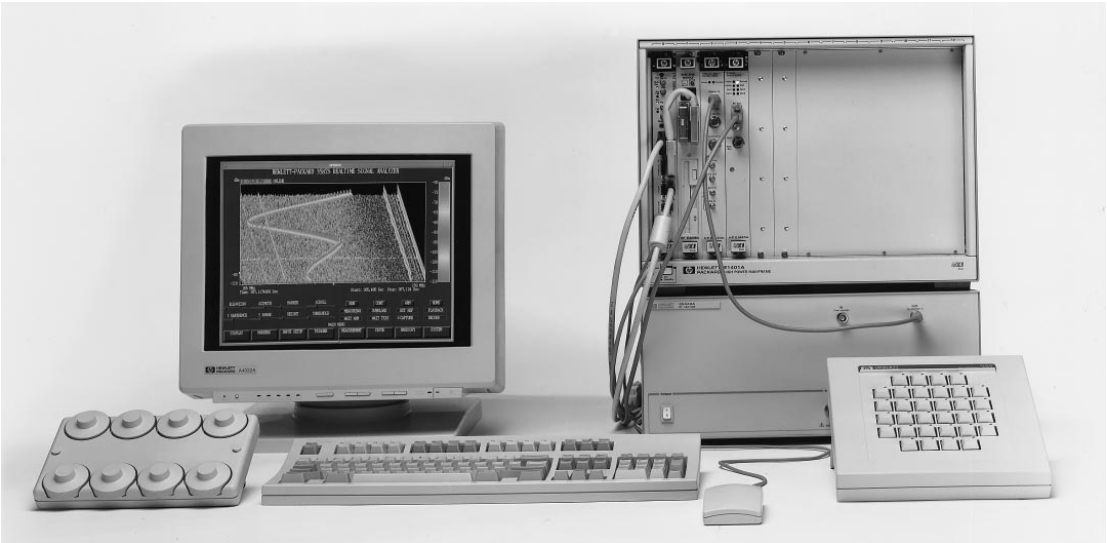
The HP 85301B/C measurement systems are customized to fit your individual requirements. HP offers a variety of options to expand the capabilities of the standard systems and also offers customization services to meet unique measurement requirements. HP has microwave systems engineers worldwide who understand your measurement needs and who will work with you to configure a measurement system that meets your specific requirements.

Ordering Information

HP 85301B Antenna/RCS Measurement System
HP 85301C Antenna/RCS Measurement System
HP 8530A Microwave Receiver

Please call your local HP sales representative for detailed information about these and other antenna products.

- Measure DC to 3 GHz
- 8 MHz maximum frequency span
- 1 MHz real-time bandwidth
- Frequency, time, and amplitude domain
- Spectrogram and waterfall displays
- Compatible with various downconverters



HP 3587S

HP 3587S Real-Time Signal Analysis System

The HP 3587S real-time signal analysis system has the measurement power and flexibility you need to capture and analyze real world signals. Its combination of speed, dynamic range, presentation flexibility, signal capture memory, and instrument-like operation will help you analyze non-stationary and low-level signals, even those close to much higher level signals, a higher percentage of the time.

8 MHz Input Bandwidth

Analyze data with up to 8 MHz bandwidth. The HP 3587S uses a 20 MSa/s 23 bit ADC module to digitize signals. This HP proprietary A/D is fully alias-protected to assure the Nyquist valid sampling that is key for signal analysis. It also provides up to –110 dBfs of spurious-free dynamic range. A 16 dB noise figure provides excellent sensitivity to complement this dynamic range. Extend the measurement range of the HP 3587S with a selection of HF and VHF/UHF downconverters.

1 MHz Real-Time Bandwidth

The digital signal processing module in the HP 3587S contains 250 MFLOPs of raw computational power. That power gives this signal analyzer 1 MHz of real-time bandwidth. That means you can monitor any 1 MHz span in the DC to 3 GHz range of the HP 3587S continuously, with < 2 kHz RBW and zero revisit time.

Versatile Data Display

Monitor and analyze signals with a choice of frequency-domain, time-domain, and histogram displays. Frequency-domain displays include single-trace spectrums, multi-spectrum waterfalls, spectrograms, and rollograms. Rollograms can update at better than 800 spectrums per second. Time-domain displays include single trace, strip chart, and waterfall. Histograms, probability density function (PDF), and cumulative density functions (CDF) are standard. Other features include digital persistence, digital image enhancement filtering, and a variety of marker functions. Option AGG allows you to create your own markers and modify signal data before it is displayed, as well as modify the user interface.

Signal Capture Memory (Option ATR)

Save important wideband signals using the throughput-to-disk option (Option ATR) and as many as eight E1562 high-speed data disk modules. This capability allows you to save time data at 10 MSa/s (4 MHz bandwidth) to 64 GB of hard disk memory. That's 52 minutes of recording time.

System Advantages

The HP 3587S is a VXI system that acts like an instrument. Knob and button controls provide the look and feel of an instrument (a standard computer keyboard is also supplied). Software is loaded at the factory, so you can take the system out of the box, hook up a few cables, and start making measurements right away.

Specifications

Frequency

Range: DC to 8 MHz
Spans: 0.95 Hz to 8 MHz, octave steps
Resolution: 51 to 12,801 lines
Real-time Bandwidth: 1 MHz (801 lines, 0% overlap, spectrogram mode, rms averaging, 16-bit word width, 1024 x 768 pixel display)

Amplitude

Input Range: +30 dBm to –24 dBm
Accuracy: ± 0.03 dB, f < 100 kHz, 25° C, ± 1 V range, dc coupled alias filter on, digital filters off
Input Impedance: 50 Ω, > 40 dB return loss to 4 MHz
Harmonic Distortion: < –110 dBfs or –80 dBc, whichever is greater

Modes

Averaging Modes: Off, rms, peak, nth
Marker Modes: Single, relative (same trace, separate trace), marker to peak, marker to next peak, right/left, band power, noise power
Memory Modes: Save/recall, record/playback, signal capture
Triggering Modes: Free-run, level, magnitude, external
Printer Output: Print screen/print trace

For more information, visit our website (http://www.tmo.hp.com/tmo/datasheets/English/HP3587S.html).

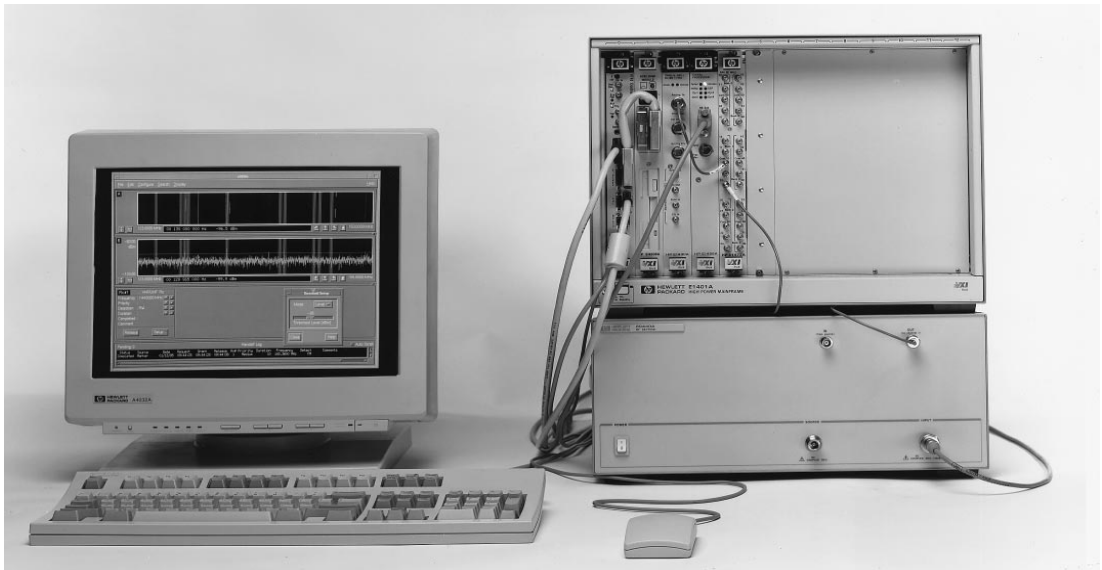
Key Literature

HP 3587S Signal Analysis System Brochure, p/n 5963-7089E
HP 3587S Technical Specifications, p/n 5963-6607E

Ordering Information

HP 3587S Real-Time Signal Analysis System
System may include: HP controller, monitor, disk drive, DAT tape, VXI chassis, DPS module, ADC module, HP-UX operating system, HP 35687B measurement/control software. For a complete configuration guide contact your local Hewlett-Packard sales office.
For a pre-bundled system, order 3587B.

- 1.7 GHz/sec scanning rate with 7.5 kHz resolution
- Manual and automatic signal isolation tools
- Automatic energy detection tools
- Hand-off receiver control
- LAN compatible



HP E3238S

HP E3238S Signals Development System

Catching intermittent or clandestine signals in dense signal environments is a challenging task. You'll be equipped to meet that challenge with the HP E3238S signals development system. It's a fast-scanning, high-selectivity receiver system with the manual and automatic tools you need to detect, classify, and collect signals of interest.

General and Directed Search (Option AS7)

The HP E3238S provides a choice of signal search modes. Choose general search to monitor a large segment of spectrum as part of an environmental scan. Choose advanced directed search (Option AS7) to scan up to 100 individual spectrum segments, skipping the parts of the spectrum that aren't critical to your mission. A full selection of resolution bandwidths and averaging types is available for both modes.

Manual Signal Isolation Tools

The mouse-controlled signal isolation tools in the HP E3238S work directly where your attention is focused, on the signal trace. Zoom in the display by dragging a box around the interesting signal with the mouse; assign a hand-off receiver to a signal by pointing at the signal with the mouse and dragging the signal to the hand-off receiver control box; read the frequency and power of a signal by pointing with the mouse and pressing the left mouse button to activate the marker.

Automatic Energy Detection Tools (Option AS8, AS9)

The HP E3238S takes automatic action based on criteria you define in advance. Choose from a selection of threshold types—flat, noise following (Option AS8), environmental (Option AS8), file (Option AS8)—to identify signal energy.

Automatically assign signals to hand-off receivers based on criteria such as frequency, bandwidth, amplitude, and signal duration. Automatically log signal parameters. Write your own signal identification algorithms and link them into the system via shared libraries (AS9).

Hand-Off Receiver Control

The HP E3238S can control any hand-off receiver with an RS-232, Ethernet, HP-IB, or VXI interface. Each receiver requires a software driver for interfacing to the HP E3238S.

LAN Control

You can operate the HP E3238S via Ethernet LAN, accessing all features, displays, and menus from any X-compatible server anywhere in your network.

System Advantages

The HP E3238S is a VXI system that comes from the factory configured and ready to run. All the software is loaded on the hard disk before the system is shipped so all you have to do to get started is take the system out of the box and hook up a few cables.

Specifications

Using the HP 89431A – 2 to 2650 MHz downconverter

Frequency
- **Range:** 2 to 2650 MHz
- **Spans:** 1 MHz to 2650 MHz, 1 Hz resolution
- **Resolution:** 7.3 Hz to 120 kHz, octave steps
- **Sweep Speed:** 1.7 GHz/s (using 7.5 kHz RBW)

Amplitude
- **Input Range:** –50 dBm to +25 dBm (5 dB steps)
- **Sensitivity:** –159 dBm/Hz (–50 dBm range)
- **Noise Figure:** 16 dB
- **Spur Free Dynamic Range:** 70 dB

For more information, visit our website (http://www.tmo.hp.com/tmo/datasheets/English/HPE3238S.html).

Key Literature

HP E3238S 2 to 2650 MHz Technical Specifications, p/n 5963-6609E
HP E3238S Scanning Signal Analysis System Brochure, p/n 5963-6610E

Ordering Information

HP E3238S Signals Development System
Includes: HP controller, monitor, disk drive, DAT tape, DSP module, ADC module, downconverter, RF MUX module, VXI chassis, HP-UX operating system, HP 35688B measurement/control software. For a complete configuration guide contact your local Hewlett-Packard sales office.
For a pre-bundled system, order E3238B.

VXI Tuner and Receiver

HP E6500A
HP E6501A

HP E6500A VXI Tuner
- 20 MHz to 1000 MHz tuning range (3000 MHz, optional)
- Excellent dynamic range (high TOI, low noise figure)
- Fully input-preselected
- Fast, synthesized tuning with 1 Hz resolution
- Software driver and register-based commands
- Compatible with HP E3238S signals development system

HP E6500A Tuner Configurations:
(left to right) HP E6500A with Option 003 (20 MHz to 3 GHz) in Option 006 six-slot mainframe; HP E6500A standard system consisting of two VXI modules (20 MHz to 1 GHz); HP E6500A Option 003 three-module set (20 MHz to 3 GHz); HP E6500A Option 003 in Option 013 thirteen slot mainframe. (Slot zero controller ordered separately in all systems.)

HP E6500A VXI Tuner

5

Description

The HP E6500A VXI tuner brings high dynamic range, preselection, fast tuning, and the flexibility of a modular architecture to signal monitoring applications in the VHF/UHF frequency ranges. The HP E6500A tuner provides frequency coverage from 20 MHz to 1000 MHz using two C-size VXI modules—the HP E6401A 20 MHz to 1000 MHz downconverter and the HP E6402A local oscillator (LO). For applications requiring frequency coverage beyond 1000 MHz, the HP E6500A Option 003 configuration adds the HP E6403A block downconverter VXI module to extend the frequency range to 3000 MHz.

Applications

The HP E6500A tuner downconverts VHF/UHF signals to an intermediate frequency (IF) of 21.4 MHz or to a baseband output of 2.5 MHz to 9.5 MHz using the HP E6500A Option 001. The high dynamic range and fast tuning make this VXI tuner an excellent front-end for numerous system applications. For example, the standard HP E6500A tuner is combined with the HP E6404A digital IF processor to form the HP E6501A VXI receiver (shown on this page). Another alternative is to use the HP E6500A Option 001 baseband configuration with the HP E1437A or E1430A digitizer in the HP E3238S signals development system.

Many applications such as direction finding (DF) require multichannel tuners, all sharing a common local oscillator (LO). Although the standard HP E6500A is a single channel tuner, HP custom-engineered system options are available to support multiple channels.

Specifications

Frequency Range: 20 MHz to 1000 MHz (3000 MHz with Option 003)
Tuning Resolution: 1 Hz
Noise Figure: 10 dB, typical (20 MHz to 1000 MHz);
14 dB, typical (1000 MHz to 3000 MHz)
Second Order Intermodulation (SOI): +40 dBm
Third Order Intermodulation (TOI): +15 dBm, typical (20 MHz spacing)
Image Rejection: 95 dB
IF Rejection: 90 dB
Phase Noise @ 20 kHz offset: –100 dBc/Hz, characteristic
Internally Generated Spurious: –100 dBm, equivalent input
LO Emissions: –110 dBm (1000 MHz); –100 dBm (3000 MHz)

Key Literature

HP E6500A Product Overview, p/n 5965-5769E
HP E6501A Product Overview, p/n 5966-0165E

HP E6501A VXI Receiver
- 20 MHz to 1000 MHz tuning range (3000 MHz, optional)
- Includes powerful Digital IF Processor VXI module
- Fast, > 2 GHz/sec signal search speed
- Multiple, simultaneous demodulation using digital drop receiver approach
- Software driver and PC-based virtual front panel demonstration software

HP E6501A Option 003 receiver (20 MHz to 3 GHz) in Option 006 six-slot mainframe. HP E6501A receiver consists of HP E6500A tuner and HP E6404A IF processor VXI module.

HP E6501A VXI Receiver

The HP E6501A VXI receiver combines the high dynamic range, fast tuning, fully preselected performance of the HP E6500A VXI tuner with the powerful digital processing capabilities of the HP E6404A digital IF processor VXI module. By providing high-value receiver subsystem hardware and accompanying software drivers, the HP E6501A enables systems integrators to more quickly and cost-effectively build signal monitoring systems that provide high-speed signal search, demodulation, and direction finding solutions for their customers.

Receiver Applications

Signal monitoring applications require receivers with fast search speed and flexible demodulation capability to detect challenging signals-of-interest. The HP E6501A is a single channel receiver configuration offering excellent RF performance, fast tuning, and DSP-based demodulation. With a software driver that supports a fast step-and-FFT approach for searches, the wide 8 MHz digital snapshot bandwidth provides search speeds faster than 2 GHz/sec with narrow channel bandwidths. Unlike traditional analog receivers which can only demodulate one signal at a time, the HP E6501A includes an optional digital drop receiver (DDR) capability which provides simultaneous demodulation of up to ten signals within an 8 MHz spectral capture range. This benefits the systems integrator by minimizing the system costs and reducing the number of VXI slots required.

Additional receiver configurations are available for applications requiring multiple channels. The HP E6502A dual receiver provides independent search and demodulation since it uses two separate tuners. It can also be configured for multiple channel demodulation requiring a capture range of at least 16 MHz. The HP E6503A dual receiver uses a single shared LO for coherent downconversion and digital I/Q outputs required in direction finding applications. Contact your HP sales representative for custom-engineered solutions supporting more than two channels.

Powerful DSP Capabilities

The HP E6501A VXI receiver includes powerful DSP capabilities to process today's challenging signals. Features and benefits include:
- DSP-based AM, FM, PM, SSB, CW demodulation
- Built-in optional digital drop receivers (DDRs) for simultaneous demodulation of multiple signals within 8 MHz capture bandwidth
- Digital IF filters from 100 Hz to 470 kHz with 1.5:1 shape factors
- Digital I and Q outputs available for post-processing

Ordering Information

HP E6500A VXI Tuner
Opt 001 Baseband Output
Opt 003 Increases Frequency Range to 3 GHz
Opt 006 Add HP E1421B six-slot VXI Mainframe
Opt 013 Add HP E1401B thirteen-slot VXI Mainframe
HP E6501A VXI Receiver
Opt 003 Increases Frequency Range to 3 GHz
HP E6502A Dual Channel Receiver (independent LOs)
HP E6503A Dual Channel Receiver (shared LO)

- 50 kHz to 26.5 GHz with expand carrier frequencies to 110 GHz
- Quick and easy integration into your ATE system
- Ability to test a wide range of devices
- Measure AM noise directly

HP E5503A

HP E5503B

HP E5500 Series Phase Noise Measurement Solutions

The new HP E5500 A-series phase noise measurement solutions have been designed to minimize production ATE test times for one-port VCOs, DROs, crystal oscillators, and synthesizers and to maximize the capability for R&D benchtop applications. In addition, with a standard offset range capability from 0.1 Hz to 100 MHz, the HP E5500 B-series provides the capability, flexibility, and versatility to meet changing and demanding needs placed upon the R&D engineer. By building upon 30 years of Hewlett-Packard low phase noise, RF design and measurement experience, the HP E5500 series solutions continue to provide excellent measurement integrity, repeatability, and accuracy.

The E5500 phase noise measurement solutions use the power of a flexible software program to automate phase noise carrier measurements. The E5500 A-series solutions include the HP 70420A phase noise test set, which contains phase detectors and phase-lock loop circuitry, a high speed VXI digitizer with mainframe and high speed VXI-to-PC interface for base-band signal analysis, selected low-noise frequency downconverters, and measurement software. When combined with a PC running WIN NT 4.0, this series provides fast phase noise measurements of carrier frequencies from 50 kHz to 1.6 GHz, 6.0 GHz, 18 GHz, or 26.5 GHz over offset-from-carrier frequencies of .01 Hz to 4 MHz. The E5500 B-series includes the HP 70420A phase noise test set, a Pentium PC running WIN NT 4.0, a PC digitizer, and an RF spectrum analyzer, selected low-noise frequency downconverters, and measurement software. This series of solutions provides phase noise measurements of carrier frequencies from 50 kHz to 1.6 GHz, 6.0 GHz, 18 GHz, or 26.5 GHz over offset-from-carrier frequencies from 0.1 Hz to 100 MHz. A variety of signal generators—such as the HP 8662A, 8663A, 8643A, 8644B, 8664A/B, 8665A—can also be added to provide a low-noise reference signal.

Phase Noise Measurement Software

A graphical user interface provides measurement menus allowing the operator to specify the measurement process, including the calibration of the system. Several output formats are available to the user, including plots of the single-sideband phase noise power of the signal, integrated noise power, or the calculated Allen variance. A real-time measurement mode is available to monitor the level of phase noise and discrete spurs as changes are made to the device-under-test. The HP E5500 series phase noise measurement software requires a Pentium PC with 32 MBytes of RAM, a 1 GByte hard drive, and WIN NT 4.0.

Windows NT 4.0 is a registered trademark of Microsoft Corp.
Pentium is a registered trademark of Intel Corp.

Specifications

HP E5500 A-Series
- **HP E5501A:** 50 kHz to 1.6 GHz
- **HP E5502A:** 50 kHz to 6.0 GHz
- **HP E5503A:** 50 kHz to 18.0 GHz
- **HP E5504A:** 50 kHz to 26.5 GHz

HP E5500 B-Series
- **HP E5501B:** 50 kHz to 1.6 GHz
- **HP E5502B:** 50 kHz to 6.0 GHz
- **HP E5503B:** 50 kHz to 18.0 GHz
- **HP E5504B:** 50 kHz to 26.5 GHz

Operating Characteristics

Offset Frequency Range
A Models: 0.01 Hz to 4 MHz
B Models: 0.1 Hz to 100 MHz
System Noise Response[1]**:** –180 dBc/Hz typically (>10 kHz offsets)
System Spurious Response[1]**:** –120 dBc typically
Phase Detector Input Power: (<1.6 GHz carrier frequency)
R input = 0 to +23 dBm
L input = +15 to +23 dBm
Downconverter Input Range: 1 GHz to 6 GHz;
1 GHz to 18 GHz; 1.5 GHz to 26.5 GHz
External Noise Input Port: 0.1 Hz to 100 MHz
Measurement Accuracy: ±2 dB (<1.0 MHz offsets);
±4 dB (<100 MHz offsets)

HP E5500 A-Series Optional Capabilities
Extend offset range to 8, 10, and 100 MHz
Add RF reference source
Add high power input capability (includes μW phase and AM detectors)
Add specific ATE computer
Extend carrier frequency to 110 GHz

HP E5500 B-Series Optional Capabilities
Add RF reference source
Add high power input capability (includes μW phase and AM detectors)
Delete PC
Add remote SCPI programming client
Extend carrier frequency to 110 GHz

Key Literature

HP E5500 Series Phase Noise Measurement Solutions,
Product Overview, p/n 5965-7590E

[1]Without reference sources or downconverters

Ordering Information

HP E5501A: Phase Noise Measurement Solution, 50 kHz to 1.6 GHz
HP E5502A: Phase Noise Measurement Solution, 50 kHz to 6.0 GHz
HP E5503A: Phase Noise Measurement Solution, 50 kHz to 18.0 GHz
HP E5504A: Phase Noise Measurement Solution, 50 kHz to 26.5 GHz

HP E5500 A-Series Solution Hardware Includes:
0.01 Hz to 4 MHz VXI digitizer
VXI to PC high speed interface
6-slot, high power VXI mainframe
MMS baseband test set andframe
HP E5502/03/04A solutions add an MMS low noise downconverter.

HP E5501B: Phase Noise Measurement Solution, 50 kHz to 1.6 GHz
HP E5502B: Phase Noise Measurement Solution, 50 kHz to 6.0 GHz
HP E5503B: Phase Noise Measurement Solution, 50 kHz to 18.0 GHz
HP E5504B: Phase Noise Measurement Solution, 50 kHz to 26.5 GHz

HP E5500 B-Series Solution Hardware Includes:
1.5 GHz swept RFSA
MMS baseband test set and frame
Pentium® PC with WindowsNT 4.0 and digitizer
HP E5502/03/04B solutions add an MMS low noise downconverter.

Warranty Options

Opt W20 2 Year Customer Return Repair Coverage
Opt W21 2 Year On-Site Repair Coverage
Opt W22 2 Year Customer Return Calibration Coverage
Opt W30 3 Year Customer Return Repair Coverage
Opt W31 3 Year On-Site Repair Coverage
Opt W32 3 Year Customer Return Calibration Coverage
Opt W50 5 Year Customer Return Repair Coverage
Opt W51 5 Year On-Site Repair Coverage
Opt W52 5 Year Customer Return Calibration Coverage

- Downconverts 1.5 to 26.5 GHz signals
- State-of-the-art phase noise performance
- AM noise detection standard
- Coverage to 110 GHz using external mixers
- Specified spurious performance

HP 71707A

HP 71707A Microwave Downconverter

The HP 71707A microwave downconverter translates microwave signals to low-RF frequencies with minimum added phase and amplitude modulated noise. The HP 71707A can be controlled automatically by the HP E5500 series or HP 3048AR phase noise measurement system and consists of a 4-slot (MMS) HP 70427A microwave downconverter module and an HP 70004A color display/mainframe.

Specifications Summary

Downconverter
Frequency Range: 1.5 to 26.5 GHz
Input Power: –30 dBm min., +30 dBm max.
IF Output
Frequency Range: 5 MHz to 1500 MHz
Level: 0 to +5 dBm

General

Operating Temperature Range: 0° to +55° C
Power: 260 W maximum (provided by the HP 70004A)
Weight: Net, 28.75 kg (63.3 lb)
Size: 425.4 mm W x 222 mm H x 526 mm D (8.74 in x 16.75 in x 20.7 in)

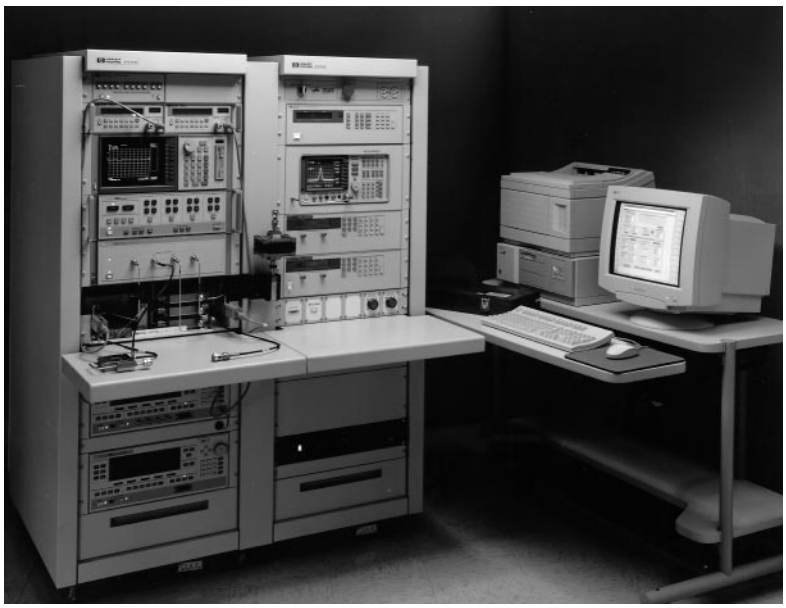
Key Literature

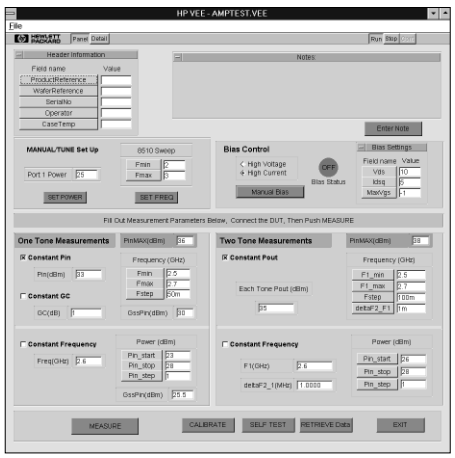
HP 71707A Microwave Downconverter Technical Data, p/n 5091-4435E

Ordering Information

HP 71707A Microwave Downconverter
(1.5 GHz to 26.5 GHz)
Opt 910 Provides a Total of Two Sets of User Guides (p/n 70427-90002) and Component Level Information Packets (p/n 70427-90004)
Opt W30 Extended Repair Service (see page 584)

- High-speed test systems for manufacturing environments
- Error-corrected S-parameter, power and distortion measurements
- Pulsed-RF and pulsed-bias capabilities to 20 V at 10 amps
- High RF power handling capability





HP 85118A

High-Throughput Test for the Manufacturing Floor

In a manufacturing environment, high-test throughput is a key to efficient production. Traditional "rack and stack" test systems, which are adequate for R&D characterization, often fall short on the production floor where a large volume and/or mix of devices need to be tested quickly. To address this need, HP has developed high-speed test systems aimed at specific device manufacturing requirements.

HP 85118A High-Power Amplifier Test System

The HP 85118A test system is specifically designed to perform high-speed characterization of high-frequency, high-power amplifiers, such as those used in many wireless communication systems. The flexible architecture incorporates a single-connection, multiple-measurement (SCMM) design combined with high-RF power handling to optimize the system for high-mix, medium-volume testing of power amplifiers. Versions are available for on-wafer, packaged device, or subassembly testing.

Full Measurement Capability

The HP 85118A offers the following features to increase your test throughput:

- Broad frequency coverage from 45 MHz to 20 GHz, extendable to 50 GHz
- High-speed S-parameter, power-level, distortion, and spur-search measurements
- Fully error-corrected measurements under CW or pulsed measurement conditions
- High RF-power handling up to 400 watts (+ 56 dBm) average
- Measurement of small- and large-signal gain, gain-slope, and gain-compression
- Optional pulsed-bias capabilities to 20 V at 10 amps

A Single Connection, Multiple Measurement Architecture

Traditional test methods require the use of multiple test stations to characterize a power amplifier, often leading to long test times and poorly correlated data. The HP 85118A is designed to perform multiple measurements on a device with a single connection. With this architecture, set-up time is minimized, dramatically reducing total test time. A single connection to the device also means the test environment remains the same for all measurements, improving data correlation. Only HP's high speed test systems offer this kind of innovative performance for your production test requirements.

Software for Automated Testing

A key part of any high-speed test system is the software. The HP 85118A system has amplifier test software available to automate the measurements. HP's full complement of software typically incorporates software written around the HP VEE graphical-user interface or Microsoft® Visual Basic. The software runs on a powerful HP 9000 Series 700 workstation under the HP-UX operating system, or on a PC with MS-Windows®.

Engineering Services

The HP 85118A series test systems offer flexibility in their hardware, software, and overall system configuration. HP systems engineers will work with you to tailor a standard system to meet your specific requirements.

Key Literature

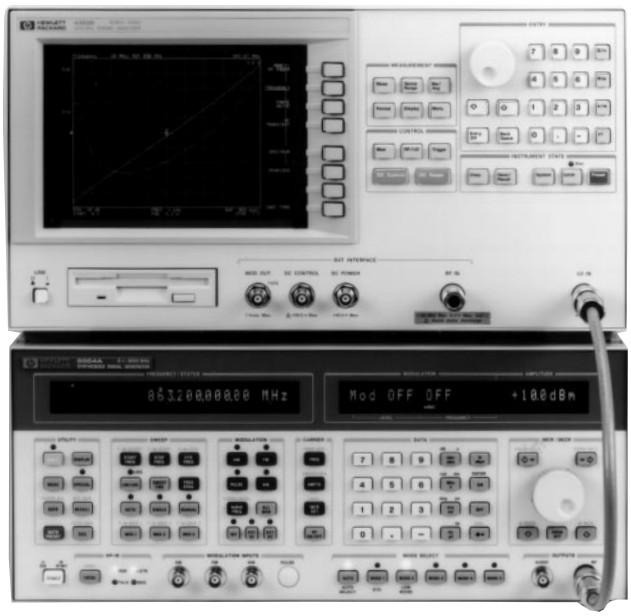
HP 85118A Series High-Power Amplifier Test Systems Product Overview, p/n 5963-9930E

Ordering Information

Prices vary. For more information, please contact your HP sales representative (listed on page 591).

HP 4352S

- Dedicated VCO and PLL parameters test system
- Excellent solution for LAB and production line
- Simple configuration and multifunctional system
- VCO tuning characteristics evaluation
- Outstanding phase noise measurement capability
- High resolution frequency transient measurement
- Automatic measurement capability and powerful analysis functions

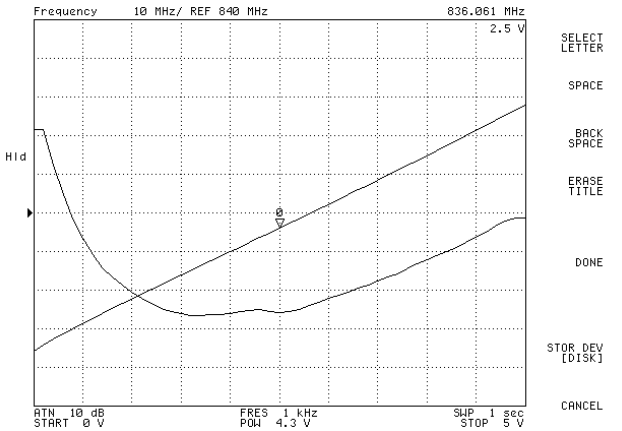


HP 4352S VCO/PLL Signal Test System

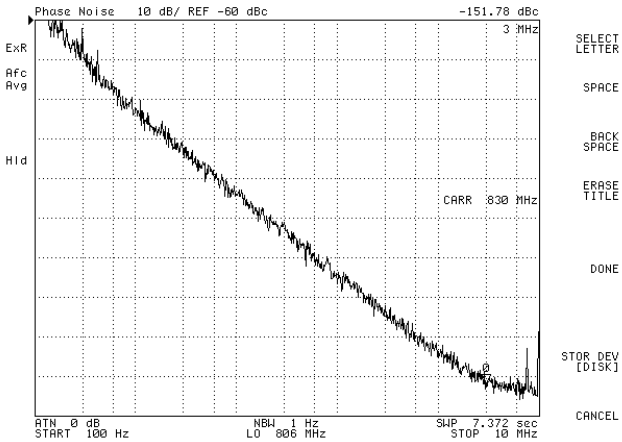
The HP 4352S test system can evaluate the characteristics of VCOs and PLLs that are essential to designing local oscillators used in RF wireless communication equipment. This system can provide both powerful analyzing capability for design evaluation in LAB and high speed measurement capability for production line test with 2 operating modes, "Signal Analyzer" and "VCO Tester" mode. The HP 4352S, which consists of the HP 4352B VCO/PLL Signal Analyzer and Hewlett-Packard low-noise signal generator controlled by the HP 4352B, covers up to 3 GHz and can measure the main VCO/PLL evaluation parameters, RF power, frequency, phase noise, spectrum, frequency transient, DC consumption current and FM deviation. In addition, the HP 4352B provides and controls the DC power supply, the low-noise DC control voltage source and the 1 kHz signal source necessary for VCO tuning characterizing.

This system can make high-speed measurements thanks to the dedicated firmware and "carrier lock multi-mode PLL" technology for phase noise measurement that enables the system lock unto the carrier of the measured signal automatically. In addition, the HP 4352B has excellent phase noise performance such as –157 dBc/Hz at 1 MHz offset typically, so that this test system can make reliable and repeatable phase noise measurement with up to 10 times reduction in measurement time. Actually it can measure 801 measurement points from 100 Hz to 10 MHz offset in 7.4 seconds/sweep. And adding the HP 71707A Microwave Downconverter expands its frequency range up to 26 GHz. Besides the powerful phase noise measurement capability, the HP 4352S can measure frequency transient with 50 Hz frequency resolution and 12.5 micro seconds time resolution. The HP 4352S improves your VCO and PLL evaluation efficiency and testing productivity dramatically.

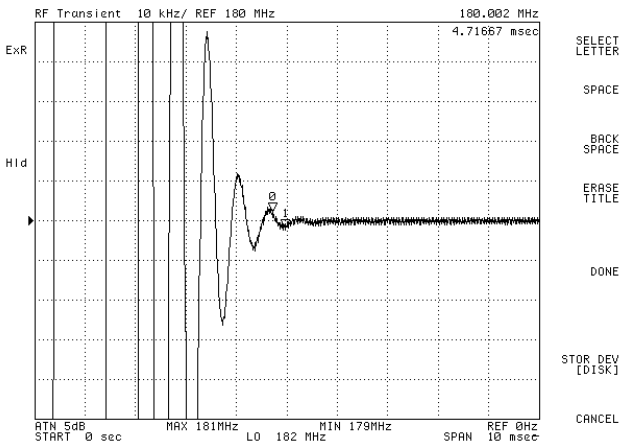
Measurement Display Examples



VCO tuning characteristics (frequency/tuning sensitivity)



VCO phase noise measurement



PLL frequency lock time measurement

Efficient Evaluation in Oscillator Circuit Design

The HP 4352S can measure the following characteristics:

For VCO evaluation

- RF power vs. tuning voltage
- Frequency vs. tuning voltage
- Tuning sensitivity
- Phase noise (Carrier-to-Noise)
- Harmonics
- FM deviation
- DC power consumption current

For PLL evaluation

- RF power
- Phase noise (Carrier-to-Noise)
- Frequency and Frequency transient
- Spurious
- Harmonics

Each parameter can be measured without changing any cable connections. So, you can easily evaluate a VCO/PLL with powerful analysis functions such as marker or limit line.

High Throughput and Easy Test Automation

Thanks to the high-speed phase noise measurement capability, it only takes about 2.5 seconds to measure five VCO parameters (RF power, frequency, phase noise, DC power consumption current and FM deviation) by using "VCO Tester" mode. The HP 4352S has the HP Instrument BASIC programming functions, built-in 3.5 inch disk drive (LIF/DOS format) and a 24-bit I/O. These capabilities allow you to interface to an automatic handler so that you can achieve automatic production-line testing without an external computer.

Specifications Summary

Source Characteristics
DC Power Voltage: 0 to +15.5 V with 1 mV step, 50 mA max.
DC Control Voltage: 0 to +20 V with 100 μV step, 20 mA max.
Option 001: –15 to +35 V
Accuracy: ± (0.1% + 2 mV)
Settling Time: < 20 ms @ 0.1% error (typical)
Noise Density: <1 nV√Hz @ 10 kHz offset
FM Signal: 1 kHz, 0 to 1 Vrms with 1 mV step @ open
Receiver Characteristics
Measurement Frequency Range: 10 MHz to 3 GHz/26 GHz
Input Power Level: –10 to +20 dBm
Input Impedance: 50 ohm
SWR: <1.2 (@ < 2 GHz); <1.3
RF Power Measurement
Accuracy @ Peak Voltage Responding
±0.2 dB (@ 1 GHz, –5 dBm, typical); ±1 dB
Resolution: 0.01 dB
Frequency Measurement
Frequency Resolution: 1 kHz
Frequency Transient Measurement
Highest Accuracy: ± 2 kHz
Highest Measurement Resolution: 50 Hz
Maximum Sweep Time: 10 sec.
Minimum Time Resolution: 12.5 usec.
Phase Noise (Carrier-to-Noise Ratio) Measurement
Offset Frequency Range: 100 Hz to 10 MHz

System Noise Level

Offset	Specification (dBc/Hz)	Typical (dBc/Hz)
100 Hz	–85	–90
1 kHz	–110	–117
10 kHz	–130	–137
100 kHz	–140	–147
1 MHz	–150	–157

Spectrum Measurement
Absolute Level Accuracy: 2 dB (–5 dBm input, @ ATT=0 dB, typical)
Relative Level Accuracy: 0.5 dB (typical)
FM Deviation Measurement
Measurement Range: 0 to 200 kHz (peak)
Accuracy: ±(2% + 0.1% of measurement range) @1 kHz FM rate; ±0.8% (typical)
Residual FM: < 3 Hzrms (@ 300 Hz – 3 kHz BW)
DC Consumption Current Measurement
Measurement Range: 0 to 50 mA
Accuracy: ±(0.2% ± 100 μA)
Storage
3.5-inch FDD: LIF/DOS format, 2DD/2HD
Internal RAM Disk: LIF/DOS format, 512 kB max.
Interfaces
HP-IB I/F, 24-bit parallel I/O I/F (HP 87510A 24-bit I/O compatible)

General Characteristics

Display: 9-inch color LCD
Operating Temperature: 0 to +40° C
Operating Humidity: 15 to 95% RH
Storage Temperature/Humidity: 0 to +40° C/15 to 95% RH
Power Requirements: 90 to 132 V or 198 to 264 V, 47 to 66 Hz, 300 VA max.
Size: 235 mm H x 425 mm W x 553 mm D
Weight (typical): 21.5 kg

Key Literature

HP 4352S VCO/PLL Signal Test System Product Overview, p/n 5965-5420E
Signal Generator Selection Guide, p/n 5091E-7274E
HP 71707A Microwave Downconverter Technical Data, p/n 5091-4435E

Ordering Information

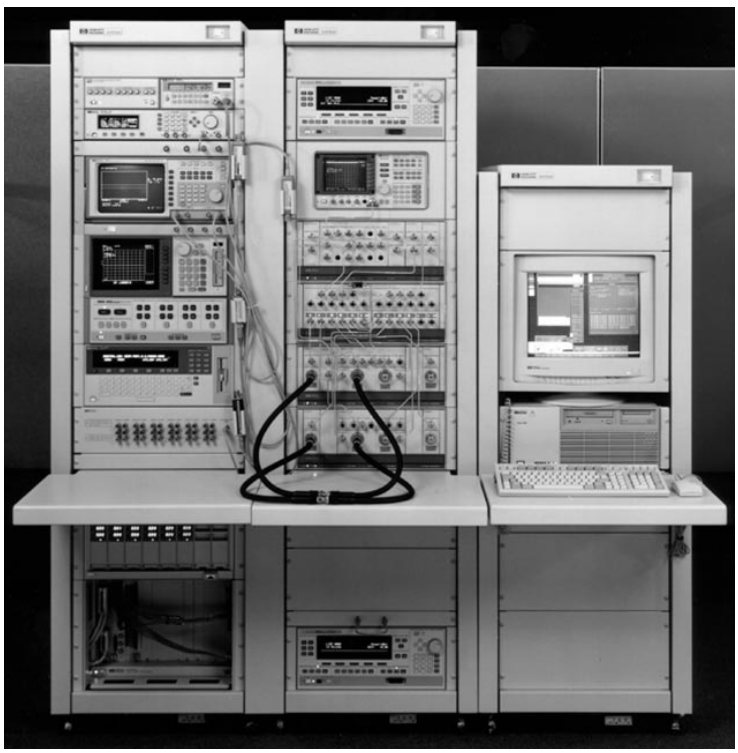
HP 4352S VCO/PLL Signal Test System
HP 4352B VCO/PLL Signal Analyzer
Opt 001 Expand DC Control Voltage
Opt 1A2 Delete Keyboard
Recommended Signal Generators
HP 8664A Synthesized Signal Generator with Option 004
HP 8644B Synthesized Signal Generator with Option 002
HP 8657B Synthesized Signal Generator
HP 71707A 26 GHz Microwave Downconverter
HP 70422A 18 GHz Downconverter Module

See Signal Sources section for more details.
When using the other signal generators, please contact Hewlett-Packard's sales office for details.

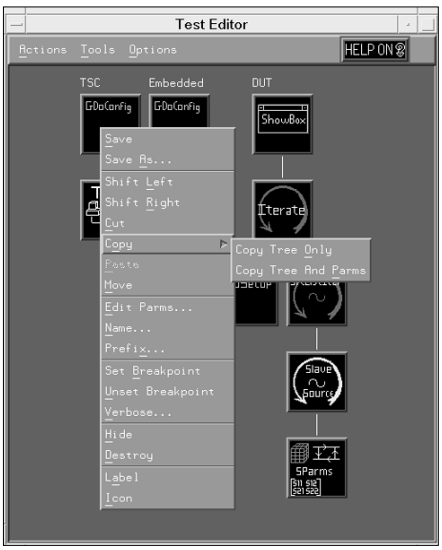
T/R Module Test System

HP 85120A Series System

- High-speed test systems for manufacturing environments
- Error-corrected S-parameter, noise figure, and power measurements
- Independent DC, RF, bias, and device-state control
- Modular and reconfigurable architecture



HP 85120A



High-Throughput Test for the Manufacturing Floor

In a manufacturing environment, high-test throughput is a key to efficient production. Traditional "rack and stack" test systems, which are adequate for R&D characterization, often fall short on the production floor where a large volume and/or mix of devices need to be tested quickly. To address this need, HP has developed high-speed test systems aimed at specific device manufacturing requirements.

HP 85120A T/R Module Test System

The HP 85120A series T/R module test systems are designed for complete RF characterization of transmit/receive modules and related MMIC devices. The flexible architecture incorporates a single-connection, multiple-measurement (SCMM) design combined with multistate device control and high-speed measurement capability to optimize the entire system for maximum measurement throughput. Versions are available for on-wafer, packaged device, or subassembly testing. Various levels of automation are available to address your specific test needs.

Full Measurement Capability

The HP 85120A offers the following features to increase your test throughput:

- Broad frequency coverage from 500 MHz to 20 GHz, extendible to 50 GHz
- High data-acquisition rates of up to 5000 points per second
- Synchronized module or device-state control during data acquisition
- High-speed S-parameter, noise figure, and power level measurements
- Fully error-corrected measurements under CW or pulsed-RF measurement conditions
- Optional pulsed bias capability
- Independent DC, RF, bias, and device-state control
- Modular and reconfigurable architecture

A Modular, Reconfigurable Architecture

The 85120A uses industry-standard instrument and computer platforms to protect your investment. Systems include both VXI and MMS mainframes and modular power supplies to quickly and easily reconfigure the resources to test different devices. You can reconfigure the system to add test ports, provide a different bias voltage, change the switched signal path configuration, provide high power to a specific port, or add additional instrumentation to test another DUT. Only HP's high-speed test systems can deliver this kind of flexibility for both your present and future production test requirements.

Software for Automated Testing

A key part of any high-speed test system is the software. The HP 85120A system has T/R module measurement software available to automate the measurements. With HP's extensive experience in T/R module testing, this software has been refined and enhanced over time, and provides a full turnkey solution for this application. The software runs on a powerful HP 9000 Series 700 workstation under the HP-UX operating system.

Engineering Services

The 85120A series test systems offer flexibility in their hardware, software, and overall system configuration. HP systems engineers work with you to tailor a standard system to meet your specific requirements. In addition, HP will develop, procure, and integrate specialized test fixtures, parts handlers, and other customized equipment to optimize the system for your needs.

Key Literature

HP 85120A Series T/R Module Automated Test Systems Product Overview, p/n 5965-2974E

Ordering Information

Prices vary. For more information, please contact your HP sales representative (listed on page 591).

Communications Design Solutions

Communications Design Suite Brochure
5964-3850E
High-Frequency Structure Simulator Rel 4.0 Technical Data Sheet
5963-9794E
HP 85146A HP Momentum Visualization Technical Data Sheet
5962-6134E
HP 85148A Circuit Envelope Simulator Technical Data Sheet
5964-3599E
HP 85150B Overview of the RF and Microwave Design System (MDS) Technical Data Sheet
5962-0206E
HP 85154A Impulse Transient Simulator Brochure
5091-4268E
HP 85180A High-Frequency Structure Simulator Rel 2.0 Brochure
5091-2459E
HP 85200A Microwave Design System Suite Brochure
5964-2309E
HP 85201A RF Design System Suite Brochure
5964-2308E
HP E4600 Series IV 6.0 Data Sheet
5962-6277E
HP E4665A HP Momentum Planar Electromagnetic Simulator Technical Data Sheet
5963-7129E
HP E4746A Touchtone and Libra for Windows Data Sheet 2.0
5965-8240E
HP E4605A OmniSys Brochure
5964-3884E
Overview (HF Design Solutions from HP EEsof) Brochure
5963-5007E
Picosecond Interconnect Modeling Suite Technical Data Sheet
5964-2310E
Series IV/PC Brochure
5964-4392E
Software Support from HP EEsof Technical Data Sheet
5965-7306E

(PN 85150-1) Using High-Frequency Instruments with MDS
5091-1702E
(PN 85150-2) Simulating Highly Nonlinear Circuits
5091-8568E
(PN 85150-3) Using HP MDS in MMIC Applications
5091-9703E
(PN 85150-4) Simulating Noise in Nonlinear Circuits
5091-9582E
(PN 85150-5) Using the High-Yield Software Package to Create Robust Designs
5962-9271E
(PN 85150-6) Sharing Data Between the Microwave Design System and OmniSys/CDS
5965-1211E
(PN E4600) Creating Measurement-Based RFIC Models
5965-7010E
(PN E4600-9) A Flexible Waveform Generator Using OmniSys and Instrumentation
5965-8120E

EMI/EMC Test Systems

Electromagnetic Compatibility 8590EM-1
5964-2151E

(PN 8566/B) Third Order Intermodulation Distortion Measurements
5954-2701

Signals Development & Intercept Solutions

HP 3587S Signal Analysis, Opt ATR, Product Overview
5964-3631E
HP 3587S See More of What's Out There, Video
5964-9460E
HP E3238S Scanning Signal Analysis System, Opt AS8, Product Overview
5964-3632E
HP E3238S They're Running Out of Places to Hide, Video
5964-0400E/PAL
WJ9119 VXI HF Tuner, Technical Specifications
5965-5021E

This page has been
intentionally left blank

Impedance Measuring Instruments

Impedance measuring instruments can be divided into two general categories: LCR meters and impedance analyzers. LCR meters primarily measure inductance, capacitance, and resistance of the test device at spot frequencies usually below 30 MHz. Impedance analyzers, in addition to all the functions of the LCR meter, measure impedance, phase, and sometimes transmission parameters. These analyzers have extended frequency range, a synthesized source, swept frequency capability, and excellent frequency resolution. Combination network/spectrum/impedance analyzers offer the benefits of impedance analysis as well as vector-network and spectrum analysis. See the Selection Guides that follow for general instrument capabilities. For higher frequencies (above 1.8 GHz) in a 50 ohm environment, a dedicated vector-network analyzer is the best solution for impedance measurements. See Network Analyzers.

Selecting a test fixture is as important as selecting the right instrument. HP offers a wide range of accessories for axial, radial, and SMD chip devices. See the HP LCR Meter and Impedance Analyzer Fixture Compatibility Guide on page 342 for more information.

Component Measurement

Today's electronic components are designed for higher performance, while being reduced in size, power consumption, and cost. Efficient and accurate component characterization, design evaluation, and manufacturing test are critical to the success of component users and suppliers. HP offers the industry's broadest line of component test instruments for passive as well as active components. The products in this section are designed to measure fundamental impedance-related parameters of electronic components and materials. For S-parameter analysis, see Network Analyzers.

Impedance Analyzer Selection Guide

Model	Frequency Range	Impedance Range/Other	Additional Information	Page
HP 4192A	5 Hz to 13 MHz	1 Ω to 1 MΩ gain-phase	Floating or grounded devices	348
HP 4194A	100 Hz to 40 MHz 10 kHz to 100 MHz 10 Hz to 100 MHz	10 mΩ to 100 MΩ 0.1 Ω to 1 MΩ gain-phase	Color display, equivalent circuit analysis, auto sequence program	346-347
HP E4915A	1 MHz to 180 MHz	Crystal Impedance Automatic resonance search	9 crystal parameters selectable 125 ms/DUT (Fr, CI measurement) PI-Network fixtures available	343
HP 4395A with Option 010 and HP 43961A	100 kHz to 500 MHz	2 Ω to 5 kΩ* S-parameters, gain-phase	Color display, vector-network and spectrum analysis , IBASIC	254-255
HP 4396B with Option 010 and HP 43961A	100 kHz to 1.8 GHz	2 Ω to 5 kΩ* S-parameters, gain-phase	Color display, vector-network and spectrum analysis, IBASIC	256-257
HP 4291A	1 MHz to 1.8 GHz	0.1 Ω to 50 kΩ*	Color display, IBASIC, SMT fixtures, equivalent circuit analysis	344-355

* 10% accuracy range

LCR and Resistance Meter Selection Guide

Model	Frequency Range	Impedance Range/ Other	Additional Information	Page
HP 4263B	100 Hz to 100 kHz (5 test frequencies)	1 mΩ to 100 MΩ	Optional transformer test	352
HP 4284A	20 Hz to 1 MHz (8610 freq. points)	0.01 mΩ to 100 MΩ	HP 42841A for high-current dc bias	353-354
HP 4285A	75 kHz to 30 MHz (100 Hz steps)	0.01 mΩ to 100 MΩ	HP 42851A Q adapter for high Q measurement	353-354
HP 4286A	1 MHz to 1 GHz (10 kHz steps)	200 MΩ to 3 kΩ	High-accuracy, high-speed RF LCR Meter	356
HP 4278A	1 kHz/1 MHz	0.00001 pF to 200 μF	High-speed capacitor test	357
HP 4279A	1 MHz	0.00001 pF to 1280 pF	C-V meter, 0 to ± 38 V	
HP 4339B	dc	1 kΩ to 1.6 x 10^{16} Ω	High-resistance meter, volume and surface resistivity, current	358
HP 4338B	1 kHz test signal	10 μΩ to 100 kΩ	Milliohmmeter	359

Materials Measurements

Materials have two properties that determine how they interact with electromagnetic fields:

- Permittivity (ε) or dielectric constant for electric fields
- Permeability (μ) for magnetic fields

Permittivity ($\varepsilon^* = \varepsilon' - j\,\varepsilon''$) and permeability ($\mu^* = \mu' - j\,\mu''$) are complex values. The real part (ε' or μ') is a measure of how much energy is stored in a material. The imaginary part (ε'' or μ'') is a measure of how much energy is lost in a material. These properties are not constant and may change with frequency or temperature, for example. Accurate measurements of these material properties during characterization or inspection help to achieve the best performance for a given application while shortening design cycles and minimizing scrap.

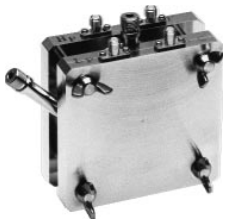
A materials measurement system consists of an instrument, a fixture to hold the material, and software or firmware to calculate complex permittivity or permeability values and display the results. For material testing applications, HP currently offers three types of solutions: LCR meter-based, impedance analyzer-based, and network analyzer-based systems. LCR meters cover up to 1 GHz with discrete test frequencies. Impedance analyzers cover from 20 Hz to 1.8 GHz. Network analyzers cover the frequency range from 300 kHz to 110 GHz.

HP offers fixture accessories based on the open-ended coaxial probe, the transmission line measurement, the parallel plate capacitance, and the inductor impedance technique. These choices allow you to best match the fixture, frequency range, and measurement technique with your material's physical and electrical test requirements. Material test applications and solutions are shown in the chart below. See pages 350 to 351 for dielectric and magnetic material test solutions.

Material Test Applications and Solutions

	DC resistivity cell (HP 16008B) Page 358	Dielectric test fixture (HP 16451B) Page 351	Liquid dielectric test fixture (HP 16542A) Page 351	Dielectric and magnetic test fixtures (HP 16453A) (HP 16454A) Page 350	Dielectric probe system (HP 85070M) Page 349	HP material measurement software (HP 85071B) Page 349
Absorber					•	•
Ceramic	•	•		•	•	
Fermentation			•		•	
Film (thin)		•		•		
Food			•		•	
Gel, semi-solid					•	
Liquid			•		•	
Loss		•	•	•	•	
Permeability				•		•
Permitivity (dielectrics)		•	•	•	•	•
Plastic	•	•	•	•	•	
Powder					•	
Printed circuit board		•		•		
Resistivity	•					
Rubber	•	•		•	•	
Solid	•	•		•	•	
Substrate	•	•		•	•	

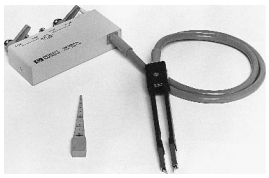
HP 16093A with HP 16099A
Note: Refer to the sections of the HP 41941A/B and 41951A for more information.



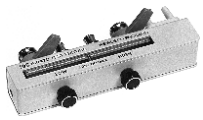
HP 16452A

HP 16314A

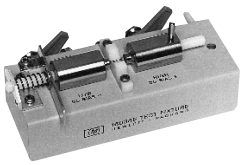
HP 16451B



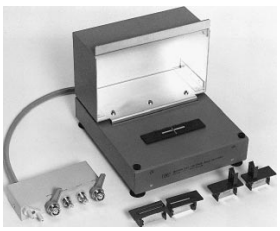
HP 16334A



HP 16047C



HP 16034E



HP 16065A

HP 16089B

LCR Meter and Impedance Analyzer Fixture Compatibility Guide

	HP 16034E SMD/Chip	HP 16047A Axial and Radial, f < 13 MHz	HP 16047C HF Axial and Radial, f < 40 MHz	HP 16047D Axial and Radial, f < 40 MHz	HP 16048A One-Meter Test Leads, BNC	HP 16048B One-Meter Test Leads, SMC	HP 16048D Two-Meter Test Leads, BNC	HP 16048E Four-Meter Test Leads, BNC	HP 16060A Transformer Test Fixture	HP 16065A Ext. Voltage Bias w/ Safety Cover, < 200 V	HP 16065C Ext. Voltage Bias Adapter, < 40 V	HP 16085B Four-Terminal Pair to APC-7 Adapter	HP 16089A/B/C/D/E Clip Leads	HP 16092A RF Spring Clip: Axial, Radial and SMD	HP 16093A RF Two-Terminal Binding Post	HP 16093B RF Three-Terminal Binding Post	HP 16094A w/8120-4779 RF Probe Tip/Adapter	HP 16095A LF Probe Adapter	HP 16099A RF Probe to APC-7 Adapter	HP 16191A Side Electrode SMD Test Fixture	HP 16192A Parallel Electrode SMD Test Fixture	HP 16193A Small Side Electrode SMD Test Fixture	HP 16194A Wide Temperature SMD Test Fixture	HP 16314A 50 Ω/4-Term Converter 100 Hz–10 MHz	HP 16334A SMD/Chip Tweezer, < 30 MHz	HP 16451B Dielectric Test Fixture < 30 MHz	HP 16452A w/HP 16048A Liquid Test Fixture	HP 16453A RF Dielectric Test Fixture	HP 16454A RF Magnetic Test Fixture	HP 42842A/B High Bias Current 20A/40A	HP 42842C High Bias Current 10A
HP 4192A	•	•	•	•	•	•				•	•	•	•	1	1	1	1	•		1	1	1	1		•	•	•				
HP 4194A	•	•	•	•	•	•				•	•	•	•	1	1	1	1	•		1	1	1	1	•	•	•	•				
HP 4194A w/HP 41941A/B														2	2	2	2		•	2	2	2	2								
HP E4916A w/Option 001, 010														2	2	2	2		•	2	2	2	2								
HP 4395A w/HP 43961A														•	•	•	•			•	•	•	•								
HP 4263B	•	•	•	•	•	•	•	•	•	•	•	•	•	1	1	1	1	•		1	1	1	1		•	•	•				
HP 4278A	•	•	•	•	•	•	•			•	•	•	•	1	1	1	1	•		1	1	1	1		•	•	•				
HP 4279A	•	•	•	•	•	•				•	•	•		1	1	1	1	•		1	1	1	1		•	•	•				
HP 4284A	•	•	•	•	•	•	•	•		•	•	•	•	1	1	1	1	•		1	1	1	1	•	•	•	•			•	
HP 4285A	•	•	•	•	•	•	•	•		•	•	•		1	1	1	1	•		1	1	1	1	•	•	•	•				•
HP 4291A														•	•	•	•			•	•	•	•					•	•		
HP 4396B w/HP 43961A														•	•	•	•			•	•	•	•								
HP 4286A														•	•	•	•			•	•	•	•								

•=Compatible
1=16085B adapter required
2=16099A adapter required

HP E4915A
HP E4916A

- Adopting transmission method
- 1 MHz to 180 MHz with 1 mHz resolution
- ± 2 ppm/± 5% Fr/CI accuracy
- High-speed measurement: 125 ms
- Remove parasitics using PI-Network calibration function
- Display equivalent circuit parameters of crystal unit
- Easy operation and fast measurement of Drive Level Dependency Test (HP E4916A)
- Small size, lightweight, one-box instrument

E4915A

E4916A

HP E4915A/E4916A Crystal Impedance Meter

The HP E4915A Crystal Impedance Meter and the HP E4916A Crystal Impedance/LCR Meter provide excellent crystal impedance (CI) and resonant frequency (Fr) measurement performance from 1 MHz to 180 MHz. CI and Fr are measured using the transmission method with a PI-Network test fixture.

HP E4915A for Simple Testing of Crystal Resonators

The HP 4915A is a low-cost product having only basic measurement capabilities. The transmission PI-Network method is used, but not the oscillator method. So, the E4915A can cover a wide frequency range using only this single product.

HP E4916A for Complex Testing of Crystal Resonators

The HP 4916A is an enhanced version of the HP E4915A adds variable output power. The E4916A also has additional functions, such as drive level dependency testing, evaporation monitoring, bandpass filter testing, and LCR measurement (optional).

Major Specifications

(See the data sheet for complete specifications.)

	HP E4915A	HP E4916A
Frequency Range:	1 MHz–180 MHz	1 MHz–180 MHz
Frequency Resolution:	1 mHz	1 mHz
Frequency Accuracy:	± 2 ppm	± 2 ppm
Power Level:	–5 dBm (5 μW @ 25 ohm)	–60 ± 18 dBm (1–100 MHz) (0.1 nW–1 mW @ 25 ohm)
Meas. Mode	Crystal, Spurious	Crystal, Spurious; Drive Level Dependency (DLD); Evaporation Monitoring (EM), Filter; LCR (Option 010)
Meas. Parameter	Fr, Fs, FL, Fa, CI, C0, C1, R1, L1, Q Spurious	Fr, Fs, FL, Fa, CI, C0, C1, R1, L1, Q; Spurious DLD: delta-Fr, delta CI, Max CI Filter: insertion loss, x dB BW; LCR: |Z|, |Y|, Θ, R, X, G, B, Ls, Lp, Cs, Cp, D, Q
Meas. Accuracy (SPC)	Fr: ± 2 ppm CI: ± 5 %	Fr: ± 2 ppm CI: ± 5 % |Z|:± 3%
Meas. Speed (SPC)	125 ms/device (Fr, CI meas.)	125 ms/device (Fr, CI meas.)

SPC: Supplemental Performance Characteristics

General Specifications

Power Requirements: 90 to 132 V or 198 to 264 V, 47 to 63 Hz, 1A max.
Operating Temperature: 0° to 55° C
Size: 320 mm W x 100 mm H x 450 mm D (12.6 in x 3.94 in x 17.72 in)
Weight: E4915A: 4.8 kg (10.6 lb) E4916A: 5.3 kg (11.7 lb)

Furnished Accessories

Operation manual, BNC cable (2 ea.), power cable
Crystal Measurement s/w for HP VEE
(The test fixture must be ordered separately.)

Key Literature

HP E4915A/E4916A Crystal Impedance/LCR Meter
Product Overview, p/n 5965-1172E

Ordering Information

HP E4915A Crystal Impedance Meter
Manual Options
Opt 0B0 Delete Manual Set
Opt 0B1 Add Manual Set
Opt ABA U.S.-English localization
Opt ABJ Japan-Japanese localization
Opt AB2 China-Chinese localization
Service Options
Opt UK6 Commercial Cal. Certificate w/ test data
Cabinet Options
Opt 1CM Rackmount Kit
Opt 1CN Handle Kit
Note: To use Option 020, HP E2120C or HP E2120D HP VEE for Windows is required. For more information about HP VEE, see the product overview of the HP E2120C or the HP E2120D.

HP E4916A Crystal Impedance/LCR Meter
Opt 001 Add Impedance Probe Kit
Opt 010 Add LCR Measurement Function
Manual Options: (Same as HP E4915A)
Service Options
UK6 Commercial Cal. Certificate w/ test data
Cabinet Options: (Same as HP E4915A)
Note: To use Option 020, HP E2120C or HP E2120D HP VEE for Windows is required. For more information about HP VEE, see the product overview of the HP E2120C or the HP E2120D.

Test Fixtures and Accessories

HP 41900A PI-Network Test Fixture
Opt 001 CL Adapter Kit
HP 41901A SMD PI-Network Test Fixture
Opt 001 to 006 Attachment kit

6

RF Impedance Material Analyzer, 1 MHz to 1.8 GHz

HP 4291A

- Basic accuracy ±0.8%
- Advanced calibration and error compensation
- Four component test fixtures (DUT size: 0.5 mm to 20 mm)
- Independent parameter selection in 2 channels
- Direct read-out permittivity, permeability
- Two material fixtures (operating temperature: –55° to +200° C)
- Versatile analysis (temperature, cole-cole plot, relaxation time)
- Sweep parameters (frequency, ac level, dc bias, temperature)

HP 4291A

HP 4291A RF Impedance/ Material Analyzer

Excellent Performance

The HP 4291A RF impedance/material analyzer provides a total solution for high-accuracy and easy measurement of surface-mount components and dielectric/magnetic materials. The HP 4291A uses a direct current-voltage measurement technique, opposing the reflection measurement technique, for more accurate impedance measurement over wide impedance range. Basic impedance accuracy is ± 0.8%. High Q accuracy enables low-loss component analysis. An internal synthesizer sweeps frequency from 1 MHz to 1.8 GHz with 1 mHz resolution. A 1.8-m error-less cable connects the analyzer to a test station so you can extend your test point away from the analyzer without losing accuracy. Advanced calibration and error compensation function eliminate measurement error factors in fixtures and assure high accuracy and repeatability at DUT/MUT.

The HP 4291A also provides automatic level control and monitor of test signals by using IBASIC programming function; devices can be measured under a constant voltage or current. Measure bias-dependent impedance characteristics with optional dc bias (up to 40 V and 100 mA). At the push of a button, the built-in Equivalent Circuit Analysis Function automatically calculates the circuit constant values of five circuit models (similar to HP 419A's Equivalent Circuit Analysis Function).

The HP 4291A has two measurement channels; each channel can be set to measure a single (e.g. Z) or dual (e.g. Z-theta) impedance parameter. The color CRT with split-display can show both active traces and memory traces (stored in RAM). A built-in floppy disk drive stores programs and test data in either LIF or MS-DOS format.

With optional IBASIC (Option 1C2), you can control external test equipment such as a temperature chamber or wafer prober directly from the HP 4291A. You do not need a separate instrument controller. Option 1C2 gives you a keyboard and the HP IBASIC programming language for test automation and integration.

Material Evaluation

The HP 4291A enables easy and sophisticated material evaluation and improves material evaluation quality and efficiency. The HP 4291A provides the total dielectric/magnetic material measurement solutions in wide frequency range (1 MHz to 1.8 GHz). See page 350 for more information.

Key Features

- Direct material parameter read-out (permittivity, permeability)
- Material analysis functions (Cole-Cole plots, relaxation time analysis)
- Versatile evaluation using a variety of swept parameters (frequency, signal level, temperature, etc.)

Test Fixtures

Select from four types of component test fixtures: HP 16191A, HP 16192A, HP 16193A, and HP 16194A. These test fixtures directly connect to the test station's APC-7 connector. Each fixture is designed for a different component size range, from 0.5 mm to 20 mm, and can handle different types of termination. These adjustable fixtures simplify device connection. For temperature coefficient testing, the HP 16194A high-temperature component test fixture can be used in a temperature oven from –55° to +200° C. Together with the HP 4291A's built-in compensation software, the fixtures ensure impedance accuracy and measurement repeatability. The HP 16453A dielectric material test fixture and HP 16454A magnetic material test fixture improve the accuracy and ease of use for permittivity or permeability measurements. These material fixtures have wide operating temperature of –55° to +200° C.

For measuring thin-film devices and semiconductors, the HP 4291A easily interfaces to a wafer prober. An extension cable connects the HP 4291A's test head to a probe station. For temperature and humidity testing, the HP 4291A can control an external temperature humidity chamber via HP-IB and display the measurement result vs. temperature or humidity.

Ease of Use

With the HP 4291A, impedance testing is easy. The analyzer comes with on-line calibration and compensation routine to simplify the task. Markers and limit-line function offer quick data analysis.

Specifications

Measurement Parameters

Impedance Parameters: |Z|, |Y|, Θ, R, X, G, B, Cp, Cs, Lp, Ls, Rp, Rs, D, Q
Converted Parameters: |Γ|, U, Γx, Γy
Material Parameters: |ε|, Θ, ε′, ε″, |μ|, μ′, μ″
Operating Frequency: 1 MHz to 1.8 GHz
Frequency Resolution: 1 mHz
Frequency Reference Accuracy: < ± 10 ppm/year @ ± 5° C
Precision Frequency Reference (Option 1D5)
Accuracy: < ± 1 ppm/year @ 0° to 55°, referenced to 23°C

Basic Measurement Accuracy

Frequency (Hz)	Impedance %	Phase (radian)
1 M to 100 M	0.8	8 m
200 M	1.0	10 m
500 M	1.5	15 m
1 G	2.5	25 m
1.8 G	4.0	40 m

Source Characteristics

OSC Level: 0.2 mV to 1 V rms (1 MHz to 1 GHz)
(Output terminal open)
0.2 mV to 0.5 V rms (1 GHz to 1.8 GHz)
Basic OSC Level Accuracy: 2 dB + 6 dB X f[MHz]/1800 @ 23 ± 5°C;
(terminated with 50 Ω) @ V ≥ 250 mV
Display Level Unit: V,I, dBm
Level Monitor Function: Voltage, current
Connector: APC-7
Output Impedance (nominal value)**:** 50 Ω

DC Bias

DC Level: 0 to ± 40 V, 0 to ± 100 mA
DC Level Accuracy:
Voltage Level: 0.1% + 4 mV + (Idc[mA] X 5 [Ω] mV @ 23 ± 5°C
Current Level: 0.5% + 30 μA + (Vdc [V]/10 [kΩ]) mA @ 23 ± 5°C
DC Level Monitor Function: DCV, DCI

Sweep Characteristics

Sweep Parameter: Frequency, ac signal level;
dc bias voltage/current (temperature by using IBASIC)

Calibration/Compensation

Open/Short/50 Ω Calibration, low loss CAL
Open/Short/Load Compensation, port extension, fixture electrical length

Key Specifications of Test Fixtures

Type of fixture	HP 16191A	HP 16192A	HP 16193A	HP 16194A
Operating freq. (typ.)	dc to 2 GHz	dc to 2 GHz	dc to 2 GHz	dc to 2 GHz
Operating temperature	–55° to +55°C	–55° to +85°C	–55° to +85°C	–55° to +200°C
DUT size (length: mm)	2.0 to 12.0	1.0 to 20.0	0.5 to 3.2	2.0 to 15.0

Display

CRT
Type: Color CRT
Size: 7.5 inch
Number of Display Channels: 2
Format: Single, dual, active + memory, graphic, and tabular

Storage

Type: Built-in 3½-inch floppy disk drive;
volatile RAM disk memory
Disk Format: LIF, DOS
Programming: HP Instrument BASIC (Option 1C2)
Input and Output Characteristics
External Reference Input: 10 MHz ± 100 Hz typically
Internal Reference Output: 10 MHz nominal
Reference Oven Output (Option 1D5)**:** 10 MHz nominal
External Trigger Input: BNC female, TTL Level

General Specifications

Operating Temperature/Humidity: 10° to 50° C/15% to 80% RH
Warm-Up Time: 30 min.
Power Requirements: 90 V to 132 V, or 198 V to 264 V, 47 to 66 Hz, 500 VA max.
Size/Weight
Mainframe: 426 mm W x 234 mm H x 537 mm D/28 kg
Test Station: 275 mm W x 95 mm H x 205 mm D/3.7 kg

Key Literature

HP 4291A 1.8 GHz Impedance/Material Analyzer Data Sheet, p/n 5091-8596E
New Technologies for Wide Impedance Range Measurements (Product Note 4291-1), p/n 5962-7177E

Ordering Information

HP 4291A RF Impedance/Material Analyzer
Furnished Accessories: High-Impedance Test Head, Calibration Kit, Operation Manual, Floppy Kisk, and Power Cable. (No test fixture is supplied with the HP 4291A.)
Options
Opt 1D5 Add High-Stability Frequency Reference
Opt 1C2 Add HP-IBASIC, HP-HIL Keyboard and Cable
Opt 001 Add DC Bias
Opt 002 Add Material Measurement Software
Opt 011 Delete High-Impedance Test Head
Opt 012 Add Low-Impedance Test Head
Opt 013 Add High-Temperature High-Impedance Test Head
Opt 014 Add High-Temperature Low-Impedance Test Head

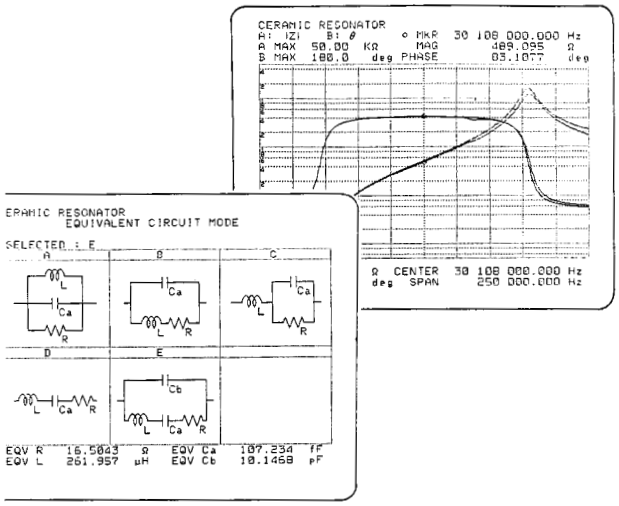
Support Options
Opt W30 Extended Repair Service
Opt W32 Calibration Service

Accessories
HP 16190A HP 4291A Performance Test Kit
HP 16191A Side Electrode Test Fixture
HP 16192A Parallel Electrode Test Fixture
HP 16193A Small Side Electrode Test Fixture
HP 16194A High-Temperature Component Test Fixture
HP 16453A Dielectric Material Test Fixture
HP 16454A Magnetic Material Test Fixture

HP 4194A

- Wide range impedance measurement:
  100 Hz to 40 MHz, 10 mΩ to 100 MΩ
  10 kHz to 100 MHz, 0.1Ω to 1 MΩ, when used with the HP 41941A/B
- Gain-phase measurement:
  10 Hz to 100 MHz, –107 dBm to +15 dBm, 0.1 dB resolution
- Flexible measurement, computation, and analysis capabilities on a color graphic display
- Fully programmable

HP 4194A with HP 41941A



HP 4194A Impedance/Gain-Phase Analyzer

The HP 4194A impedance/gain-phase analyzer is an integrated solution for efficient measurement and analysis or go/no-go testing of components and circuits. Detailed impedance and transmission characteristics, including secondary parameter derivations, can be simply and quickly evaluated or tested. The HP 4194A can contribute to improving engineering productivity and reducing test cost. The analyzer is flexible and has wide measurement capabilities in both impedance and transmission measurements. It is also fully programmable using Auto Sequence Programming (ASP). Desired measurements and computations, including graphics analysis, can be programmed simply by storing front-panel keystroke operations, allowing you to customize measurement, computation, and analysis functions. The HP 4194A also features high-accuracy and error elimination functions to ensure reliable measurements.

Wide-Range Accurate Measurement

Featuring a wide test frequency range—100 Hz to 40 MHz for impedance measurement (10 kHz to 100 MHz when using the HP 41941A/B Impedance Probe Kit) and 10 Hz to 100 MHz for gain-phase measurements—the HP 4194A satisfies a wide spectrum of needs. Realistic device characteristics can be analyzed under actual operating conditions by varying the test frequency, test signal level, and dc bias. The HP 4194A's high degree of measurement accuracy—0.17 percent for impedance measurements (1.5 percent when using the HP 41941A/B) with an amplitude ratio of 0.1 dB—ensures that you'll improve the quality of your test devices.

Quick Analysis

The HP 4194A makes high-speed measurements, (approximately 3.7 ms per point), displays results on a color CRT, and performs parameter analysis of components and circuits quickly and efficiently, substantially reducing development and evaluation time. The analysis function not only provides you with impedance and transmission characteristics, but also allows you to determine secondary parameters. Using the marker and line cursor functions, you can obtain the resonating frequency of resonators and the pass band width of band pass filters quickly.

Equivalent Circuit Analysis Function

Using the HP 4194A's equivalent circuit analysis function, you can easily and quickly obtain those equivalent circuit constants that, until now, required a number of time-consuming, complicated calculations. By using measured values, this unique function can approximate the circuit constant values of five circuit models. For example, a resonator's equivalent circuit elements or a coil's self inductance, lead resistance, and stray capacitance can be easily obtained.

The equivalent circuit analysis function also simulates the frequency characteristics of components by using derived circuit values or values you specify. By using approximation and simulation, you can compare design values to measurement values, thereby improving component design efficiency.

Auto Sequence Program (ASP)

The HP 4194A's ASP function, an internal programming feature, allows you to control all HP 4194A operations (measurement, display, and analysis) without the need for an external computer. By using ASP and actual measurement values, you can readily calculate many secondary parameters that you may need to evaluate. You can use the HP 4194A's powerful analysis functions to analyze these calculated parameters.

You can also use ASP to enhance such HP 4194A functions as alternate sweep, sweep timing control, and marker tracking. Because ASP eliminates the need for external controller, thereby eliminating data transfer time, the HP 4194A can quickly and efficiently perform production line go/no-go testing of components such as resonators and filters. All these features combine to increase your engineering and manufacturing productivity.

Increased Capabilities with the HP 41941A/B Impedance Probe Kit

When using the HP 4194A with the HP 41941A/B impedance probe kit, you can perform reliable impedance evaluations up to 100 MHz. Measurement errors due to residual impedance and stray admittance are eliminated by using the calibration standards furnished with the HP 41941A/B and the HP 4194A's automatic calibration function. This makes it possible to make highly accurate measurements (basic measurement accuracy 1.5 to 3 percent) over a wide measurement range of 100 mΩ to 1 MΩ. Calibration accuracy is guaranteed to the tips of the HP 41941A (1.5 m) and HP 41941B (3 m) impedance probes.

The HP 41941A/B can be used as a grounded probe to evaluate the impedance of in-circuit components such as printed circuit patterns, and the input/output impedance of circuits. In addition, you can connect an external dc bias source directly to the HP 41941A/B to perform dc biased measurements up to ± 150 V/0.5 A, to measure the dc characteristics of inductors, capacitors, materials, and semiconductors. To perform swept dc bias measurements, use the HP 4194A's ± 40 V internal dc bias source.

Specifications

Impedance Measurements

Measurement Parameters: |Z|, |Y|, Θ, R, X, G, B, L, C, D, Q.
Twenty parameter combinations are available.
Test Frequency: 100 Hz to 40 MHz (cable length: 0m); 100 Hz to 15 MHz (cable length: 1 m), 1 mHz resolution.
OSC Level: 10 mV –1 V rms (≤ 10 MHz), 10 mV–0.5 V rms (> 10 MHz) (UNKNOWN terminal open), 3-digit resolution
DC Bias: 0 to ± 40 V, 10 mV resolution
Measurement Terminal: 4-terminal pair configuration

Measurement Range and Maximum Resolution:

Measurement parameter	Range	Max. resolution
|Z|,R,X	10 mΩ to 100 MΩ	100 μΩ
|Y|,G,B	10 nS to 100 S	1 nS
Θ	±180°	0.01°
L	1 nH to 100 kH	10 pH
C	10 fF to 0.1 F	0.1 fF
D	0.001 to 10	0.0001
Q	0.1 to 1000	0.1

Basic Measurement Accuracy: 0.17%
Level Monitor: 1 mV to 1 V rms, 1 μA –20 mA

Gain-Phase Measurements

Measurement Parameters: Tch/Rch (dB, Linear Ratio), Tch, Rch (V, dBm, dBV), Θ (degree, rad), τ
Tch=Test Channel, Rch=Reference Channel, τ=Group Delay
Measurement Frequency: 10 Hz to 100 MHz, 1 mHz resolution
Aperture Frequency Range (Group Delay Measurements)**:** 0.5% to 100% of frequency span
OSC Level: –65 dBm to + 15 dBm, 0.1 dB resolution
Measurement Range
- **Tch/Rch:** 0 to ± 120 dB, 0.001 dB resolution
- **Tch, Rch:** –107 dBm to –5 dBm (0 dB attenuator); –87 dBm to +15 dBm (20 dB attenuator); 0.001 dB resolution
- **Θ:** ± 180° (can display phase continuously with the phase scale expansion function), 0.01° resolution
- **τ:** 0.1 ns to 1 s, 0.1 ns resolution

Basic Measurement Accuracy
- **Tch/Rch:** 0.1 dB, 0.5°
- **Tch, Rch:** 0.35 dBm

Level Monitor: Monitor the input level of the reference and test channels in units of dBm, dBV and Volts

Impedance Measurements Using the HP 41941A/B

The specifications listed are for the HP 4194A when used with the HP 41941A/B.
Frequency Range: 10 kHz to 100 MHz, 1 mHz resolution
OSC Level
- **Option 350:** 10 mV to 1.28 V rms
- **Option 375:** 10 mV to 1.54 V rms

DC Bias
- **Internal:** ± 40 V, ± 20 mA
- **External:** ± 150 V, ± 500 mA, max. 25 W

Measurement Range: 100 mΩ to 1 MΩ
Basic Measurement Accuracy: ± 1.5% to 3% (≥ 100 kHz), ± 3% to 6% (< 100 kHz)
Cable Length: HP 41941A: 1.5 m; HP 41941B: 3 m

Common Specifications

Trigger Mode: Internal, external, and manual
Sweep Capabilities
- **Sweep Parameter:** Frequency, OSC level, dc bias (impedance measurements only)
- **Entry:** START/STOP or CENTER/SPAN
- **Sweep Type:** LIN, LOG, ZERO SPAN (dc Bias: LIN or ZERO SPAN only)
- **Number of Measurement Points:** 2 to 401 points
- **Sweep Functions:** Partial sweep, expand markers sweep, program points measurement

Display

CRT: 7.5-inch color CRT
Display Mode: Rectangular (X- A & B), rectangular (A–B), table
Display Control: Autoscale, superimpose, and storage

Analysis

Marker: Single, delta, double markers
Line-Cursor: Line-cursor, delta-line cursor
Equivalent Circuit Function: Approximation, simulation
Arithmetic Operation
- **Data Register Manipulation:** Use arithmetic operations and functions to manipulate data registers
- **Go/No-Go Limits**

Programming

Auto Sequence Program (ASP)**:** Control the HP 4194A's operation with an internal program language. ASP can be entered using the front-panel keys or downloaded from HP-IB
Program Memory Size: 20 kB of nonvolatile memory
Copy: Dump, plot, print mode

General Specifications

Operating Temperature and Humidity: 0 to 40° C (HP 41941A/B: –20 to + 65° C), ≤ 95% RH at 40° C
Storage Temperature: –30° C to + 60° C (HP 41941A/B: –40 to + 65° C)
Safety: Based on IEC-348, UL-1244
Power: 100, 120, 220 V ± 10%, 240 V –10% + 5%, 48 to 66 Hz, 400 VA (max.)
Size: 425 mm W x 375 mm H x 620 mm D (16.73 in x 14.76 in x 24.41 in)
Weight: Net, approximately 37 kg (81.4 lb)

Reference Data

Typical Measurement Speed
- **Impedance:** Approximately 3.7 ms/point
- **Gain-phase:** Approximately 3.5 ms/point
- **Impedance when used with the HP 41941A/B:** Approximately 6 ms/point

Accessories Furnished

HP 16047D: Direct Coupled Test Fixture
HP 8120-1838: 30-cm BNC Cable (2 ea.) (Option 350)
HP 04194-61640: 30-cm BNC Cable (2 ea.) (Option 375)
HP 8120-1839: 60-cm BNC Cable (Option 350)
HP 04194-61641: 60-cm BNC Cable (Option 375)
HP 1250-0080: BNC Adapter

Key Literature

HP 4194A Impedance/Gain-Phase Analyzer Data Sheet, p/n 5952-7802

Ordering Information

HP 4194A Impedance/Gain-Phase Analyzer
- **Opt 350*** 50 Ω System
- **Opt 375*** 75 Ω System
- **Opt W30** Extended Repair Service
- **Opt 001** High-Stability Frequency Reference

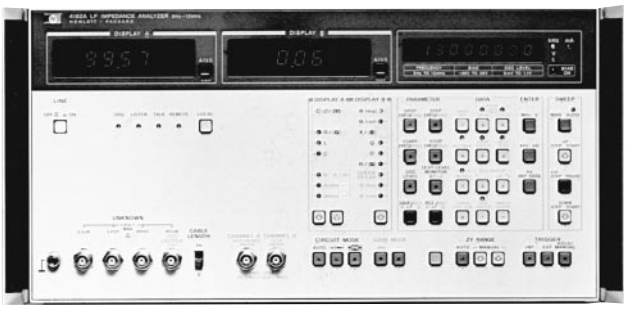
HP 41941A* Impedance Probe Kit (1.5 m)
HP 41941B* Impedance Probe Kit (3 m)

*Must select either Option 350 or 375.

LF Impedance Analyzer, 5 Hz to 13 MHz

HP 4192A

- 5 Hz to 13 MHz variable frequency
- Gain-phase measurement: amplitude, phase, group delay
- Floating or grounded devices
- Impedance measurement: |Z|, |Y|, Θ, R, X, G, B, L, C, D, Q, Δ, Δ%
- Standard HP-IB



HP 4192A (shown with Option 907 handles

HP 4192A LF Impedance Analyzer

HP-IB

The HP 4192A LF impedance analyzer performs both network analysis and impedance analysis on such devices such as telecommunication filters, audio/video electronic circuits, and basic electronic components. Both floating and grounded devices can be tested.

Specifications

(Refer to data sheet for complete specifications.)

Measuring Signal (23° ± 5°C)

Frequency Range: 5 Hz to 13 MHz
Frequency Step: 0.001 Hz (5 Hz to 10 kHz), 0.01 Hz (10 kHz to 100 kHz), 0.1 Hz (100 kHz to 1 MHz), 1 Hz (1 MHz to 13 MHz)
Frequency Accuracy: ± 50 ppm
OSC Level: 5 mV to 1.1 V rms variable into 50 Ω (amplitude-phase measurement) or open circuit (impedance measurement)
OSC Level Step: 1 mV (5 mV to 100 mV), 5 mV (100 mV to 1.1 V)
Level Monitor (impedance measurement)**:** Current-through or voltage-across sample can be monitored
Control: Spot and sweep via front panel or HP-IB

Measuring Mode

Spot Measurement: At specific frequency (or dc bias)
Swept Measurement: Manual or automatic sweep from START to STOP frequency (or dc bias) at selected STEP frequency (or dc bias) rate
Sweep Mode: Linear or logarithmic (frequency only)
Recorder Outputs: Output dc voltage proportional to each measured value, and frequency or dc bias
Maximum Output Voltage: ± 1 V
Key Status Memory: Five sets of measuring conditions can be stored and recalled at any time
HP-IB Data Output and Remote Control: Standard
Self-Test: Automatic introspective testing
Trigger: Internal, external, manual, or HP-IB

Amplitude-Phase Measurement

Parameter Measured: Relative amplitude B-A (dB) and phase Θ (degrees or radians), B-A and group delay, absolute amplitude A (dBm or dBV) or B (dBm or dBV), and deviation (Δ, Δ%) of all parameters
Reference Amplitude: 0 dBV = 1 V rms, 0 dBm = 1 mW (with 50 Ω termination)
OSC Output Resistance: 50 Ω
Channels A and B: Input Impedance: 1 M Ω ± 2%, shunt capacitance: 25 pF ± 5 pF
Measurement Accuracy (23 ±5° C)**:** Specified at BNC unknown terminals after 30-minute warm-up (test speed: normal or average)

B-A (relative amplitude) and Θ (phase) measurement:
± 0.01 dB, ± 0.05° (at –20 to 0.8 dB V input, freq. =100 to 10 kHz)
A, B (absolute amplitude) measurement:
± 0.4 dB (at –50 to 0.8 dB V input. freq. = 100 to 1 Mhz)

Impedance Measurement

Parameter Measured: |Z|–Θ, |Y|–Θ, R–X, G–B, L–D, Q, R,G, C–D, Q, R, G and deviation (Δ, Δ%) of all parameters
Display: 4½ digits, max. display 12999 counts, 19999 for L & C
Circuit Mode: Series equivalent circuit ( ) and parallel equivalent circuit ( ). Automatic selection available.
Auto ZERO Adjustment: Automatic normalization of the readout offset due to residuals of the test fixture by pushbutton operation (at spot frequency)
Measuring Range and Accuracy (23° ± 5°C)**:** Specified at BNC unknown terminals after 30 minute warmup when OSC level is more than 0.1 V and when auto ZERO adjust is performed (test speed: normal or average). Accuracy given below is only valid when the measured value is equal to full scale of each range.

|Z|–Θ , R–X, |Y|–Θ, G–B Measurement:

Parameters	Measurement range	Basic accuracy
|Z|, R, X	1.0000 Ω to 1.000 MΩ	0.15%
|Y|, G, B	10.000 μS to 10.00 S	0.15%
Θ	–180.00° to +180.00°	0.08°

R accuracy (D ≥ 10); X accuracy (D < 1)
G accuracy (D > 1); B accuracy (D ≤ 0.1)

L–D • Q, C–D • Q Measurement:
(automatically calculated from measured Z/Y values)

Parameters	Measurement range*	Basic accuracy
L	100.00 nH to 1000 H	0.27%
C	1.0000pF to 199** mF	0.15%
D(1/Q)	0.0001 to 19.999	0.001 (C-measurement) 0.003 (L-measurement)

* Varies with measuring frequency except for D(1/Q)
** Accuracy of C ranges over 100 mF is not specified

Internal dc Bias: Standard (impedance measurement only)

Voltage Range: –35 V to +35 V, 10 mV step
Setting Accuracy (23° ± 5°C)**:** 0.5% of setting +5 mV
Bias Control: Spot and swept, using front panel controls or HP-IB

General Specifications

Measuring Time (high-speed mode)
B-A and Θ , A or B: 88 to 127 ms (≥ 400 Hz)
Impedance Parameters: 58 to 91 ms (≥ 1 kHz)
Test Level Monitor Range (impedance measurement)
Voltage: 5 mV to 1.1 V
Current: 1 μA to 11 mA
Operating Temperature: 0° to 55° C, ≤ 95% RH at 40° C
Power: 100, 120, 220 V ± 10%, 240 V +5% to –10%, 48 to 66 Hz, 150 VA max.
Size: 425.5 mm W x 235 mm H x 615 mm D (16.5 in x 9 in x 22.6 in)
Weight: Approximately 19 kg (41.9 lb)
Furnished Accessories and Parts: HP 16047A test fixture, HP 11048C 50 Ω feed thru terminations (2 ea.), power splitter, HP 11170A BNC cables (2 ea.), BNC adapter

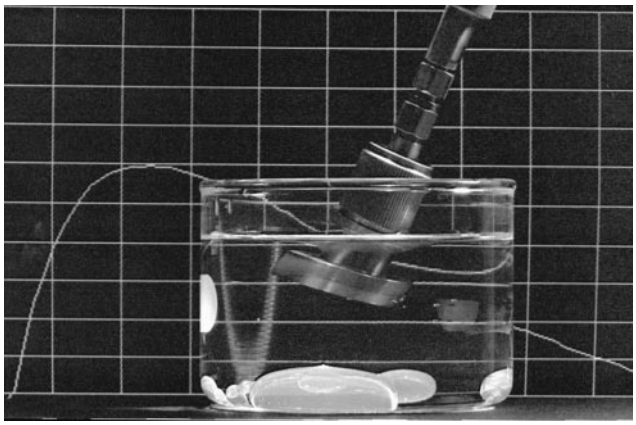
Key Literature

HP 4192A LF Impedance Analyzer Data Sheet, p/n 5952-8896

Ordering Information

HP 4192A LF Impedance Analyzer
Accessories
HP 16095A Probe Fixture
HP 16096A 2-Port Component Text Fixture
HP 16097A Accessory Kit
HP 16047C Test Fixture
HP 16048A Test Leads (BNC connector)

- Accessories and complete turnkey systems for characterizing the dielectric properties of materials
- Fast and convenient
- Wide frequency ranges from 30 kHz to 110 GHz
- Compatible with the HP 8752, 8753, 8719, 8720, 8722 and 8510 network analyzers
- Software runs on HP Vectra (MS-DOS) or HP 9000 Series 300 (HP BASIC) controllers



HP 85070M Dielectric Probe System

Measure the dielectric properties of materials quickly and conveniently with the HP 85070M dielectric probe measurement system. Measurements made with this probe-based system are nondestructive and require no sample preparation—saving you time, trouble, and material. The dielectric probe is well-suited for measurements of liquid or semi-solid materials. Simply immerse the probe into the material; there is no need for special fixtures. The dielectric probe is not recommended for thin (substrates) or low-loss (resonators) materials.

Knowledge of the dielectric loss of food, rubber, plastic, and ceramic products can assist researchers in the design and optimization of materials in microwave heating processes. Dielectric properties also correlate directly with other material properties—such as moisture content, phase transitions, molecular structure, polarizability, and relaxation constants. For example, this information has been useful in the development of microwaveable prepared foods.

A measurement system based on the HP 85070B dielectric probe yields permittivity (dielectric constant), loss factor, loss tangent, or Cole-Cole diagrams—versus frequency—from 200 MHz to 20 GHz (depending on the network analyzer and material). Measurement accuracy for the dielectric probe is typically five percent.

The HP 85070M is a fully-configured materials measurement system consisting of the HP 85070B dielectric probe kit, network analyzer, cables, probe stand, and pre-configured HP Vectra PC. The probe kit contains both the dielectric probe and software.

HP 85070B Dielectric Probe Kit

The HP 85070B high-temperature dielectric probe kit features a hermetic glass-to-metal seal, which makes it resistant to corrosive or abrasive chemicals. It withstands a wide –40° to +200° C temperature range, which allows measurements versus frequency and temperature. This is an important variable, since the dielectric constant of a material can vary significantly as a function of temperature. A special refresh calibration simplifies measurements over temperature. The probe kit contains accessories including cables, port/cable adapters, switch, short circuit, mounting bracket, software, adapters, 50 ohm termination, stand, vials, and stoppers.

HP 85071B Materials Measurement Software

Calculate the permittivity and permeability of material samples loaded into sections of coaxial airline or rectangular waveguide using the HP 85071B software. This measurement technique works well for solid materials that can be machined to fit precisely inside a transmission line.

A dielectric measurement can provide critical design parameter information for materials used in state-of-the-art RF and microwave electronic component applications. The loss of a cable or the impedance of a substrate can be related to its dielectric properties. This information is also useful for improving ferrite, radome, absorber, and packaging designs.

There are a variety of different measurement models to choose from in the HP 85071B software. A complete system requires the addition of a fixture (coaxial or waveguide transmission line), network analyzer, and controller. Measurement accuracies of one percent to two percent are typical from 100 MHz to 110 GHz (depending on the material, fixture, and network analyzer).

Other Solutions

Other measurement techniques based on RF or microwave network analyzers exist and offer their own unique advantages. For example, free-space methods are noncontacting and suitable to temperature extremes. (The HP 85071B materials measurement software is compatible with free-space measurements.) Resonator or cavity methods provide the highest accuracy and sensitivity to low-loss materials.

Below 30 MHz, the HP 16451B dielectric test fixture (coupled with an LCR meter or impedance analyzer) provides accurate low-frequency measurement of materials.

Key Literature

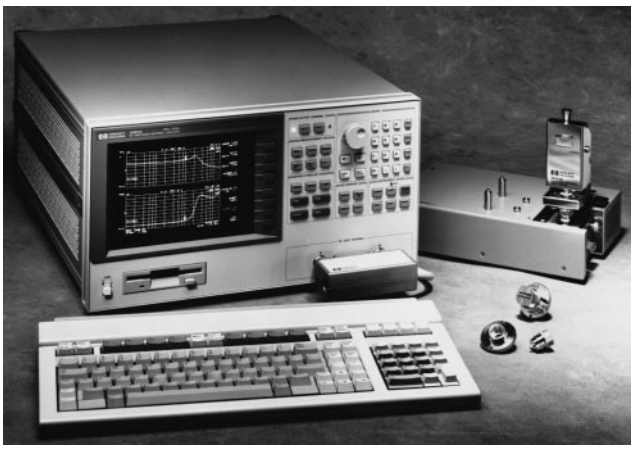
HP 85070M Dielectric Probe Measurement System
HP 85070B High-Temperature Dielectric Probe Kit Technical Data, p/n 5091-6247E
HP 85071B Materials Measurement Software Technical Data, p/n 5091-6248E
Solutions for Measuring Permittivity and Permeability, p/n 5091-9052E

Ordering Information

HP 85070M 3 GHz Dielectric Probe Measurement System
Opt 1FF Deletes HP Vectra PC
Opt 020 20 GHz System
HP 85070B High-Temperature Dielectric Probe Kit
Opt 001 Adds Probe Stand
Opt 002 Adds High-Temperature Cable
Opt 300 Substitute HP BASIC Software
HP 85071B Materials Measurement Software
Opt 300 Substitute HP BASIC Software

HP 4291A
Option 002
HP 16453A
HP 16454A

- Integrated system for permittivity and permeability measurement from 1 MHz to 1.8 GHz
- Versatile fixtures for substrate materials and toroids
- Built-in firmware for direct parameter measurement and easy data analysis



HP 4291 System (HP 4291A, 16453A, and 16454A)

HP 4291A Impedance/Material Analyzer (Option 002 required)

The HP 4291A impedance/material analyzer provides an easy and versatile material test solution from 1 MHz to 1.8 GHz. The analyzer measures impedance accurately and automatically calculates permittivity and permeability data from impedance. Various interchangeable test fixtures, designed specifically to work with the HP 4291A, let you measure dielectric materials and magnetic materials easily.

HP 16453A Dielectric Test Fixture

The HP 16453A dielectric test fixture is best used for measuring substrate materials (solid, sheet material samples) less than 3 mm in thickness such as PC boards, substrates, and polymer materials. When used with the HP 16453A, the firmware (HP 4291A Option 002) built into the analyzer automatically calculates permittivity parameters. Typical accuracy is ±8% for real part of permittivity and ±0.005 for loss tangent. The flexible firmware also lets you display data as a Cole-Cole plot or find relaxation time.

HP 16454A Magnetic Test Fixture

For permeability analysis, the HP 16454A magnetic test fixture is designed for testing toroidal-shaped samples up to 20 mm in diameter. Examples of suitable materials-under-test are soft ferrite and magnetic cores. The HP 16454A comes with different sizes of sample holders for different toroid sizes for maximum flexibility. Built-in firmware (HP 4291A Option 002) automatically computes permeability parameters, eliminating cumbersome coil-winding or lengthy calculation. Typical accuracy is ±4% for real part of permeability and ±0.002 for loss tangent.

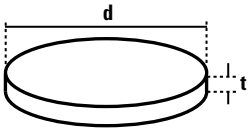
Temperature Coefficient Testing

Both HP 16453A and HP 16454A have an operating temperature range from –55° to +200° C. Two hardware options are available for interfacing the fixtures to a temperature chamber. Choose the HP 4291A Option 013 high-temperature, high-impedance test head for the HP 16453A, or the HP 4291A Option 014 high-temperature, low-impedance test head for the HP 16454A.

Specifications

HP 4291A Option 002
Material Parameters: $|\varepsilon_r|$, ε_r', ε_r'', $|\mu_r|$, μ_r', μ_r'', tan δ
Operating Frequency: 1 MHz to 1.8 GHz
Basic Accuracy: Permittivity: ε_r: ±8% at ε_r < =10, tan δ: ±0.005 (typical)
Permeability: μ_r: ±4%, tan δ: ±0.002 (typical)

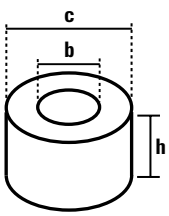
HP 16453A Dielectric Test Fixture



Sample Material Specifications
t: ≤3mm
d: ≥15mm
Operating Frequency Range: 1 MHz to 1.8 GHz*
Operating Temperature Range: –55° to +200° C

* Measurement error increases for some materials with large ε_r above 1 GHz. Check Technical Specification Document (HP p/n 5962-6974E) for details.

HP 16454A Magnetic Test Fixture



Sample Material Specifications

Fixture Holder	Small A	B	Large C	D
c	≤8 mm	≤6 mm	≤20 mm	≤20 m
b	≤3.1 mm	≤3.1 mm	≤6 mm	≤5 mm
h	≤3 mm	≤3 mm	≤10 mm	≤10 mm

Operating Frequency Range: 1 MHz to 1.8 GHz*
Operating Temperature Range: –55° to +200° C

* Measurement error increases for some materials with large μ_r or ε_r above 1 GHz.

Key Literature

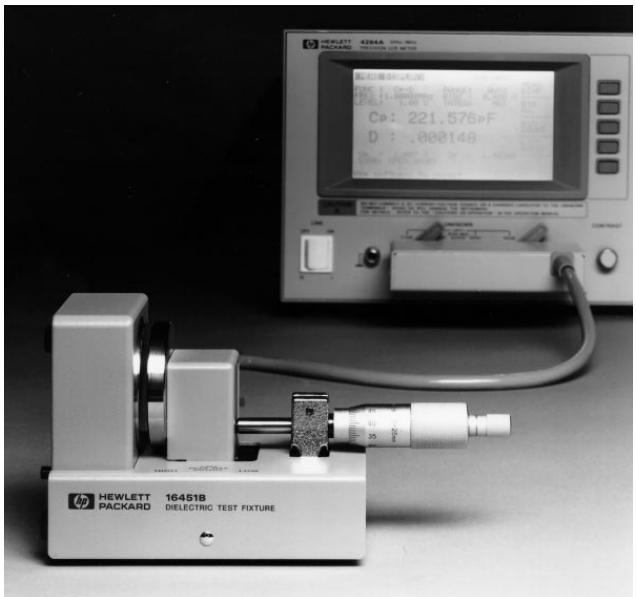
HP 4291A RF Impedance/Material Analyzer Data Sheet, p/n 5091-8596E
Permittivity Measurements of PC Board and Substrate Materials (Solution Note 4291-4), p/n 5962-6973E
Permeability Measurements using HP 4291A and HP 16454A (Solution Note 4291-5), p/n 5962-6972E

Ordering Information

HP 4291A RF Impedance/Material Analyzer
Opt 002 Material Measurement
Opt 013 High-Temperature, High-Impedance Test Head
Opt 014 High-Temperature, Low-Impedance Test Head
HP 16453A Dielectric Test Fixture
HP 16454A Magnetic Test Fixture

HP 16451B
HP 16452A

- For measuring capacitance or dielectric constant of solid materials
- Designed for HP four-terminal-pair LCR meters or impedance analyzers



HP 16451B Dielectric Test Fixture

HP 16451B Dielectric Test Fixture

For dielectric constant evaluation of solid materials such as polymer, electric insulator, PC board, ceramic substrate, etc., use the HP 16451B dielectric test fixture with any HP four-terminal-pair LCR meter or impedance analyzer up to 30 MHz. The HP 16451B has four types of electrodes which can be replaced according to sample size or measurement technique. Stray admittance and residual impedance of the test fixture can be eliminated by the OPEN/SHORT error correction function of the measurement instrument by using the furnished OPEN/SHORT attachments.

Specifications

Frequency Range: ≤ 30 MHz (depends on instruments)
Operating Temperature: 0 to +55° C
Sample Size: Diameter 10 to 56 mm, Thickness ≤10 mm
Parameters: Capacitance, $|\varepsilon|$, or loss tangent (depends on the LCR meter used)
Electrical Interface: Four-terminal pair

Key Literature

HP 16451B Dielectric Test Fixture Data Sheet, p/n 5950-2368

Ordering Information

HP 16451B Dielectric Test Fixture

- For measuring capacitance or dielectric constant of liquids
- Designed for HP four-terminal-pair LCR meters or impedance analyzers

HP 16452A Liquid Test Fixture

HP 16452A Liquid Test Fixture

For convenient testing of liquids, use the HP 16452A liquid test fixture with any HP four-terminal-pair LCR meter or impedance analyzer. With the HP 16452A, you will be able to measure permittivity and impedance characteristics of liquid materials like plastic resins, biological fluids, and petrochemical products. The fixture has inlet/outlet ports which allow continuous measurements of liquids flowing in a process monitoring environment. The internal cell allows accurate measurements to be performed on a small amount of liquid samples.

Specifications

Operating Frequency: 20 Hz to 30 MHz
Operating Temperature: –20° to +125° C
Sample Size: 1 ml to 4 ml
Parameters: Capacitance, $|\varepsilon|$, or loss tangent (depends on the LCR meter used)
Electrical Interface: Four-terminal pair

Key Literature

HP 16452A Liquid Test Fixture Data Sheet, p/n 5091-9228E

Ordering Information

HP 16452A Liquid Test Fixture
Recommended measurement cables for connecting the HP 16452A to a HP four-terminal-pair LCR meter or impedance analyzer: HP 16048A Test Lead (0° to +55° C) or HP 16452-61601 (–20° to +125° C)

LCR Meter

HP 4263B

- 0.1% basic accuracy
- 100 Hz, 120 Hz, 1 kHz, 10 kHz, 100 kHz test frequencies
- 20 m to 1 Vrms in 5m Vrms steps
- Test signal level monitor function
- High-speed measurement: 25 ms
- High-speed contact check
- Wide capacitance test range
- Transformer parameter measurements (optional)

HP4263B

HP 4263B LCR Meter

The HP 4263B LCR meter is Hewlett-Packard's most cost-effective low-end LCR meter, designed for both component evaluation on the production line and fundamental impedance testing for bench-top applications. The HP 4263B has five test frequencies that allow you to simulate testing under the correct conditions: 100 Hz, 120 Hz, 1 kHz, 10 kHz, and 100 kHz. An optional 20 kHz test frequency can be added to those five frequencies (Option 002).

High-Speed Measurements

The HP 4263B can boost throughput with a measurement speed of 25 ms at any test frequency. This ability improves the throughput of electrolytic capacitor and transformer testing. The HP 4263B can check the contact condition between the test terminals and the device-under-test (DUT). This function ensures the reliability of PASS/FAIL testing with automatic handlers in production. The quick recovery system of the HP 4263B improves throughput. Normal operation is resumed the instant a faulty DUT is removed from the handler, so the handler can always be operated at its full speed.

Electrolytic Capacitor Measurements

The HP 4263B's accuracy and wide measurement range are the right tools to make precise measurements of electrolytic capacitors. Charged capacitors can discharge through the front end and destroy an instrument. The HP 4263B's front end is designed for protection and maintains test integrity.

Transformer Parameter Measurements

With the HP 4263B's ability to make turns ratio (N), mutual inductance (M), and dc resistance (DCR) measurements, data calculations and changing test setups are no longer time-consuming tasks (Option 001). The flexible signal level setting and the voltage-and-current monitor function facilitate the use of the HP 4263B for level dependent DUTs, such as core inductors.

Specifications

(Refer to Product Overview for complete specifications.)

Measurement Functions

Measurement Parameters: |Z|, |Y|, θ, R, X, G, B, L, C, Q, D, ESR

Option 001: Add DCR (dc resistance), N (turns ratio), and M (mutual inductance) measurement

Measurement Circuit Mode: Series and parallel

Mathematical Functions: Deviation and percent deviation

Test Cable Lengths: 0 m, 1 m, 2 m, 4 m (freq. = 100/120/1k Hz); 0 m,1 m, 2 m (freq. = 10k/20k Hz); 0 m, 1 m (freq. = 100 kHz)

Test Signal Information

Test Frequency: 100 Hz, 120 Hz, 1 kHz, 10 kHz, and 100 kHz

Option 002: Add 20 kHz test frequency

Frequency Accuracy: ± 0.01% (freq. = 100 Hz, 1 kHz, 10 kHz, (20 kHz, 100 kHz), ± 1% (freq. = 120 Hz)

Output Impedance: 100 Ω ± 10%, 25 Ω ± 10% (≤ 1 Ω range)

AC Test Signal Level: 20 m to 1 Vrms in 5m Vrms steps

Accuracy: ± (10% + 10 mV)

Internal dc Bias

Level: 1.5 and 2 V; **Accuracy:** ± (5% + 2 mV)

External dc Bias: 0 to +2.5 V

Measurement Range

Parameter	Measurement range
|Z| , R, X	1 mΩ to 100 MΩ
|Y| , G, B	10 nS to 1000 S
C	1 pF to 1 F
L	10 nH to 100 kH
D	0.0001 to 9.9999
Q	0.1 to 9999.9
θ	–180° to +180°
DCR	1 mΩ to 100 MΩ
N	0.9 to 200 (unspecified)
L, M	1 μH to 100 H (unspecified)
Δ%	–999.99% to +999.99%

Measurement Accuracy: ± 0.1% (basic) (for |Z|, R, X, |Y|, G, B,C, L)

Measurement Time

Mode	Time (typical)
SHORT	25 ms
MEDIUM	65 ms
LONG	500 ms

Test Signal Level Monitor: Voltage and current

Front-End Protection: Internal circuit protection when a charged capacitor is connected to the input terminals. The maximum capacitor voltage is: Vmax = √(8/C) typical @ Vmax ≤ 250 V; Vmax = √(2/C) typical @ Vmax ≤ 1000 V, C is in Farads.

Display Digits: 3, 4, or 5 (selectable)

Correction Function

Zero OPEN/SHORT: Eliminates measurement errors due to stray parasitic impedances in the test fixtures.

Load: Improves measurement accuracy by using a calibrated device as a reference.

Comparator Function: HIGH/IN/LOW for each primary measurement parameter and secondary measurement parameter.

Contact Check Function: Contact failure between the test fixture and device can be detected. Additional time for contact check: 5 ms.

Other Functions

Save/Recall: Ten instrument setups can be saved/recalled from the internal nonvolatile memory.

Continuous Memory Capability: If the instrument is turned off, or if a power failure occurs, instrument settings (except dc bias on/off) are automatically memorized (≤ 72 hours at 23° ± 5° C).

HP-IB Interface: All control settings, measured values, and comparator information.

Handler Interface: All output signals are negative-logic, optically isolated open collectors. Output signals include HIGH/IN/LOW, no contact, index, end of measurement, and alarm. Input signals include keylock and external trigger.

General Specifications

Power Requirements: 90 to 132 V or 198 to 264 V, 47 to 66 Hz, 45 VA max.
Operating Temperature: 0 to 45° C
Size: 320 mm W x 100 mm H x 300 mm D (12.6 in x 3.94 in x 11.81 in)
Weight: 4.5 kg (9.9 lb)

Key Literature

HP 4263B LCR Meter Product Overview, p/n 5964-6181E
LCR Meters, Impedance Analyzers and Test Fixtures Selection Guide, p/n 5952-1430

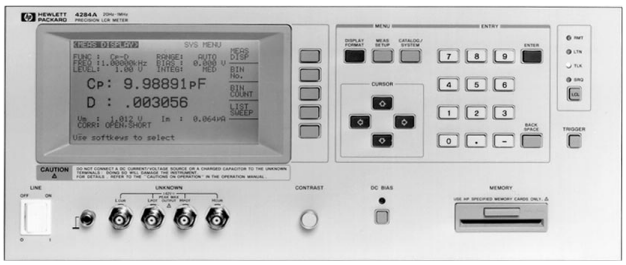
Ordering Information

HP 4263B LCR Meter
Opt 001 Add N/M/DCR Measurement Function
Opt 002 Add 20 kHz Test Frequency
Opt ABA US-English Localization
Opt ABJ Japan-Japanese Localization
Opt OBO Delete Operation Manual
Opt W30 Extended Repair Service
HP 16060A Transformer Test Fixture (Opt 001 required)
HP 16065C External Bias Adapter (up to 40 Vdc)
HP 16089A Kelvin Clip Leads (1 m, 2 large clips)
HP 16089B Kelvin Clip Leads (1 m, 2 medium clips)
HP 16089C Kelvin Clip Leads (1 m, 2 IC clips)
HP 16089D Alligator Clip Leads (1 m, 4 medium)
HP 16089E Kelvin Clip Leads (1 m, 2 large clips)
HP 16064B LED Display/Trigger Box (pass/fail display and trigger)

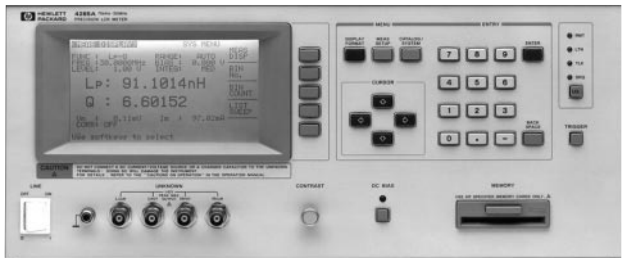
HP 4284A
HP 4285A

- 20 Hz to 1 MHz, with over 8,600 test frequencies
- 0.05% basic accuracy, 6-digit resolution
- Constant V or I test signal level
- 20 Vrms level option (Option 001)
- 40 Adc with HP 42841A
- List sweep measurement capability

- 75 kHz to 30 MHz in 100-Hz steps
- 0.1% basic accuracy
- High-speed measurements: 30 ms/meas.
- Constant V or I test signal level
- 10 Adc with HP 42841A
- Accurate Q measurement with HP 42851A
- List sweep measurement capability



HP 4284A



HP 4285A

HP 4284A, HP 4285A Precision LCR Meters

The HP 4284A and HP 4285A precision LCR meters are cost-effective solutions for component and material measurement. They can be used to improve component quality by providing an accurate, high-throughput test solution. The wide 20 Hz to 1 MHz test frequency range and superior test-signal performance allow the HP 4284A to test components to the most commonly-used test standards, such as IEC/MIL standards, and under conditions that simulate the intended application. For demanding RF component tests, the HP 4285A offers a higher test-frequency range, from 75 kHz to 30 MHz. Whether in research and development, production, quality assurance, or incoming inspection, the HP 4284A and HP 4285A will meet all of your LCR meter test and measurement requirements.

Specifications

(Refer to Data Sheet for complete specifications.)
Parameters Measured: |Z| -θ, |Y| -θ, R-X, G-B; C-D, Q, ESR, G, Rp; L-D, Q, ESR, G, Rp; Deviation and % deviation
Measurement Circuit Modes: Series and parallel
Ranging: Auto and manual
Trigger: Internal, external, manual, and bus (HP-IB)
Delay Time: 0 to 60.000s in 1 ms steps
Measurement Terminals: Four-terminal pair
Test Cable Length:
HP 4284A: Standard: 0 and 1 m; with Option 006: 0, 1, 2 and 4 m
HP 4285A: 0, 1 and 2 m
Integration Time: Short, medium, and long
Averaging: 1 to 256, programmable
Test Signal:
HP 4284A: 20 Hz to 1 MHz ± 0.01%, 8610 selectable frequencies
HP 4285A: 75 kHz to 30 MHz ± 0.01%, 100-Hz steps
Test Signal Modes:
Normal: Programs selected voltage or current at the measurement terminals open or shorted, respectively, and not at the device-under-test.
Constant: Maintains selected voltage or current at the device-under-test independent of changes in the device's impedance.

Test Signal Levels (rms)	Normal	Constant
HP 4284A	5 mV to 2 V, 50 μA to 20 mA	10 mV to 1 V, 100 μA to 10 mA
Option 001	5 mV to 20 V, 50 μA to 200 mA	10 mV to 10 V, 100 μA to 100 mA
HP 4285A	5 mV to 2 V, 200 μA to 20 mA	10 mV to 1 V, 100 μA to 20 mA

DC Bias:
HP 4284A Standard: 0 V, 1.5 V and 2 V
HP 4284A/4285A Option 001: 0 V to ± 40 V

Measurement Display Range

Parameter	Range
|Z|, R, X	0.01 mΩ to 99.9999 MΩ
|Y|, G, B	0.01 nS to 99.9999 S
C	HP 4284A: 0.01 fF to 9.9999 F HP 4285A: 0.01 fF to 999.999 μF
L	HP 4284A: 0.01 nH to 99.9999 kH HP 4285A: 0.001 nH to 99.9999 H
D	0.000001 to 9.99999
Q	0.01 to 99999.9
θ	–180.000° to 180.000°
Δ%	–999.999% to 999.999%

Basic Measurement Accuracy

	|Z|, C, L	D
HP 4284A	0.05%	0.0005
HP 4285A	0.1%	0.001

@ 23° ± 5° C, after OPEN and SHORT correction

Supplemental Characteristics

Measurement Time: Typical measurement time from the trigger command to the end of measurement (EOM) output at the handler interface connector

	HP 4284A at 1 KHz	HP 4285A 75 kHz to 30 MHz
SHORT	40 ms	30 ms
MEDIUM	190 ms	65 ms
LONG	830 ms	200 ms

Option 001 DC Bias Current Output: 100 mA max.

Display

LCD dot-matrix display: Displays measured values, control settings, comparator limits and decisions, list sweep tables, self-test messages, and annunciations.

Correction Function

Zero OPEN/SHORT: Eliminates measurement errors due to the test fixture's stray parasitic impedance.
Load: Improves measurement accuracy by using a calibrated device as reference.

List Sweep Function

A maximum of ten frequencies or test signal levels can be programmed. Single or sequential testing can be performed. When Option 001 is installed, dc voltage bias testing can also be performed.

6

Comparator

Ten-bin sorting for the primary measurement parameter. IN/OUT for the secondary measurement parameter.
Bin Count: 0 to 999999
List Sweep Comparator: HIGH/IN/LOW decision output for each measurement point in the list sweep table

Other Functions

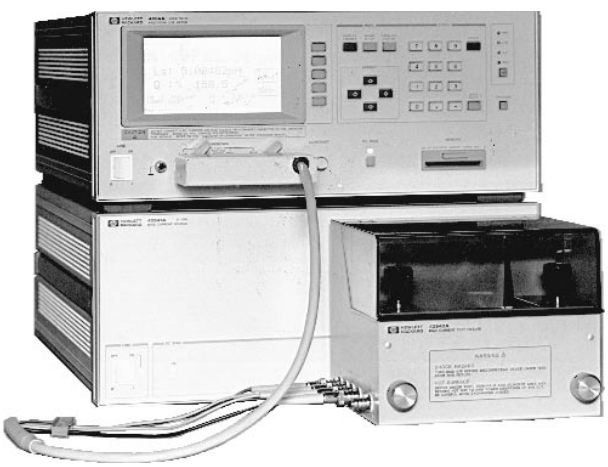
STORE/LOAD: Ten instrument setups can be stored/ loaded from the internal non-volatile memory. Ten additional setups can also be stored/loaded from a memory card.
HP-IB: All instrument control settings, measured values, comparator limits, list sweep table, and self-test results.
Memory: The memory buffer can store a maximum of 128 measurement results and output the data over HP-IB, ASCII, and 64-bit binary data formats.

General Specifications

Power Requirements: 100/120/220 V ± 10%, 240 V 5%/–10%, 47 to 66Hz
Power Consumption: 200 VA max.
Operating Temperature and Humidity: 0° to 55° C, ≤ 95% RH at 40° C
Size: 426 mm W x 177 mm H x 498 mm D (16.77 in x 6.97 in x 19.61 in)
Weight: Approximately 16 kg (35.2 lb)

Accessories

HP 42841A Bias Current Source
Bias Current Output: (23 ± 5° C); 0.01 A–20.0 A
Basic Impedance Accuracy: 1% when used with the HP 4284A/4285A (1 kHz to 1 MHz)
Interface: Custom, directly controllable by the HP 4284A/4285A with Option 002
HP 48242A/B Bias Current Test Fixture
Used with the HP 4284A and HP 42841A for high dc bias current measurements:
HP 42842A: 20 A max.
HP 42842B: 40 A max.
HP 42842C Bias Current Test Fixture
Used with the HP 4285A and HP 42841A for high dc bias current measurement. 10 A max.
HP 42843A Bias Current Cable
Used with the HP 4284A, HP 42841A (2 units), and HP 42842B for 40 A maximum applications



HP 4284A with HP 42841A and HP 42842A

HP 42851A Precision Q Adapter

Used with the HP 4285A for resonant Q measurements
Parameters Measured: Q-L, Q-C
Q Measurement Range: 5.00 to 999.99
Basic Q Accuracy: 5%
Measurement Time: 75 ms to 1.5 s
Interface: Custom, directly controllable by the HP 4285A with Option 002
Option 001: SMD Text Fixture

HP 4285A with HP 42851A

Key Literature

HP 4284A/HP 4285A/HP 4286A Precision LCR Meter Family Data Sheet, p/n 5963-5391E
HP 4284A Technical Data, p/n 5963-5390E
HP 4285A Technical Data, p/n 5963-5395E
LCR Meters, Impedance Analyzers and Test Fixtures Selection Guide, p/n 5952-1430

Ordering Information

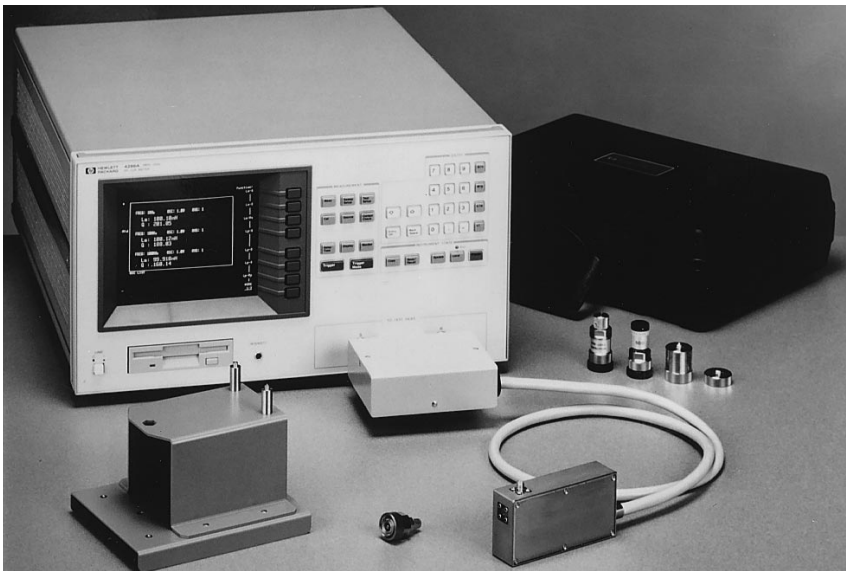
HP 4284A Precision LCR Meter
HP 4285A Precision LCR Meter
Opt 001 Power Amplifier/DC Bias (HP 4284A)
DC Bias (HP 4285A)
Opt 002 Bias Current Interface (HP 4284A)
Accessory Control Interface (HP 4285A)[1]
*__Opt 004__ Memory Card
Opt 006 2m/4m Cable Length Operation (HP 4284A only)
*__Opt 109__ Delete HP-IB Interface
*__Opt 201__ General-Purpose Handler Interface
*__Opt 202__ Handler Interface
*__Opt 301__ Scanner Interface
HP 42841A Bias Current Source
HP 42842A Bias Current Test Fixture (20 A max.)
HP 42842B Bias Current Test Fixture (40 A max.)
HP 42842C Bias Current Test Fixture (10 A max.)
Opt 001 SMD Test Fixture (HP 42842C only)
HP 42843A Bias Current Cable
HP 42851A Precision Q Adapter
Opt 001 SMD Test Fixture

[1] Options 001 and 002 do not operate simultaneously.

* Common options

HP 4286A

- 1 MHz to 1 GHz, with 10 kHz steps
- 1% basic accuracy
- High-speed measurements: 15 ms
- 1 m/3 m errorless cable with APC-3.5 test head



HP 4286A RF LCR Meter

HP-IB

High Accuracy with Wide Impedance Range

The HP 4286A RF LCR meter offers accurate and reliable measurements in order to improve the quality and performance of your electronic components or circuit design. The HP 4286A employs direct-current voltage-measurement technique, as opposed to the reflection-measurement technique, for more accurate impedance measurement over wide impedance range. Also, Q measurement can be much improved due to advanced calibration technique (typical Q accuracy: 6% @ 100 MHz, Q=100). So you can reduce the design uncertainty by measuring your device's true impedance values at RF range.

Ease of Use

The HP 4286A can be easily operated by pressing the front panel keys. In addition, the HP 4286A with Option 1C2 HP-IBASIC allows you to customize measurement, test sequences, process control, and perform data analysis. Also, a number of APC-7 SMD test fixtures are applicable to the HP 4286A with the furnished fixture stand and APC-3.5-to-APC-7 adapter. You don't need to build your own fixture.

Simplified System Integration and High Throughput

The HP 4286A is suitable for testing the electronic components in the production line at RF range. The 1 m/3 m option-selectable errorless cable with test head can be easily connected closely to the tip of the device-under-test of the handler without accuracy decrease. The built-in comparator function, a high-speed HP-IB interface, and an optional handler interface, are available for easily combining with the handler. The HP 4286A also allows you to reduce test time and improve testing efficiency and reliability. The measurement speed is especially remarkable (approximately 15 ms).

Specifications

(Refer to Data Sheet for complete specifications.)
Measurement Parameters: |Z|, |Y|, Theta, R, X, G, B, L, C, Q, D, ESR
Measurement Circuit Mode: Series and parallel
Operating Frequency: 1 MHz to 1 GHz
Frequency Resolution: 10 kHz
Source Characteristics:
- **OSC Level:** 10 mVrms to 1 Vrms; (output terminal open); 10 mVrms to 0.5 Vrms @ 3 m test head, ≥ 500 MHz
- **Basic OSC Level Accuracy:** 2 dB @ V ≥ 0.25 V
- **Display Level Unit:** V, I, dBm
- **Level Monitor Function:** Voltage, current
- **Connector:** APC-3.5

Output Impedance (Nominal Value)**:** 50 Ω
Trigger: Internal, external, manual, and HP-IB
Delay Time: Point delay time, list-sweep delay time
Averaging: Point average, list-sweep average
Impedance Measurement Range: 200 mΩ to 3 kΩ
Basic Measurement Accuracy: |Z|: 1%, D: 0.01
Measurement Time: 15 ms
Interface: HP-IB, handler interface
Display: 7-inch B/W CRT display
Storage:
- **Type:** Built-in 3.5-inch floppy disk drive; backup SRAM disk memory

Disk Format: LIF, DOS
Programming: HP Instrument BASIC (Option 1C2)
General Specifications
- **Operating Temperature/Humidity:** 10 to 50° C/15% to 80% RH
- **Warm-Up Time:** 30 min.
- **Power Requirements:** 90 V to 132 V, or 198 V to 264 V, 47 Hz to 66 Hz, 500 VA max.
- **Size/Weight**
  - **Main Frame:** 426 mm W x 234 mm H x 537 mm D; 28 kg
  - **Test Head:** 110 mm W x 55 mm H x 28 mm D; 0.3 kg

Key Literature

HP Precision LCR Meter Family Data Sheet, p/n 5963-5391E
HP 4286A Specification Sheet, p/n 5963-5394E

Ordering Information

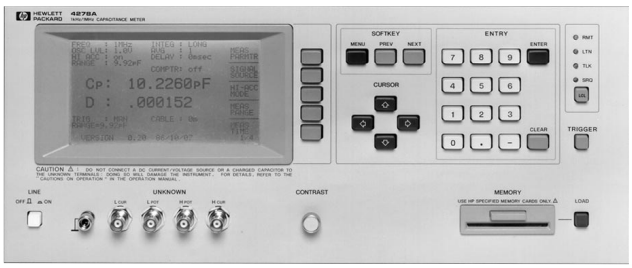
HP 4286A RF LCR Meter
Furnished Accessories: Right Angle Test Head (1m), APC-3.5-to-APC-7 Adapter, Test Fixture Stand, HP 16195A APC-7 Calibration Kit, Operation Manual, Floppy Disk, and Power Cable. (No test fixture is supplied with the HP 4286A.)
Options
- **Opt 021** Add Straight-Angle Test Head (1 m)
- **Opt 022** Add Straight-Angle Test Head (3 m)
- **Opt 031** Delete Right-Angle Test Head (1 m)
- **Opt 032** Add Right-Angle Test Head (3 m)
- **Opt 001** Delete HP 16195A Calibration Kit
- **Opt 002** Delete Test Fixture Stand
- **Opt 004** Add Working Standard Set
- **Opt 1C2** Add HP-IBASIC, Keyboard, Cable

Accessories Available
HP 16190A Performance Test Kit
HP 16191A Side Electrode SMD Fixture
HP 16192A Parallel Electrode SMD Fixture
HP 16193A Small Side Electrode SMD Fixture
HP 16194A High-Temperature Test Fixture
HP 16195A APC-7 Calibration Kit
HP 16092A Test Fixture (≤ 500 MHz)
HP 16093A Binding Post Fixture (≤ 250 MHz)
HP 16093B Binding Post Fixture (≤ 125 MHz)
HP 16094A Probe Test Fixture (≤ 125 MHz)
HP 16200A External dc Bias Adaptor (± 5 A, ± 40 V)

1 kHz/1 MHz Capacitance Meter

HP 4278A

- Measurement speed: 6.5 ms/10 ms/21 ms
- Measurement parameters: C-D,Q,ESR,G
- C-D measurement accuracy: 0.07%, 0.0005 (1 kHz, 21 ms); 0.05%, 0.0002 (1 MHz, 21 ms)
- High resolution: 6 digit, D:0.00001
- Intelligent built-in comparator: 10-bin sorting



HP 4278A

HP 4278A Capacitance Meter

The HP 4278A 1 kHz/1 MHz capacitance meter is a high-speed, highly reliable, precision test instrument aimed at incoming/outgoing capacitor inspection applications on the production line and in quality control. The HP 4278A will improve test efficiency by performing comparative measurements of low to medium value capacitors (up to 200 μF—a range that covers most ceramic and film capacitors). The HP 4278A's standard measurement frequencies and oscillator output levels are 1 kHz/1 MHz and from 0.1 V to 1 V in 0.1 V steps, respectively.

The built-in comparator function of the HP 4278A gives you the ability to sort parts into ten bins. A high-speed HP-IB interface and an optional handler interface are available for combining the HP 4278A with an automatic handler and an external computer, to build a total solution for automatic testing and data acquisition and analysis.

Specifications

(Refer to Data Sheet for complete specifications.)
Measurement Parameters: C-D,Q,ESR,G
Display: Dot-matrix LCD. 4, 5, 6 digits, selectable
Measurement Circuit Modes: Parallel and series
Test Signals
Frequency: 1 kHz and 1 MHz, ± 0.02%
Signal Level: 0.1 to 1 V rms, ± 10% (C≤ 20 μF), in 0.1 V rms steps
Measurement Time Modes: SHORT, MEDIUM, and LONG

Measurement Times

Mode	SHORT	MEDIUM	LONG
Time*	6.5 ms	10 ms	21 ms

*Measurement time includes settling, integration (analog measurements), calculation, and comparison times.

Measurement Range

Measurement Parameter	1 KHz	1 MHz normal mode 1 MHz high accuracy
C	0.001 pF to 200.000 μF	0.00001 pF to 1280.00 pF; 0.00001 pF to 2663.00 pF
D	0.00001 to 9.99999	0.00001 to 9.99999; 0.00001 to .99999

For 1 kHz normal mode: 7 decade ranges 100 pF to 100 μF full scale. 100% overranging on all ranges, (max. 200000 counts) when D ≦ 0.5.
For 1 MHz normal mode: 11 binary ranges, 1 pF to 1024 pF full scale. 25% overranging on all ranges, when D ≦ 1.
For 1 MHz high accuracy mode: Measurement range is ± 30% of the user-defined nominal value, maximum 2048 pF, when D ≦ 0.05.

Measurement Accuracy

It is specified at the UNKNOWN terminals and at the end of standard 1- or 2-m test leads under the following conditions:
- Warm-up time: ≥ 10 minutes
- Ambient temperature is 23 ± 5° C and variance is less than 0.2° C/minute
- Test signal level is set to 1 V rms
- Zero OPEN/SHORT compensation has been performed
- D ≦ 0.05 for 1 MHz High Accuracy Mode; D ≦ 0.1 for 1 kHz and 1 MHz Normal Modes
- Accuracies are only valid when the measured value is equal to the full scale of each range
- Accuracy stated in the tables is given for LONG integration time
- Accuracy equations are read as follows:
  C: ± (% of reading + % of full scale)
  D: ± (% of reading + absolute D value)
  (C: ± (% of reading + absolute C value) for Table 3)

Table 1: 1 kHz Measurement Accuracy

C range	C	D
100 μF	0.07% + 0.025%	0.065% + 0.0025
100 pF to 10 μF	0.05% + 0.025%	0.05% + 0.0005

Table 2: 1 MHz Normal Mode Measurement Accuracy

C range	C	D
256 to 1024 pF	0.1% + 0.02%	0.1% + 0.0005
4 to 128 pF	0.05% + 0.02%	0.1% + 0.0005
2 pF	0.05% + 0.03%	0.1% + 0.0005
1 pF	0.05% + 0.06%	0.1% + 0.001

Table 3: 1 MHz High Accuracy Mode Measurement Accuracy

Nominal C + Open Circuit C	C	D
1024 to 2048 pF	0.11%	0.0004
256 to 1024 pF	0.07%	0.0003
4 to 256 pF	0.05%	0.0002
2 to 4 pF	0.06% + 0.0004 pF	0.0003
0 to 2 pF	0.08% + 0.0004 pF	0.0006

Trigger Modes: Internal, external, or manual
Measurement Terminals: Four-terminal pair, guarded
Cable Length Compensation: 0, 1, or 2 m
Compensation Function: Zero OPEN/SHORT, standard, offset
Comparator: Ten-bin sorting for capacitance, and go/no-go testing for D, Q, ESR, and G
Self Test: Checks the HP 4278A's basic operation
Memory Card Slot: Memory card slot for external memory for storing and recalling control settings and comparator limits (memory card is optional–see Option 004 below)

General Specifications

Operating Temperature/Humidity: 5° to 45°C, 95% RH @ 40° C
Power: 100, 120, 220 Vac ±10%, 240 Vac +5 –10%, 48 to 66 Hz, 200 VA max.
Size: Approximately 426 mm W x 177 mm H x 498 mm D
(16.77 in x 6.97 in x 19.61 in)
Weight: Approximately 15 kg (33 lb, standard)

Key Literature

HP 4278A Capacitance Meter Data Sheet, p/n 5952-7882

Ordering Information

HP 4278A 1 kHz/1 MHz Capacitance Meter
Opt W30 Extended Repair Service
Opt 001 1 kHz Test Frequency Only
Opt 002 1 MHz Test Frequency Only
Opt 003 1% Frequency Shift: Prevents possible test signal interference when component test contacts are located close to those of other test units
Opt 004 Memory Card
Opt 101 HP-IB Compatibility
Opt 201 Handler Interface
Opt 202 Handler Interface
Opt 301 Scanner Interface
Accessories Available
HP 16270A Memory Card Set
HP 16334A Tweezer-Type Test Fixture for Chip Components
HP 16047A Direct-Coupled Test Fixture
HP 16047C Test Fixture
HP 16048A Test Leads, BNC (1 m)
HP 16048B Test Leads, SMC (1 m)
HP 16048D Test Leads, BNC (2 m)

HP 4339B
HP 4349B

- Wide measurement range: 1 x 10^3 Ω to 1.6 x 10^{16} Ω
- Stable test fixtures: resistivity cell, component test fixture
- High-speed measurement: 10 ms
- Test sequence programming
- Resistivity calculations
- Grounded DUT measurement

HP 4339B

HP 4339B High-Resistance Meter

The HP 4339B high-resistance meter is Hewlett-Packard's most advanced tool for making precision high-resistance measurements.

Precise and Stable Measurement

The measurement range is from 1 x 10^3 Ω to 1.6 x 10^{16} Ω, with a basic accuracy of 0.6%. This wide range allows accurate, high-resistance measurement of capacitors, relays, switches, connectors, materials, cables, and PC boards. The grounded device-under-test (DUT) measurement capability of the HP 4339B gives you the ability to evaluate cables and transformers under grounded conditions. The HP 16008B resistivity cell and the HP 16339A component test fixture are designed for stable and safe measurements of materials or components.

Ease of Use

The test-sequence program function allows you to control a series of resistance measurements in a sequence (charge-measure-discharge). You can set the charge time, measurement interval time, and number of measurements in a sequence through the front panel. The remaining time can be displayed when executing the sequence measurements. Surface resistivity (ρs) and volume resistivity (ρv) functions can be called to act upon measurement data. Calculated results are then automatically displayed, saving you time and effort.

High-Test Throughput

The 10 ms measurement time, 2 ms high-speed contact check function, built-in comparator, and HP-IB/handler interfaces deliver high-speed test throughput for production environments.

HP 4349B 4-Channel High-Resistance Meter

The HP 4349B 4-channel high-resistance meter is HP's highest throughput high-resistance meter for production testing of capacitors. The four-channel configuration permits simultaneous testing of four capacitors with different test voltages using external voltage sources. (Refer to Product Overview for HP 4349B specifications and ordering information.)

HP 4339B Specifications

(Refer to Product Overview for complete specifications.)
Measurement Parameters: R (dc resistance), I (dc current), ρs (surface resistivity), ρv (volume resistivity)
Mathematical Functions: Deviation and percent deviation
Display Digits: 3, 4, or 5 (selectable)
Test Voltage: 0.1 to 1000 Vdc, 0.1 V steps @ 0.1 to 200 V, 1 V steps @ 200 to 1000 V
Voltage Accuracy: (0.16% + 100 mV) @ ≤ 200 V, (0.16% + 500 mV) @ > 200 V
Maximum Current: 10 mA @ ≤ 100 V, 5 mA @ ≤ 250 V, 2 mA @ ≤ 500 V, 1 mA @ ≤ 1 kV
Current Compliance Setting: 0.5 mA, 1 mA, 2 mA, 5 mA, 10 mA
Output Resistance: 1 kΩ ± 10%
Input Resistance: 1 kΩ ± 10%
Test Cable Lengths: 2 m maximum

Measurement Range/Accuracy

Parameter	Measurement range	Basic accuracy
I	60 fA to 100 μA	± 0.4%
R (Ω)	1 x 10^3 Ω to 1.6 x 10^{16}	± 0.6%

Measurement Time: Time interval from a trigger command to the end of measurement (EOM) signal output at the handler interface port (range: hold, display, off)

Mode	Time (typical)
SHORT	10 ms
MEDIUM	30 ms
LONG	390 ms

Correction Function
Zero OPEN: Eliminates measurement errors due to stray parasitic resistance in the test fixtures
Test Sequence Program: Controls a series of resistance measurements. Charge time, measurement internal time, and measurement number can be programmed.
Comparator Function: HIGH/IN/LOW for the measurement parameter
Contact Check Function
Contact failure between the test fixture and device can be detected
Available DUT Type: Capacitive DUTs only
DUT Capacitance: ≥ 1 pF + 5% of residual stray capacitance
Residual Stray Capacitance of the Fixture: ≤ 50 pF
Additional Measurement Time for Contact Check: 2 ms
Other Functions
Save/Recall: Ten instrument setups can be saved/recalled from the internal nonvolatile memory
Continuous Memory Capability: If the instrument is turned off, or if a power failure occurs, instrument settings are automatically memorized (≤ 72 hours at 23° ± 5° C)
HP-IB Interface: All control settings, measured values, and comparator information
Handler Interface: All output signals are negative-logic, optically isolated open collectors. Output signals include: HIGH/IN/LOW, no contact, index, end of measurement, and alarm. Input signals include: high voltage off, keylock, and external trigger.

General Specifications

Power Requirements: 90 to 132 V or 198 to 264 V, 47 to 66 Hz, 45 VA max.
Operating Temperature: 0° to 45° C
Size: 320 mm W x 100 mm H x 450 mm D (12.6 in x 3.94 in x 17.72 in)
Weight: 6.5 kg (14.3 lb)

Furnished Accessories

Operation manual, shunt connector, power cable (Test fixtures and/or test leads must be ordered separately.)

Key Literature

HP 4339B/HP 4349B High Resistance Meters Product Overview, p/n 5964-6182E

Ordering Information

HP 4339B High-Resistance Meter
Opt ABA US-English Localization
Opt ABJ Japan-Japanese Localization
Opt OBO Delete Operation Manual
Opt W30 Extended Repair Service
HP 16339A Component Test Fixture
HP 16008B Resistivity Cell (50 mm Diameter Electrode)
Opt 001 Add 26/76 mm Diameter Electrodes
Opt 002 Add 26 mm Diameter Electrode
Opt 003 Add 76 mm Diameter Electrode
HP 16117B Low-Noise Test Leads (1 m, 2 clips)
Opt 001 Add Pin Probes
Opt 002 Add Soldering Sockets
Opt 009 Delete Alligator Clips
HP 16117C Low-Noise Test Leads (1 m, connectors)
HP 16118A Tweezer Test Fixture
HP 16064B LED Display/Trigger Box

HP 4338B

- Low and selectable test signal current: 1 μA to 10 mA
- Wide measurement range: 10 μΩ to 100 kΩ
- 10 μΩ resolution
- Contact check function
- 1 kHz ac measurement
- High-speed measurement: 34 ms
- Built-in comparator
- Auto-measurement mode

HP 4338B

HP 4338B Milliohmmeter

The HP 4338B milliohmmeter is a precise, reliable, high-speed test tool for measurements of low resistance.

Precise, Low-Resistance Measurement

Contact failure of electromechanical components in a low-current circuit is a key issue for component reliability. The HP 4338B offers selectable low ac test signals (1 μA to 10 mA). Users can now characterize low resistances of electromechanical components under low-current conditions. A high resolution of 10 μΩ allows you to determine the slightest differences in contact resistance testing of relays, switches, connectors, PC board traces and cables. The 1 kHz test signal eliminates potential errors introduced by thermoelectric effects on the device-under-test (DUT) contacts. The 1 kHz ac test signal is the best solution to evaluate the internal resistance of batteries, because it avoids dc energy consumption.

High-Speed Measurements

The high-speed (34 ms), built-in comparator and HP-IB/handler interfaces make it possible to construct a measurement system using an automatic handler and external computer to minimize production test time.

Auto-Measurement Mode

When performing gross continuity testing where the test signal level is not a significant factor in the test, the auto-measurement function allows the instrument to select an appropriate test signal and measurement range setting.

Specifications

(Refer to Product Overview for complete specifications.)
Measurement Function
Measurement Parameters: R (ac resistance), X (reactance), L (inductance), |Z| (impedance), θ (phase [°])
Combinations: R, R–X, R–L, |Z| –θ (series mode only)
Mathematical Functions: Deviation and percent deviation
Display Digits: 3, 4, or 5 (selectable)
Test Signal Characteristics
Test Frequency: 1 kHz
Frequency Accuracy: ± 0.1%
Test Signal Level: 1 μA, 10 μA, 100 μA, 1 mA, 10 mA rms
Level Accuracy: ± (10% + 0.2 μA)
Maximum Voltage Across Sample: 20 mV peak in any case

Measurement Range

Parameter	Measurement range
R	10 μΩ to 100 kΩ
X, |Z|	10 μΩ to 100 kΩ (typical)
L	10 nH to 10 H (typical)
θ	–180° to +180° (typical)

Measurement Accuracy: ± 0.4% Basic for R

Measurement Time: Time interval from a trigger command to the end of measurement (EOM) signal output at the handler interface port

Mode	Time (typical)
SHORT	34 ms
MEDIUM	70 ms
LONG	900 ms

Correction Function
Zero SHORT: Eliminates measurement errors due to parasitic impedances in the test fixture
Comparator Function
HIGH/IN/LOW for each primary measurement parameter and the secondary measurement parameter
Contact Check Function
Contact failure between the test fixture and device can be detected
Other Functions
Superimposed dc: ± 42 Vdc maximum may be present on measurement terminals.
Save/Recall: Ten instrument setups can be saved/recalled from the internal nonvolatile memory.
Continuous Memory Capability: If the instrument is turned off, or if a power failure occurs, instrument settings are automatically memorized (≤ 72 hours at 23 ± 5° C).
HP-IB Interface: All control settings, measured values, and comparator information
Handler Interface: All output signals are negative-logic, optically isolated open collectors.
Output Signals Include: HIGH/IN/LOW, index, end of measurement, and alarm. Input signals are keylock and external trigger.

General Specifications

Power Requirements: 90 to 132 V or 198 to 264 V, 47 to 66 Hz, 45 VA max.
Operating Temperature: 0° to 45° C
Size: 320 mm W x 100 mm H x 300 mm D (12.6 in x 3.94 in x 11.81 in)
Weight: 4.5 kg (9.9 lb)

Furnished Accessories

Operation manual, power cable (mating cable and test leads, or HP 16338A test lead set, must be ordered separately)

Key Literature

HP 4338B Milliohmmeter Product Overview, p/n 5964-6183E

Ordering Information

HP 16338A Test Lead Set
HP 16143B Mating Cable (0.6 m)
HP 16005B Kelvin Clip Lead (0.4 m, with large clip)
HP 16005C Kelvin IC Clip Lead (0.4 m, with IC clip)
HP 16006A Pin-Type Probe Lead (0.4 m)
HP 16007A Alligator Clip Leads (0.4 m, with 2 red clips)
HP 16007B Alligator Clip Leads (0.4 m, with 2 black clips)
HP 16064B LED Display/Trigger Box
HP 4338B Milliohmmeter
Opt ABA US-English Localization
Opt ABJ Japan-Japanese Localization
Opt OBO Delete Operation Manual
Opt W30 Extended Repair Service

Impedance Measuring Instruments

Evaluating Chip Inductors Using the HP 4291A
5091-9904E (Application Note 1255-2)
Highly Accurate Evaluation of Chip Capacitors Using the HP 4291A
5091-9267E (Application Note 1255-1)
HP 4192A LF Impedance Analyzer Data Sheet
5952-8896
HP 4194A Impedance/Gain-Phase Analyzer Technical Data
5952-7802
HP 4291A 1.8 GHz Impedance/Material Analyzer Data Sheet
5091-8596E
HP 4291A Technical Data
5962-6974E
Accessories Selection Guide for Impedance Measurements Configuration Guide
5965-4792E
HP E4915A Crystal Impedance Meter and HP E4916A Crystal Impedance/LCR Meter Product Overview
5965-1172E

(PN 16451B-1) Dielectric Constant Measurements Using the HP 16451B Test Fixture
5962-9522E
(PN 4291-1) New Technologies for Wide Impedance Range Measurements to 1.8 Ghz
5962-7177E
(PN 4291A-2) Evaluating Temperature Characteristics Using a Temperature Chamber and the HP 4291A
5962-6922
(PN 4291A-7) On-Chip Semiconductor Device Impedance Measurement Using the HP 4291A
5964-1690E

Materials Test Equipment

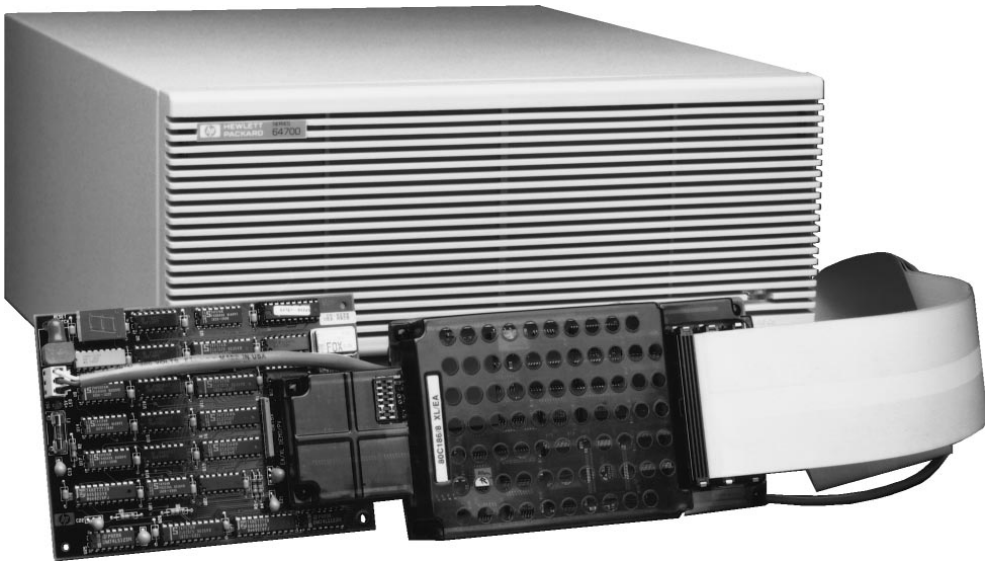
Permeability Measurements Using the **HP 4291A** and **HP 16454A**
5962-6972E (Application Note 1255-4)
Permittivity Measurements of PC Board and Substrate Materials Using **HP 4291A** and **HP 16453A**
5962-6973E (Application Note 1255-3)
Solutions for Measuring Permittivity and Permeability
5965-9430E
HP 4291A 1.8 GHz Impedance/Material Analyzer Data Sheet
5091-8596E
HP 4291A Technical Data
5962-6974E
HP 85070M Dielectric Probe Measurement System and HP 85070B High-Temperature Dielectric Probe Kit
5091-6247E/EUS
HP 85071B Materials Measurement Software Technical Data
5091-6248E/EUS
HP 16200A DC Bias Adapter Product Overview
5964-6700E
HP16451B Dielectric Test Fixture Data Sheet
5962-9522E
HP16452A Liquid Test Fixture Product Overview
5091-9228E

(PN 4291A) Impedance Measurements Using the HP 4291A and the Cascade Microtech Prober
5965-5054E
(PN 4291A-5) Dielectric constant Evaluation of Rough Surface Materials
5965-5055E

LCR & Resistance Meters

LCR Meter Family Brochure
5963-5391E
LCR Meters, Impedance Analyzers and Test Fixtures Selection Guide
5952-1430E
HP 16380A/HP 16380C Standard Capacitator Sets
5091-1390E
HP 4278A Capacitance Meter Data Sheet
5952-7882
HP 4286A Specification Sheet
5963-5394E
HP 4338B Milliohm Meter Data Sheet
5964-6183E
HP 4339B/HP 4349B High Resistance Meters
5964-6182E
HP 4284A Technical Data
5963-5390E
HP 4285A Technical Data
5963-5395E
HP 4279A 1 MHz C-V Meter Product Overview
5965-3414E
HP 4263B LCR Meter Product Overview
5964-6181E
HP E4916A RF LCR Meter Product Overview
5965-1374E

This page has been
intentionally left blank



A Complete Software Debugging Environment

The HP 64000 series development tools compose a comprehensive embedded software development, debugging, and analysis environment. The system continues to meet the increasing demands of software design with powerful tools that complement the emulators and analyzers. The resulting combination of development tools and system integration and analysis tools are integrated under a common user interface and operating environment to create an embedded design system that accelerates the development process.

Superior Design Tools at a Lower Cost per User

The addition of lower-cost debugging tools, such as processor probes that complement the emulators, allows each team member to have the necessary tools to accomplish his or her part of the task efficiently, at a lower cost per team member than was previously possible. These new lower-cost options also reside under the common user interface that allows software designers to move easily between simulators and debuggers and real-time analysis.

HP 64700 Series Emulators/Analyzers

Real-Time, Transparent Emulation and Analysis

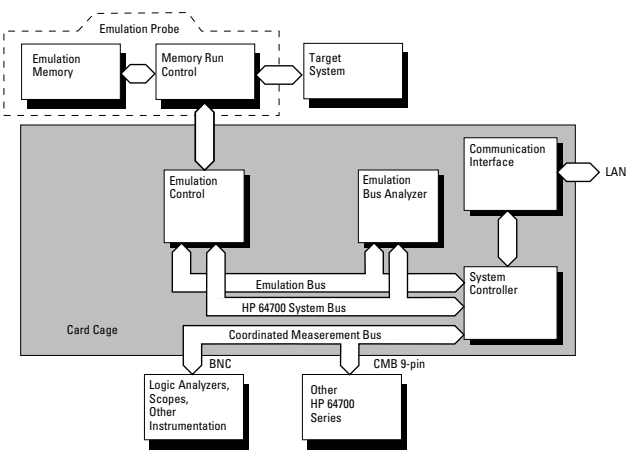
HP 64700 series emulators/analyzers provide real-time, transparent emulation and analysis for popular microprocessors. The HP 64700 series is made up of modular emulation and analysis tools that can be controlled from a terminal, an optional HP 9000 or Sun Motif-style interface, or a Windows-based PC-hosted interface. This choice of interfaces, plus high-speed program download, over LAN, makes for efficient embedded system development.

High Performance

- Real-time, transparent emulation
- Triggering capabilities in an emulation bus analyzer support eight-level sequencing, time tags, pre-store analysis for establishing software interrelationships
- 1K, 8K, 64K, or 256K trace memory
- PC-hosted real-time C debugger
- Workstation-hosted embedded debug environment
- In a workstation environment, a software performance analyzer card is available for evaluating and improving code performance and efficiency
- An 80-channel emulation bus analyzer available with trace buffer depths of 1K, 8K, 64K or 256K
- Synchronized operation and cross-triggering between multiple emulators for multiple processor designs
- Dual-bus architecture and dual-ported emulation memory to ensure nonstop, real-time emulation
- Fully tested to rugged electrical, temperature, and shock standards to ensure continued reliability and performance
- Meets international requirements for RFI/EMI emissions
- LAN interface provides high-speed, industry-standard communications to PCs or workstations

Choice of Design Environments

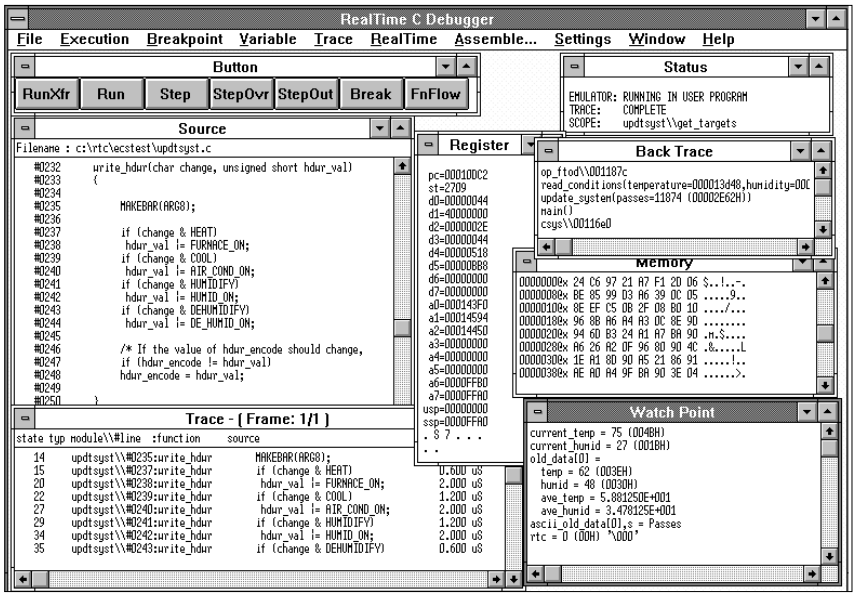
HP 64700 series emulators/analyzers offer several flexible configuration options. These host-independent emulation and analysis vehicles can be controlled from a simple terminal, or the emulator interface can be hosted on an MS-DOS-compatible PC, such as the HP Vectra PC. For large team-oriented or complex designs, the HP 64700 integration environment hosted on MS-DOS-compatible PC, HP 9000, or Sun workstations offers powerful development solutions.



HP 64700 series emulators/analyzers have a dual-bus architecture. This dual-bus architecture gives you maximum transparency by allowing traces to be executed and displayed without halting processor execution.

Key Literature

HP 64700 Series Development Tools for Embedded Design, p/n 5963-5141E



Real-time C debugger for PC-hosted HP 64700 series emulators offers powerful, nonintrusive debugging of embedded C and assembly code. Real-time concurrency allows several views to be active while a target system runs.

PC-Hosted Environment

The real-time C debugger is an MS-Windows-based, graphical user interface for HP 64700 emulators. It provides a mouse-driven method of controlling emulator functions, making measurements of target system activity, and controlling the state of a target system. The debugger takes full advantage of the HP 64700 emulator's dual-bus architecture to perform many C and assembly debug functions while the target runs at full speed. This means that C debugger functions such as setting breakpoints, display and edit of C variables, and measurement of C program behavior, which traditionally could only be performed when a user program was stopped, can now often be performed without interrupting program execution. Other operations, such as register display and modify are performed with much less intrusion than is possible with traditional debuggers.

This real-time C debugger provides the functions and features expected of a C debugger, as well as the capabilities expected of a traditional emulation interface. It supports a variety of HP emulators for Intel and Motorola processors and popular language tool file formats for those processors such as IEEE-695 and OMF-86. An Ethernet LAN connection to the emulator provides high performance while RS-232C capability is available for a serial connection. The real-time C debugger requires a PC running Windows 3.1, Windows 95 or Windows NT.

Workstation Interface

Easy-to-use interfaces are available on HP and Sun workstations. These interfaces are Motif-style, including terminal window operation, 3D look-and-feel, pull-down menus, point and click, cut and paste, and pop-up recall buffers and help screens. This interface makes it easy to move about an emulation session with pop-up windows, recall commands, specifications, and file history, reducing the need to remember many commands or file names.

Emulation Memory

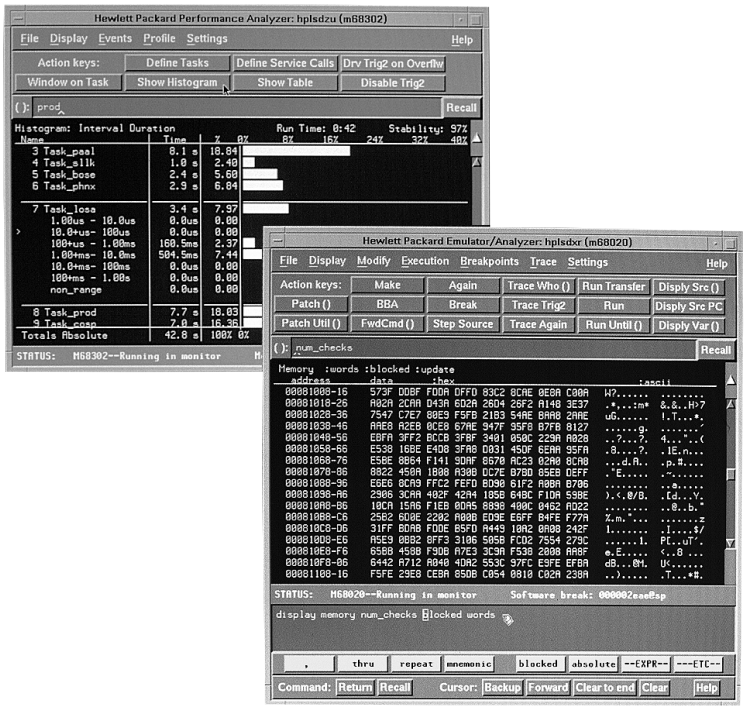
Dual-ported emulation memory in the HP 64700 series emulators runs at maximum processor speeds with no wait states for accurate duplication of target system performance. The dual-ported memory allows emulation displays and modifications of emulation memory without halting the processor during emulation. Memory can be mapped in 256-byte, 512-byte, or 1-Kbyte blocks, depending on the processor, and can be configured as either emulation or target RAM, emulation or target ROM, or guarded memory. The emulator checks for writes to ROM or guarded memory.

Popular File Formats

Popular absolute file formats are accepted by the HP 64700 series emulators, including Intel OMF-86, OMF-51, OMF-286, OMF-386, and IEEE-695.

Key Literature

Real-Time C Debugger for PC-hosted HP 64700 Emulators, p/n 5091-7156E
HP 64700B Card Cage, p/n 5962-6209E



The graphical user interface combined with the HP Software Performance Analyzer provides a complete, real-time view of program execution.

8-, 16-, and 32-Bit Emulation

High-quality, real-time emulators are the core from which HP has evolved support for the microprocessor software development process. Full-speed execution of microprocessor code can be traced and analyzed nonintrusively with or without functional prototype hardware. Emulation of multiple processors makes possible interactive measurements and coordinated execution starts of complex designs.

Emulators provide an essential link between the software development environment and the target system. Programs developed on the HP 64700 development environment are run on the emulation subsystem for real-time debug and analysis. The emulation bus analyzer provides the displays and triggering conditions for the emulator and is the access point for interactive emulation analysis. Processor-run controls in the emulator allow you to single step, display, and modify memory. Modifications and improvements to software are made quickly in the early design phases; emulation gives you the flexibility to experiment before committing a product to firmware.

Comprehensive Logic Analysis

Emulation Bus Analysis

Each HP 64700 series emulator includes an emulation bus analyzer for tracing microprocessor code flow. The analyzer trace depth may be selected to have 1K, 8K, 64K, or 256K states and has abundant resources for solving the most complex system problems. Up to eight hardware resources, each consisting of address, data, and status event comparators, can be combined in several fashions. Those resources can be grouped to establish complex sequential trace specifications using "find A, followed by B..." constructs, up to eight levels deep. A range comparator can be applied to address or data events at any one of the levels. Each event is tagged with an execution time for easy measurement of code execution times. A dual-bus architecture allows all traces to be set up and reviewed without breaking processor execution. A pre-store function allows tracking of relationships between a given software element and one or more other software events that influence that element. For example, pre-store helps pinpoint which of several different tasks accessing a variable is responsible for corrupting it.

Emulation bus analyzer features include:

- Eight levels of sequencing for complex program flow tracking
- Address, data, or status range resources
- Pre-store queue for variable access tracking
- Time tagging for instruction execution measurements
- Choice of 1K, 8K, 64K, or 256K trace memory
- Store qualification resources

Emulator Probing Accessories

HP's advanced probing and interfacing technology makes it easy to connect HP emulators to your embedded processor designs. Transition boards, flexible extenders and adapters are available from HP to accommodate package types for processors supported by HP emulators. These include PGA, PLCC, PQFP/CQFP and TQFP packages.

HP offers several probing options for connecting the HP 64700 series emulator to your target. HP offers flexible extenders which are devices that allow you to plug into microprocessor sockets that are in tight places like card cages. Transition boards are available which turn a generic device into a processor-specific one. Connection adapters are also available. These devices usually convert the connection from one package type to another. As an example, allowing the connection of a PGA emulator probe into a PQFP target. Please refer to the following list for the appropriate probing scheme for the emulator you're using.

HP 64000 Embedded Debug Environment

Tools of the HP Embedded Debug Environment

HP Processor Probes

- Provide debugging capabilities including run control
- Symbolic display and modification of memory and registers
- High-speed code download

HP Software Performance Analyzer

- Verify code performance by providing real-time measurements of code execution
- Works with RTOS measurement tool

Each tool provides a different perspective into the operation of embedded code. For example, using the software performance analyzer, you can trigger emulation trace measurements based on real-time code execution time. This makes it easy to determine why an important interrupt did not get serviced in the specified time interval. Emulation trace measurements can pinpoint problems and help direct you to a solution.

For more information on HP processor probes, see 369.

Flexible Extenders

Processor Type	Extender
68020 PGA	E3403A
68030 PGA	E3405A
68340 PGA	E3410A
68302 PGA	E3418A
80960SA/SB PLCC	E3419A
68000 PGA	E3420A
80C186XL PLCC	E3422A
80C186XL PGA	E3427A
68040 PGA	E3429A
68360 PGA (for emulator only)	E3430A

Emulator Probing Accesories

Motorola Microprocessor

	Package	Emulator	Flexible Extender	Probing Accessory	Comments
MC68000	PGA	HP 64744C	E3420A	—	PGA flexible extender
MC6800/HC001	PLCC	HP 64744D	E3422A	—	PLCC flexible extender
MC68020	PGA	HP 64748D	E3403A	—	PGA flexible extender
MC68020	PQFP	HP 64748D	—	E3404A	PGA to PQFP adapter
MC68EC020	PGA	HP 64748D	—	E3400A	020 to EC020 PGA adapter
MC68EC020	PQFP	HP 64748D	—	E3401A	PGA to PQFP adapter
MC68030/EC030	PGA	HP 64747B	E3405A	—	PGA flexible extender
MC68030/EC030	PQFP	HP 64747B	—	E3406A	PGA to PQFP adapter
MC68040/EC040	PQFP	HP 64783A/B	E3429A	—	PGA flexible extender
MC68040V	PQFP	HP 64783A/B	—	E3440A	040 to 040V adapter
MC68302	PGA	HP 64798C	E5367A	—	PGA adapter kit
MC68302	PQFP	HP 64798C	—	E3437A	PGA to PQFP adapter kit
MC68302	TQFP	HP 64798C	E5336A	—	144-pin TQFP adapter
MC68302	TQFP	HP 64798C	—	E5338A	TQFP flexible extender
MC68LC302	TQFP	HP 64798F	—	E5356A	100-pin adapter kit
MC68EN302	TQFP	HP 64798C	E5336A	—	144-pin TQFP adapter
MC68EN302	TQFP	HP 64798C	—	E5338A	TQFP flexible extender
MC6833x	PQFP	HP 64746J	E3407A	—	PGA to PQFP adapter
MC6833x	PQFP	HP 64782x	E3407A	—	PGA to PQFP adapter
MC6833x	TQFP	HP 64782x	—	E5359A	144-pin PQFP adapter
MC68340	PGA	HP 64751A	E3410A	—	PGA flexible extender
MC68340	PQFP	HP 64751A	—	E3409A	PGA to PQFP adapter
MC68340	TQFP	HP 64751A	—	E5358A	144-pin transition board
MC68360/EN360	PQFP	HP 64780A	—	E5363A	240-pin PQFP adapter
MC68360/EN360	PGA	HP 64780A	E3430A	—	PGA flexible extender

Intel/Hitachi Microprocessor

	Package	Emulator	Flexible Extender	Probing Accessory	Comments
I80186	PGA	HP 64767A	E3427A	—	PGA flexible extender
I80186XL	PGA	HP 64767A	—	E3413A	PGA to PQFP adapter
I80186	PLCC	HP 64767A	E3422A	—	PLCC flexible extender
I80C186EA/188EA	PQFP	HP 64767A	—	E3412	PGA to PQFP adapter
I80C186EB/188EB	PQFP	HP 64767B	—	E3414A	PGA to PQFP adapter
I80186EB/188EB/C186	PLCC	HP 64767B	E3419A	—	PLCC flexible extender
I80186XL	PGA	HP 64767A	E3427A	—	PGA flexible extender
I80L186/188EC	PQFP	HP 64767C/CL	—	E3432A	PGA to PQFP adapter
I80C186EC	PQFP	HP 64767C	—	E3424A	PGA to PQFP adapter
I80960SA/SB	PLCC	HP 64761A	E3419A	—	PGA flexible extender
I80386EX	PQFP	HP 64789C	—	E3417A	PGA to PQFP adapter
I80386EX	PGA	HP 64789C	—	E3442A	PGA transition board
H8S/2000	TQFP	HP E3471A	E3471B	—	TQFP flexible extender
H8S/2000	PQFP	HP E3471A	E3471C	—	PQFP flexible extender
H8S/2000	P/TQFP	HP E3471A	E3471D	—	TQFP/PQFP extender
H8/3003	PQFP	HP 64784A	—	64784C	QFP adapter
H8/3002/4X	PQFP	HP 64784A	—	64784D	QFP adapter
H8/300H	PGA	HP 64784A	—	64784E	QFP adapter
H8/3003	PGA	HP 64784A	—	64784F	PGA flexible extender
H8/3002/Rx	PGA	HP 64784A	—	64784G	PGA flexible extender
H8/303x	PGA	HP 64784A	—	64784H	PGA flexible extender
H8/3001	PGA	HP 64784A	—	64784J	PGA flexible extender
H8/3004/5	PGA	HP 64784A	—	64784K	PGA flexible extender

Software Performance Analysis

Software performance analysis verifies and benchmarks both high-level and assembly-level code, even when they are mixed. The software performance analyzer (SPA) can measure activity generated by your entire program, find the most active modules, determine if they are being called too often, and measure how long any subroutine takes to execute. These measurements show where your optimization effort will yield the greatest benefit.

An additional advantage of SPA is its ability to show convergence when measuring, for example, the duration of a process. SPA calculates a measurement error tolerance level each time additional data is acquired. Best of all, SPA lets you make software performance benchmarks and predictions before any costly hardware is produced.

SPA is closely coupled to the emulation/analysis environment by such features as cross-triggering and an enable/disable window. You can control when data is collected and filter out irrelevant activity.

The software performance analyzer provides overview measurements to aid in evaluating total system effectiveness of programs operating in real time. Global measurements let software designers determine where resources are being used in terms of execution times, memory usage, and interaction traffic. Software performance measurements aid in determining where to focus optimization efforts for maximum effect on system performance.

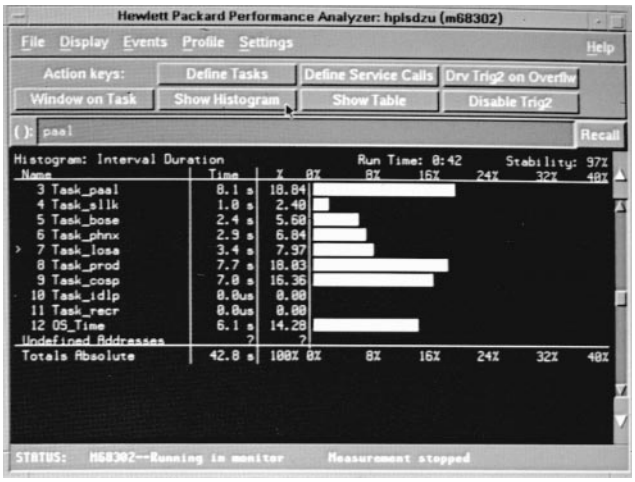
- Monitors up to 254 specified simultaneous events during activity measurements
- Monitors up to 84 simultaneous events in real time for duration measurements
- Supports 16- and 32-bit processors
- Graphical user interface that is compatible with X11/Motif
- Histogram or statistical data list displays
- Statistical data list includes mean, percentage, standard deviation, and maximum and minimum times by either state or time counts
- Hosted on HP 9000 Series 700 workstations and Sun SPARCstations

HP 64000 Debugger Relationships

HP has strong ties with several embedded software development partners. Our partners offer products including: development environments, optimizing compilers, source code control, graphical browsers and explorers, and source level debugging. These high-performance software products, combined with HP emulators, provide a full suite of tools for every phase of embedded systems design.

HP Software Development Partners

- **Microtec**
- **Cadul**
- **Cygnus**
- **Diab Data**
- **Green Hills**
- **Intermetrics**
- **ISI**
- **Microware**
- **Paradigm**
- **Pharlap**
- **Rational**
- **SDS**
- **Tartan Ada**
- **Thompson Software**
- **Wind River**

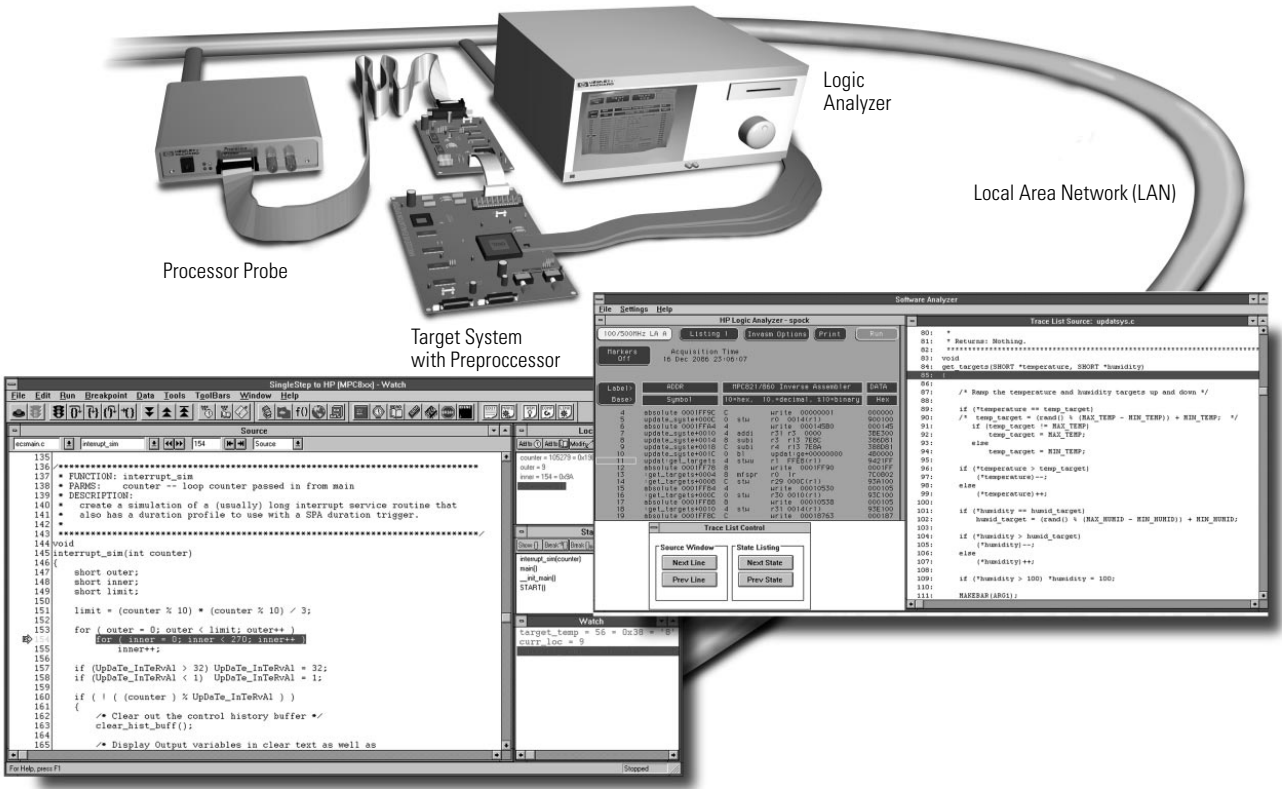


Optimize your code using the software performance analyzer and real-time, non-statistical measurements. With this analyzer you can measure program activity, locate the most active modules, determine if they are being called too often, and measure how long any subroutine takes to execute. The software performance analyzer operates in a workstation environment.

Ordering Information

The HP 64700 modular analyzers/emulators are a dynamic family of software and hardware development tools for embedded microprocessor-based systems. With development support for 8-, 16-, and 32-bit microprocessors, there are many combinations of solutions available. It is recommended that an HP field engineer be contacted for a suggested system configuration that will fit your application. For information about our products, visit our website (http://www.hp.com/go/emulator).

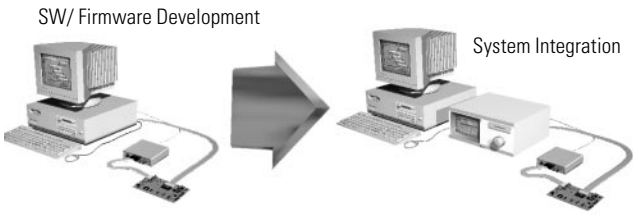
Processor Vendor	HP Emulator Support
Hitachi	H8/300X, H8/303X, H8/304X H8/510, H8/532, H8/536, H8/536S H8S/2000 Series, SH7032/34
Intel	80186, 80C186, 80C/L186EA, 80C/L186EB, 80C186XL 80188, 80C188, 80C188EA, 80C188EB, 80C188XL 80C186EC, 80L186EC 80386DX, 80386EX
Mitsubishi	MELPS 7700, 7750/51, M16C/60 Series
Motorola	68000, 68HC000, 68HC001 68EC000 68302, 68LC302, 68EN302 68020, 68EC020 68030, 68EC030 68040, 68EC040, 68LC040 68331, 68332, 68334, 68336, 68338 68340 68360, 68EN360, 68MH360
NEC	V40, V40HL V50, V50HL V53A, V55PI
Toshiba	TLCS 9000/42



Embedded Processors Today

Embedded processors continue to evolve into more complex architectures, faster bus speeds, and more product variations within processor families. In response to these trends, HP has developed emulation solutions, which help designers get past the barriers imposed by new complex processors.

Emulators typically include processor run control, real-time trace analysis, a debugger and development environment, and in some cases, overlay memory. HP emulation solutions offer these functionalities in a more flexible and scalable solution for your design team.



HP tools span all phases of the development phase.

HW/SW integrators and firmware developers need powerful tools to solve today's complex problems in the form of a scalable solution with a consistent interface across all tools. Three types of solutions are available:

- Complete HP emulation solution—System Integration
- Hardware-assisted run-control with the HP processor probe—Software or Firmware Development
- Logic analyzer with a preprocessor—Hardware Developer

Some members of a design team have different needs. With HP emulation solutions, the design team can customize the pieces of the solution to their individual needs without purchasing unnecessary equipment.

HP emulation solutions combine powerful, general-purpose HP logic analysis equipment with debuggers and HP processor run control for a complete development and debug environment.

To protect your investment, the logic analyzer can be used by others on the current project or future projects. Depending on future designs, you may only need to purchase a preprocessor and possibly a new processor probe.

Complete HP Emulation Solutions

The complete HP emulation solution includes an HP logic analyzer, an HP processor probe, an HP software analyzer, and a connection to a debugger.

Logic Analyzer

Logic analyzers have historically been used by hardware designers to find tough design problems. Today, the logic analyzer is used in many embedded designs to solve both hardware and software problems. Technological advances such as LAN and X-Window interfaces have expanded the role of a logic analyzer across the entire design team. With an expanded-use model, the logic analyzer provides a powerful tool to address the problems associated with system integration.

Preprocessors are processor-specific mechanical and electrical interfaces between HP logic analyzers and the processor. An inverse assembler, which helps correlate measurements to assembly-level code, is included with the preprocessor. Other post-analysis software is available to show code coverage and filter out unexecuted prefetches.

There are several HP logic analyzer solutions depending on your requirements and budget constraints. The HP 1660C/CS or HP 1670D series provide a benchtop solution, while the HP 16500 series offers a modular solution. See page 370 for a complete overview of the logic analyzers available from HP.

Software Analyzer

The HP software analyzer provides a window interface that allows designers to view their actual source code time-correlated to the trace display. Trigger conditions can be set up using symbolic names instead of address values.

The HP software analyzer is available for several hosts, or on the HP 16505A Prototype Analyzer. See page 375 for a complete description of the HP software analyzer and the system requirements.

Symbol tables provide the link from your source code to the execution trace captured by the logic analyzer. This makes it possible to view symbols instead of addresses in the trace.

HP currently supports several file formats including IEEE-695, OMF86/286/386, OMF96, ELF/DWARF, Cygnus a.out, TI COFF, ELF/STAB, and general-purpose ASCII. Compiler vendors also offer translation tools between the various file formats.

Processor Probes

HP processor probes allow you to solve many in-circuit debug problems at a lower cost-per-seat. The processor probes provide run control, high-speed code downloading and memory/register display and modification.

Connection to source level debuggers provides features for memory modification and code downloading. Program execution can also be controlled by setting software breakpoints from the debugger interface or with externally-generated breakpoints.

Access to the target for the processor probe doesn't require a physical connection to all the pins on the processor. A simple connector designed into the target board is all that is needed. The processor probe interfaces with the Background Debug Mode (BDM) pins found on Motorola processors or the J-TAG pins found on new generation Intel, Motorola, ARM and IBM processors.

Depending on future analysis needs, additional components may be purchased for a complete system debug environment. Your equipment investment is protected and you have a scalable solution for future needs.

HP E3458A CPU 32 Processor Probe

Full-Featured Debugger Interface

HP processor probes are currently supported by the following debugger vendors to provide complete emulation solutions: Cad-Ul, Green Hills Software, Microtec, Rational, PLS and SDS. A full-featured debugger is used to control the processor probe over the LAN and download code to the target.

For more information on debugger connections, contact your debugger vendor or local HP representative.

Ordering Information

All solutions listed below require a debugger unless otherwise stated.

Supported Processor	Processor Probe	Preprocessor Interface	Key Literature
Hitachi SH7050	E3473A	—	—
Hitachi SH7040	E3472A	—	5965-5180E
IBM and Motorola PowerPC 6xx	E3452A	—	5965-2789E
PowerPC 603/603e	E3452A	E2455B	5965-6037E
Intel Pentium processor	E3491A*	E2457A*	5963-6855E
Intel Pentium Pro	E3493A*	E2466B*	5965-6036E
Intel Pentium II processor	E3493A*	E2466C*	5965-6036E
Motorola 683xx	E3458A		5962-9539E
Motorola MPC 505/509	E3456A	E2490A	5966-0235E
Motorola MPC 821/860xxx	E3497A	E2476A	5965-5053E
Motorola MPC 850	E3497A	—	5965-5053E
Motorola MPC 801	E3497A	—	5965-5053E
Toshiba R3900 Series	E3429A	—	5965-1529E

* Only available with the HP 16505A Prototype Analyzer. No debugger required. Refer to page 372.

A processor probe is all that is needed for run control. A complete emulation solution configuration with run control and trace analysis requires a preprocessor interface, a processor probe and a logic analyzer. For the latest microprocessors support, contact your local HP representative.

Key Literature

HP B3740A Software Analyzer, p/n 5962-7114E
HP B4620A Software Analyzer Tool Set, p/n 5964-9333E
HP Distributed Emulation—Flexibility for the Future, p/n 5964-9773E
HP Distributed Emulation—color brochure, p/n 5964-9952E

Also see literature listed in chart above.

All solutions listed below require a debugger unless other wise stated.

HP Processor Probes for In-Target Debugging

HP processor probes allow you to get much of your day-to-day debugging done at a lower cost-per-seat. They easily integrate into your computer network and complement HP logic analyzers.

High-Speed Code Download

HP processor probes have been designed to the same high standards as our high-end HP 64700 series emulators. In general, the probes download code to your target system at a rate of 4 MB/minute, as fast as our high-end emulators. You'll also notice the speed of the processor probes when you single-step through your code.

Easy Connection to Your Target System

The HP processor probes do not directly probe the microprocessor. Instead, a standard connector provides access to the chip's internal debugging features. HP supports built-in debug features including Background Debug Mode (BDM), JTAG and others. This makes it much easier for you to connect to your target system and allows you to begin debugging quickly. This ease of connection is a benefit whether you're debugging a released product in the field or designing a new system.

Debugging Functionality

HP processor probes support much of the functionality you need to do day-to-day in-target debugging of software. For example, you can set breakpoints, symbolically modify registers and memory, and download code to the target system.

Integrated with Other HP Development Tools

HP processor probes can trigger or be triggered by other HP development tools such as the HP logic analyzers. For example, you can use the HP software analyzer to specify a trigger condition that will capture a real-time trace using the HP 16500C logic analysis system and display it as high-level source code. Simultaneously, the software analyzer can trigger the processor probe to generate a break in program execution.

Interfaces on UNIX and MS-Windows Platforms

Source level debuggers provide the interface for HP processor probes. From the debugger you can control the processor probe in the high-level source context you're familiar with. For example, you can set a breakpoint by simply "clicking" with your mouse on a source line. Modifying a variable is done by using a high-level language expression. Source level debuggers are available from Cad-UI, Green Hills Software, Microtec, Rational, PLS and SDS.

Lower Cost-Per-Seat

An ideal development system includes a high-end HP 64700 emulator/analyzer and/or an HP software analyzer along with processor probes for all engineers doing in-target debugging. The HP processor probes are one-quarter to one-third the price of a traditional emulator so you can outfit your entire design team at a lower cost-per-seat.

Supported Processors

HP processor probes support a variety of microprocessors. Because we are constantly adding support, please contact your HP sales representative if your chip is not listed on page 392.

Terminal Mode Operation

A firmware-resident ASCII terminal interface is embedded in the HP processor probes. Commands are ASCII strings; file transfers using industry-standard formats are accepted. Since a terminal can access these commands, host independence is realized. This interface is ideal for remote field applications, and for use of portable computers, field service, or other applications where a host is impractical or unavailable.

Key Literature

HP Distributed Emulation—Flexibility for the Future, p/n 5964-9773E
Solutions for the Motorola MPC 800 Embedded Power PC Microprocessor Family, p/n 5965-5053E
HP E3458A Processor Probe for Motorola CPU32 Microcontrollers, p/n 5965-6676E
HP E3491B Pentium Processor Probe, p/n 5963-6855E (see page 391 for more information)
HP E3492B Distributed Emulation for Toshiba R3900 Family, p/n 5965-1529E
HP E3452A Processor Probe for the Power PC 400 and 600, p/n 5965-2789E
HP E3492A Embedded MIPS Processor Probe, p/n 5964-3958E

HP provides a broad range of logic analyzers that help you solve your hardest problems the fastest way.

HP 1660 and 1670 Series Benchtop Logic Analyzers

Identifying the cause of problems in embedded microprocessor system designs can be difficult. Hewlett-Packard benchtop logic analyzers have the features to help you troubleshoot hardware and find software defects fast.

The HP 1660 and 1670 series logic analyzers can capture a real-time software trace from your microprocessor and correlate it to source code in C and other high-level languages. They can also verify critical timing relationships in hardware and show analog waveforms. This combination of features makes HP benchtop logic analyzers especially well suited to find problems at the integration stage of prototype hardware and software.

Product Summary

The HP 1660 logic analyzers include nine models with 34, 68, 102, and 136 channels so you can match the instrument to your specific needs. Members of the HP 1660 family have sophisticated timing and state analysis capabilities and an optional LAN interface for networked operation. The CS models add a built-in two channel oscilloscope with 1-GSa/s performance.

Upgrade kits are available for HP 1660 series logic analyzers to add more functionality and protect your existing investment.

The HP 1670 logic analyzers knock down the barrier between deep-memory logic analysis and your budget. They have up to 1M samples of acquisition depth and a standard LAN interface at prices well below those of comparable products. These models are suited for real-time software debug applications and come in channel counts to match your microprocessor.

See page 385 for more information about HP benchtop logic analyzers.

HP 16500C Modular Logic Analysis System

The HP 16500C modular logic analysis system helps you quickly solve today's problems while providing a growth path to tomorrow. Since 1987, HP has continuously upgraded and improved the performance of the HP 16500 system.

The HP 16500C is a measurement resource for the entire digital design team. Design team members can make a variety of time-correlated, simultaneous measurements, from analog to source-code-referenced traces.

Product Summary

Capture data from multiprocessor systems using up to 1,020 channels of 100-MHz state analysis with 4-Kb/channel memory depth, or up to 680 channels of 110-MHz state analysis with 2-Mb/channel memory depth. All data is time-correlated (see page 376).

Track down signal integrity problems with HP's 2-GSa/s digitizing oscilloscope module (see page 380).

Simulate missing boards or create low-volume test systems with the HP 16522A 200 M vectors/s pattern generator, which provides complex stimulus programs with 258,048 deep memory (see page 383).

Remotely operate and view measurements and access data from the convenience of your office, or from a remote site. The X-Windows protocol is used to bring the HP 16500C interface into your windowed environment, on PCs or workstations (see page 376).

Software developers can access and track real-time processor traces referenced to source code instructions with the HP B4620A Software Analyzer while obtaining traces that are 2-Mb/ channel deep (see page 375).

HP 16505A Prototype Analyzer

Use the power of HP 16505A's visual measurements environment to find the toughest integration and debug problems. The prototype analyzer is a complete environment for system integration and debug for the entire digital design team.

View your system's behavior from signals to source code. Instantly switch from off-line analysis to real-time measurements as you track down problems. Control your target system with optional processor run control and correlate results in real-time. Filter large data records to discover hidden dependencies.

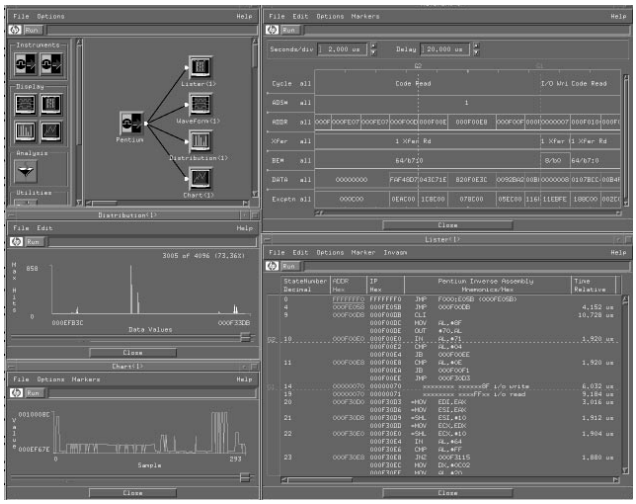
Product Summary

The HP 16505A works in conjunction with the HP 16500C logic analysis system mainframe and popular measurement modules. The prototype analyzer is a turnkey data analysis and display processor, enabling the entire design team to view time-correlated measurements and uncover hidden system relationships. You have complete control over measurements from your lab, office, or another remote site.

View and correlate your system's behavior across multiple processors and buses with the HP 16505A's window displays. The same measurement data can be viewed simultaneously with different display modes, such as waveform, listing, chart, source, and distribution, using drag-and-drop markers to provide time correlation across all displays. Or, use just one window to view activity from your multiprocessor system.

Quickly create, view, and modify measurements with drag-and-drop measurement tools which are always right at your fingertips. Rapidly modify or tear down measurements, or save your data and configurations for further analysis or documentation.

See page 371 for more information.



The HP 16505A couples powerful analysis, the benefits of a windows interface and the measurement capabilities of the popular HP 16500 series logic analysis system.

HP 16505A Prototype Analyzer

Reduce Your Integration and Debug Time

The HP 16505A prototype analyzer helps to quickly solve your toughest design integration and debug problems. The HP 16505A couples powerful analysis, the benefits of a windows interface and the measurement capabilities of the popular HP 16500C logic analysis system in one easy-to-learn and use measurement system. You can view your system's activity from analog signals to source code, all in one instrument. Simultaneous viewing of source, trace and waveform displays enable you to quickly track down cross-domain cause and effect.

Designed Around the Way You Work

HP has designed the prototype analyzer around the way you and your team work. You can move rapidly between post-capture analysis and real-time capture of another trace as you test theories about the nature of system crashes. Recall previously-stored measurements to conduct further analysis, then use the same instrument configuration to capture new data. Or save a measurement for later analysis with a colleague.

The HP 16505A is a turnkey system. You don't need to worry about operating system compatibility or computer configurations; just connect a PC SVGA monitor to the HP 16505A and you are ready to go.

Leading-edge networking technology enables you to access the prototype analyzer at your bench or from a remote location, using the X-Window System. You can remotely control and view the entire measurement system. The HP 16505A also acts as an X-Window System server, so you can view your X-Window-compatible applications right at your lab bench. The prototype analyzer also supports network printers.

Access HP 16505A data from your host computer using FTP or NFS. The HP 16505A acts as both an NFS client and server, so the prototype analyzer can dynamically link to source files stored on your file server. Perform off-line analysis using the file-in and file-out tools. Time correlation and symbolic links remain intact.

Quickly Create, View and Modify Measurements

Rapidly set up and tear down measurements as you test ideas about the nature of your system crashes. You simply "drag and drop" the appropriate instrument, analysis or display tool onto the workspace and connect the tools together. Instrument tools are similar to the popular HP 16500 series measurement module configuration, format, and trigger menus. Enhancements to the format and trace windows such as bit reordering and trigger libraries enable you to set up the instrument faster.

Real-Time Software Analysis

Software engineers can view real-time traces as source-line-referenced displays, with full symbolics. Use deep memory and multiple source displays to view both the cause and effect of subtle hardware/software integration problems. Trigger the analyzer directly from the source trace. Use built-in search functions to jump to the next occurrence of a source-code instruction. Use bookmarks to keep track of events in the trace. Post-processed filtering can be used along with inverse-assembly to provide a high-level overview of code flow.

Track the execution of variables in embedded systems graphically, using the chart display. Choose the variables you want to display from a built-in symbol browser. Popular symbol formats are supported; see page 375.

New Features NEW

Find Differences Between Acquisitions Easily

An essential aid to any debug process is the ability to quickly locate differences and similarities in your trace data. The compare tool provides a means to compare data from one measurement, subsequent measurement, or measurements taken on more than one analyzer. Quickly troubleshoot between a known good system and a system under test or characterize system performance over a range of temperatures.

Differences are highlighted using color in the listing display or shading in the waveform display. Configure the compare tool's labels, bit, range, alignment and termination conditions to display similarities and differences in the data to accelerate your problem solving. The tool can be tailored to compare the entire trace or a certain subset of the data.

Rapidly Create Reliable Stimulus Vectors

The powerful user interface of the HP 16505A allows you to quickly develop or import stimulus vectors for the HP 16522A pattern generator. Five automatic pattern fill utilities (fixed, count, rotate, toggle, and random) quickly let you generate and insert patterns into your sequences and user macros. (See page 383 for more information on the pattern generator capabilities.)

You can also turn logic analyzer data into vector sequences for the pattern generator. Use the file out tool to store logic analyzer traces in either the internal or ASCII format. Simply import the data directly into the pattern generator's INIT or MAIN sequences.

Control Your Target Microprocessor

The run control interface adds full microprocessor control capabilities to your HP 16505A for selected microprocessors (see page 392). The run control interface provides an easy, intuitive way to control your target processor execution, access internal registers, and display or modify internal or external memory in many different modes. With a processor probe and the logic analyzer, you can control the processor and make coordinated trace measurements. The interface supports code download for Intel Extended Hex, Motorola S-records, and plain binary formats.

View Time-Correlated Events that Occur Seconds Apart

The data you capture and observe is time-correlated. This means you can maintain timing relationships across measurement domains, such as state, timing and chart. Time-correlation means you can quickly move between windows using markers to uncover hidden relationships in your data.

You can examine your data using as many displays as necessary to analyze the measurement. See both the cause and the result of your system's problem by using multiple, time-correlated windows to view timing events that occur seconds apart. For example, you can view as many time windows in the waveform record as you want by just connecting additional waveform tools to the visual measurements graph.

Multiple, Sizable Windows

You can view data across multiple windows simultaneously. Each window is sizable up to the entire breadth of your local display at resolutions up to 1024 x 768.

Dynamically resize the waveform, histogram and chart displays using the mouse. Simply drag the mouse across the area you want to view in more detail and the window automatically rescales the viewing area for you. Use the right mouse button to instantly return to the previous scaling or center the trace about markers.

See up to 100 individual timing waveforms at one time, correlated with analog traces. Timing waveforms can be individually sized and colored so you can recognize important channels at a glance. Bus values can be displayed inside the waveform.

State listing windows can be sized to the maximum screen dimensions. Vary the data text size to suit your environment. Labels can be dynamically reordered to optimize your viewing area.

Rapidly Pinpoint Problems with Drag-and-Drop Markers

Global time-correlated markers enable team members to immediately pinpoint events between displays. As you move a global marker in one window, other data windows will follow. Local markers act as extra resources for measurements specific to the local display.

Find the source of a functional problem quickly by placing a global marker on its occurrence in the list or chart display and use time-correlated global markers to find the exact spot of the occurrence in the waveform display.

Drag-and-drop markers and paned-window marker controls make time-interval measurements easy. Simply drag the marker across the data and drop it where you want, then just read the time or sample value at the top of the window. Add marker functions to search for patterns or display data label values.

Use Post-Processing to Find Answers in Real-World Data

Use powerful post-processing sequencing capabilities to search or filter megabytes of trace data quickly. See just the address bus values you want using the HP 16505A's pattern filter tool. Or use the pattern filter on the data bus so you can see the data values that correspond to a variable.

The pattern filter can be used with any instrument tool from analog to state analysis. The flexible architecture of the prototype analyzer also allows you to view data before and after filtering. You can cascade pattern filters to get to just the data you want. In all cases, the data is time-correlated.

Key Product Characteristics

The HP 16505A prototype analyzer works in conjunction with popular measurement modules in the HP 16500C to provide a complete prototype analysis environment. You have full control over the HP 16500C and its measurement modules from the prototype analyzer. A high-speed data port between the HP 16500C and the prototype analyzer ensures fast screen update rates. Supported measurement modules include:

- HP 16517A/18A 4-GHz Timing/1-GHz State; 64K/128K depth
- HP 16522A 200 MVector/sec Pattern Generator; 258K depth
- HP 16532A 1-GSa/s Digitizing Oscilloscope; 8K depth
- HP 16533A 1 GSa/s Digitizing Oscilloscope; 32K depth
- HP 16534A 2 GSa/s Digitizing Oscilloscope; 32K depth
- HP 16535A MultiProbe 2-Output Control Module
- HP 16550A 100-MHz State/500-MHz Timing; 4K depth
- HP 16554A 70-MHz State/250-MHz Timing; 512K depth
- HP 16555A/D 110-MHz State/500-MHz Timing; 1M/2M depth
- HP 16556A/D 100-MHz State/400-MHz Timing; 1M/2M depth
- HP E2474A 200-MHz State Analyzer Module

The prototype analyzer is designed to sit on top of the HP 16500C system. The HP 16505A includes everything you need to begin making measurements, except a PC-compatible SVGA monitor.

Configuration files, data files and inverse assembly files can all be used as the basis for starting measurements with the prototype analyzer. If you currently own an HP 16500A or 16500B frame, you can upgrade to an HP 16500C frame using the HP E2479A Upgrade Kit (see page 397).

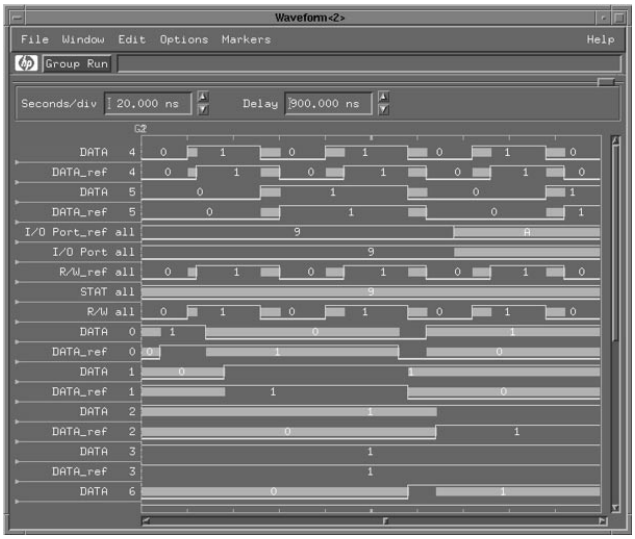
Printer Support: Parallel I/O interface supports PCL (B&W or color) and Postscript printers. PCL (B&W or color) or Postscript networked printers are also supported. TIF, PCX and Postscript image files can be created. ASCII-tabular data files (direct print files not available) can be created from the Listing display or from the file-out tool.

Network Protocols Supported: 15-pin AUI or RJ-45 physical Ethernet connections, TCP/IP, FTP, NFS (client and server), Telnet (in and out) and X-Windows (client and server). The HP 16505A can act as an X-server.

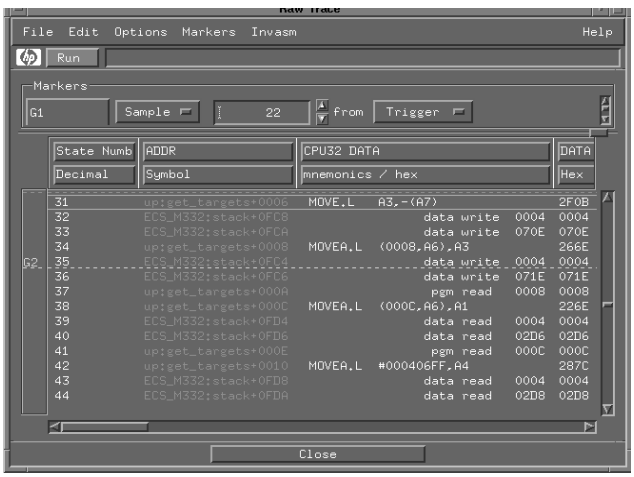
Key Literature

The HP 16500C Logic Analysis System and HP 16505A Prototype Analyzer, Product Overview, p/n 5965-3187E

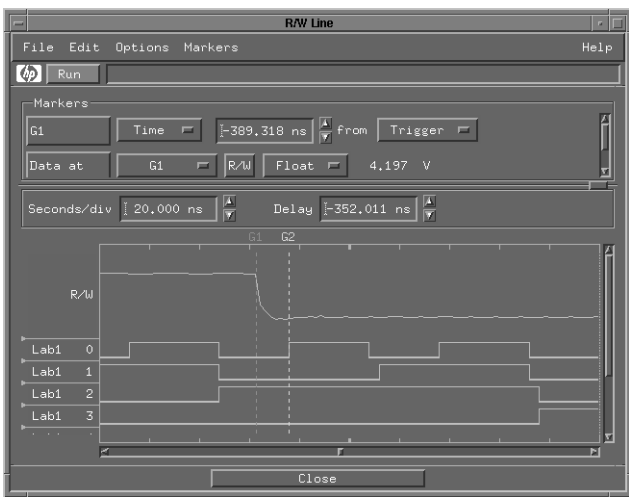
Configuration Guide, HP 16500C Logic Analysis System and Measurement Modules, HP 16505A Prototype Analyzer and Tool Sets, p/n 5965-3185E



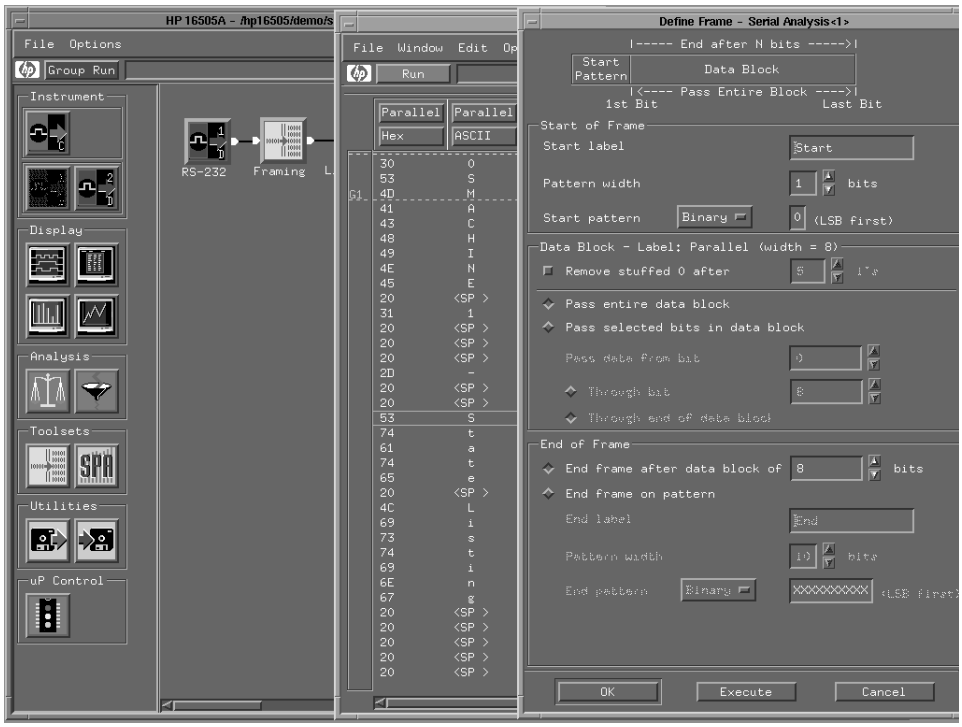
Shading in the waveform display helps you quickly locate differences in timing traces.



Simultaneously view time-correlated bus, inverse-assembled and source (not shown) trace data. Data columns can be individually reordered or assigned unique color. Traces from multiple processors can be displayed in the same display, or in separate displays, based on your viewing preference.



Instantly size, reorder or assign color to any waveform. Display time-correlated analog and timing traces from any instrument in the same display. Dynamically resize the viewing area with a swipe of the mouse.



NEW

The HP serial analysis tool allows you to quickly convert serial data streams into an easy-to-view and analyze parallel word format.

7

Analyze Serial Data in the Context of System Activity

Having the right tools to acquire and view serial data streams in the context of system activity is essential to evaluating and debugging complex digital designs. The HP B4601A serial analysis tool allows you to quickly convert serial data streams into an easy-to-view parallel word format. View the parallel data in hex, binary, octal, decimal, ASCII, or Twos complement format.

Because every logic analyzer trace is nonintrusive, and every event captured in the trace is time-stamped, you can correlate activity from your serial bus with other events in the target system. Global time-correlated markers enable you to quickly pinpoint events elsewhere in the system trace that directly correspond to the serial activity.

The HP B4601A serial analysis tool set is an optional package for the HP 16505A prototype analyzer. The serial analysis tool uses the full power of the HP 16505A prototype analyzer and HP 16500 logic analysis system to meet the unique debug needs of today's system designers using serial buses. All logic analysis modules supported by the HP 16505A can serve as data sources for the HP B4601A.

The HP B4601A serial analysis tool post-processes your acquired serial data. You can examine the converted parallel data in the listing and waveform displays. The serial analysis tools allow you to:

- Convert acquired serial bit streams into an easy-to-view parallel word format
- Time correlate real-time serial traces to system activity
- Process frame and data portions of the serial bit stream separately
- Reconstruct and convert serial data from a signal that has no external clock reference
- Specify MSB (Most Significant Bit) or LSB (Least Significant Bit) order
- Remove stuffed bits from the data block

Reduce Time Setting Up and Analyzing Serial Measurements

The serial tool provides you the flexibility to customize the tool setup to meet the analysis needs of your serial data stream. Quickly configure the tool for your proprietary serial data or standard serial protocols. Set up the tool once for your specific serial bus, then store the configuration for all future uses. Quickly recall previously captured traces for comparison or analysis purposes.

Markers allow you to quickly search from frame to frame in the data. Find the Nth occurrence of specific frames or data relative to the trigger, other markers, or the beginning or end of the trace.

Use Multiple Tools to Extract and Display Abstractions of Your Serial Activity

Multiple serial tools can be used in parallel when you want to view several serial lines simultaneously. Monitor send and receive transmissions on different lines at the same time. Input data from multiple tools into a single display.

You can also connect multiple HP B4601A tools serially. For example, with RS-232 data, use the first tool to strip start-and-stop bits, use the second tool to view frames of data.

Process Frame Information to Isolate Data

Framing data is useful if you want to synchronize the start of a serial to parallel conversion to a specific pattern of bits, or, to identify and convert "data blocks within frames" of data.

A graphic within the framing menu makes setup easy. The graphic changes to reflect your selections. You get immediate feedback as you configure the tool for your serial bit stream's frame and data configuration.

You also have the ability to remove stuffed bits from the trace before the other serial analysis functions are performed.

Capture Various Serial Formats

Capture and analyze serial bit streams that have no external clock reference. Use a timing analyzer to acquire the trace, then configure the serial tool to reconstruct the serial bit stream. RS-232 is an example of a bus with clocking embedded within the serial bit stream.

You can also capture and analyze up to 1 GHz serial bit streams using the HP 16517A high-speed timing/synchronous state analyzer.

Key Literature

The HP B4601A Serial Analysis Tool Set, p/n 5965-7591E

Profile Your System's Performance from Signals to High-Level Source Code

The HP B4600A system performance analysis (SPA) tool set for the HP 16505A prototype analyzer is designed to profile the entire system at all levels of abstraction—from signals to high-level source code—to clearly identify and optimize the components that affect the global behavior of your system.

The HP B4600A SPA tool set can be used during the entire prototyping phase of product design because it is based on the same HP 16500C measurement tools you already use. Adding SPA is as simple as dragging and dropping an icon. In addition to performance analysis, it can be used, at any time, to test and document characteristics such as memory coverage and response time.

The HP B4600A SPA tool set is an optional software package for the HP 16505A prototype analyzer. The SPA tool set uses the full power of the HP 16505A and HP 16500C logic analysis system. All measurement modules supported by the HP 16505A can serve as data sources for the HP B4600A without modification.

The HP B4600A SPA tool set generates statistical representations of data captured by the measurement modules. It helps provide answers to the following software and hardware performance questions:

Performance and Responsiveness

- What functions are most often executed by the processor?
- What functions are never executed?
- What is the relative workload of each processor in a multiple-processor system?
- What is the minimum, maximum, and average execution time of a function (including calls)?
- How many interrupts does the system receive per consecutive time slice?
- What is the response time of my system to an external event?

Coverage

- Do my test suites provide thorough coverage of my application?
- Is this function or variable accessed by the application?

Debug and System Parameter Analysis

- Does this pointer address the correct memory buffer?
- How does the system react when it receives too many interrupts?
- Is the stack size adequate?
- Is the cache size adequate?

Analog, Timing and Bus Measurements

- What is the setup/hold time of this signal or group of signals?
- Is the distribution of voltages of this analog signal acceptable?
- Is this signal spending too much time in the switching region?
- What bus states occur most often?
- What is the bus loading?
- How does the bus affect overall system performance?
- How much time is spent in bus arbitration?
- What is the histogram of bus transfer times?

Processor/Cache Measurements

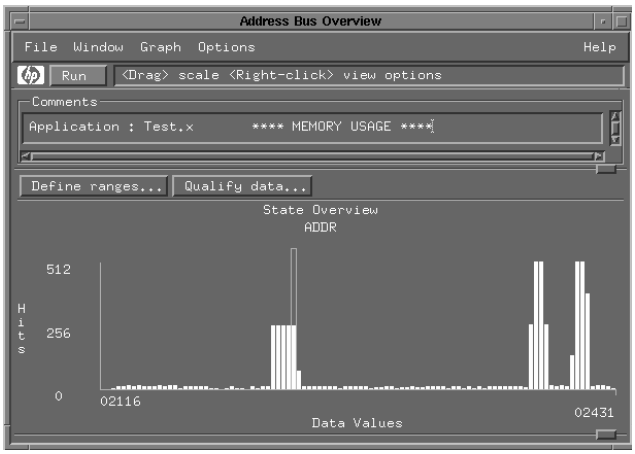
- Which processor bus states occur most often?
- Which peripherals are used most often?
- What is the profile of load sharing in a multiple-processor system?
- How does the cache size affect system performance?

Four Powerful Tools

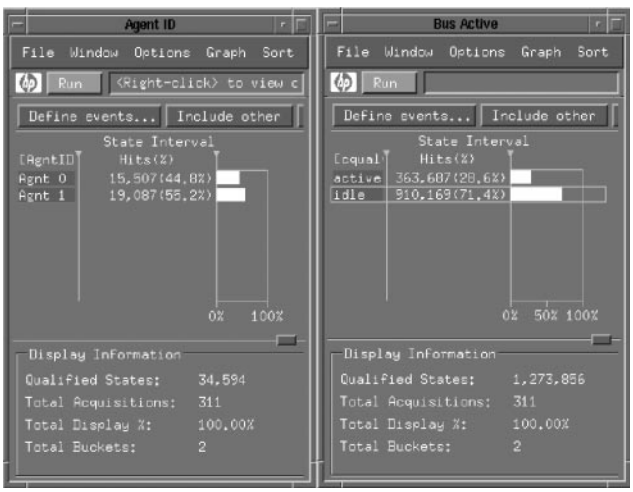
The HP B4600A System Performance Analysis Tool Set consists of four powerful tools:
1) the State Overview tool: an overview of bus/memory activity.
2) the State Interval tool: a histogram of event activity.
3) the Time Interval tool: a histogram of event times.
4) the Time Overview tool: an overview of occurrence rates over time.

Key Literature

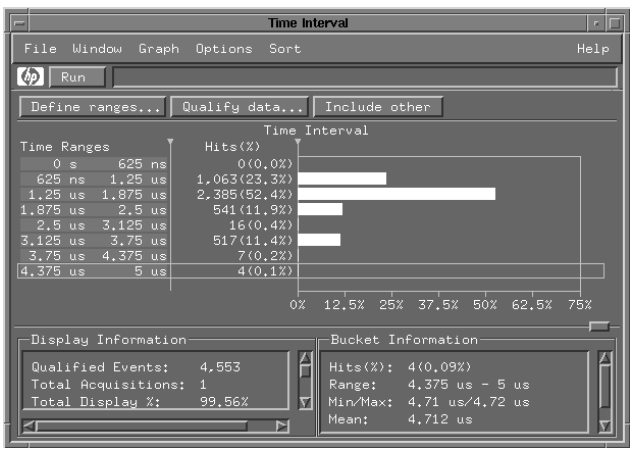
The HP B4600A System Performance Analysis Tool Set, p/n 5964-3561E



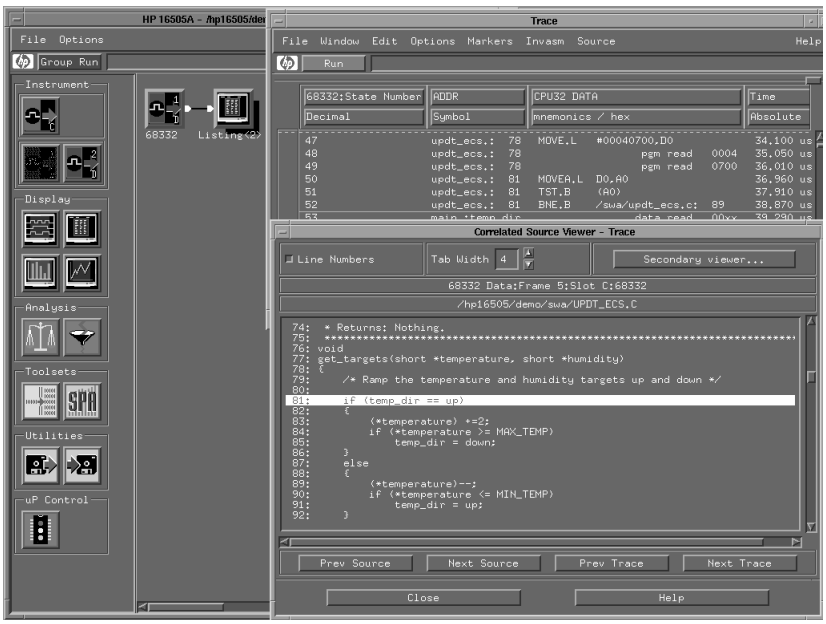
The State Overview tool displays the number of accesses for each memory location. It is used to display memory (or bus) activity and provides insight into which areas of the hardware or software are candidates for optimization.



The State Interval tool provides a histogram based on the occurrence level of functions, procedure, or events (or states) in a measurement. Symbolic information obtained from an executable file is used in this display to show the functions which are called most frequently. You can sort by frequency or alphabetically.



The Time Interval tool displays a distribution of the execution time of functions or the time between two user-defined events. The results help you determine the best- and worst-case execution times so you can help decide if optimization is required. The resolution and accuracy of the time-interval measurements are dependent on the measurement module used.



The HP software analyzer combines the versatility of a logic analyzer with an interface tailored to software developers.

Debug Real-Time Code at the Source Level

Use the HP software analyzer to link your real-time trace to your high-level source language. The HP software analyzer can be used with the HP 16500C and HP 16505A prototype analyzer (B4620A) or in conjunction with the HP Benchtop logic analyzers (B3740A). The HP B3740A requires the use of an external host computer.

Complements Your Current Debugging Tools

The use of a static software debugger and breakpoints allows the embedded software engineer to accurately inspect the state of a halted system at a fixed point in time. The real-time trace of a logic analyzer complements this tool by providing a complete software execution history that does not halt or impact the real-time performance of the target system.

See Source-Referenced Trace on Your Computer

The software analyzer acts as a file browser, enabling you to see the source code that was actually executed in real time by the target system. In another window, the trace information captured during program execution is displayed in assembly code.

The two windows are interlocked so you get a time-correlated view of your code execution in both high-level source and microprocessor mnemonics. You can single-step through the captured trace history, either forward or backward, by source line or by bus state. You can also correlate hardware events such as analog or timing waveforms to source code.

Point and Click on Source Code for Trigger Specification

The HP B4620A software analyzer makes it even easier to specify trigger conditions. Simply point the mouse at a line of source code, and the HP 16500C logic analyzer trigger control is reprogrammed. Save time by letting the software analyzer pinpoint trigger specifications. Just point and click and you're ready to go (available only in the HP B4620A).

A Familiar Context for Using a Logic Analyzer

The HP software analyzer uses your source code to simplify using a logic analyzer for software debug.

- Single step through execution history at the source code or assembly code level.
- Trigger the execution history by pointing and clicking on a line of source code (available only in the HP B4620A).
- Use source code symbolics in the execution history and for advanced triggering.

A System for the Entire Design Team

An HP logic analyzer equipped with the HP software analyzer becomes a system both hardware designers and software designers can use for prototype debug and verification. This system leads to quicker resolution of hardware/software integration problems by facilitating team interaction.

Extensive Symbolic Support with Your Language System

The HP software analyzer provides extensive symbolic support. Symbols from your software program can be used to specify trigger conditions and are also listed in the trace display. Examples of supported symbols include: variable names, function and procedure names, and module names. File formats supported include:

- HP/MRI IEEE-695
- Intel OMF86/286/386
- Intel OMF96
- Cygnus a.out
- Elf/Dwarf 1.0/1.1/2.0
- ELF/STABS
- TI-COFF

If none of these standard file formats is suitable for your application, a general-purpose ASCII file format is also available. The HP software analyzer requires LAN/TCP-IP connectivity to the location of your source code files.

Support for a Wide Variety of Computing Environments

The HP B4620A software analyzer is available on the HP 16505A prototype analyzer which can be used as an X-Window server on a compatible LAN network. See page 371 for more information on the prototype analyzer. The HP B3740A software analyzer is supported on the following computer systems:

- PCs running Microsoft Windows®
- Sun SPARC® Workstations running Solaris or SUN OS
- HP 9000 series 700 workstations running HP-UX

Microprocessor Support

HP supports many of the most popular embedded microprocessors with the software analyzer. Contact your local sales office for the latest list of supported microprocessors.

Key Literature

HP B4620A Software Analyzer, p/n 5964-9333E
HP B3740A Software Analyzer, p/n 5962-7114E

HP 16500C
HP 16501A
HP E2479A

The HP 16500C Mainframe

The HP 16500C mainframe and companion HP 16501A expander frame house up to 10 integrated, time-correlated measurement modules—state/timing analysis, oscilloscope analysis, pattern generation, ultra-deep data capture and ultra-high-speed timing. A consistent menu-driven user interface spans all modules.

A Complete Digital Design Team Tool

The HP16500C modular logic analysis system mainframe can be configured for a wide range of measurement tasks, including microprocessor debug with source-code referencing, timing verification and debug, software performance analysis, and characterization. The modular nature of the HP 16500C enables you to add new measurement modules as your needs change.

Fast, Direct User Interface

Save time with the HP 16500C color touchscreen. Simply point to the field you want to change; the touchscreen eliminates the need to search a front panel for the right button. Pop-up menus offer all choices at a glance and the software ensures that you always make a valid choice. Front-panel operations can also be executed with a mouse and/or keyboard, providing complete user-interface flexibility.

Commitment to Your Investment

Hewlett-Packard is committed to protecting your investment in the HP 16500 series. Since 1987, HP has continuously introduced new and more powerful measurement modules, system software upgrades and analysis/display functionality.

The HP E2479A upgrade kit transforms an HP 16500A or 16500B frame into a 100-percent compatible, newer-generation HP 16500C frame, at just over half of the cost of investing in a new frame.

7

Integration into Your Windowed, Networked Environment

The HP 16500C networked user interface brings logic analysis to your computing environment. You can use the HP 16500C's X-Window system interface for remote viewing and control at your workstation or PC. You can even operate an HP 16500C's LAN from remote locations across the Internet.

Obtain Network Access to Your Measurement Data

Easily move captured measurement data and screen images into your computer using the HP 16500C interface and either NFS or FTP file protocols. You can obtain captured data in a label-by-label ASCII format. Using the NFS protocol, you can mount the logic analyzer and treat captured or stored data as an extension to your file system. If you are not using the HP 16500C in a networked environment, you can store data and screen images to the MS-DOS®-based floppy disk drive.

Store Setups and Data Quickly with Built-in Mass Storage

It's easy to store and retrieve measurement results and setups with the built-in hard disk drive or 3½-inch floppy disk drive. Both disks are MS-DOS compatible.

Precise Intermodule Measurement Correlation

Run any HP 16500C measurement module independently or combine their capabilities and correlate their acquisitions with 2-ns resolution. The intermodule menu graphically communicates complex arming sequences in an easy-to-understand format.

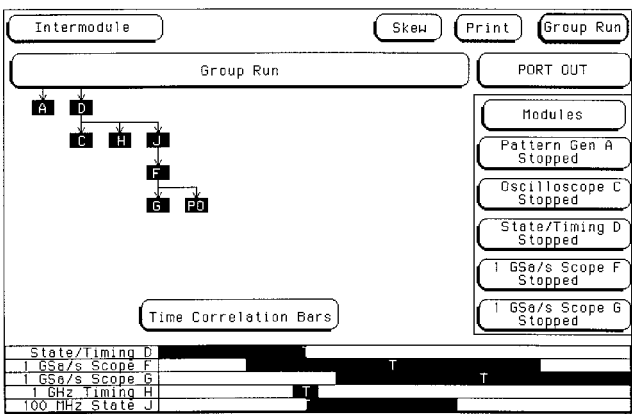
Use the state analyzer to identify a problem sequence, then arm the timing and oscilloscope modules to trigger only when the measurement context you are interested in occurs.

Key Literature

The HP 16500C Logic Analysis System and HP 16505A Prototype Analyzer, Product Overview, p/n 5965-3187E
Configuration Guide, HP 16500C Logic Analysis System and Measurement Modules, HP16505A Prototype Analyzer and Toolsets, p/n 5965-3185E
HP 16500C Logic Analysis System, Technical Specifications, p/n 5965-3184E

HP 16500C modular logic analyzer with color touchscreen, keyboard or mouse-driven user interface helps you quickly solve today's problems and provides room to grow in the future.

The HP 16500C's menus can be remotely viewed and controlled from a PC or workstation using the X-Window protocol.



Powerful cross-domain triggering helps you pinpoint problems that display symptoms in one domain but are caused by activity from another domain.

Key Specifications and Characteristics

	HP 16550A	HP 16555A/16555D[1]	HP 16556A/16556D[1]
Timing-analysis rate	Conventional: 250/500 MHz[2] Transitional: 125/250 MHz[2] Glitch: 125 MHz	Conventional: 250/500 MHz[2]	Conventional: 200/400 MHz[2]
State-analysis rate	100 MHz	110 MHz[3]	100 MHz
Channels/card **Channels/timebase**	102 204	68 204	68 340
Memory depth/channel	4 K/8 K[4]	1M/2M[4], 2M/4M[4]	1M/2M[4], 2M/4M[4]
Setup/hold time	3.5/0 ns to 0/3.5 ns adj. in 500 ps steps	3.5/0 ns to 0/3.5 ns adj. in 500 ps steps	3.5/0 ns to 0/3.5 ns adj. in 500 ps steps
Minimum detectable glitch	3.5 ns	3.5 ns	3.5 ns
Probe input R and C	100k Ω and ~ 8 pF	100k Ω and ~ 8 pF	100k Ω and ~ 8 pF
Triggering terms	Patterns: 10; Ranges: 2; Edge and glitch: 2; Timers: 2	Patterns: 10[5]; Ranges: 2; Edge and glitch: 2; Timers: 2	Patterns: 10; Ranges: 2; Edge and glitch: 2; Timers: 2
Trigger sequence levels	12 in state and 10 in timing	12 in state and 10 in timing	12 in state and 10 in timing
Symbols	Unlimited	Unlimited	Unlimited

[1] HP 16555A, 16555D, 16556A and 16556D can only be used with the HP 16500B or 16500C logic analysis mainframe.
[2] Half-channel mode doubles memory depth, doubles maximum conventional timing speed and doubles maximum transitional timing speed.
[3] For 110-MHz mode only–single clock edge with qualifiers. 100-MHz mode and below is the same as the HP 16550A.
[4] Memory depth doubles in half-channel timing mode.
[5] Eight pattern recognizers are available in HP 16555A/16555D timing and 110-MHz state analysis modes.

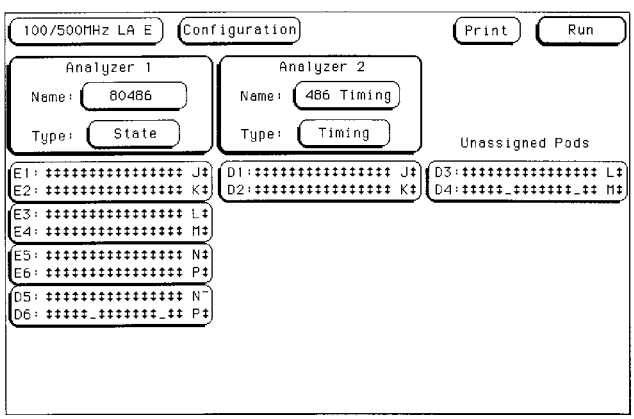
State and Timing Analysis with a Choice of Depth

The HP 16550 series of state and timing analyzers offers a range of memory depths and state analysis speeds to fit your application. The HP 16550A offers industry-standard state and timing analysis features at an affordable price. The HP 16555A, 16556A, 16555D and 16556D analyzers provide the same acquisition and triggering capabilities as the HP 16550A, but provide the deeper memory needed to capture elusive system crashes.

All HP 16550 series analyzers use the same probing scheme, which makes it possible for you to easily interchange probing interconnections whenever your probing needs change. All HP 16550 series analyzers also connect to Hewlett-Packard's broad and growing selection of preprocessor solutions because the probes are compatible with previous HP state and timing analyzer modules.

Capture State or Timing Data on All Channels

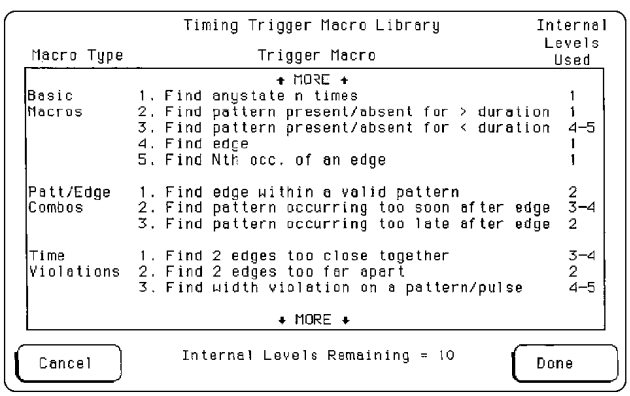
With the HP 16550 series of state and timing analyzers, there is no need to connect special probes to view timing activity. All channels on HP state and timing analysis modules perform either state or timing functions. Set up your HP 16550 series analyzer to perform simultaneous, fully time-correlated state analysis on some channels, and timing analysis on the rest.



Assign channels to capture state and timing data without moving probes.

Advanced Trigger Macros Capture Elusive Problems

Both basic and complex state and timing macros are available in the trigger macro library. Macros can be combined to create custom trigger setups.

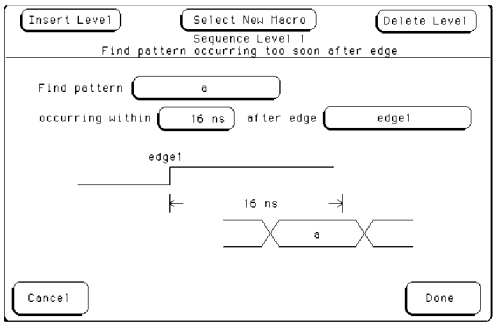


The HP 16550 series timing trigger macro library

Each trigger macro has a graphic of the measurement and a sentence-like structure to make triggering easy. Set up your triggering in terms of the measurement you want to make, rather than in terms of the trigger functions in the logic analyzer.

Families of trigger macros make it easy to pick out just the trigger macro you need, and avoid the hassle of wading through a long list of triggers to find the one you want. Families of trigger macro measurements include:

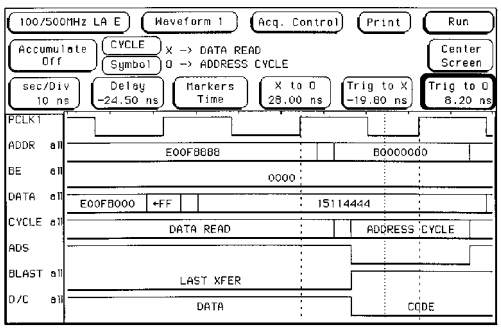
- Basic macros, including find anystate n times;
- Sequence-dependent macros, including find a n-bit serial pattern;
- Time-violation macros, including find an event 2 occurring too soon after event 1.



Typical timing trigger macro input screen.

Analyze Distant Timing Events with Transitional Timing

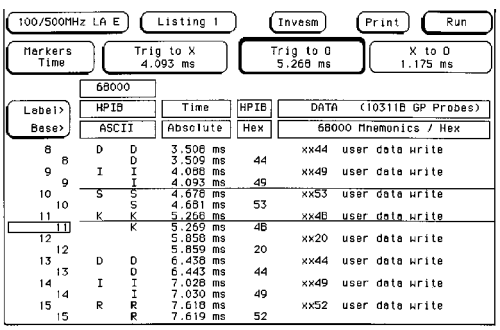
Capture events that are seconds apart while maintaining 4-ns resolution with the HP 16550A. Transitional timing samples at full speed but only stores data when a transition occurs. This technique effectively extends the total time captured by the acquisition memory while maintaining high time resolution.



Display timing measurements with bus values overlaid in the waveforms.

Track Problems in Multiprocessor and Multiple Bus Systems

Configure your HP 16550 series logic analyzer as two independent state analyzers that sample data using separate clocks. Time tagging of states lets you time-correlate and view the state listing interleaved on the same screen.



View interactions between two separately clocked systems.

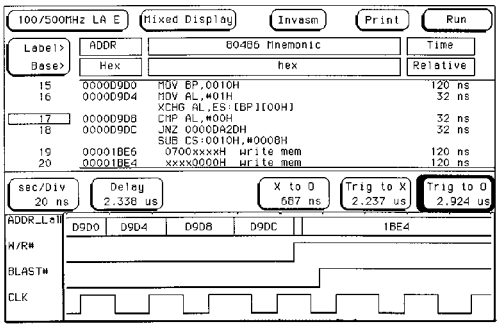
Capture Up to 340, 2M Deep Channels Simultaneously

Use the HP 16555A, 16556A, 16555D and 16556D to debug ASICs, 8-bit, 16-bit, 32-bit and 64-bit microprocessors. Connect five HP 16556A or 16556D cards for 340-channel wide measurements. The HP 16555D and 16556D provide 2M of acquisition memory across all channels, while the HP 16555A and 16556A provide 1M.

The memory depth of all cards is doubled in timing analysis half-channel mode.

Find Whether the Problem is in Software or Hardware

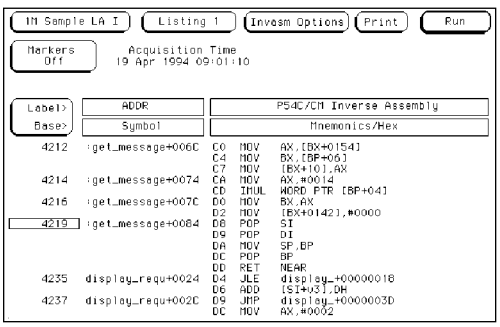
Arm the timing analyzer with the state analyzer to capture system behavior between states. Display both measurements on one screen and use time-correlated markers to identify the cause of problem states.



Display time-correlated state and timing measurements on the same screen.

Analyze Your Software with Informative Listings

New technology allows you to filter the disassembled trace, so it's easier to analyze. For example, suppress the display of instructions that were prefetched, but not executed. Display your high-level symbols in the state listing. If you program in a high-level language, the symbol utility lets you import symbols from source code. The utility reads industry-standard object module formats.



Disassembly filters let you analyze software from multiple view-points. The symbol utility lets you import and display symbols from your software.

200 MHz State Analysis NEW

Confidently capture high-speed measurements with the HP E2474A. When combined with the HP 16500 system, it offers up to 200 MHz state analysis while requiring a mere 1 ns setup/hold time windows.

Key Literature

A Family of State and Timing Analyzers for the HP 16500C Logic Analysis System, p/n 5962-7245E
The HP E2474A 200 MHz State Analysis Module, p/n 5965-7832E
HP E2474A Product Overview, p/n 5965-7666E

- Trigger directly on setup and hold violations down to 2.0 ns.
- Make timing measurements across as many as 80 channels with the resolution and precision of an oscilloscope.
- Characterize the performance of a high-speed ASIC or target system.
- Capture the most complex problems with an easy to use trigger macro library.

HP 16517A/16518A High-Speed State and Timing Modules

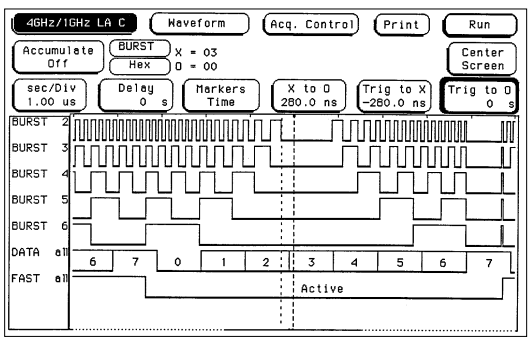
Key Specifications and Characteristics

	HP 16517A/16518A
Maximum timing speed	2 GSa/s or 4 GSa/s[1]
Maximum state speed	1 GSa/s or 2 GSa/s[2]
Memory depth	64 K or 128 K[1]
Channels per card	16/16[3]
Probe input R&C	0.2 pF, then through 500 Ω, 3 pF and 100 kΩ
Trigger macro library	Yes, with 4 sequence levels
Channel-to-channel skew	250 ps, typical

[1] Half-channel mode doubles memory depth and doubles timing speed.
[2] Maximum state speed with oversampling.
[3] HP 16518A expansion card requires HP 16517A master card. Up to four HP 16518As are supported by each HP 16517A.

Find the Cause of Elusive Problems

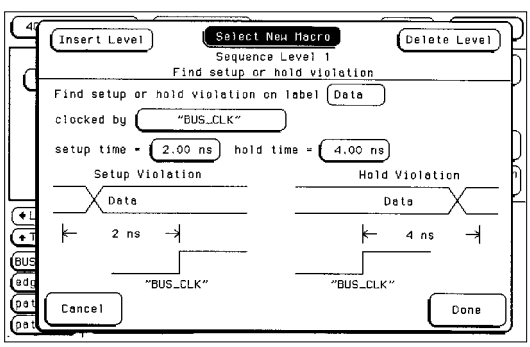
The 64-K deep memory lets you capture data over many clock cycles while retaining the highest multi-channel accuracy ever in a logic analyzer. Verify the timing of critical edges with 250-ps resolution across up to 40 channels, or 500-ps resolution, across up to 80 channels. Use the 1-GSa/s synchronous state analysis to view high-speed data streams across up to 80 channels.



Capture 32 μS of circuit activity while maintaining 250-ps resolution.

Precisely Characterize Setup or Hold Times

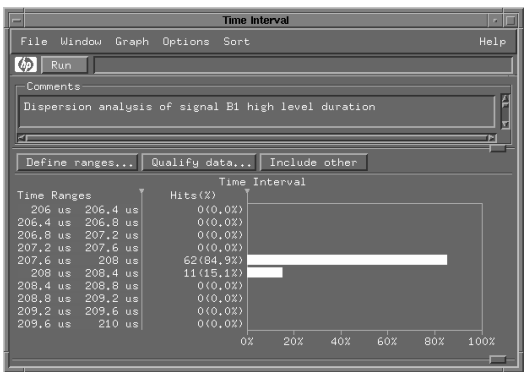
The 250-ps precision (channel-to-channel skew) allows this logic analyzer to be used in place of an oscilloscope for characterization. The high-channel count of a logic analyzer improves the efficiency of the characterization process.



A graphical trigger macro library ensures fast trigger condition setups.

Profile Your High-Speed Measurements with the HP 16505A Prototype Analyzer

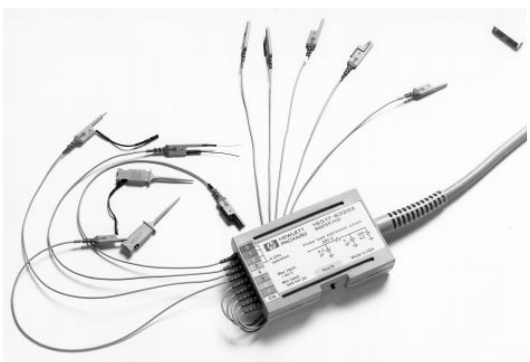
The time-interval tool of the HP 16505A's SPA tool set can be used to verify signal timing specifications. The time-interval tool measures the distribution of time between two user-defined events. The tool can be used to measure setup and hold times, the jitter between two edges or the variation between two bus states. Accumulate mode can be used to analyze the behavior of your system over a long period of time. Statistics, such as the maximum time, minimum time, standard deviation and mean, help you document system behavior.



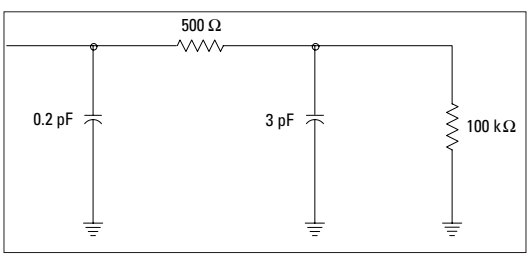
Visually verify signal timing specifications.

Flexible High-Speed Probing

HP has developed special active probe pods to meet the needs of ultra-high speed timing measurements. Lightweight probe leads can attach to the target system via a variety of probing adapters. The probe loading of the target system is kept to a bare minimum by the use of an innovative RC circuit.



Flexible probe options allow you to get the measurement you need.



HP 16517/18A Probe load equivalent circuit

Key Literature

Technical Specifications for HP 16517A, HP 16518A State and Timing Card, p/n 5091-7216E

HP 16534A and 16533A Digitizing Oscilloscopes

Built-In, Full-Featured Digitizing Oscilloscopes

The HP 16534A and 16533A offer the features of a color digitizing oscilloscope integrated into your logic analyzer. They offer digitizing advantages such as autoscale, automatic measurements, powerful triggering, negative-time (pre-trigger) viewing, voltage markers, and time markers.

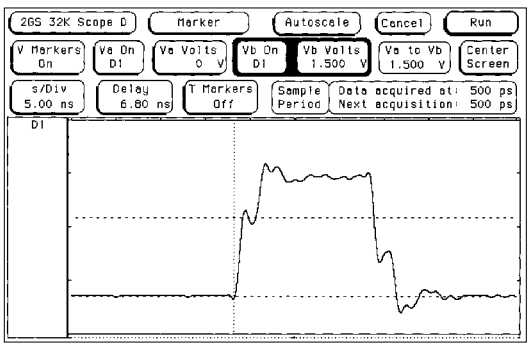
Key Specifications and Characteristics

	HP 16534A	HP 16533A
Sample rate	2 GSa/s	1 GSa/s
Bandwidth[1]	500 MHz	250 MHz
Rise time[2]	700 ps	1.4 ns
Time-interval accuracy	± 100 ps	± 100 ps
ADC resolution	8 bits	8 bits
Waveform record length	32K	32K
Channels per card	2	2
Max. single time base channels	8	8
Max. channels per system	20	20

[1] Specifications
[2] Rise time is calculated from: Rise time = 0.35/bandwidth

Use as a Standalone Scope with Many Channels

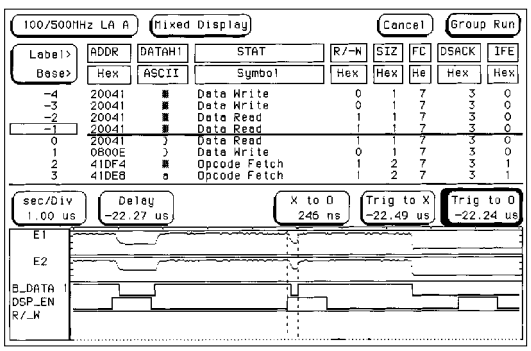
You can capture up to eight analog channels simultaneously (single time base). You can measure slow and fast events by adding additional oscilloscope modules to create a multiple time base digitizing oscilloscope. For large channel count measurements, you can configure as many as 20 scope channels in a single system.



With 500-MHz bandwidth and 2-GSa/s sampling, the HP 16534A will faithfully reproduce the signal anomalies that can cause problems in high-speed digital circuits.

Combine Scope with Other Logic Analysis Modules

You can arm or trigger the oscilloscope from any other module in the HP 16500 series to capture and display the analog events that affect your digital system.



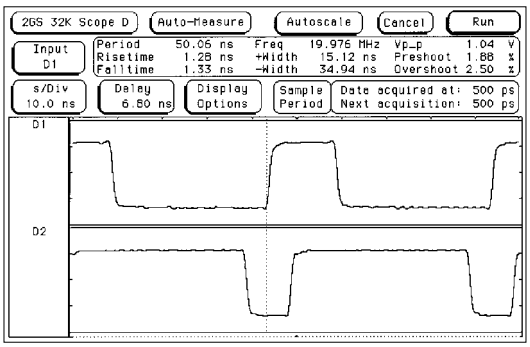
Time-correlated state, timing, and analog displays give you the critical insight to solve tough digital circuit debugging problems.

Autoscale, Auto-Measure, Voltage and Time Markers, and Color Save You Time

Select Autoscale and the scope adjusts the time, voltage, and trigger levels instantly for a stable display of your waveforms. Use automatic measurements to analyze a signal's behavior easily. Independent voltage and time markers can be used to measure voltage and timing relationships. Plus, automatic marker placement and statistics allow you to characterize a circuit quickly. Waveforms are independently colored for fast and easy identification.

Automatic measurements display:

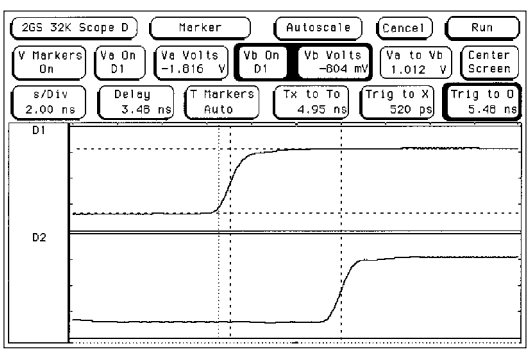
Period	Frequency	Peak-to-peak voltage
Rise time	+ Pulse width	Preshoot
Fall time	– Pulse width	Overshoot



Automatic measurements save time in characterizing signal parameters.

Flexible Display Modes Help You Find Signal Problems

Capture random signal variations or metastable states with the accumulate mode. Filter out noise with the average mode. Show true single-shot events with the single mode. Scan many periods of the waveform easily with the connect-the-dots feature. Analyze differential waveforms with the A-B mode.



Time and voltage markers allow you to measure signal details precisely.

Key Literature

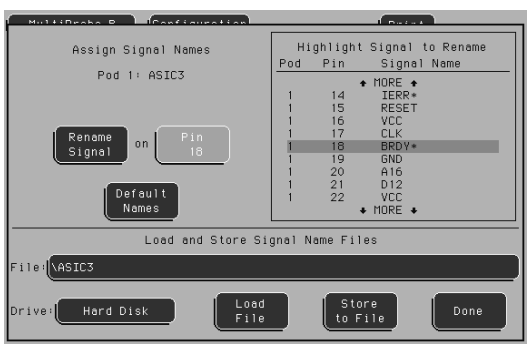
1 Gigasample/Second and 2 Gigasample/Second Oscilloscope Modules for the HP 16500B Logic Analysis System, p/n 5964-0238E

HP 16535A
HP E5320A
HP E5321A
HP E5322A

MultiProbe Analog Probing System

Probing Made Easy

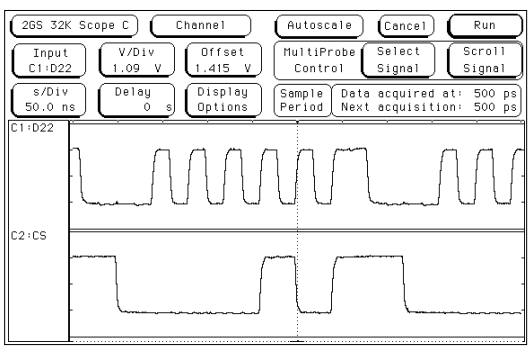
HP MultiProbe pods allow you to connect high-performance, active oscilloscope probes to all pins of fine-pitch, surface-mount ICs without soldering. You can spend your time making measurements, not struggling to attach soldered wires and scope probes.



Select any two of hundreds of analog signals from the HP 16500C's user interface.

Signal Selection Made Easy

With the HP MultiProbe System, you select the analog signals you want to see by turning the knob on the HP 16500C, by typing the name of the signal, or by clicking the mouse. No more moving scope probes when you want to see different signals. No more counting closely-spaced IC leads trying to find the right signal. HP's Multi-Probe system finds the signals for you—by name—with certainty.



Signals are labeled on the HP 16533A or 16534A oscilloscope with their real assigned names.

Getting to Know Your Signals by Name

When you select signals with the HP MultiProbe system, you call them by name, such as "BRDY" or "W/R," not "channel 1." The label you see on the HP 16533A or 16534A scope display is the name you have assigned to the signal. The signal names appear on printouts and are stored along with the signal when you store a file to the HP 16500C's disk drive. So, when you analyze a problem after making measurements, the signals are easily identified in the documentation.

Secure, Reliable Connection to Finely-Spaced IC Pins on QFP Devices

HP MultiProbe pods maintain secure, reliable connection even when you move the target system around. A retainer is glued to the top of the device to ensure positive retention and precision alignment. Controlled force keeps the pods firmly in contact with the IC pins.

Signal Integrity Measurements

With the HP MultiProbe System, grounds on the device are programmed in the personality adapter. This allows multiple grounds depending on the device. Ground path lengths are greatly minimized enabling high-quality signal integrity measurements.

System Level Debugging

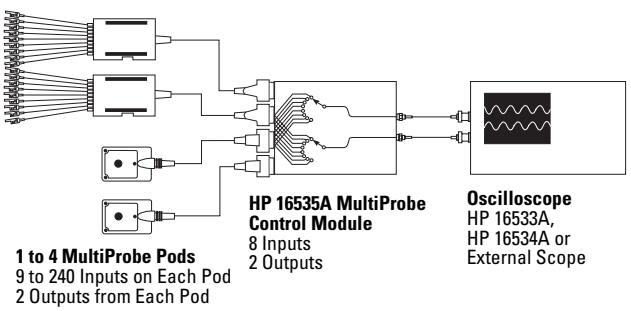
The HP MultiProbe System is part of the HP 16500C Logic Analysis System. Signal integrity measurements can be made in relation to activity throughout the entire system. HP 16500 series logic analysis cards can be used in conjunction with the HP MultiProbe System. The logic analyzer can trigger on complex bus cycles or other system activity with the acquired data time-correlated to the oscilloscope waveforms on the same display.

Performance to Match Your High-Speed Design

HP MultiProbe technology has the signal measurement capabilities to reliably detect the anomalies that cause problems in high-speed CMOS, ECL, and GTL circuits. High-density MultiProbe pods have 750-MHz bandwidth. The HP E5320A general-purpose pod has 1-GHz bandwidth for measurements on the fastest logic signals.

Key Specifications and Characteristics

	High-density MultiProbe pods HP E5322A HP E5321A	General-purpose MultiProbe pod HP E5320A
System bandwidth with		
HP 16533A oscilloscope or	250 MHz	250 MHz
HP 16534A oscilloscope	500 MHz	500 MHz
MultiProbe and control module bandwidth	750 MHz	1 GHz
Input capacitance (typical)	3.3 pF	1 pF
Input resistance (nominal)	20 KΩ	10 KΩ



HP MultiProbe System block diagram

HP 16535A
HP E5320A
HP E5321A
HP E5322A

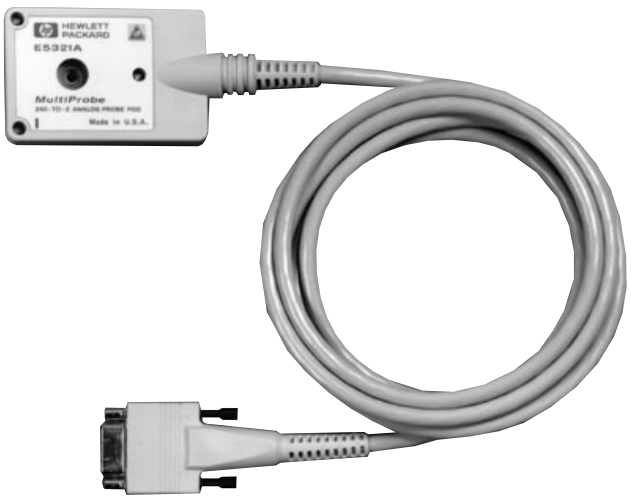
HP MultiProbe System Components

An HP MultiProbe System consists of the following products:
- HP 16500C logic analysis system mainframe
- One or more MultiProbe pods
- HP 16535A MultiProbe control module
- HP 16533A, 16534A or other oscilloscope

HP MultiProbe Pods

MultiProbe pods select any two of the signals to which they are connected. Up to four pods can be connected at once as shown on page 381. There are two types of MultiProbe pods: high-density pods that attach to all leads of surface-mount ICs, and a general-purpose, flying-lead pod for connection to various test points in the system.

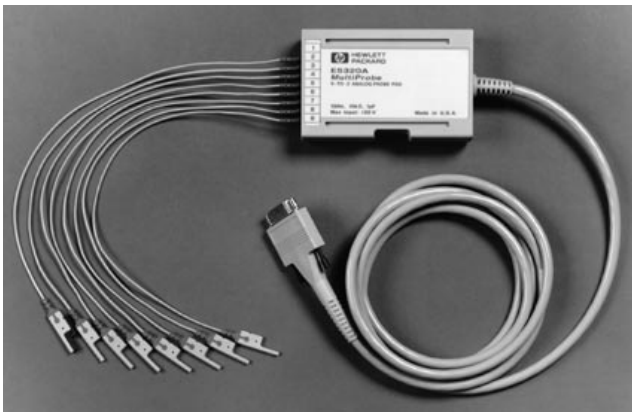
High-Density MultiProbe Pods



High-density MultiProbe pods are available for a variety of surface-mount quad flat pack (QFP) IC styles.

QFP Package Type	240 pins 0.5 mm	208 pins 0.5 mm	160 pins 0.65 mm
Order HP MultiProbe pod model number	E5321A	E5322A	E5322A
Options			
For first time use	Option 001	Option 001	Option 002
Additional personality adapters (1 each)	Option 101	Option 101	Option 102
Additional retainers (5 each)	Option 201	Option 201	Option 201
Additional locator tool	Option 202	Option 202	Option 203

General-Purpose MultiProbe Pod



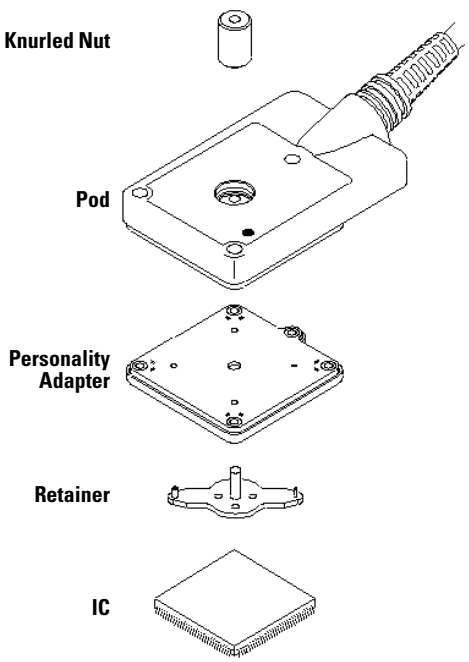
The general-purpose MultiProbe pod, HP E5320A, has nine flying leads with miniature scope probe tips.

MultiProbe Control Module, HP 16535A

The HP 16535A MultiProbe control module installs in the HP 16500C mainframe. It selects any two signals, which can be from the same pod or different pods, to apply to the oscilloscope. It also provides power and control signals to the pods.

Oscilloscope

Any oscilloscope can be used with the HP MultiProbe system. HP recommends the HP 16533A, 1-GSa/s, 250-MHz or the HP 16534A, 2-GSa/s, 500-MHz oscilloscope modules, which are part of the HP 16500C system. Refer to page 380 for more information on the HP 16533A or HP 16534A oscilloscope modules. When the HP 16533A or HP 16534A oscilloscope is used with an HP MultiProbe system, the signal selection is integrated into the scope's user interface and the MultiProbe calibration correction factors are automatically applied in the oscilloscope.



HP MultiProbe high-density pod components

Key Literature

The HP MultiProbe System Color Brochure, p/n 5964-0239E
The HP MultiProbe System Technical Specifications, p/n 5964-0237E
The HP MultiProbe System Configuration Guide, p/n 5964-0236E

- 200 million vectors-per-second—20 bits/module
- 100 million vectors-per-second—40 bits/module
- 258,048 vector deep memory
- Up to 200 output channels in a 5-module system

HP 16522A Digital Pattern Generator Module

Functionally Test Your Designs

The HP 16522A digital pattern generator module is the perfect tool for functional testing of your digital design. The pattern generator allows you to check the functional characteristics of your system. See how your system responds to specific signals or clock speeds. Correlate data captured with other HP 16500 series modules to verify correct operation. Use the HP 16522A in automated test environments to run design verification tests quickly, using only one instrument. Save time normally spent developing custom test hardware used for stimulus.

Use Parallel Development of Subsystems to Reduce Time to Market

When you have the ability to test system subcomponents, you can find problems earlier in the design process. As a result, you can cut your development time and make improvements in the finished product. Use the HP 16522A as a substitute for missing boards, integrated circuits (ICs), or buses. Instead of waiting for the missing pieces, you can continue to test and verify your design.

Software engineers can create infrequently-encountered test conditions and verify that their code works—before complete hardware is available. Hardware engineers can generate the patterns necessary to put their circuit in the desired state, operate the circuit at full speed or single-step the circuit through a series of states.

Digital Stimulus and Response

Configure the HP 16500C system to provide both stimulus and response in a single instrument. For example, have the pattern generator stimulate a circuit initialization sequence. The pattern generator can then signal the state or timing analyzer to begin making measurements. Use compare mode on the state analyzer to determine if the circuit or subsystem is functioning as expected.

Conveniently enter patterns in hex, octal, binary, decimal, two's complement, or symbolic bases. Easily edit data with Delete, Insert, Copy, and Merge functions. Use macros to specify repeating patterns, without reentering them.

Digital Stimulus for Prototype Turn-on and Evaluation

The HP 16522A pattern generator provides a number of features to help you turn on and evaluate prototypes quickly:

Vectors Up to 200 Bits Wide

Vectors are defined as a "row" of labeled data values. Each data value can be from one to 32-bits wide. Each vector is output on the rising edge of the clock. Up to five, 40-channel HP 16522A modules can be interconnected within an HP 16500C (or HP 16501A expansion frame) to support vectors of any width up to 200 bits with excellent channel-to-channel skew characteristics (see specific data pod information on the facing page). At clock speeds above 100 MHz, the pattern generator operates in "half channel" mode, resulting in 20 output channels per HP 16522A module.

Synchronized Clock Output

You can operate with either an internal or external clock. The external clock is input via a clock pod, and has no minimum frequency or duty cycle requirements. The internal clock is selected as a clock period from 5 ns to 250 μs in a 1, 2, 2.5, 4, 5, 8 sequence (4 kHz to 200 MHz). A Clock Out signal is available from the clock pod and can be used as an edge strobe with a variable delay of up to 11 ns.

Wait for Input Pattern

The clock pod also accepts a 3-bit level-sensed input pattern. Up to four "Wait for Pattern" conditions can be defined and inserted any number of times into a stimulus program. A "Wait for IMB" (intermodule measurement bus) condition can also be defined to wait for an intermodule measurement bus event.

Initialize Block for Repetitive Patterns

The vectors in the initialize block are only output during the first occurrence of a repetitive run. This feature is very useful when the circuit or subsystem needs to be initialized. A "Signal IMB" instruction can be inserted to signal other modules to start acquisition at the time "interesting activity" is started.

Conditional Branch at 50 MHz

With clock speeds of 50 MHz or less, a single "IF block" of vectors can be defined. The "IF condition" can be either a 3-bit input pattern or an IMB event. When running repetitively, use of the "IF" instruction will result in a latency time of indeterminate duration between the last and the first vectors of the main sequence.

Macros and Repeat Loops Simplify Creation of Stimulus Programs

Parameterized macros permit you to define a pattern sequence once, and then insert the macro by name wherever it is needed. Repeat loops enable you to repeat a defined block of vectors a specified number of times. A memory utilization indicator helps you track the percentage of memory used in the stimulus program.

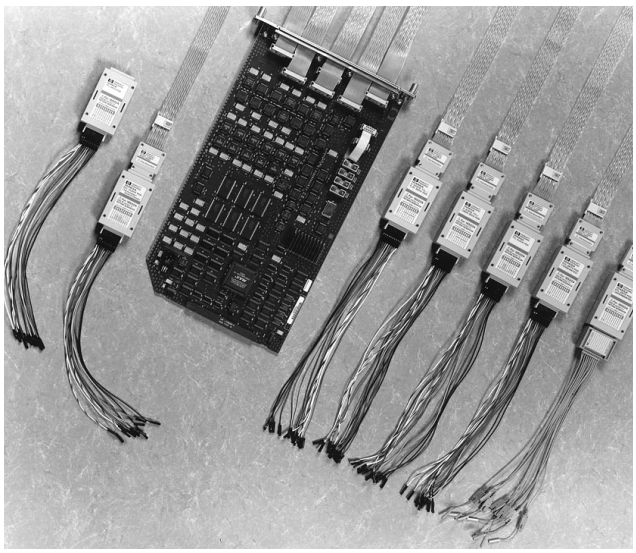
ASCII Input File Format

The HP 16522A supports an ASCII file format which facilitates connectivity to other tools in your design environment. By generating stimulus vectors in this file format, you can read stimulus programs into the pattern generator via the HP 16500C LAN (Local Area Network) connection, via the HP 16500C HP-IB connection, or via the HP 16500C floppy disk drive. This format has been specifically designed for fast file transfer into the HP 16522A pattern generator.

Configuration

The HP 16522A requires a single slot in an HP 16500B/C or 16501A frame (The pattern generator is not compatible with the HP 16500A frame). The pattern generator is designed for operation with the external clock and data pods and lead sets described on this page. Both the data pods and data cables use standard connectors that you can design into your system.

The electrical characteristics of the data cables are also described for users with specialized applications who want to avoid the use of a data pod.



Up to five HP 16522A 40-channel pattern generator modules can be interconnected into a 200-channel system. The clock and data pods support TTL, CMOS, 3.3 volt, and ECL logic levels.

Lead Set Characteristics

HP 10474A 8-Channel Probe Lead Set: Provides most cost-effective lead set for the HP 16522A clock and data pods. IC clips are not included.
HP 10347A 8-Channel Probe Lead Set: Provides 50 Ω coaxial lead set for unterminated signals, required for HP 10465A ECL Data Pod (unterminated). IC clips are not included.

Data Pod Characteristics

HP 10461A TTL Data Pod
- **Output Type:** 10H125 with 100 Ω series
- **Maximum Clock:** 200 MHz
- **Skew** (Note 1)**:** Typical < 2 ns; worst case = 4 ns
- **Recommended Lead Set:** HP 10474A

HP 10462A 3-State TTL/CMOS Data Pod
- **Output Type:** 74ACT11244 with 100 Ω series; 10H125 on non-3-state channel 7 (Note 2)
- **3-State Enable Pin:** High input disables output; low input or no connect enable output
- **Maximum Clock:** 100 MHz
- **Skew** (Note 1)**:** Typical < 4 ns : worst case = 12 ns
- **Recommended Lead Set:** HP 10474A

HP 10464A ECL Data Pod (terminated)
- **Output Type:** 10H115 with 330 Ω pulldown, 47 Ω series
- **Maximum Clock:** 200 MHz
- **Skew** (Note 1)**:** Typical < 1 ns; worst case = 2 ns
- **Recommended Lead Set:** HP 10474A

HP 10465A ECL Data Pod (unterminated)
- **Output Type:** 10H115 (no termination)
- **Maximum Clock:** 200 MHz
- **Skew** (Note 1)**:** Typical < 1 ns; worst case = 2 ns
- **Recommended Lead Set:** HP 10347A

HP 10466A 3-State TTL/3.3 Volt Data Pod
- **Output Type:** 74LVT244 with 100 Ω series; 10H125 on non-3-state channel 7 (Note 2)
- **3-State Enable Pin:** High input disables output; low input or no connect enable output
- **Maximum Clock:** 200 MHz
- **Skew** (Note 1)**:** Typical < 3 ns ; worst case = 7 ns
- **Recommended Lead Set:** HP 10474A

Note 1: Typical skew measurements made at pod connector with approximately 10 pF/50 k Ω load to GND; worst-case skew numbers are a calculation of worst-case conditions through circuits. Both numbers apply to any channel within a single or multiple module system.
Note 2: Channel 7 on the 3-state pods is brought out in parallel as a non-3-state signal. By looping this output back into the 3-state enable line, the channel can be used as a 3-state enable.

Data Cable Characteristics Without a Data Pod

The HP 16522A data cables without a data pod provide an ECL terminated (1 k Ω to – 5.2 V) differential signal (from a type 10E156 or 10E154 driver). These are usable when received by a differential receiver, preferably with a 100 Ω termination across the lines. These signals should not be used single-ended due to the slow fall time and shifted voltage threshold (they are not ECL compatible).

Clock Pod Characteristics

HP 10460A TTL Clock Pod
- **Clock Output Type:** 10H125 with 47Ω series; true and inverted
- **Clock Output Rate:** 100 MHz maximum
- **Clock Out Delay:** 11 ns maximum in 9 steps
- **Clock Input Type:** TTL – 10H124
- **Clock Input Rate:** DC to 100 MHz
- **Pattern Input Type:** TTL – 10H124 (no connect is logic 1)
- **Clock-in to Clock-out:** Approximately 30 ns
- **Pattern-in to Recognition:** Approximately 15 ns + 1 clk period
- **Recommended Lead Set:** HP 10474A

HP 10463A ECL Clock Pod
- **Clock Output Type:** 10H116 differential unterminated; and differential with 330 Ω to – 5.2 V and 47 Ω series
- **Clock Output Rate:** 200 MHz maximum
- **Clock Out Delay:** 11 ns maximum in 9 steps
- **Clock Input Type:** ECL – 10H116 with 50 k Ω to –5.2 V
- **Clock Input Rate:** DC to 200 MHz
- **Pattern Input Type:** ECL – 10H116 with 50 k Ω (no connect is logic 0)
- **Clock-in to Clock-out:** Approximately 30 ns
- **Pattern-in to Recognition:** Approximately 15 ns + 1 clk period
- **Recommended Lead Set:** HP 10474A

Key Literature

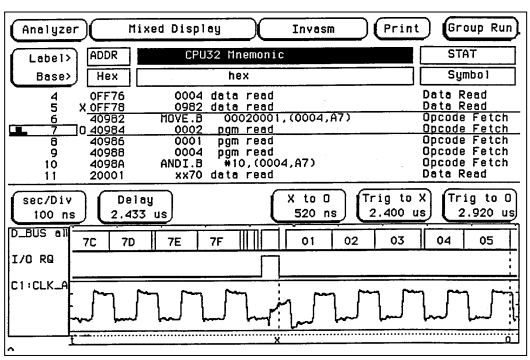
HP 16522A 200 M Vector/sec Pattern Generator Module for the HP 16500B/C Logic Analysis System, p/n 5964-2250E
Digital Verification with the HP 16522A Pattern Generator, p/n 5964-6347E

HP 1660C
HP 1661C
HP 1662C
HP 1663C
HP 1660CS
HP 1661CS
HP 1662CS
HP 1663CS
HP 1664A

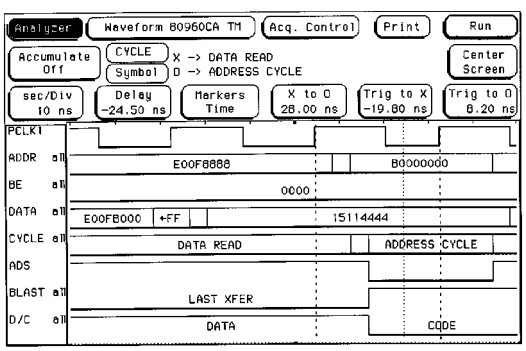
HP 1660 Series Benchtop Logic Analyzers

Benchtop Logic Analyzers to Help You Identify the Root Cause of Difficult Problems Fast

- Features to bridge the hardware and software worlds
- Broad microprocessor support with source code linkage
- Optional Ethernet LAN for networked operation
- 5 modes of timing analysis to capture different kinds of data
- Optional built-in oscilloscope shows the analog perspective
- Upgrade paths to add more channels, LAN, or an oscilloscope



Code listings, timing waveforms, and oscilloscope waveforms can be time-correlated and displayed together to speed troubleshooting.



Timing waveforms can be displayed with data values and symbolic information to illustrate bus cycles and data flow.

Seeing a Problem from All Sides Gives the Fastest Answers

Designing hardware and software for embedded microprocessor systems is difficult enough; getting it all to work together can be a real challenge. The HP 1660 series logic analyzers were designed to make things easier by bridging the gap between the hardware and software worlds. They cover a wide application range—from the isolation of elusive hardware flaws to the debugging of real-time code. You can see it all displayed together with time correlation and markers that track between code and waveforms.

An Excellent Toolset for Hardware Development

Carpenters keep more than one kind of hammer in their toolsets so they can match the task at hand with the right hammer. The HP 1660 logic analyzers have five modes of timing analysis so hardware designers can adapt the analyzer to the speed and type of data they need to capture. Conventional timing analysis resolves time intervals as short as 2 ns between edges. Transitional timing is right for situations when you need to look at data bursts with periods of inactivity between.

Some of the tougher hardware problems can be found only with digital triggering and solved only with an oscilloscope. That's why the CS models come with a built-in, 1-GSa/s oscilloscope that can be triggered by the logic analyzer. Now, you can see what bus lines really look like at critical moments.

More Functionality than a Software Engineer Would Expect

We've added some important capabilities to our logic analyzers to help software engineers even more. The HP 1660 models have functionality that was previously available only with more expensive logic analyzers—symbol and source code links and an Ethernet LAN interface.

A high percentage of the software written for embedded systems today is in C, a high-level language. So, the code trace taken by a logic analyzer should be shown at the source level. The HP Software Analyzer package (see page 375) gives you the high-level view required for faster debug by displaying a disassembled state analysis listing with symbolic data in a window alongside your source code listing. That makes finding elusive software defects a lot easier.

HP 1660C
HP 1661C
HP 1662C
HP 1663C
HP 1660CS
HP 1661CS
HP 1662CS
HP 1663CS
HP 1664A

HP 1660 Series Logic Analyzers

Key Specifications and Characteristics for HP 1660 Series Logic Analyzers

	HP 1660C HP 1660CS	HP 1661C HP 1661CS	HP 1662C HP 1662CS	HP 1663C HP 1663CS	HP 1664A
State and timing channels	136	102	68	34	34
State analysis speed	100 MHz in all modes				50 MHz in all modes

State/Timing Memory Depth: 4K samples on all channels, 8K samples on half channels (state analysis depth is halved when time tags are turned on)
Setup/Hold Time: 3.5/0 ns to 0/3.5 ns adjustable in 500-ps increments
Timing Analysis Modes and Speeds
- **Conventional:** 250 MHz on all channels, 500 MHz on half channels
- **Transitional:** 125 MHz on all channels, 250 MHz on half channels
- **Glitch:** 125 MHz on half channels

Min. Detectable Glitch Width: 3.5 ns
Probe Input R & C: 100 k Ω and ~ 8 pF
Trigger Resources
- **Patterns:** 10
- **Edge and Glitch Terms:** 2
- **Ranges:** 2
- **Timers:** 2

Trigger Sequence Levels: 12 with state analysis and 10 with timing analysis
Trigger Macros: 23 pre-defined trigger sequences with graphical representations and plain language descriptions

7

Mass storage	Hard disk drive and 1.44-MB flexible disk drive	1.44-MB flexible disk drive
Ethernet LAN interface	Optional; twisted pair and coaxial connectors	Not available
OS Boot Method	Flash ROM	Flexible disk

Additional Information for 1660CS, 1661CS, 1662CS, and 1663CS

Logic Analysis Capabilities
- **HP 1660CS:** Identical to HP 1660C
- **HP 1661CS:** Identical to HP 1661C
- **HP 1662CS:** Identical to HP 1662C
- **HP 1663CS:** Identical to HP 1663C

Scope Channels: 2
Scope Sample Rate, Bandwidth: 1 GSa/s, 250 MHz
Scope Vertical Resolution: 8 bits
Scope Memory Depth: 8K samples per channel

Hard Disk Drive, I/O Connections and Ethernet LAN

A 540-MByte hard disk drive is standard in all HP Benchtop Logic Analyzers. A Centronics parallel printer port, an HP-IB and RS-232 interfaces are standard. Ethernet LAN is available as an option. Connecting a PC-style mouse and/or keyboard is easier than ever with the standard DIN connector interface. We've included the features you need to keep up with your changing needs and work environment.

Compatible with a Computer-Oriented World

You're probably spending more time working with a PC or UNIX computer today than you have in recent years. Computers are quickly becoming the center of design work for both hardware and software engineers. The HP 1660C/CS logic analyzers have features to bring your test equipment and computer closer together.

Data and screen images can be stored in standard file formats (EPS, TIF, PCX, and ASCII) on the MS-DOS® flexible disk and read into your computer for documentation or further analysis. You can move the same files across an Ethernet LAN by using FTP or NFS commands.

X-Window software lets you operate the logic analyzer from a remote location across a LAN or WAN. The instrument display is duplicated (pixel for pixel) in an X11 window on your computer. A mouse and keyboard can control the logic analyzer from a computer, just like they do when plugged into the instrument.

Upgrade Kits to Help You Protect Your Investment

You don't have to buy an entirely new instrument if you own an HP 1660A/AS series logic analyzer and want the features in the C/CS models. Just order the HP E2469A CPU upgrade kit. If you wish you had purchased a scope with your logic analyzer, that can be added, too. Order the HP E2460CS oscilloscope upgrade kit. Do you need more channels to support the microprocessor in your new embedded design? The HP E2460B, E2461B, and E2462B will upgrade the number of channels in your logic analyzer. Most models, excluding the HP 1664A, can be upgraded with one of these kits. The price of each upgrade kit includes installation and testing at a qualified Hewlett-Packard service center and extends the instrument warranty by one year.

An upgrade kit costs more than if you bought the new features as part of your original purchase. But, the upgrade kit can protect a large part of the investment you have already made.

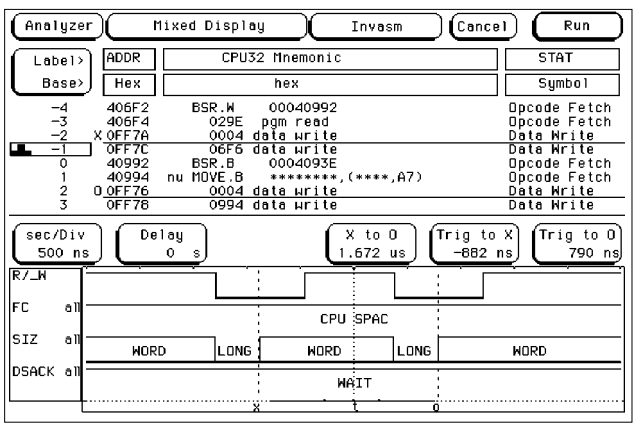
Key Literature and Ordering Information

The HP 1660 and 1670 Series Benchtop Logic Analyzers
Color Brochure, p/n 5964-3665E
The HP 1660 Series Benchtop Logic Analyzers
Technical Specifications, p/n 5964-3664E
The HP 1670 Series Benchtop Logic Analyzers
Technical Specifications, p/n 5964-3666E
The HP 1660 and 1670 Series Benchtop Logic Analyzers
Demonstration Video Tape (10 min.), p/n 5965-7501EUS (NTSC), or 5965-7501E (PAL)

See page 399 in this catalog, or the above literature for ordering information.

Deep Memory Logic Analyzers Help You Identify the Root Cause of Difficult Problems Fast

- 64K standard acquisition depth with optional 1M depth
- Broad microprocessor support and advanced inverse assemblers
- High-level source code and symbol linkage
- Ethernet LAN interface for networked operation
- State and timing analysis mixed display



Code execution and hardware activity can be displayed together with time correlation and synchronized markers to show cause/effect relationships.

Get the Whole Picture with Deep Memory

Deep memory can be a valuable logic analyzer feature for solving difficult problems in embedded microprocessor systems. It saves time you might otherwise spend taking multiple traces to piece together a complete picture of prototype behavior. Deep memory can also reduce the need to set up multilevel triggers because you don't have to be as precise about the data you capture. The HP 1670 series logic analyzers have 64K samples of memory depth that can be extended to 1M samples as a purchase option.

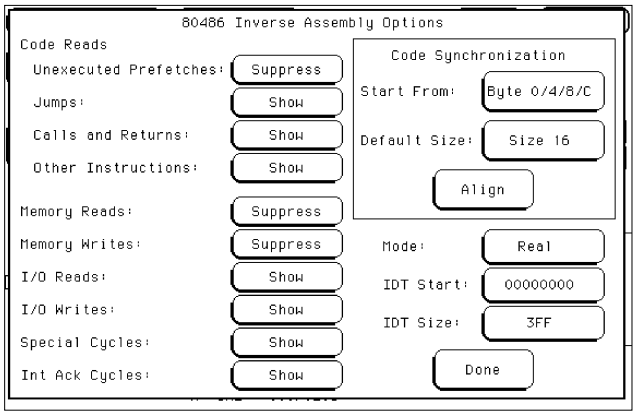
Priced for Your Budget

The most outstanding feature of our HP 1670 models is not their memory depth. It's the low price you will pay for them. Full-featured, deep memory logic analyzers at widths of up to 136 channels have never cost less. (See page 399.)

Depth Makes a Measurement Difference

The HP 1670 series logic analyzers can take real-time code traces showing cause and effect events separated by hundreds of thousands of microprocessor instructions. Having a trace that long can be very important when you need to look through nested interrupt service routines and other lengthy sections of code to find answers. And, with the added depth, you won't have to worry about program loops that can quickly fill the program buffer in a normal logic analyzer.

On the hardware side, when using an HP 1670D series logic analyzer with the deep memory option, the half-channel conventional timing mode doubles the acquisition memory depth to 2M. This lets you capture waveforms as long as 8ms with 4-ns resolution. Even longer time intervals can be captured at slower sample rates.



Advanced inverse assemblers let you choose the information you want to display and conceal the rest.

The Broadest Microprocessor and Bus Support

Hewlett-Packard and its third-party partners have the largest array of microprocessor and bus support packages of any logic analyzer vendor. The chances are good that we have the hardware interface that you need and an inverse assembler to work with it. (See pages 390 through 393.) Many of the Motorola and Intel microprocessor interfaces come with advanced inverse assemblers that let you filter a code trace to show only what you want to see.

These support packages work with HP 1660 series and HP 1670 series logic analyzers as well as the HP 16500C logic analysis system. Common processor support packages simplify equipment issues when your team is using more than one logic analyzer.

See Software Traces In Terms of Your Source Code

Most of the software that runs in embedded systems today starts as code written in a high-level language. The fastest way to confirm that an algorithm works correctly or to isolate a software defect, is to see executed code at the source level. The HP B3740A software analyzer correlates the real-time software trace captured by a state analyzer with your high-level source code on a line for line basis.

The HP B3740A software analyzer runs on MS-DOS®-based PCs, Sun workstations, and HP 9000 series 700 workstations. Your computer connects to the logic analyzer via Ethernet LAN and displays side-by-side windows of your source code and the inverse assembled state listing. The software analyzer highlights the line of source code that corresponds to the current line in the state listing and tracks as you move through the listing. Symbolic information is also integrated into state listings so you can read the symbolic names instead of address numbers. The HP B3740A software analyzer makes those conversions for you. (See page 375 for more information.)

Networked Operation Made Easy

We've tried to make things simple when it comes to networking your HP 1670 series logic analyzer. The Ethernet LAN interface comes as standard equipment. Both thinLAN (BNC) and twisted pair (RJ-45) connectors are on the instrument so you don't have to worry about using a MAU, or converting media types. After making the physical connection, just enter an IP address and the gateway address into a front-panel menu. Then, you are ready to use the logic analyzer from a computer across your local or wide area network. The TCP/IP Ethernet protocol suite is supported along with FTP and NFS file transfer protocols and X-Window system (X11R5) graphical interface protocol.

Key Specifications and Characteristics for HP 1670 Series Logic Analyzers

State and Timing Channels
- **HP 1670D:** 136
- **HP 1671D:** 102
- **HP 1672D:** 68

State Analysis Speed: 100 MHz in all modes
State/Timing Memory Depth (state analysis depth is halved when time tags are turned on)
- **Standard Depth:** 64K samples on all channels, 128K samples on half channels (timing mode only)
- **Optional Depth:** 1M samples on all channels, 2M samples on half channels (timing mode only)

Setup/Hold Time: 3.5/0 ns to 0/3.5 ns adjustable in 500-ps increments
Timing Analysis Modes and Speeds
- **Conventional:** 125 MHz on all channels, 250 MHz on half channels

Minimum Detectable Glitch Width: 3.5 ns
Probe Input R&C: 100 kΩ and ~ 8pF
Trigger Resources
- **Patterns:** 10
- **Edge and Glitch Terms:** 2
- **Ranges:** 2
- **Timers:** 2

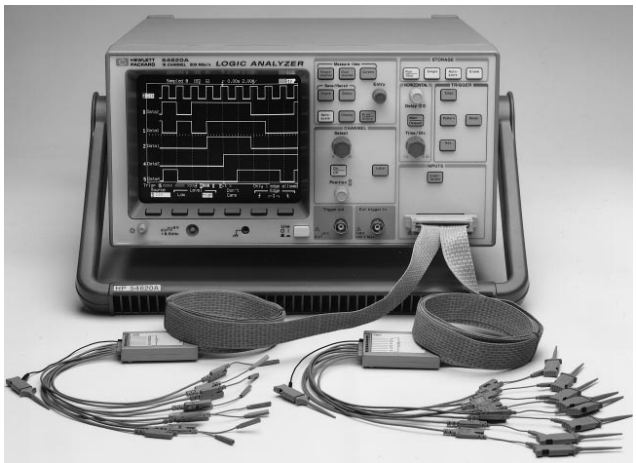
Trigger Sequence Levels: 12 with state analysis and 10 with timing analysis
Trigger Macros: 23 pre-defined trigger sequences with graphical representations and plain language descriptions
Mass Storage: Hard disk drive and 1.44-MB flexible disk drive
Ethernet LAN Interface: Standard equipment; twisted pair and coaxial connectors
OS Boot Method: Flash ROM

Key Literature and Ordering Information

The HP 1660 and 1670 Series Benchtop Logic Analyzers
Color Brochure, p/n 5964-3665E
The HP 1660 Series Benchtop Logic Analyzers
Technical Specifications, p/n 5964-3664E
The HP 1670 Series Benchtop Logic Analyzers
Technical Specifications, p/n 5964-3666E

See page 399 in this catalog, or the above literature for ordering information.

- 16 channels of 500 MSa/s timing analysis
- 3.5-ns glitch capture at any sweep speed
- Simple scope-like controls
- High-speed oscilloscope-like display shows changing and unstable signals
- One button set-up with Autoscale
- Edge, pattern, and advanced triggering
- Automatic and cursor measurements
- Optional HP-IB, RS-232, and parallel I/O
- Fully compatible with HP BenchLink Software
- HP 54620C provides full color display



HP 54620A and 54620C Logic Analyzers

HP 54620A and 54620C 16-Channel Logic Analyzers

Save Valuable Troubleshooting Time

You will be able to test and troubleshoot your digital and mixed signal circuits easier and faster with these easy-to-use logic analyzers working with your scope. By operating like your familiar oscilloscope, you will be able to put one of these powerful logic analyzers to work in your lab without having to study any manuals. If you are comfortable using a delayed sweep scope, you already know how to operate this logic analyzer. These are powerful products with the performance you need to find tough problems. Both the color and monochrome versions offer 16 channels of 500 MSa/s performance which gives you 2-ns resolution of your system's operation as well as exceptional single-shot capture ability.

Triggering performance ranges from the simple scope-like edge mode for most applications to pattern when you need more triggering power than your oscilloscope provides. The advanced triggering feature can be applied for those special situations when you need to capture elusive problems.

High-Speed Scope-Like Display

These analyzers employ a high-speed display system that clearly shows you changing and unstable situations in your circuit. Because of this high-speed display system, you will be able to isolate circuit problems without having to spend time developing complex triggering set-ups to convince yourself that the condition is occurring.

Color Makes the Display Even Easier to Use

The HP 54620C adds a color display to this troubleshooting tool. With the addition of color, you can simplify the display by grouping channels according to their function, or, areas of special interest can be highlighted. For example, the clock could be yellow, while the data lines are cyan and the strobe red.

Simple Scope-Like Controls Save Test Time

Don't add time to your project by having to learn how to operate your logic analyzer. If you are comfortable with your oscilloscope, you already know how to operate the HP 54620A/C logic analyzers. Direct access knobs control most functions. This means you can quickly set up an experiment without having to work your way through a series of menus. For example, to change time-per-division, simply turn the Time Base knob. More advanced features are accessed by the use of softkeys at the bottom of the display. In most cases these menus are only one layer deep. Setup is as simple as pressing the Autoscale button. When you press the HP 54620A/C's Autoscale button, the analyzer finds all the channels that have signal activity and places them into the display.

Triggering Power to Find Tough Problem

The HP 54620A/C logic analyzers provide scope-like edge triggering in addition to more advanced triggering modes. The edge mode is the most scope-like in its operation. Simply select the channel and edge (rising, falling or either) to set up the edge trigger. When you need additional triggering power, the pattern mode can be used to establish a trigger of high, low, and "don't care" levels, across all 16 channels. The advanced trigger mode expands the instrument's triggering power. In this mode, two trigger patterns can be set up and then the trigger can be based on logical operations between these terms.

Glitch Capture Finds Elusive Problems

The HP 54620A/C logic analyzer's glitch capture mode can capture events as narrow as 3.5 ns at any sweep speed. This means that you don't have to be concerned about missing critical information as you expand the time scale of your display. Glitch mode is automatically engaged whenever the analyzer's sampling speed must be reduced to fit a wider time window display. For those applications needing the full 8K memory depth, auto glitch detect can be turned off.

Specifications

Timing Channels: 16 channels plus an external trigger
Input RC: 100 KΩ and ~ 8pF
Timebase
Range: 1 s/div to 5ns/div (main and delayed)
Accuracy: 0.01% of reading
Cursor Accuracy
Single Channel: ± (sample period +0.01% of reading + 0.2% of screen width)
Dual Channel: Single channel accuracy ± channel-to-channel skew
Maximum Sample Rate: 500 MSa/sec
Record Length: 2k samples for sample periods of 8 ns or slower (sweep speeds of 1 μs/div to1 s/div) with glitch detect on 8k samples for sample periods of 4 and 2 ns (sweep speeds of 500 ns/div and faster) and all sweep speeds with auto glitch detect off.
Glitch Detection: Minimum detectable pulse width 3.5 ns
Trigger Modes: Edge, pattern and advanced
Advanced Operators: AND, OR Then, Entered, Existed, occurs N times, duration < time, and duration > time

Key Literature

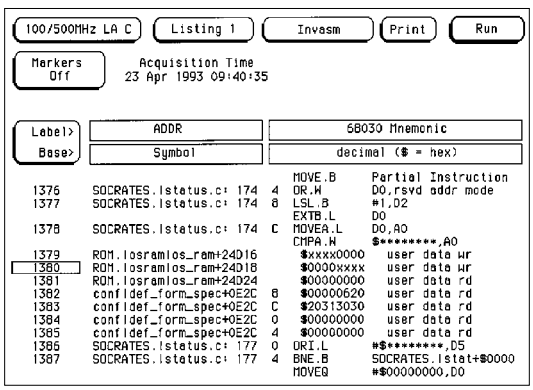
HP 54620A Technical Specifications, p/n 5963-3565 EN/EUS

Ordering Information

HP 54620A 16-Channel Logic Analyzer
HP 54620C 16-Channel Logic Analyzer with Color Display
Please refer to the HP 54600 series oscilloscopes section page 99 for complete environmental specifications and options.

This preprocessor architecture is commonly used for microcontrollers. State, timing, and parametric measurements are available.

HP's low-profile architecture preprocessors let you connect even when space is limited.



The symbol utility lets you import and use symbols from your high-level language.

Easy Connection Between a Logic Analyzer and the Target System

Preprocessor interface hardware provides an easy way to connect a Hewlett-Packard logic analyzer to your target system. The interface provides a clean electrical and mechanical connection, eliminating the need to probe individual lines. Additionally, clock signals are generated by the preprocessor to ensure that data is captured at the correct time. Many preprocessors for complex microprocessors have the ability to track address pipelines and properly align address and data in the trace listing.

Software Eases Setup and Interpretation of Data

Software that automatically configures the logic analyzer for your specific microprocessor or bus is included. When a trace is taken, the disassembler translates the binary data into microprocessor mnemonics. The resulting display can easily be compared to the original assembly code listings to track down software defects.

For popular microprocessors, unique filters let you selectively focus on only the information of interest. For example, you can suppress the display of instructions that were pre-fetched, but never executed. Or, you may choose to exclusively display jump and return instructions as well as I/O writes.

HP Support for New Microprocessors and Bus Interfaces

Hewlett-Packard is committed to providing support for the latest microprocessors and bus interfaces. HP works with semiconductor vendors and other preprocessor channel partners to ensure early development solutions for new processors and bus interfaces. If the processor or bus interface you are interested in is not listed in the table on page 392, contact your local HP sales representative for the latest support status.

Channel Partner Support

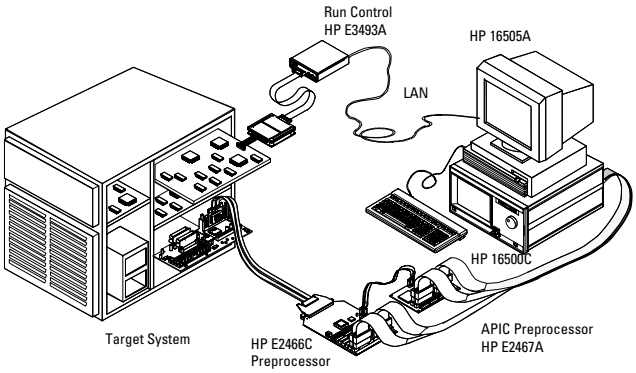
Hewlett-Packard has teamed up with a number of third-party hardware and software vendors to provide complete solutions for your microprocessor and bus analysis needs. For a complete list of third-party vendors, refer to page 394.

Design Your Own Interface with the HP E2445A

The HP E2445A user-definable interface provides the basic equipment required to create a custom interface to a wide variety of target systems. You can quickly design and build an interface which will utilize the full data acquisition and analysis capabilities of HP logic analyzers. The HP E2445A supports analysis of 8-bit and 16-bit microprocessors, and bus systems using 96 signals or less.

Custom Inverse Assemblers

If your target-system microprocessor is not supported by HP or an independent third-party vendor, you can write your own disassembler with the HP 10391B. This software package allows you to create software that displays your system operation in familiar mnemonics. The physical connection to your target system can be made by using the HP E2445A to design a custom preprocessor or by simply placing connectors that accommodate the logic analyzer pods on your target system.



The HP E2466C provides easy connection from the HP 16500 logic analysis system to the target system.

Intel Pentium, Pentium II and Pentium Pro Processor System Debug

Pentium, Pentium II and Pentium Pro processor desktop computers and servers rely on multiple buses to achieve high performance. In addition to the processor bus, most systems incorporate PCI and ISA buses. Isolating the root cause of elusive system turn-on and compatability problems requires that you track the interactions between the processor(s) and critical buses in the system. When tailored to your system requirements with processor and bus specific preprocessors and processor run control, the HP 16500 logic analysis system gives you invaluable insight into system operation.

Increasing Your Insight into Elusive Hardware Problems

Pentium, Pentium II and Pentium Pro Processor Bus Preprocessors

Connecting to and tracking the operation of the Pentium, Pentium II and Pentium Pro processor's 66 MHz buses is simplified when the HP E2457A Pentium, HP E2466B Pentium Pro and HP E2466C Pentium II preprocessors are used with the HP 16500 logic analysis system. These preprocessors include software that configures the logic analyzer and performs instruction disassembly of bus trace data into Intel mnemonics. While using HP's Pentium, Pentium II or Pentium Pro preprocessor with the HP 16500 logic analysis system, it's easy to view bus timing information or disassembled processor instruction flow. The disassembler provided with the HP E2457A and HP E2466B/C preprocessors allows you to display or suppress the display of processor bus cycles by cycle type. In addition, the HP E2466B includes transaction tracking software that displays complete transactions on the Pentium Pro processor's multiprocessor bus.

Multiple Bus Debug

To capture the complete picture of your computer system's operation, it's necessary to track activity on multiple buses at once. The HP 16500 logic analysis system allows you to time-correlate the display of data captured on multiple buses in your system. Using the HP 16505A prototype analyzer in conjunction with the HP 16500 logic analysis system, it's simple to display Pentium, Pentium II or Pentium Pro processor bus traffic in the same listing as PCI, ISA, and APIC (HP E2467A preprocessor) bus traffic. In addition, bus cycles on the Intel i960RP peripheral processor bus can be captured and viewed using the HP E2484A preprocessor. Since data captured on each bus in the system is time-correlated, it's easy to measure time delays across bus bridges in your system.

Pentium, Pentium II and Pentium Pro Processor Probes

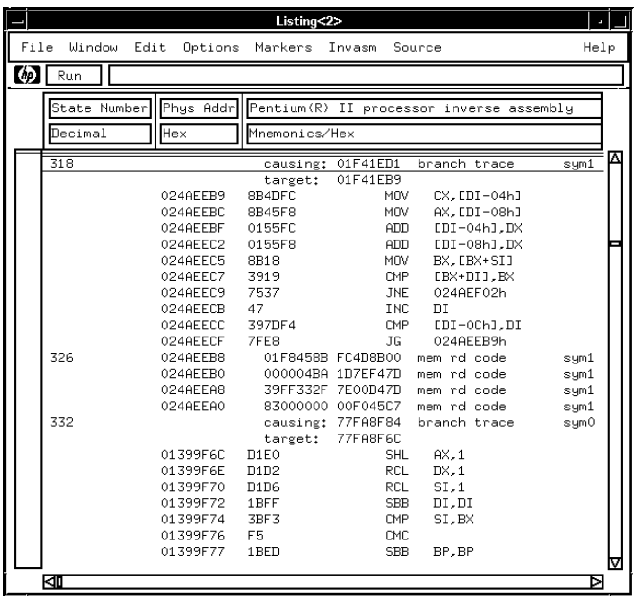
The HP E3491A Pentium, HP E3493A Pentium II and Pentium Pro processor probes provide processor run control for system designers. You have the ability to read, and modify the contents of registers, I/O, system memory, and disassemble program memory. The HP E3491B and HP E3493A increase debug efficiency by expanding the capabilities of the HP 16500 logic analysis system and HP 16505A prototype analyzer.

Increasing System Debug Efficiency

Pentium, Pentium II and Pentium Pro processor-based system debug is simplified by using the HP E3491B and HP 3493A in combination with the HP 16500/HP 16505 logic analysis tools. Combining logic analysis and processor run control provides the system visibility needed to trace problems to their root cause quickly.

Following program operation with a logic analyzer while cache memories are enabled is difficult because the processor may execute out of internal memory for hundreds of instructions. The HP E3491A and HP E3493A enhance real-time debug using a logic analyzer by providing a simple means of enabling the Pentium, Pentium II and Pentium Pro processors' branch trace messaging. With branch messaging enabled, the HP E2457A and HP 2466B/C preprocessor interfaces, in combination with HP 16550 series logic analyzer modules, will display branch messages. Branch messages reveal your program's path while the processor is executing out of cache memory.

The powerful triggering facilities of the HP 16550 series of logic analyzer modules expand the breakpoint conditions usable for stopping program execution. While the Pentium processor is limited to breaking execution on selected addresses and status, logic analyzer triggers can be defined that span address, status, and data. The HP 16550 series modules can be set to generate a breakpoint on a write of a particular data value to a specific memory or I/O address.



Inverse Assembly Listing

Key Literature

HP E2457A Pentium Processor Preprocessor, p/n 5962-9730E
HP E2466B Pentium Pro Preprocessor, p/n 5964-2343E
HP E2466C Pentium II Preprocessor, p/n 5965-9268E
HP E2467A APIC Bus Preprocessor, p/n 5965-3000E
HP E2484A i960RP Processor Preprocessor, p/n 5965-2999E
HP E3491B Pentium Processor Probe, p/n 5964-6855E
HP E3493A Pentium II and Pentium Pro Processor Probe, p/n 5965-6036E

Selection Guide

Device Manufacturer and Name	Device Package Type	Logic Analyzer Support[5] 510	550	55X	6X	7X	Min # pods[8]	Bus Clk MHz	HP product or Channel Partner[6]
Actel FPGA									
ACT1010,1020	PGA	1	1	2	61	71	5	50	Corelis
ACT1280	PGA	1	1	2	61	71	5	50	Corelis
Altera EPLD									
EPM5128-P	PGA	1	1	1	62	72	4	35	Corelis
EPM5192-P	PGA	1	1	2	61	71	5	35	Corelis
AMD									
29000/50	PGA	1	1	2	61	71	5	50	Corelis
29030	PGA	1	1	2	61	71	5	50	Corelis
29040	PGA	1	1	2	61	71	5	50	Corelis
29200	PQFP	1	1	2	61	71	5	50	Corelis
29202	PQFP	1	1	2	61	71	5	25	Corelis
29205	PQFP	1	1	2	61	71	5	16	Corelis
29240/243/245	PQFP	1	1	2	61	71	5	25	Corelis
186EM/ES	PQFP	1	1	1	62	72	4	40	Corelis
	TQFP	1	1	1	62	72	4	40	Corelis
188EM/ES	PQFP	1	1	1	62	72	4	40	Corelis
	TQFP	1	1	1	62	72	4	40	Corelis
Analog Devices									
ADSP 2100/2101	[1]	1					3		Factory[9]
ADSP 2111	PQFP	1	1		62	72	3	All	ET
Aptix									
AX1024D FPIC	PGA	1	1		62	72	4	All	Aptix
ARM									
ARM-7	[1]		1	1	62	72	4	All	Corelis
ARM6, ARM7TDMI AMBA Bus									
Ext. Dbus=32 bit	[1]		1	2	61	71	5	All	*E2493A
Ext. Dbus=16 bit	[1]		1	2	61	71	5	All	*E2493A
Ext. Dbus=8 bit	[1]		1	1	62	72	4	All	*E2493A
AT&T									
92010 (Hobbit)	PQFP	2	1	2	61	71	6	All	Corelis
Cyrix									
486SLC	PQFP	1	1		62	72	4	33	ET
Dallas									
80C320	DIP	1	1		64	72	2	8	ET
	PLCC	1	1		64	72	2	8	ET
	PQFP	1	1		64	72	2	8	ET
DEC									
SA-110	TQFP		1	2	61	71	5	All	Corelis
Fujitsu									
MB86930	PQFP		1	2	61	71	6	40	ALD
MB86932	PQFP		1	2	61	71	6	40	ALD
MB86933H	PQFP		1	2	61	71	6	25	ALD
MB86934	PQFP		1	2	61	71	6	60	ALD
MB86935	PQFP		1	2	61	71	6	50	ALD
MB86936	PQFP		1	2	61	71	6	50	ALD
GTE									
65816	[1]	1					3	All	Factory[9]
IBM									
PowerPC 403GA/ 601/603/604	[1]		2	2	60	70	8	66	E2449B
PowerPC 603/ 603e	PQFP		2	2	60	70	8	66	*E2455B
PowerPC 403GA/ 403GC	PQFP		1	2	61	71	5	50	E2468A
	(PowerPC 403GA/GC requires E2468A and E5335A PQFP adapter)								
PowerPC 604	PGA		2	2	60	70	8	66	*E2465A
IDT									
R3041	PLCC	1	1	2	61	71	5	50	Corelis
79R3051/52	PLCC	1	1	2	61	71	5	50	Corelis
79R3081/82	PLCC	1	1	2	61	71	5	50	Corelis
R36100	MQUAD	2	1	2	61	71	6	33	Corelis
R4000/4400PC	PGA	2	2	2	60	70	8	50	Corelis
R4640	MQUAD	1	1	1	62	72	4	All	Corelis
R4650	MQUAD	2	1	2	61	71	6	All	Corelis
R4600/4700	PGA	2	1	2	61	71	6	All	Corelis
	MQUAD	2	1	2	61	71	6	All	Corelis
R5000	PGA	2	1	2	61	71	6	All	Corelis
Intel									
8080	[1]	1					2	All	Factory[9]
8085	DIP	1	1	1	63	72	2	12	ET
MCS-51[2]	DIP		1	1	62	72	3	16	*E2415B
	PLCC	(44-pin PLCC requires E2415B and ET adapter)							ET
8031/51	DIP	1	1		63	72	2	16	ET
8031/51	PLCC	1	1		63	72	2	16	ET
8X51GB	PLCC	1	1	1	63	72	2	16	ET
MCS-96[3]	PLCC	1	1	1	62	72	3	25	E2416B
80C196KA/KB	PLCC	1	1	1	62	72	3	25	E2416B
8086/8088	DIP	1	1	1	62	72	3	10	ET
80C186-88EA/XL	PGA	1	1	1	62	72	3	20	*E2434A
	PLCC	1	1	1	62	72	3	20	*E2434A
	QFP	(Soldered QFP requires E2434A and #1CC)							#1CC
Intel, cont'd									
80C186/188EB	PLCC	1	1	1	62	72	3	20	*E2434B
	QFP	(Soldered QFP requires E2434B and #1CC)							#1CC
80C186/188EC	QFP	1	1	1	62	72	3	20	*E2434C
	QFP (Sqr)	(Soldered QFP requires E2434C and E3432A)							
	QFP	(Socketed QFP requires E2434C and ET adapter)							ET
80186/88	PGA	1	1	1	62	72	3	20	ET
	PLCC	1	1	1	62	72	3	20	ET
	LCC	1	1	1	62	72	3	20	ET
80186XL	QFP	1	1	1	62	72	3	20	ET
80C186EB	QFP	1	1	1	62	72	3	20	ET
	PLCC	1	1	1	62	72	3	20	ET
80286	PGA	1	1	1	62	72	3	25	*E2409C
	PLCC	(Requires E2409C and #1CB)							#1CB
80386CX	PQFP	1	1	2	61	71	5	25	ET
80386EX	PQFP		1	1	62	72	4	25	*E2454A
	TQFP	(Requires E2454A, E5336A, E3442A and E5338A)							
80386SX	PQFP	1	1		62	72	4	25	ET
80486SX, DX2, OD	PGA		1	2	61	71	5	50	*E2411C
	PQFP	(Soldered 208-pin 486DX4, SLE requires E2411C and E5344A)							
	PQFP	(Soldered 196-pin 486SX requires E2411C and ET adapter)							
	PQFP	(Soldered 176-pin 486SXSF requires E2411C and E5353A)							
Pentium 567/66	PGA		2				10	66	ET
Pentium 567/66	PGA		2	2	60	70	8	66	*E2443B
Pentium	SPGA		2	2	60	70	8	66	*E2457A
Pentium MMX	SPGA		2	2	60	70	8	66	*E2457A
Pentium Pro	SPGA		2	3			10	66	*E2466B
Pentium II	Slot 1 SEC		2	3			10	66	*E2466C
80860XR	PGA	1	1	2	61	71	5	50	Corelis
80960CA	PGA	1	1	2	61	71	5	40	Corelis
80960CA/CF	PGA	1	1	2	61	71	5	40	E2432A
80960H-series	PGA		1	2	61	71	6	40	*E2473A
80960J-Series	PGA	1	1	2	61	71	5	33	*E2464A
	PQFP	(Soldered PQFP requires E2464A and E5337A)							
80960KA,KB,MC	PGA	1	1	1	62	72	4	25	Corelis
80960KA,KB,MC	PGA	1	1	2	61	71	5	25	Corelis
80960RP	BGA		1	2	61	71	5	33	*E2484A
80960SA,SB	PLCC	1	1		62	72	4	All	ET
LSI Logic									
LR33000/33050	PGA	1	1	2	61	71	5	50	Corelis
LR33020	PGA	2	2	2	60	70	7	50	Corelis
LR333X0	PQFP	1	1	2	61	71	5	50	Corelis
MIPS – See IDT, LSI Logic, NEC, Performance, Siemens, or Toshiba									
Motorola									
146805E2	[1]	1	1	1	63	72	2	All	Factory[9]
56000/01	[1]	1	1	1	62	72	3	All	Factory[9]
56116/156/166	[1]	1	1	2	61	71	5	50	Corelis
56303	TQFP		1	1	62	72	4	80	Corelis
56L811	TQFP	1	1	1	62	72	4	All	Corelis
6800,6802	DIP	1	1	1	63	72	2	2	ET
6803	[1]	1					2	All	Factory[9]
6809	DIP	1	1	1	63	72	2	2	ET
68000/10	DIP	1	1	1	62	72	3	12.5	ET
68000/10	SDIP	1	1	1	62	72	3	12.5	ET
68000/10	PLCC	1	1	1	62	72	3	12.5	ET
68000/HC000	PGA	1	1	1	62	72	3	16.7	E2447AA
68EC000	PLCC	1	1	1	62	72	3	16.7	E2447AB
68008	DIP	1	1		62	72	3	12.5	ET
68020	PGA	1	1	2	61	71	5	33	*E2426A
	PQFP	(Soldered PQFP requires E2426A and #1CC)							#1CC
68020	PQFP	1	1	2	61	71	5	33	ET
68EC020	PGA	1	1	2	61	71	5	33	*E2426B
	PQFP	(Soldered PQFP requires E2426B and #1CC)							#1CC
68030	PGA	1	1	2	61	71	5	50	*E2406A
	PQFP	(Soldered PQFP requires E2406B and #1CC)							#1CC
68030-Socketed	PQFP	1	1		61	71	5	33	ET
68EC030[4]	PGA	1	1	2	61	71	5	50	*E2406A
68060/68040	PGA[5]		1	2	61	71	6	50	E2459A
	PQFP	(Soldered 184-pin 68040 requires E2459A and E5345A)							
68HC001	PGA	1	1		62	72	3	12.5	ET
68HC001	PLCC	1	1		62	72	3	12.5	ET
68HC11[7]	DIP	1	1	1	62	72	3	8.4	10315G
68HC11[7]	PLCC	1	1	1	62	72	3	8.4	10315H
68HC11F1	PLCC	1	1	1	62	72	3	8.4	ET
68HC11K4	PQFP		1	1	62	72	3	8	ET
68HC12A4	TQFP		1	1	62	72	3	16	ET
68HC12B32	PQFP	1	1	1	63	72	2	16	ET
68302	PGA	1	1	1	62	72	3	25	Corelis
68302-Soldered	PQFP	1	1	1	62	72	3	25	Corelis
68EN302	PGA		1	1	62	72	3	25	Corelis
	TQFP		1	1	62	72	3	25	Corelis
68LC302	PGA		1	1	62	72	3	25	Corelis
	TQFP		1	1	62	72	3	25	Corelis
68302	PGA	1	1		62	72	3	20	ET
68302-Socketed	PQFP		1		62	72	3	20	ET
68306	PQFP		1	1	62	72	3	16	E2456A
	(Soldered PQFP requires E2456A and E3417A)								

7

Selection Guide, cont'd

Device Manufacturer and Name	Device Package Type	Logic Analyzer Support[5] 510	550	55X	6X	7X	Min # pods[8]	Bus Clk MHz	HP product or Channel Partner[6]
Motorola, cont'd									
68331/32/34/35	QFP(132 pin)		1	1	62	72	4	25	*E8115A
	QFP (144 pin)		1	1	62	72	4	25	*E8116A
68336/376	QFP (160 pin)		1	1	62	72	4	25	*E8118A
68332-Socketed	PQFP	1	1		62	72	4	20	ET
68339	QFP	1	1	1	62	72	4	20	ET
68340-Socketed	PQFP	1	1		62	72	4	20	ET
68340	PGA	1	1	1	62	72	3	25	Corelis
68360/EN360/	PGA		1	2	61	71	6	33	*E2448B
MH360	PQFP		1	2	61	71	6	33	*E8123A
68HC16Y1	PQFP		1	1	62	72	4	20	*E2470A
	(Soldered PQFP requires E2470A and E5335A)								
MPC 505/509	PQFP		1	2	61	71	6	33	*E2490A
MPC 505/509	[1]		1	2	61	71	6	33	*E2491A
MPC 860/821	BGA		1	2	61	71	6	50	*E2476A
MPC 860/821	[1]		1	2	61	71	6	50	*E2477A
88100	PGA	1	1	2	61	71	5	35	Corelis
88200	PGA	1	1	2	61	71	5	35	Corelis
88110	PGA		2	2	60	70	7	50	Corelis
PowerPC 601/603/ 604	[1]		2	2	60	70	8	66	E2449B
PowerPC 603/ 603e	PQFP		2	2	60	70	8	66	*E2455B
PowerPC 604	PGA		2	2	60	70	8	66	*E2465A
National									
NS32016	[1]	1					3	All	Factory[9]
HPC16003/4/64	[1]	1	1	1	62	72	3	All	Factory[9]
NEC									
7810/11	[1]	1					3	All	Factory[9]
V25	PLCC	1	1		63	72	2	16	ET
R4000/4400PC	PGA	2	2	2	60	70	8	50	Corelis
VR4100	TQFP	1	1	2	61	71	6	All	Corelis
Vr4200	PQFP	2	1	2	61	71	6	50	Corelis
Vr4300	PQFP	1	1	1	62	72	4	All	Corelis
R5000	PGA	2	1	2	61	71	6	All	Corelis
PACE									
P1750	PGA	1					3	40	Tasco
Performance									
R4000/4400PC	PGA	2	2	2	60	70	8	50	Corelis
QED									
5230	PQFP		1	2	61	71	6	All	Corelis
5260	PQFP		1	2	61	71	6	All	Corelis
Rockwell									
6502	[1]	1	1	1	63	72	2	All	Factory
Siemens									
R4000/4400PC	PGA	2	2	2	60	70	8	50	Corelis
80515	PLCC	1	1		63	72	2	16	ET
80C166	PQFP	1	1		62	72	3	40	ET
80C167	PQFP	1	1		62	72	3		ET
Texas Instruments									
320C20/25	PGA	1	1	1	62	72	3	50	Corelis
320C30	PGA	1	1	1	62	72	4	40	Corelis
320C31	PQFP	1	1	1	62	72	4	40	Corelis
320C31-Socketed	PQFP	(Adapter for socketed 320C31 PQFP)							ET
320C32	PQFP	1	1	2	61	71	5	All	Corelis
320C40	PGA	1	1	2	61	71	5	All	Corelis
320C10/14	[1]	1	1	1	63	72	2	All	Factory[9]
320C50/51/53	PQFP	1	1	1	62	72	3	28.5	Corelis
320C52	PQFP	1	1	1	62	72	4	All	Corelis
320C542/8	TQFP	1	1	1	62	72	4	All	Corelis
320C80	PGA	2	2	2	60	70	8	All	Corelis
34010	[1]	1	1	1	62	72	2	All	Factory[9]
370C16	[1]		1	2	61	71	6	All	Corelis
370C50	[1]	1	1	1	63	72	2	20	Factory[9]
470R1X	TQFP		1	1	62	72	4	All	Corelis
Toshiba									
R3900	PQFP	2	1	2	61	71	6	All	Corelis
R4000/4400PC	PGA	2	2	2	60	70	8	50	Corelis
Xilinx LCA									
XC3020/3030	PLCC	1	1	2	61	71	5	75	Corelis
X C3X42/64/90	PGA	1	1	2	61	71	5	75	Corelis
	PLCC	1	1	2	61	71	5	75	Corelis
XC4005/4006	PGA	1	1	2	61	71	5	75	Corelis
XC4008/4010	PGA	1	1	2	61	71	5	75	Corelis
Zilog									
Z8	DIP	1							Zilog
Z80	DIP	1	1	1	63	72	2	16	ET
Z80	PLCC	1	1	1	63	72	2	16	ET
Z180	PLCC	1	1	1	62	72	3	16	ET
Z8001/8002	[1]	1					3	All	Factory[9]
Z89C00	All		1	2	61	71	5	All	Zilog
Z893XX DSP	All		1	2	61	71	5	All	Zilog

Device Manufacturer and Name	Device Package Type	Logic Analyzer Support[5] 510	550	55X	6X	7X	Min # pods[8]	Bus Clk MHz	HP product or Channel Partner[6]
Standard Buses									
AGP	N/A		1	1	62	72	4	All	FuturePlus
APIC	N/A		1	1			2	33	E2467A
DIMM/Ext.	N/A		1	2	61	71	6	All	FuturePlus
EISA	N/A	2	1		61	71	6		ALD
IEEE 488 (HP-IB)	N/A	1	1	1	63	72	1		ALD
IEEE1284	N/A	1	1	1	63	72	2		ALD
I2C	N/A	1	1	1	63	72	2		ALD
IBM ISA (AT)	N/A	1	1	2	61	71	5	All	Corelis
ISA	N/A	1	1	2	61	71	5	16	FuturePlus
IBM ISA (AT)	N/A	1	1		61	71	5		Tasco
IBM MCA	N/A		2		60	70	7		ALD
JTAG 1149.1	N/A	1	1	1	63	72	1	All	Corelis
JTAG 1149.5	N/A	1	1	1	62	72	4	All	Corelis
PCI-32	N/A	1	1	1	62	72	4	66	Corelis
PCI-32/Extender	N/A	1	1	1	62	72	4	33	FuturePlus
PCI-64	N/A	2	1	2	61	71	6	66	Corelis
PCI-64	N/A	2	1	2	61	71	6	66	FuturePlus
PCI-64/Extender	N/A	2	2	2	60	70	7	66	FuturePlus
PCI-Mezzanine/Ext.	N/A	1	1	1	62	72	4	33	FuturePlus
PCI CardBus/Ext.	N/A	1	1	1	62	72	4	33	FuturePlus
PCI Compact	N/A	1	1	1	62	72	4	33	FuturePlus
PCI Logic Scope	N/A	1	1	1	62	72	4,6	66	FuturePlus
PCI Scope	N/A	Call FuturePlus							FuturePlus
PCMCIA	N/A	1	1		62	72	4		Mobile
RS-232/RS449	N/A	1	1	1	63	72	2		ALD
SBus	N/A	1	1		61	71	5		ALD
SCSI 1,2	N/A	1	1	1	63	72	2		E2423A
SIMM Bus/Ext.	N/A	1	1	1	62	72	4		FuturePlus
USB	N/A	1	1	1	63	72	2	All	FuturePlus
VME64/VXI	N/A	Call FuturePlus						5,7,9	FuturePlus
User Defined									
User Defined Interface	N/A	1	1	1	62	72	1		E2445A

Device Manufacturer and Name	Device Package Type	HP product or Channel Partner[6]
Special Adapters		
68020	PGA to 68EC020 PGA Adapter	E3400A
68020	PGA to 68EC020 PQFP/CQFP Adapter	E3401A
68020	PGA to PGA Flexible Extender	E3403A
68020	PGA to PQFP/CQFP Adapter	E3404A
68030	PGA to PGA Flexible Extender	E3405A
68030/EC030	PGA to PQFP/CQFP Adapter	E3406A
68331/332	PGA to PQFP/CQFP Adapter	E3407A
68302	PGA to PQFP/CQFP Adapter	E3408A
68340	PGA to PQFP/CQFP Adapter	E3409A
68340	PGA to PGA Flexible Extender	E3410A
80960 SA/SB	PGA to PQFP/CQFP Adapter	E3411A
80186EA	PGA to PQFP/CQFP Adapter	E3412A
80186XL	PGA to PQFP/CQFP Adapter	E3413A
80186EB	PGA to PQFP/CQFP Adapter	E3414A
Generic	PGA to 132-pin PQFP/CQFP Adapter	E3417A
68302	PGA to PGA Flexible Extender	E3418A
80960SA/SB	PLCC to PLCC Flexible Extender	E3419A
68000	PGA to PGA Flexible Extender	E3420A
80C186	PLCC to PLCC Flexible Extender	E3422A
80186XL	PGA to PGA Flexible Extender	E3427A
68360	PGA to PGA Flexible Extender	E3430A
80C186EC	100-pin square QFP Probe	E3432A
68360	240-pin PQFP to PGA Adapter	E5317A
68F333	160-pin PQFP to PGA Adapter (Power PC 403)	E5335A
80960J-series	132-pin PQFP to PGA Adapter	E5337A
Generic	Flexible Adapter Cable	E5342A
68020	PGA 90 degree CW and CCW Rotators	ET, JME
68EC020	PGA 90 degree CW and CCW Rotators	ET, JME
68030	PGA 90 degree CW and CCW Rotators	ET, JME
68EC030	PGA 90 degree CW and CCW Rotators	ET, JME
68040	PGA 90 degree CW Rotator	ET, JME
68302	PGA 90 degree CW and CCW Rotators	ET, JME
80286	PGA 90 degree CW and CCW Rotators	ET, JME
80486	PGA 90 degree CW and CCW Rotators	ET, JME
29000	PGA 90 degree CW and CCW Rotators	ET, JME
	11 X 11 X 6 Generic PGA CW and CCW Rotators	ET, JME
	17 X 17 X 3 Generic PGA CW and CCW Rotators	ET, JME
	13 X 13 X 7 Generic PGA CW and CCW Rotators	ET, JME
	15 X 15 X 8 Generic PGA CW and CCW Rotators	ET, JME
	17 X 17 X 9 Generic PGA CW and CCW Rotators	ET, JME
	18 X 18 X 9 Generic PGA CW and CCW Rotators	ET, JME

Channel Partners

The following companies provide products that complement HP logic analyzers. Hewlett-Packard works closely with these companies to ensure quality products, but the Channel Partner is responsible for functionality, post-sales support, and warranty.

ALD
Premiere Channel Partner
Advanced Logical Design (Re-sell Code ALD)
12280 Saratoga Sunnyvale Rd., Suite 201
Saratoga, CA 95070
Ph 408-446-1004
Fax 408-944-0646
http://www.ald.com

APTIX
Aptix Corporation
2880 N. First St.
San Jose, CA 95134
Ph 408-428-6200
Fax 408-944-0646
http://www.aptix.com

CAPITAL
Capital Equipment Corp.
900 Middlesex Turnpike, BLDNGZ
Billerica, MA 01821

CORELIS
Premiere Channel Partner
Corelis, Inc. (Re-sell Code CRL)
12607 Hidden Creek Way
Cerritos, CA 90703
Ph 310-926-6727
Fax 310-404-6196
Distributors: Japan, Germany, Sweden
http://www.corelis.com

DIAGONAL
DS Diagonal Systems
800 El Camino Real West, Suite 180
Mountain View, CA 94040
Ph 415-903-2255
Fax 415-903-2237
http://www.diagonal.com

ET
Premiere Channel Partner
Emulation Technology Inc. (Re-sell Code ETN)
2344 Walsh Ave., Bldg F.
Santa Clara, CA 95051
Ph 408-982-0660
Fax 408-982-0664
Distributors: most major countries in Europe and Asia
http://www.emulation.com

Future Plus
Premiere Channel Partner
Future Plus Systems Corporation (Re-sell Code FSI)
3550 N. Academy Blvd., Suite 214
Colorado Springs, CO 80917-5088
Ph 719-380-7321
Fax 719-380-7362
http://www.futureplus.com

JME
J M Engineering
2430 Waynoka Dr.
Colorado Springs, CO 80915
Ph 719-591-1119
Fax 719-637-1777

McK
McKenzie Technology
910 Page Ave.
Fremont, CA 94538
Ph 510-651-2700
Fax 510-651-1020
Distributors: Germany, Japan, Korea, Singapore

MOBILE
Mobile Media Research
1799 O'Toole Ave.
San Jose, CA 95131
Ph 408-428-0310
Fax 408-428-0379

NI
National Instruments
6504 Bridge Point Parkway
Austin, TX 78730-5039
Ph 800-433-3488
http://www.natinst.com

POMONA
Pomona Electronics, Inc.
1500 E. Ninth St.
Pomona, CA 91769
Ph 909-469-2900
Fax 909-629-3317

SUMMIT
Summit Designs
9305 SW Gemini Dr.
Beaverton, OR 97008
Ph 503-643-9281
Fax 503-646-4954
http://www.summit-design.com

TASCO
Tasco Electronics, Inc.
80 Express St.
Plainview, NY 11083
Ph 516-938-6464
Fax 516-938-4141

ZILOG
Zilog, Inc.
210 East Hacienda Ave.
Campbell, CA 95008
Ph 408-370-8000
Fax 408-370-8056
Distributors: most major countries in Europe and Asia
http://www.zilog.com

FOOTNOTES

[1] Inverse assembly only. No interface hardware is provided.
[2] Includes 8031/33, 8051/52, and CMOS versions. Supports all microcontrollers which conform to the architecture, instruction set, and packaging of the Intel 8051.
[3] Includes 8096/97-90, -AH, -BH, 80C196KA/KB/KC/KD.
[4] An adapter from a 68030 to a 68EC030 is required. You can make one by clipping the unused pins D5, F4, F10, and K5 on a 68030 PGA socket.
Or you may order McKenzie Technology part number PGA124M004B1-1309R.
[5] Minimum Logic Analyzer required; an analyzer with more pods may be substituted.
510: HP 1650, 1652, 16510 (5 pods), 1654 (4 pods; check to insure "Min # pods" column is four or less)
550: indicated number of HP 16550As (6 pods) required
55X: indicated number of HP16554As, 16555A/Ds, 16556A/Ds (4 pods) required
6X – HP 1660C (8 pods), HP 1661C (6 pods), HP 1662C (4 pods), HP 1663C (2 pods), HP 1664A (2 pods)
7X – HP 1670A/D (8 pods), HP 1671A/D (6 pods), HP 1672A/D (4 pods)
Note: If a preprocessor is not supported by the analyzer you desire, contact the factory.
[6] If the preprocessor product number has a preceeding asterisk (*), the product contains the enhanced inverse assembler for the HP 1660 and 70 series, HP 16550A, HP 16554A, HP 16555A/D, and HP 16556A/D when installed in the HP 16500B/C.
For the following third parties (Channel Partners), these products are also available from HP. See the Pub. No. 5963-6854E US for the HP product number and HP list price: Advanced Logical Design, Corelis, Emulation Technology, Future Plus Systems.
[7] A0, A1, A8, E1, E9, A2, E2 versions supported. For support of other versions, contact the factory for information.
[8] The minimum number of pods refers to the minimum number of pods needed to support state analysis with inverse assembly. Additional pods may be needed to see all signals simultaneously. Refer to the data sheet for more detailed information. If the entry for this column is blank, the preprocessor does not support inverse assembly.
[9] Free inverse assembler, no interface hardware is provided. Please contact your HP sales representative.
[10] The following SCSI adapter cables are available from COL; additional versions are available from HP Direct Marketing Division (800-637-7740):
E2423A Option 001 – 50 pin High Density to 50 pin Low Density 1 meter cable
E2423A Option 002 – 50 pin High Density to 50 pin High Density 1 meter cable
E2423A Option 003 – 68 pin High Density to 68 pin High Density 1 meter cable

Probing fine-pitch QFP (Quad Flat Pack) parts has become more difficult over the past several years. Hewlett-Packard has developed several revolutionary probing adapters for 0.5 mm and 0.65 mm high-density TQFP (Thin Quad Flat Pack), CQFP (Ceramic Quad Flat Pack), and PQFP (Plastic Quad Flat Pack) packages.

With these new, rugged and reliable probing solutions from HP, soldering wires to devices is no longer necessary. An easy connection to your device will save valuable time for logic analysis and oscilloscope measurements.

HP offers a wide assortment of flex adapters, transition boards, and other accessories to be used with preprocessors, custom probing solutions, or general-purpose applications.

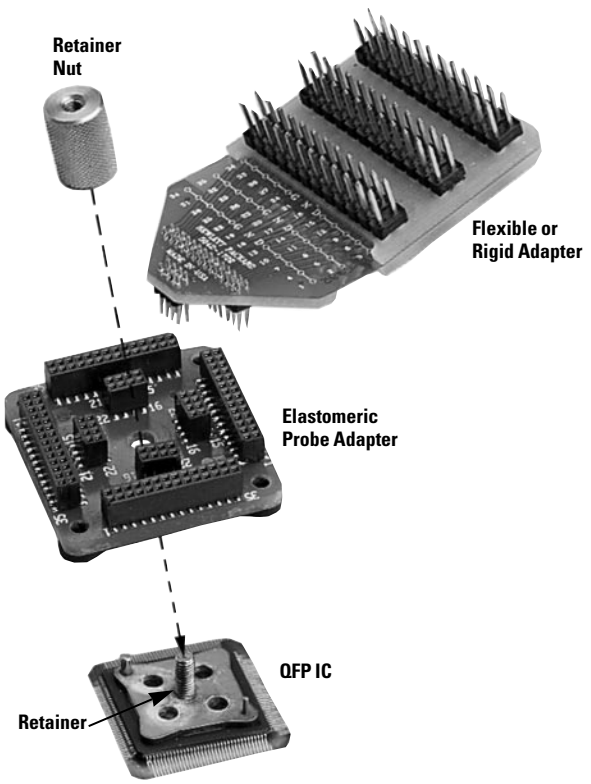
Refer to page 392 for specific microprocessors and bus interfaces.

Elastomeric Probing Solutions

The elastomeric probing solution from HP offers an inexpensive, rugged, and easy-to-use probing solution for both TQFP and PQFP packages. These probes require a minimal "keep out" area around the device.

The elastomeric probe makes contact to the pins of a device with an elastomer material. There are redundant connections for each pin ensuring a reliable and rugged connection. A retainer is glued to the top of the device to ensure a solid connection to each pin of the device.

Five retainers, a locator tool, and adhesive are included with each probe adapter.



Elastomeric Probing System Configuration

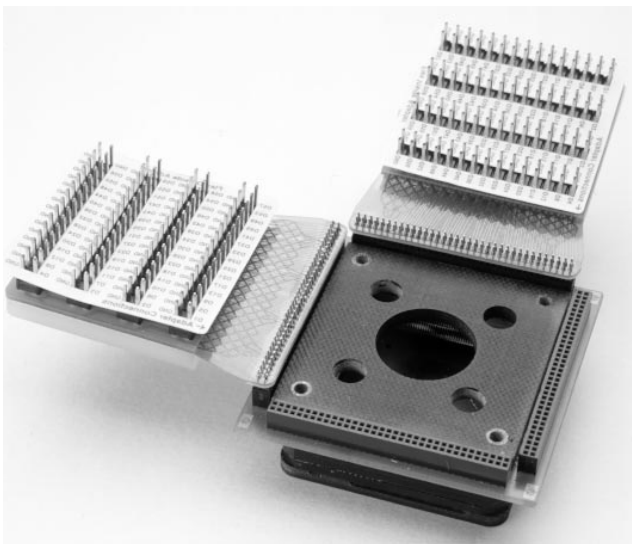
Supported Elastomeric Packages	Pin Pitch	Elastomeric Probe Adapter
144-Pin TQFP	0.5 mm	HP E5336A
144-Pin PQFP/CQFP	0.65 mm	HP E5361A
160-Pin PQFP/CQFP	0.65 mm	HP E5373A
176-Pin PQFP	0.5 mm	HP E5348A
208-Pin PQFP/CQFP	0.5 mm	HP E5374A
240-Pin PQFP/CQFP	0.5 mm	HP E5363A

Locator-Base Probing Solutions

There are several solutions available for high-density packages using a locator base. This solution allows connection to 0.5 mm or 0.65 mm pitch CQFP and PQFP devices.

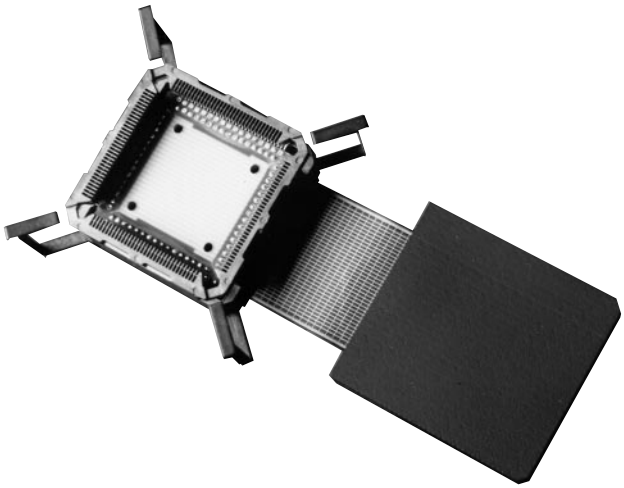
A locator base must be placed on the PC board around the device to be tested. The base can be glued to the board or connected directly to the board with mounting screws. The probe adapter then slides over the chip and attaches to the locator base. Connection is made to each pin on the device.

The probe adapter includes one probe, one locator base (with inserts), four #2-56 screws, a pin guard protector for the adapter, and adhesive to install the locator base.



Locator base probing system with ¼ flex adapters.

Supported Locator Base Packages	Pin Pitch	Locator Base Adapter
160-Pin PQFP/CQFP	0.65 mm	HP E5319A
184-Pin PQFP/CQFP	0.5 mm	HP E5343A
208-Pin PQFP/CQFP	0.5 mm	HP E5318A
240-Pin PQFP/CQFP	0.5 mm	HP E5315A
304-Pin PQFP/CQFP	0.5 mm	HP E5331A



The HP E3417A QFP adapter provides a reliable measurement connection for your 132-pin QFP devices.

Termination adapters available from HP

Optional Accessories for Probes

Flexible and rigid adapters are available to bring the signals from the probe adapters to general-purpose headers for easy connection to logic analyzers, oscilloscopes, or other test equipment. Four flexible or rigid adapters are required to view all signals on a device.

Package Supported	Probe Part Number	Flexible Adapter	Rigid Adapter
Elastomeric Probing Solutions			
144-Pin TQFP	HP E5336A	HP E5340A	—
144-Pin PQFP/CQFP	HP E5361A	HP E5340A	—
160-Pin PQFP/CQFP	HP E5373A	HP E5349A	—
176-Pin PQFP	HP E5348A	HP E5349A	—
208-Pin PQFP/CQFP	HP E5374A	HP E5371A	—
240-Pin PQFP/CQFP	HP E5363A	HP E5371A	—
Locator Base Solutions			
160-pin Adapter	HP E5319A	HP E5316A	HP E5330A
184-pin Adapter	HP E5343A	HP E5316A	HP E5330A
208-pin Adapter	HP E5318A	HP E5316A	HP E5330A
240-pin Adapter	HP E5315A	HP E5316A	HP E5330A
304-pin Adapter	HP E5331A	HP E5333A	—

Termination Adapter

The HP 01650-63203 termination adapter allows you to use 3M 2x10 connectors in your system for connection to an HP logic analyzer. The termination is located at the probe tip of the termination adapter for easy application. Each connector is used for 16 data channels and one clock.

The 3M 2x10 connectors can be purchased from either 3M (p/n 2520-6002) or HP (p/n 1251-8106).

High-Density Adapters

The HP E5346A and HP E5351A high-density adapters provide a convenient and easy way to connect an HP logic analyzer to the signals on your target system. With difficult packages to probe, such as BGA, or with other probing restrictions, the high-density adapters provide a high-density logic analysis connection.

The HP high-density adapters provide a connection strategy to route your important signals to the HP logic analyzer. Simply design the AMP Mictor connectors onto the board for the critical signals you need such as address, data, and status bits. This process consumes a minimal amount of board space with the AMP Mictor connectors. Each Mictor connector provides 32 channels of logic analysis per connector with two clocks.

The HP E5346A includes the required termination for logic analysis right at the probe tip for easy application and use. The HP E5351A does not include the required termination in the probe tip. Termination for the signals must be designed into your target system. Refer to the data sheet listed below for specifications and dimensions.

Mictor connectors may be purchased directly from Hewlett-Packard or from AMP (p/n 2-767004-2).

Product Number	Description
HP E5346A	High-Density Adapter
HP E5351A	High-Density Adapter
HP E5346-44701	Recommended Support Shroud
HP E5346-60002	High Speed Mictor Break-out Adapter
HP E5346-68701	Five Mictor Connectors and Five Support Shrouds

Key Literature

Probing Solutions for TQFP/CQFP/PQFP Packages, p/n 5965-2790E
Minimizing Intrusion Effects When Probing With a Logic Analyzer, p/n 5962-8620E
HP E5346A and HP E5351A High-Density Adapters, p/n 5965-5475E

The HP 1660C series portable logic analyzers offer a variety of upgrade kits to help protect your investment in an HP logic analyzer.

Logic Analyzer Upgrade Kits

Upgrade kits include software and hardware to enhance the performance of your logic analyzer. The text below summarizes the upgrade options available for the HP logic analyzers listed.

HP 1660 Series Upgrades

The HP E2469A CPU upgrade kit converts an HP 1660A/AS series model to the corresponding C/CS model. Your upgraded unit will have a faster CPU system, a hard disk drive, an Ethernet LAN interface, a Centronics printer interface and DIN connections for PC-style mice and keyboards.

Add a built-in oscilloscope to your HP 1660C series logic analyzer (except the 1664A) with the HP E2460CS upgrade kit. The oscilloscope has two channels with simultaneous 1-GSa/s sampling, 250-MHz bandwidth and 8 bits of vertical resolution.

You can also add more logic analyzer channels to most models with the HP E2460B, E2461B and E2462B upgrade kits. The HP E2472A upgrade kit will add LAN capability to a 1660C/CS series model. All HP 1660 series upgrade kits include installation and testing at a qualified Hewlett-Packard service center.

The HP 1670D series of logic analyzers can have the acquisition memory upgraded from 64K to 1M of memory by ordering HP E2471D. The HP E2471D upgrade requires installation and testing at a qualified Hewlett-Packard service center.

HP 16500 Upgrades

The HP E2479A includes everything necessary to upgrade your HP 16500A or 16500B to an HP 16500C frame at just over half the cost of investing in a new frame. The HP E2479A upgrade must be installed by an HP Service Center. The price includes all charges, including installation, except for shipping.

HP Testmobiles and Carrying Cases

Make your logic analysis system a portable one with the HP testmobile. Each testmobile is designed to withstand rugged use. The HP 1181A and 1182A testmobiles are designed for the HP 16500 logic analysis system. For the HP 1660 and 1670 series of logic analyzers, order the HP 1180B testmobile. A variety of accessories can be added to these carts to tailor them to your work environment.

The HP 1540-1066 soft carrying case allows you to easily carry your HP 1660 and 1670 series portable logic analyzer and its accessories to remote sites.

Sturdy testmobiles give your logic analyzer mobility and free up bench space.

Software Development Tools

Inverse Assembler Development

The HP Inverse Assembler Development package allows the user to develop a custom inverse assembler that will operate in all HP 1660, 1670 and 16500 series logic analyzers. The product requires an MS-DOS-based PC with a minimum of 256K of memory, MS-DOS 2.1 or higher operating system, and a 3.5-inch floppy drive.

Media Supplied
3.5-inch disk

Ordering Information

HP 10391B Inverse Assembler Development Package

Software Analyzer

The HP software analyzer combines the versatility of a general-purpose logic analyzer with an interface that is tailored for software engineers. Now, you can debug your code at the source level while retaining the benefits of broad processor support and easy setup. The HP software analyzer provides a link between your trace listing and high-level source code language. Once a trace is complete, it is correlated to high-level source code in the source window. The trace is displayed in the control window in microprocessor mnemonics. See page 375 for more information on the HP software analyzer.

Key Literature

HP B3740A Software Analyzer Product Overview, p/n 5962-7114E
HP B3740A Configuration Guide, p/n 5962-9887E
HP B4620A Software Analyzer Tool Set, p/n 5964-9333E

Ordering Information

HP B4620A Software Analyzer for the HP 16505A Prototype Analyzer
HP B3740A Software Analyzer
- **Opt AJ4** IBM, 3.5-inch Media/Documentation
- **Opt AAY** HP 9000 Series 700 Media/Documentation
- **Opt AAV** Sun Media/Documentation
- **Opt UDY** IBM Single-User License
- **Opt UBY** HP 9000 Series 700 Single-User License
- **Opt UBK** Sun Single-User License

Test Development Tools

HP VEE

HP Visual Engineering Environment instrument drivers are available for the HP 1660, 1670, and 16500 series logic analyzers. HP VEE's powerful visual programming environment allows the user to integrate HP logic analyzers with other VEE-capable test and measurement instruments to create an extensive test system.

Key Literature and Ordering Information

See HP VEE, page 62.

LabVIEW, LabWindows

National Instruments distributes LabVIEW and LabWindows/CVI instrument drivers to control the HP 16500B/C Logic Analysis System. These instrument drivers operate on a variety of platforms: Windows 3.1/95/NT, Sun OS, Macintosh/Power Macintosh OS, and HP-UX. They provide the user with flexible, high-level functions, such as Load, Run, Store as well as low-level configuration and measurement functions. This structure allows the user to quickly configure the instrument, execute a test, and analyze the returned data. Both LabVIEW and LabWindows/CVI integrate extensive data analysis and presentation libraries that allow the user to quickly process and present the acquired data.

Novice or advanced C programmers can develop any application with LabWindows/CVI, and the many virtual instrumentation developers who prefer graphical development can use LabVIEW, the industry's first and most widely used graphical programming system.

Key Literature and Ordering Information

National Instruments (See Channel Partners, page 394)

TestPoint

The Capital Equipment Corporation TestPoint software is a tool for designing and developing test, measurement and data acquisition applications for Windows. TestPoint lets you build a complete application to control an HP logic analyzer without drawing, connecting or wiring icons or writing lines of code. You simply place graphs, displays, and the other interactive parts of your test on a display panel—order isn't important. Then list the things the test should do by placing objects in an Action List. TestPoint then builds the code to run the test and a description of the test for you. TestPoint provides an intuitive editing environment that makes it easy to build applications so you can concentrate on solving the problem rather than learning the tool.

Media Supplied
3.5-inch disk

Key Literature and Ordering Information

Capital (See Channel Partners, page 394)

EDA Links

WaveGrabber

The Summit Design WaveGrabber software delivers an integrated analysis environment for both logic analyzer and logic simulation data. Through its versatile data link, WaveGrabber allows you to combine the power of your logic simulator with both the HP 16500C logic analysis system and HP 1660/70 series logic analyzers. This unique and sophisticated pairing gives you the power to:
- Acquire data from existing circuitry (ASICs, boards or systems) for logic simulation
- Compare simulated with actual behavior
- Use simulation stimulus data as patterns for logic analyzer pattern generation
- Facilitate failure analysis by comparing failed circuit and good circuit behavior
- Analyze data for compliance with device specifications and tester compatibility.

Key Literature and Ordering Information

Summit Design (See Channel Partners, page 394)

WAVE-Link 16500

The Diagonal Systems WAVE-Link software is a highly-interactive digital stimulus editor and result analyzer successfully used by design engineers as a graphical front-end tool to logic simulators such as VHDL and Verilog. The integration of WAVE-Link with the HP 16500C logic analysis system opens new perspectives for the design engineer who wants to send stimulus patterns to the HP 16522A pattern generator or capture circuit response from the actual hardware with any of the logic analyzer modules such as the HP 16550A. WAVE-Link is a standalone tool, but is integrated in the popular EDA frameworks. From a VHDL circuit description or EDA schematic database, the signal list is automatically extracted to guarantee signal naming consistency. The code generators compile the designer's stimuli from the WAVE-Link database in the language of the HP 16500C or chosen simulator or ATE with just a few mouse clicks. Furthermore, the simulation results are imported into WAVE-Link analysis tools without requiring any modification.

Key Literature and Ordering Information

Diagonal Systems (See Channel Partners, page 394)

HP 16505A Prototype Analyzer and Tool Sets

Product

16505A Prototype Analyzer–requires HP 16500C
B4600A Software Performance Analysis Toolset
B4601A Serial Analysis Toolset
B4620A Software Analysis Toolset
E3491A Intel Pentium® Processor Probe

HP 16500 Series Modular Logic Analyzers

Product

16500C Logic Analysis System Mainframe
16501A Logic Analysis System Expansion Frame
E2474A 200 MHz State Analysis Module
16517A 16-Channel 4 GHz Timing/1 GHz State Master Card
16518A 16-Channel 4 GHz Timing/1 GHz State Expander
16522A 40-Channel 200-MVector/s Pattern Generator Card*
16533A 2-Channel 1 GSa/s Oscilloscope Card
16534A 2-Channel 2 GSa/s Oscilloscope Card
16550A 102-Channel 100 MHz State/500 MHz Timing Card with 4k Acquisition Memory/Channel
16554A 68-Channel 70 MHz State/250 MHz Timing Card with 512k Acquisition Memory/Channel
16555A 68-Channel 110 MHz State/500 MHz Timing Card with 1M Acquisition Memory/Channel
16556A 68-Channel 100 MHz State/400 MHz Timing Card with 1M Acquisition Memory/Channel
16555D 68-Channel 110 MHz State/500 MHz Timing Card with 2M Acquisition Memory/Channel
16556D 68-Channel 100 MHz State/400 MHz Timing Card with 2M Acquisition Memory/Channel

* Various stimulus pods can be ordered separately. See page 384.

Product Options
Consult the appropriate product data sheet or contact your local HP sales office for a list of all options available for a specific product.

HP 1660 Series Benchtop Logic Analyzers

Product

1660C 136-Channel 100 MHz State/500 MHz Timing
1660CS 136-Channel 100 MHz State/500 MHz Timing with Integrated 2-Channel 1-GSa/s Oscilloscope
1661C 102-Channel 100 MHz State/500 MHz Timing
1661CS 102-Channel 100 MHz State/500 MHz Timing with Integrated 2-Channel 1-GSa/s Oscilloscope
1662C 68-Channel 100 MHz State/500 MHz Timing
1662CS 68-Channel 100 MHz State/500 MHz Timing with Integrated 2-Channel 1-GSa/s Oscilloscope
1663C 34-Channel 100 MHz State/500 MHz Timing
1663CS 34-Channel 100 MHz State/500 MHz Timing with Integrated 2-Channel 1-GSa/s Oscilloscope
1664A 34-Channel 50 MHz State/500 MHz Timing

Option 015 Ethernet LAN interface can be added to any 1660 series logic analyzer (except 1664A) for an additional charge at the time of purchase.

HP 1670 Series Deep Memory Logic Analyzers

Product

1670D 136-Channel 100 MHz State/250 MHz Timing with 64K Memory Depth and Ethernet LAN
  Opt 30 Extend memory depth to 1M samples/channel
1671D 102-Channel 100 MHz State/250 MHz Timing with 64K Memory Depth and Ethernet LAN
  Opt 30 Extend memory depth to 1M samples/channel
1672D 68-Channel 100 MHz State/250 MHz Timing with 64K Memory Depth and Ethernet LAN
  Opt 30 Extend memory depth to 1M samples/channel

HP Logic Analyzer Upgrade Kits

Product

E2479A 16500A/B to 16500C Upgrade Kit
E2460AS 1660 Series Oscilloscope Upgrade Kit
E2469A 1660 Series A/AS to C/CS Upgrade Kit
E2472A 1660 Series LAN Upgrade Kit
E2471A 1670A Series 64k to 500K Memory Upgrade
- **Opt 001** 1670D 64k to 500K acquisition memory
- **Opt 002** 1671D 64k to 500K acquisition memory
- **Opt 003** 1672D 64k to 500K acquisition memory

E2471D 1670D Series 64K to 1M Memory Upgrade
- **Opt 001** 1670D 64k to 1M acquisition memory
- **Opt 002** 1671D 64k to 1M acquisition memory
- **Opt 003** 1672D 64k to 1M acquisition memory

Probing Adapters

Microprocessor and Bus Interfaces–please see page 392
QFP Adapters, Flexible Extenders–please see page 395

HP User-Definable Interface Products

Product

E2445A User-Definable Probing Interface
10391B Inverse Assembler Development Package

HP State/Timing Analyzer Probes and Lead Sets

Part Numbers

5959-9333 5 Replacement Signal Leads
5959-9334 5 Replacement Short Ground Leads
5959-9335 5 Replacement Long Ground Leads
01650-61608 16-Channel Probe Lead Set
01650-63203 Termination Adapter
E5346A High-Density Termination Adapter
1810-1278 9-Channel IC DIP Termination
1810-1588 5-Channel IC SIP Termination
1251-8106 2 x 10, 0.1-inch Center Header
5090-4356 20 Surface Mount IC Clip
5959-0288 20 Throughhole IC Clip

The HP 16517/18A cards have unique probing lead sets. Please see page 379 for more information on this very high-speed analyzer.

Probes for Integrated Oscilloscopes

Product

HP 10441A 50 MHz, 10:1, 9 pF Mini-Probe, 2 meters
HP 1144A Active Probe, 800 MHz, 10:1, 2pF
HP 1145A Dual Active Probe, 750 MHz, 10:1, 1.6pF

MultiProbe Analog Probe Multiplexing for the 16500C Logic Analysis System

Product

16535A Multiprobe Control Module
E5320A 9-to-2 General Purpose Pod
E5321A 240-to-2 High Density Pod
E5322A 208-to-2 High Density Pod

HP MultiProbe System requires an HP 16500C logic analysis system equipped with a HP 16533A or HP 16534A oscilloscope card. See the HP MultiProbe Configuration Guide, p/n 5964-0236E for more information.

Other Accessories for HP Logic Analyzers

Product

1180B Testmobile for HP 1660 and HP 1670 Series
1181A Testmobile for the HP 16500C
E2427B Keyboard Kit for HP 1660, 1670 and 16500C
1540-1066 Soft Carrying Case for HP 1660/70 Logic Analyzers
16500H 16500B Interface for connecting to a 16505A
B3740A Software Analyzer

Product Options
Consult the appropriate product data sheet or contact your local HP sales office for a list of all options available for a specific product.

The new HP 81200 Data Generator/Analyzer for characterizing complex multi-channel digital designs, shown here with the larger mainframe.

Designing and testing devices for future computers, peripherals and communications systems is a challenge due to continuously increasing speed and complexity.

Today's digital test instruments must therefore not only be fast, but must also address issues such as the complex and sometimes proprietary protocols of communications systems, computer busses, etc.

Also, in order to get to the market on time, the designer has an urgent need to uncover problems as early as possible. This can only be done if individual devices and concepts can be thoroughly tested under target conditions early in their design cycle. For this reason, HP's Digital Verification Tools go beyond pulse generators and include integrated stimulus-response systems that operate the device under emulated system conditions, and capture and analyze the device outputs.

Some of these tools are application-specific—such as the PCI series of the Computer Verification Tools or the traffic generator/analyzer for testing routers. Others are general-purpose, ranging from the pulse generator for less complex applications to multi-channel stimulus-response systems. These systems offer functional and pulse-parametric capabilities to test today's and tomorrow's digital devices. They include analyzer channels which perform capture, replay, real-time compare and BER measurements for performing functional verification, error analysis and margin test.

For more information, visit our website: (http://www.hp.com/go/dvt).

Digital Verification Tools

General-Purpose Tools Stimuli-Only	Page	General-Purpose Tools Stimulus-Response	Page	Application-Specific Tools Stimulus-Response	Page
HP 8114A 15 MHz High Power Pulse Generator	410	HP 81200 Data Generator/Analyzer Platform	406/407	HP E2920 Computer Verification Tools, PCI Series	404/405
HP 8110A 150 MHz Pulse/Pattern Generator	408/409	Can also be configured as a generator only, e.g. four phase clock, multi-channel pulse generator, data generator, etc.		HP E4829B Parallel Cell/Traffic Generator and Analyzer	456
HP 8133A 3 GHz Pulse/Pattern Generator	411			HP E4859A Serial Cell Generator and Analyzer	403
HP 80000 Series Pulse/Pattern Generator Generator System	412				

Key Characteristics of the General-Purpose Tools

	Pulse Generators HP 8114A	HP 8110A	HP 8133A	Data Generator HP 80000	Data Generator/Analyzer HP 81200		
Special Features	100 V, 2 A	Pattern, channel addition	Resolution, stability, prbs	Stability, prbs and prws for MUX test	Variable timing, looping, prbs, and prws. Capture, real-time compare, BER.		
Max. Clock Rate MHz	15	150	3000	1000	660 Mb/s[4]		200 Mb/s
Transition Time (50 ohm into 50 ohm)							
10% to 90% spec.	7 ns fixed	2 ns var.	100 ps fixed	250 ps fixed			–1.5 ns fixed
10% to 90% typ.	5 ns fixed	1.8 ns var.	60 ps fixed	150 ps fixed	**Differential outputs**		**Single**
20% to 80% typ.			40 ps[2] fixed	100 ps[2] fixed	200 ps[2] fixed	400 ps[2] variable	450 ps[2] fixed
Max. Output into 50 ohm							
50 ohm source	50 Vpp	10 Vpp	3 Vpp	2.5 Vpp	4 Vpp	5.5 Vpp	2.5Vpp
Hi-Z source	100 Vpp	20 Vpp	N/A	N/A	N/A	N/A	N/A
Timing Resolution	3 digits	3 digits	1 ps	2 ps	2 ps	2 ps	2 ps
Bits/Channel	N/A	4 k	32 or $2^{23}-1$ prbs RZ/NRZ	16/128 k and $2^{23}-1$ prbs/prws RZ/NRZ	1 M and $2^{15}-1$ prbs RZ/NRZ		NRZ
Channels per Frame	1	1 or 2[1]	1 or 2[1]	4 to 20 (80[3])	RZ: 2 to 36 (128[3]), NRZ (max. 200 Mbit/s): double. Small frame: RZ 2 to 10, NRZ		

[1]For more channels, master/slave solutions are available.
[2]ECL Levels
[3]with expander frames
[4]See page 406 for internal 2:1 mux capability for data rates up to 1.32 Gbit/s, NRZ.

An HP 8110A setup for characterizing designs with low channel counts. For lasers and diodes needing more power, use the HP 8114A. For fast technologies requiring low jitter and high timing resolution, use the HP 8133A, or, for more channels, the HP 80000 or HP 81200 modular instruments.

Accessories

1. With BNC connectors
HP 15104A Pulse Adder/Splitter: 50 ohm delta network, rise time 150 ps, 6 dB insertion loss, 2 W
HP 15116A Pulse Inverter: 50 ohm pulse transformer, 5% droop (500 ns pulse), 0.3 dB insertion loss, 0.75 W
HP 15115A Splitter-Inverter: 50 ohm delta network with pulse transformer in one output. Output skew: 1 ns, other specs as HP 15104A/15116A.
2. With SMA connectors
HP 11667B Pulse Adder/Splitter: 50 ohm series network, 26.5 GHz bandwidth, 6 dB insertion loss, 0.5 W

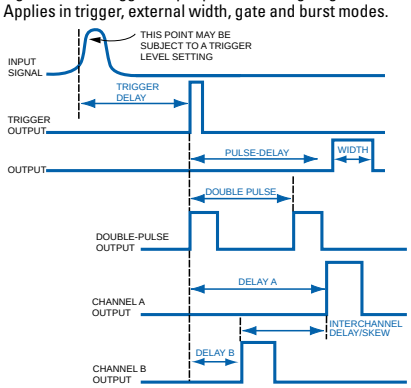
Transition Time Converters:

These components are for use when a very smooth pulse is needed, or when the stimulus is too fast for the DUT (as evidenced by excessive cross-talk, ringing, etc). The converters use a patented absorption technique for minimum reflection and to allow cascading.

Model	Output Transition
HP 15435A	150 ps
HP 15432B	250 ps
HP 15433B	500 ps
HP 15434B	1 ns
HP 15438A	2 ns

Pulse Parameter Definitions of Terms Used in Instrument Specifications

Time Reference Point: Median (50% amplitude point on pulse edge).
Pulse Period: The time interval between the leading edge medians of consecutive trigger output pulses.
Trigger Delay: Interval between trigger point of input signal and the trigger output pulse's leading-edge median. Applies in trigger, external width, gate and burst modes.

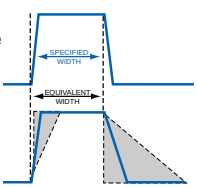


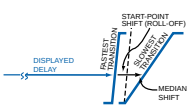
Pulse Delay: Interval between leading-edge medians of trigger-output pulse and output pulse.
Double-Pulse: Interval between leading-edge medians of the double-pulse.
Interchannel Delay/Skew: Interval between corresponding leading-edge medians.
Pulsewidth: Interval between leading and trailing-edge medians.

Additional Information for Pulse Generators with Variable Transition Times

Pulsewidth: The specified and displayed value are those which are obtained with the fastest edges, essentially equal to the interval from the start of the leading edge to the start of the trailing edge.

By designing the pulse edges so that they turn about their start points, the interval from leading-edge start to the trailing-edge start stays unchanged* when transition times are varied. This is more convenient for programming, and the width display is easy to interpret.

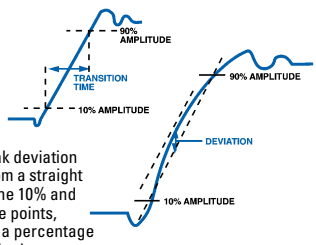




* In practice, start points may shift with changes in transition time.

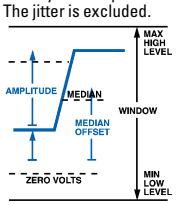
Delay: The specified and displayed values are those obtained with the fastest leading edge. For a slower edge, the actual delay exceeds the displayed delay by the combined shift of the start point and the median.

Transition Time: Interval between the 10% and 90% amplitude points on the leading/trailing edge.

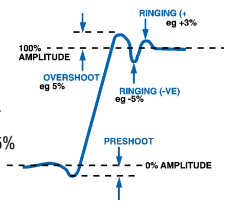


Linearity: Peak deviation of an edge from a straight line through the 10% and 90% amplitude points, expressed as a percentage of pulse amplitude.
Jitter: Short-term instability of one edge relative to a reference edge. Usually specified as an rms value, which is one standard deviation or "sigma". If the distribution is assumed to be Gaussian, six sigma represents 99.74% of the peak-to-peak jitter.

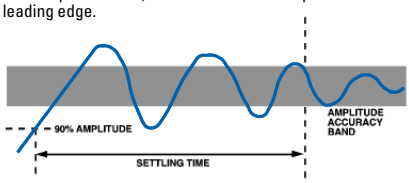
The reference edge for the period jitter is the previous leading edge, whereas the reference edge for the delay jitter is the leading edge of the trigger output. Width jitter is the stability of the trailing edge with regard to the leading edge.
Stability: Long-term average instability over a specific time, for example, an hour, or a year. The jitter is excluded.
Pulse Amplitude: Pulse output is specified as pulse top and pulse base (usually referred to as high level and low level), or as peak-to-peak amplitude and median offset. A "window" specification shows the limits within which the pulse can be positioned.



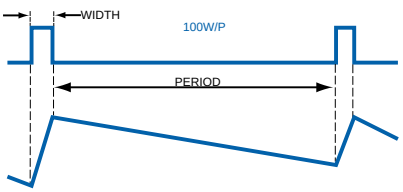
Preshoot, Overshoot, Ringing: Preshoot and overshoot are peak distortions preceding/following an edge. Ringing is the positive-peak and negative-peak distortion, excluding overshoot, on pulse top or base. A combined preshoot overshoot, ringing specification of e.g. ±5% implies:
- Overshoot/undershoot <5%
- Largest pulse top oscillation < ±5% of pulse amplitude



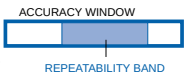
Settling Time: Time taken for pulse levels to settle within a level specification, measured from a 90% point on the leading edge.



Duty Cycle: Percentage ratio of pulsewidth to period. In pulse/function generators, this term is also used to define sine and triangle symmetry. Note that in pulse generators, this is a secondary parameter derived from the period and width settings. The duty cycle achieved is therefore subject to width and period accuracies.



Output Impedance/Resistance: Effective pulse source impedance/dc resistance.
Reflection Coefficient: Reflection at the pulse generator output expressed as a percentage of the incident pulse amplitude. (Test pulse edges correspond to the generator's fastest transitions.)
Repeatability: When an instrument operates under the same environmental conditions and with the same settings, the value of a parameter will lie within a band inside the accuracy window. Repeatability defines the width of this band.



HP-IB Programming Times

Listen Time: The time an instrument occupies the bus to receive and verify a message. The NRFD signal is active during this period.

Settling Time: The time taken by the instrument to execute an HP-IB message and for the output to settle within the accuracy specification. NRFD inactive.

Execution Time: The sum of Listen Time and Settling Time.

Talk Time: The time an instrument occupies the bus to output a specified string. Output data is typically instrument error status, or current or stored parameters.

For more information, visit our website: (http://www.hp.com/go/dvt).

HP E4859A
HP E4853A
HP E4854A

- Error performance analysis of burst-mode data
- Up to 16 serial cell generators
- Cells with mixed PRBS/user-defined pattern
- Variable cell lengths and cell timing
- Bit rate 170 kb/s to 250 Mb/s (optional 660 Mb/s)
- Auto-adjust cell transfer delay and threshold
- Detect mode with clock and data input

HP E4859A, with HP E4854A and peripherals

HP E4859A Serial Cell Generator and Analyzer Entry System

The HP E4859A serial cell generator and analyzer entry system provides one bursted serial cell generator, a companion cell error analyzer, and a central synthesized clock source. For configurations requiring multiple generators or analyzers, modules can be added to the entry systems.

The HP E4859A is used in research and development to characterize the transmission performance of Time Division Multiple Access (TDMA) and other burst-mode transmitters/receivers used in communication systems.

Generation of All Types of Burst-Mode Data

Multiple HP E4854A dual serial cell generators can be set up to emulate burst-mode data in a network. Cell length, cell content and cell timing can be varied for each generator to allow characterization of the transmission performance under real network conditions, even for designs using proprietary cell formats.

Error Performance Analysis of Burst-Mode Data

The HP E4853A serial cell analyzer measures the bit error performance of burst-mode cells transmitted from one of the generators. The generator and analyzer are synchronized by auto-adjust.

Applications

Applications include characterization of burst-mode transmitter/receiver, components, modules, and sub-systems during research and development:

- Time Division Multiple Access (TDMA). TDMA technology is typically used in point-to-multipoint networks, especially for upstream transmission in local access networks for interactive B-ISDN. Such networks are Passive Optical Network (PON), Passive Double Star (PDS), Fiber To The Curb (FTTC), and ground stations for Personal Handy Phone System (PHS).
- Time Compression Multiplex (TCM or pingpong)
- Wavelength Division Multiplex (WDM)
- Point-to-point burst-mode transmission
- Optical bus, optical computer interconnects, LAN
- Digital/optical CATV transmission
- Military communication system

Specifications (typical)

HP E4854A provides two serial cell generators.
HP E4853A provides one serial cell analyzer and one generator.
Bit Rate: 170 kb/s to 250 Mb/s, optional 660 Mb/s
Cell Content: Up to 28 segments of user-defined pattern and/or PRBS
User-Defined Pattern: 64 Kb per channel
PRBS: 2^7-1 to $2^{31}-1$
Segment Length: 1 bit to 64 Kb
Guardtime Between Cells in Burst-Mode: 0 to 24 ms, resolution 10 ps
Output Amplitude: 0.3 V to 2.5 V, TTL, ECL, PECL
Auxiliary Output (opt.)**:** Cell envelope, bursted clock, continuous clock
Auto-Adjust: Synchronization of analyzer and generator
Clock Input (opt.)**:** Detect mode with clock and data input for the analyzer
Measurements: Bit error count, bit error ratio; individual cell segments can be selected
Decision Threshold Voltage: –2.1 V to +5.1 V
Module Size: VXI C-size, one slot

For more information, visit our website: (http://www.hp.com/go/dvt).

Key Literature

Product Overview, p/n 5963-9985E
Technical Data, p/n 5963-9924E
Configuration Guide, p/n 5964-0004E

Ordering Information

The entry system is needed. Optionally, the free slots can be used for additional HP E4853A and HP E4854A modules. For assistance in defining your configuration, please contact your local Hewlett-Packard sales office.

HP E4859A Entry System* (seven free slots)
  Opt 001 Auxiliary Output
  Opt 002 Clock Input for Analyzer
  Opt 660 Bit Rate 660 Mb/s max.
HP E4853A Generator/Analyzer Module (one slot)
  Opt 001 Auxiliary Output
  Opt 002 Clock Input for Analyzer
  Opt 660 Bit Rate 660 Mb/s max.
HP E4854A Dual Generator Module (one slot)
  Opt 001 Auxiliary Output
  Opt 660 Bit Rate 660 Mb/s max.

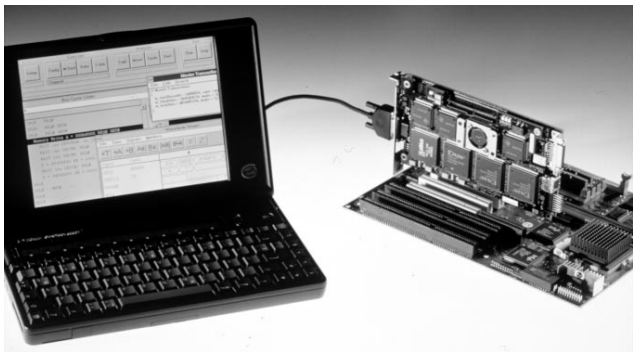
*The entry system comes pre-installed and includes mainframe, clock source and sequencer, one HP E4853A (one generator/one analyzer) module, controller with operating system, application software, licenses, and documentation. Monitor, keyboard, and mouse have to be ordered separately.

7

HP E2920 PCI Series

HP E2925A
HP E2926A
HP E2970A
HP E2971A
HP E2972A
HP E2974A
HP E2975A

- PCI Exerciser and Analyzer card, includes programmable PCI Master and Target, protocol monitor and logic analyzer
- Windows 95/NT User Interfaces for interactive control from PC
- Fully programmable via PCI for in-system validation
- Modular software and hardware with open C-API
- Built-in, ready-to-go test functions for asynchronous stress and data integrity test
- Real-time and post-processing performance analyzers



HP E2920 Computer Verification Tools

The HP E2920 PCI Series of Computer Verification Tools is a family of test tools designed to provide early and extensive insight into PCI-based designs, revealing and solving design problems sooner throughout the entire development process, from initial bring-up of devices and systems through to system validation.

Standardize Tools and Processes

By using the same tools from initial prototype bring-up in R&D through to in-system validation in multiple platforms, you can communicate tests and results between departments, or even with customers and suppliers, to resolve problems faster.

Interactive Debugging Solution

By choosing from the user interface products, you can tailor a solution to meet your interactive debugging needs—from a PCI analyzer up to a complete PCI Exerciser and Analyzer.

Integrates Into Your Test Environment

With its C-Application Programming Interface (C-API), the fully in-system programmable HP E2925A 32 bit, and HP 2926A 32/64 bit, 33 MHz PCI Exerciser and Analyzer card can be completely integrated into your test software for validating chips, cards and systems.

Early and Extensive Insight

Start sooner with concurrent bring-up or integration, and the associated debugging. Emulate expected bus traffic from missing devices, and also unexpected traffic. You'll invoke problems sooner with an independent, deterministic and flexible PCI Bus Master and Target, and analyze the problems quickly with the on-board analyzer. Together with ASIC emulation hardware, you can verify your design's behavior before you commit to silicon. Use the Performance Analyzer, together with the ideal Master and Target capabilities of the exerciser, to optimize device and system performance, and identify bottlenecks for future design modifications.

Reveal and Solve Problems Faster

As well as exhaustively testing traffic and protocol variations, the on-board CPU and built-in test functions let you generate asynchronous traffic stress and sophisticated data integrity tests quickly and easily. Use multiple cards under system control to emulate typical traffic behavior of different types of devices or generate worst-case conditions for peer-to-peer background traffic, arbitration and interrupt testing. You can intensify your testing beyond anything possible with normal PCI devices, while retaining deterministic control and repeatability to ease debugging.

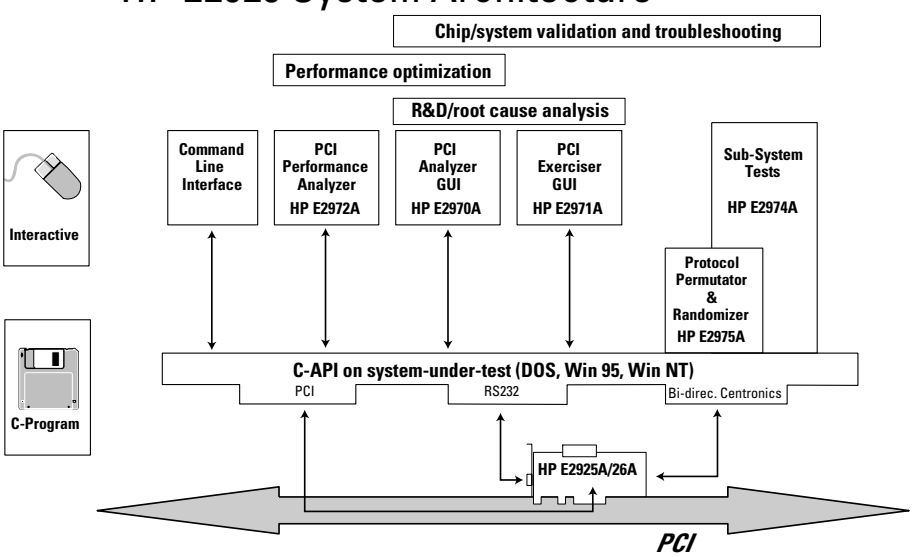
Technical Summary

HP E2925A PCI Exerciser and Analyzer

The HP E2925A 32 bit, 33 MHz PCI Exerciser and Analyzer is a complete PCI exerciser and analyzer on a single, short PCI card:

- Programmable 32 bit, 33 MHz PCI Master and Target, with low and high level control of protocol and traffic behavior
- Master supports all commands except Dual Address Cycle, Target supports all memory, I/O and configuration commands
- 32 k state PCI logic analyzer with PCI-oriented triggering and storage qualification
- Programmable PCI configuration space and Expansion EEPROM
- 128 kB of partitionalbe memory and/or I/O space-data source for master, read/writeable as target, for bursts up to 32 kDwords
- Programmable interrupt generator
- PCI Protocol Monitor checks 30 rules in real-time
- On-board CPU and built-in test functions, such as write, read and compare, guarantee asynchronous stress and data integrity test
- 3.3 V and 5 V compatible
- Optional external logic analyzer adapter for system-wide analysis
- CPU port interface and sideband I/O for controlling and monitoring registers and signals beyond PCI
- C-API programmable-library and Command Line User Interface
- RS232 or optional bi-directional Centronics interface for external control
- Also controllable via PCI from system-under-test
- Provides fast, convenient port into system-under-test's memory, I/O and configuration spaces, for example to download test code or data

HP E2920 System Architecture



HP E2926A PCI Exerciser and Analyzer

- Programmable 32/64 bit, 33 MHz PCI Master and Target, with low and high level control of protocol and traffic behavior
- Master and Target support all command types
- 128 k state PCI logic analyzer with PCI-oriented triggering and storage qualification
- Programmable PCI configuration space and Expansion EEPROM
- 1 M of partitionable memory and/or I/O space-data source for master, read/writeable as target, for bursts up to 4 GB
- Programmable interrupt generator
- PCI Protocol Monitor checks 30 rules in real-time
- On-board CPU and built-in test functions, such as write, read and compare, guarantee asynchronous stress and data integrity test
- 3.3 V and 5 V compatible, in 32/64 bit systems
- Optional external logic analyzer adapter for system-wide analysis
- CPU port interface and sideband I/O for controlling and monitoring registers and signals beyond PCI
- C-API programmable-library and Command Line User Interface
- RS232 or optional bi-directional Centronics interface for external control
- Also controllable via PCI from system-under-test
- Provides fast, convenient port into system-under-test's memory, I/O and configuration spaces, for example to download test code or data
- 64 bit addressing and 64 bit data transfer, supported by Master, Target and Analyzer
- Real-time data compare
- Exhaustive protocol variations with hardware support for protocol permutations
- Hardware sequencing of block transfers/transactions for extremely dense traffic (e.g. read/write changes in 15 cycles, fast back-to-back)

The HP E2925/E2926A's C-API library lets you access all the functions of the Exerciser and Analyzer card from your own test software, either running on the system-under-test, or on an external test controller. The Command Line Interface gives you interactive control using command strings or batch files of commands. The following options are available:

Option 001 External Power Supply

An external power supply is available for applications where the card should be transparent to the system-under-test and draw no power.

Option 002 Fast Host Interface

A bi-directional Centronics interface card (ISA), driver and cable provide a higher bandwidth control interface than RS232 for an external test controller. This improves performance for applications where an external controller transfers data or test code to and from the system-under-test using the card as a port into the system.

Option 003 HP Logic Analyzer Adapter

An add-on daughter card with terminated connectors lets you connect an external HP logic analyzer for system-wide analysis, with visibility of all PCI, bus-state and protocol monitor signals which are available to the on-board analyzer.

Option 004 General Logic Analyzer Adapter

This generic logic analyzer adapter provides all of the on-board PCI analyzer signals to connect to an external logic analyzer. Appropriate terminators, depending on the selected logic analyzer, have to be added.

Option 100 1 M Memory/Performance Board (applies to HP E2925A only)

This 1 M memory/performance board provides a deeper trace memory for up to 1 M PCI trace samples in combination with a differential storage qualifier, trigger sequencer and five real-time counters. Thus, all analyzer capabilities are extended. Together with the HP E2972A PCI Performance Analyzer, performance measurements can be carried out at real-time using in-depth post-processing. All functions can be accessed through the C-API library.

HP E2970A PCI Analyzer Graphical User Interface

The HP E2970A PCI Analyzer Graphical User Interface provides a comprehensive Windows 95/NT user interface for the HP E2925A/E2926A's on-board logic analyzer, allowing you to analyze PCI bus traffic quickly and easily using an external PC or the system-under-test itself:

- Easy setup of trigger sequences and storage qualification for on-board PCI state logic analyzer, for example, to capture all memory transfers, including wait states but filtering out idle states between transfers
- Real-time PCI protocol checker
- State Waveform Lister displays waveform trace of all PCI signals, sideband I/O and internal bus state signals
- Bus Cycle Lister disassembles bus traffic at state level, with comprehensive error reporting including cross-references to PCI specification
- Bus Transaction Lister summarizes bus transfers at address and data level

HP E2971A PCI Exerciser Graphical User Interface

The HP E2971A PCI Exerciser Graphical User Interface provides a comprehensive Windows 95/NT user interface for the HP E2925A/E2926A's programmable PCI Master and Target:

- Configuration Space Editor to set up the PCI configuration space
- Data Editor to view and modify the contents of the on-board memory
- Master Transaction Editor to set up master transactions and protocol behavior
- Target Behavior Editor to set up protocol behavior sets for the target

HP E2972A PCI Performance Analyzer

The HP E2972A PCI Performance Analyzer is a comprehensive graphical user interface for the HP E2925A/E2926A, featuring:

- Real-time counter-based performance analysis
- Post-processing performance analysis of captured bus traffic
- Graphical presentation of statistics
- Standard measurements for critical performance measures such as data transfer rate, data efficiency and bus usage
- Hierarchical data representation for fast problem detection and in-depth root cause analysis

HP E2974A Sub-System Stress Tests

The HP E2974A Sub-System Stress Tests provides a library of ready-to-run tests designed to stress PC systems and sub-systems through the PCI port during system validation, featuring:

- Ready-to-run test functions
- Easy-to-use GUI to set up test parameters
- Test function sequencing
- Ability to run on device-under-test
- Detailed reporting of test results and detected errors
- System Memory Test, Interrupt System Test and PCI Bandwidth Consumption
- Ongoing, concurrent PCI protocol monitoring

HP E2975A PCI Protocol Permutator and Randomizer Software

The HP E2975A PCI Protocol Permutator and Randomizer Software provides a C-API library to set up deterministic protocol variations using a sophisticated permutation algorithm, featuring:

- Automatic PCI protocol variations in hardware within user-defined constraints
- Reduced test time, as use of system CPU is not required
- Compatible with any ANSI-C compiler for integration in any development environment

Ordering Information

HP E2925A 32 bit, 33 MHz PCI Exerciser and Analyzer
- **Opt 001** External Power Supply
- **Opt 002** Fast Host Interface Kit
- **Opt 003** HP Logic Analyzer Adapter
- **Opt 004** General Logic Analyzer Adapter
- **Opt 100** 1 M Memory/Performance Board

HP E2926A 64 bit, 33 MHz PCI Exerciser and Analyzer
HP E2970A PCI Analyzer GUI for Windows 95
HP E2971A PCI Exerciser GUI for Windows 95
HP E2972A PCI Performance Analyzer
HP E2974A Sub-System Tests
HP E2975A Protocol Permutator and Randomizer Software

For detailed information, request the technical specifications, HP E2925A p/n 5965-4724E, HP E2970A p/n 5965-4726E, HP E2971A p/n 5965-4725E, HP E2972A p/n 5965-8008E, HP E2974A p/n 5965-8009E, HP E2975A p/n 5965-8010E, and the PCI Series brochure p/n 5965-4723E.

Data Generator/Analyzer Platform

HP 81200

- Characterizes digital hardware from ICs to systems
- Function and margin tests, error analysis
- Stimulus and response in one ready-to-use instrument
- Stimulus up to 660 Mb/s (RZ)
- Response sampling rate up to 660 MSa/s
- 2 to 100 channels (2 to 240 NRZ/single-threshold channels)
- 100 ps resolution, 50 ps accuracy
- Semi-automatic deskew

Confirm Digital Hardware Early in the Product Cycle

The HP 81200 Data Generator/Analyzer Platform helps engineers in design and engineering environments to characterize digital hardware such as ICs, boards, modules, frames and systems. The HP 81200 configurations are compact and accessible so that characterization under near-to-real conditions can be performed at an early stage in the design or manufacturing cycle, thus reducing risks, costs and time-to-market.

Application Examples

- CMOS, ECL logic characterization
- Emulate clock, data and control signals
- Functional test, margin test, error analysis
- Computer clock, multi-phase clocks
- High speed DACs
- High speed digital transmission devices

Emulate the Device's Environment

Communication and computing devices can require very complex stimuli. To meet this need, the HP 81200 provides sequencing and looping so that its 1 Mb/channel memory can generate very deep patterns. The internal editor includes memory-based prbs/prws (pseudo-random binary/word sequences) to simulate traffic and allow multiplexer testing.

Programmable output levels, pulsewidth and delay are independent for each channel so that performance at and beyond working conditions can be measured. RZ/NRZ (return-to-zero/no-return-to-zero) and R1 (return-to-one) formats are available, and RC (return-to-complement) can be arranged by the logical addition of two channels using the EX-OR output addition feature.

For high speed devices, fast, stable edges with rates up to 660 Mb/s, RZ/NRZ are available. For higher data rates, the EX-OR feature allows 2:1 multiplexing for data rates up to 1.32 Mb/s NRZ, without halving the voltage. This feature can be of use in communications applications where prbs (pseudo-random binary sequences) up to 2^{15}–1 are adequate. (If the device requires a clock for the multiplexed signal, an external source such as the HP 8133A, is needed to clock the HP 81200 at up to 660 MHz, and at the same time, clock the device at twice that frequency.)

For less demanding applications (control signals, slower logic), dual output/input module front-ends are available which can reduce investment.

Easy Performance Measurement

The performance measurements are easy because they are implemented under the same user interface as the stimulus. The HP 81200 captures, and, if required, compares data in real time so that an error map or error count can be observed while stimulus parameters are adjusted. Analyzer timing and thresholds are, of course, programmable so that output performance can be measured dynamically. Dual thresholds are available so that "bad" pulses with undefined levels can be detected. Skews introduced by the user's cabling and fixturing can be compensated by a software-guided procedure (HP E4805A and Option 003 required).

Bench and System Operation

Manual operation is via a Windows NT-based user interface. Channel allocation, pattern and parameters are among the items that can be set up. Patterns can be imported and exported in ASCII via HP-IB (SCPI), LAN or 3.5" disk. For system operation, the HP-IB can be used in one of two ways: to control other HP-IB instruments (for this, a suitable controller language such as C, HP Basic or HP VEE must be installed by the user in the built-in PC), or another computer can control the HP 81200.

The HP 81200 Data Generator/Analyzer shown in the 10- and 3-slot mainframes. In front, the optional Display and Entry Panel.

Convenient and Upgradeable

Bench users, in particular, will appreciate the HP 81200's "switch on and go" philosophy and will adapt rapidly to the Windows-type instrument control.

The HP 81200 is supplied ready-to-use[1] with the desired number and types of channels. The software supports any channels that the user may choose to add at a later date.

[1]All software and hardware is in place and connected. However, expander modules and monitors are packaged separately, and these items must be connected for initial use. In the case of expander modules, the mainframe clock generator must be removed and opened in order to connect a ribbon cable to the expander clock module(s).

The modular structure (mainframes, modules, module front-ends and user interfaces) allow required channel counts to be implemented economically. The following table gives some examples using the small frame:

Requirement	Minimum	Optional
Generator-only, max. 10 channels, up to 660 Mb/s	Small frame, Clock/Data module, 1 or 2 HP E4843A front-ends	2 HP E4841A modules 8 HP E4843A front-ends
Generator-only, max. 20 channels, up to 200 Mb/s	Small frame, Clock/Data module, 1 or 2 HP E4846A front-ends	2 HP E4841A modules 8 HP E4846A front-ends
Generator/analyzer, max. 8 channels, up to 600 Mb/s and 660 MSa/s	Small frame Clock module HP E4841A module Up to 4 HP E4843A/44A front-ends, any mix	HP E4841A Up to 4 HP E4843A/44A front-ends, any mix
Generator/analyzer, max. 16 channels, up to 200 Mbit/s and 200 M/Sa	Small frame Clock module HP E4841A module Up to 4 HP E4845A/46A front-ends, any mix	HP E4841A module Up to 4 HP E4845A/46A front-ends, any mix

HP 81200 Brief Specifications (50 Ω load, 10 to 40° C)

HP E4805A Clock and HP E4831A Clock/Data Modules

Frequency: 1 kHz to 660 MHz
Resolution: 1 Hz (HP E4831A: 4 digits)
Accuracy: 50 ppm (HP E4831A: 100 ppm)
Jitter: 5 ps rms, typ.
Ext. Clock: 170 kHz to 666.66 MHz
Front-End Slots: None (HP E4831A: 2 generator)
Ck Fan-Out: 11x HP E4841A + 2x HP E4805A (HP E4831A: 6x HP E4841A)

Data Generator Configurations (HP 4831A, E4841A)

Front-End Slots per Module: 4 (HP E4831A: 2)
Memory Depth: 1 Mb per HP E4831A/41A front-end slot
Pattern Up/Download: ASCII file via LAN, 3.5" disk or HP-IB to/from the internal database. Transfer between database and hardware is executed by the supplied HP 81200 user interface.
Segments: The memory can be divided into segments. The segments, which are loopable, can contain user-defined patterns or a prbs, or represent a pause.
Prbs: 2^n–1 (n = 7, 9, 10, 11, or 15), Prws: 2^{15}–1
Loops: The maximum number of loops is 60 minus the number of segments
Delay: Zero to > 1 period, worst case 3 μs (2 ps resolution). Each channel is independent.
Pulsewidth: Variable in RZ mode with 2 ps resolution. For limits, see table "Generator Front-Ends", below.
Edge-Placement Accuracy: ± 50 ps ± 50 ppm
Output Skew: < 50 ps typ. after deskew. Constant levels and frequency.
Output Levels: See Table "Generator Front-Ends", below
Output Impedance: 50 Ω typ; output connector: SMA

Generator Output Front-Ends

	HP E4843A	HP E4846A
Target Logic	ECL, PECL 2.5 V	CMOS, TTL
Frequency	660 MHz RZ max.	200 Mbit/s NRZ max.
Outputs	1, differential	2, single-ended
Format	RZ, R1, DNRZ	DNRZ
Amplitude	0.3 to 2.50 Vpp	0.25 to 3.50 Vpp
Transition Time[1]	350 ps fixed	2.5 ns fixed
Minimum Width	600 ps[1]	5 ns
Maximum Width[2]	1 period–600 pc	N/A

[1] At ECL levels, 20–80% of amplitude
[2] RZ format

Data Analyzer Configurations (HP E4841A)

Front-End Slots per Module: 4, generator or analyzer, any mix
Memory Depth: 1 Mb per HP E4841A front-end slot. In Compare mode, memory is shared between expected data and captured data
Sampling Point Delay: Zero to > 1 period, worst case 3 μs (2 ps resolution). Each channel is independent.
Capture Mode: State list, max. sample rate is 660 MSa/s
Compare Mode: State list (with highlighted errors), error map, error count or bit error rate. Max. sample rate is 333.33 MSa/s.
Other Characteristics: See following table "Analyzer Front-Ends"

Analyzer Input Front-Ends

	HP E4844A	HP E4845A	HP E4847
Sampling Rate	660 MSa/s	660 MSa/s	330 MSa/s
(Divide by two in compare mode)	330 MSa/s if two thresholds are used	330 MSa/s if both thresholds are used	
Inputs	1	2	2
Input Sensitivity	200 mV	200 mV	200 mV
Impedance/ Connector	50 Ω SMA (f) 3.5 mm	50 Ω SMA (f) 3.5 mm	50 Ω/high impedance exchangeable SMA (f) 3.5 mm
Input Threshold	–2.1 v to +5.1 V, 5 mV resolution	–2.1 v to +5.1 V, 5 mV resolution	–2.1 v to +5.1 V, 5 mV resolution
Number of Thresholds	2	1	1
Analog Bandwidth typ.	1 GHz	1 GHz	350 MHz

General

Programming Interface: From an external controller over HP-IB, SCPI (1992) commands. Alternatively, use the embedded PC to control other test equipment via HP-IB.
Graphical User Interface: Windows-based, colored, on-line help, graphical sequencing and channel connection windows.
Display and Entry Panel: TFT display and alpha-numerical entry pad. Alternatively, monitor, keyboard and mouse.
Save/Recall: Multiple settings and test patterns can be stored in an internal database.
Built-in Diagnostics: Module and system self-tests can be implemented.
Mainframe Dimensions:
HP E4840A: 177 mm H x 426 mm W x 498 mm D (Option 001: add 10 mm)
HP E4849A: 310 mm H x 426 mm W x 602 mm D (Option 001: add 10 mm)
Operating Temperature: 10° C to 40° C
Interfaces: LAN 10baseT (AUI, BNC), RS232, SVGA port, SCSI, Centronics parallel port, mini-DIN connectors for keyboard and mouse, HP-IB, 3.5" floppy drive
Warranty: 3 years
Standards: CE-mark, designed and produced according to ISO 9001, IEC1010-1, CSA 1010.1, En 55011/CISPR 11, Group 1, Class A +10 dB

Ordering Information

Mainframes
HP E4840A Small mainframe with 3 slots
Includes embedded PC and installed software (Windows NT™ operating system and HP E4873A user software
- **Opt 001** Display and entry panel HP E4807A
- **Opt 003** 15" VGA monitor
- **Opt 004** 17" VGA monitor
- **Opt 005** 21" VGA monitor
- **Opt 006** Keyboard, USA/English, Windows 95/NT™, mini DIN
- **Opt 007** Mouse, 2-key, mini-DIN connector (Options 003 – 007 are not required if Option 001 is ordered)
- **Opt 008** External CD-ROM drive, SCSI, required for HPE4873A user software updates

HP E4849A Mainframe with 10 free slots (9 with Option 002)
Includes HP E4806A PC module and installed software (Windows NT™ operating system and HP E4873A user software)
- **Opt 002** VXI extender module HP E1482B required for 1 or 2 expander frames (Other options as HP E4840A)

HP E4848A Expander frame, includes HP E1482B VXI extender module and all cables for connecting to the mainframe. HP E4805A Clock module required.

Modules
HP E4805A 660 MHz clock module
- **Opt 003** Deskew probe HP 1144A

HP E4831A 660 MHz clock and data module
HP E4841A 660 MHz data generator/analyzer module

Generator Front-Ends
HP E4843A 660 Mbit/s RZ/NRZ
HP E4846A 200 Mbit/s NRZ, dual channel

Analyzer Front-Ends
HP E4844A Dual threshold, 50 Ω
HP E4845A Dual input, 50 Ω
HP E4847A Dual input, 50 Ω/hi-z

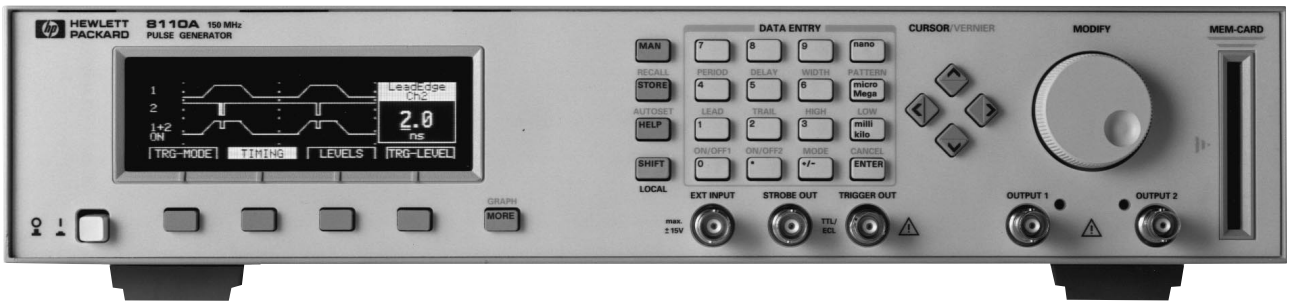
For more information, please request these publications:
Technical Specifications 5965-3415E
Brochure 5965-3416E
Configuration Guide 5965-3417E

For more information, visit our website:
(http://www.hp.com/go/dvt).

150 MHz Pulse Generator for Real-World Digital Signals

HP 8110A

- VFO and PLL timing
- 10 ps resolution
- 2 ns variable transitions
- 20 V into 50 Ω
- Pulse, burst and data modes
- 3 and 4 level signals
- Configurable
- Master/slave capability



HP 8110A and two HP 81103As

HP 8110A Pulse Generator

Precise edge-positioning, plus the ability to simulate digital signals as they occur in the real world, make this pulse generator stand out as a partner for your HP oscilloscope or logic analyzer. On the bench, you can verify designs, achieving reliable results quickly at frequencies where emulation becomes uncertain or cumbersome. In systems, high resolution lets you optimize yield. True-to-life signals improve measurement credibility.

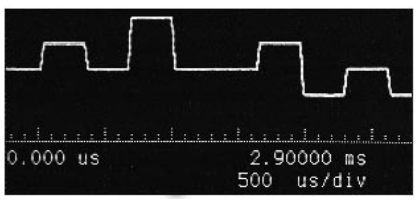
The HP 8110A pulse generator can be factory-configured with one or two channels and can include a PLL module and a Deskew module. The second channel and the modules are retrofittable.

Real-World Signals for Testing Digital Designs

Clock and data signals can be set up in the main channels; a separate strobe channel is available for device control signals. For more channels, two or more units can be master/slaved.

Through internal channel addition, you can model high frequency effects so that you can perform measurements before making substantial hardware investment. Many effects can be set up, such as irregular pulsewidths, overshoot, pulse droop, ripple, crosstalk, reflections, ground-bounce, etc.

Three and four level waveforms are also solved using waveform addition. The picture here shows part of a 2B1Q communications signal generated by an HP 8110A.



Bench Features

- All parameters at a glance, easy entry through knob or key pad, plus graphic visualization mean rapid error-free setups
- Setups internally storable, or on 95LX-type memory cards
- Timing conflicts quickly resolved with the autoset key or the intelligent help feature

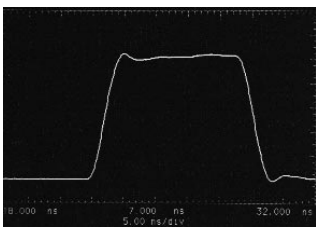
Device Interfacing Features

- Test bed delays compensated at the device
- Level display valid for all load resistances
- Voltage or current settings, amplitude or levels, can be preset
- Voltage or current device protection
- Parameter terms to suit the measurement, e.g., frequency/period, duration/phase/duty cycle

Measurement Confidence

To ensure reliable measurements with good long-term repeatability, the high resolution pulse edges are fast and clean with remarkably low jitter. The PLL module enhances frequency resolution, stability and accuracy.

The thorough specifications are valid over a wide temperature range. This avoids temperature-dependent recals and hence contributes to consistent performance.



Flexible Triggering

The PLL module provides an additional triggering layer so that the pulses, even in an externally-triggered sequence, can be synchronized to the system clock. This capability allows, for example, programmable wait loops to be set up in order to optimize microprocessor performance. A different example of two layer triggering, useful for repetitive measurements, is where a data or burst sequence needs to be repeated at intervals without recourse to an external trigger.

CAT Features

- Low profile saves rack space
- Optional rear panel connectors and rack mounting
- SCPI standard commands—less learning, protects software from obsolescence
- Wide operating temperature range, no de-rating
- International electro-magnetic compliance standards
- PLL module synchronizes with system clock
- Display can be switched off to enhance bus speed
- Built-in diagnostics

HP 8110A Brief Specifications
50 Ω load, 0 to 55° C

Please refer to Brochure 5964-6335E for details.

HP 8110A Mainframe

Frequency: 1.00 Hz to 150 MHz
Period: 6.65 ns to 999 ms
Resolution (best case)**:** 10 ps
Accuracy: 5% + 100 ps
Jitter: 0.03% + 25 ps, rms
Modes: Continuous/externally-triggered/externally-gated sequences of pulses, double-pulses, bursts, and patterns. Also external width.
Burst Length: 2 to 65536 pulses or double-pulses
Strobe Channel: 2 to 4096 bits, freely programmable
Format: NRZ
Level: TTL/ECL selectable
Source Resistance: 50 Ω, typical

HP 81106A PLL/Ext. Clock Module

Frequency: 1.000 mHz to 150.0 MHz
Period: 6.65 ns to 999.0 seconds
Resolution (best case)**:** 10 ps
Accuracy: 0.1%
Jitter: 0.003% + 20 ps, rms
Stability: 50 ppm/year, typical
Clock Modes:
Int. Clock: With int. or ext. references (as period source or trigger for bursts and patterns)
Ext. Clock: For synchronization to a system clock or for master/slave operation

HP 81103A Channel Module

Timing
Delay: 0.00 ns to 998 ms } mutually
Double-Pulse: 6.65 ns to 998 ms } exclusive
Accuracy: 5% + 1 ns
Width: 3.30 ns to 998 ms
Accuracy: 5% + 250 ps
Jitter: 0.03% + 25 ps, rms
Transitions (10 to 90% amplitude)**:** 2.00 ns to 200 ms
Accuracy: 10% + 200 ps
Overshoot, Ringing: 5% + 20 mV

Output Parameters (into 50 Ω load)

	50 Ω source	1 kΩ source
Amplitude, p-p	100 mv to 10.0 V	200 mV to 20.0 V
High level	–9.90 to + 10.0 V	–18.8 to + 19.0 V
Low level	–10.0 to + 9.90 V	–19.0 to + 18.8 V

Also programmable as current ±4.00 to ±400 mA.
Limits: programmable to suit and protect device.

Source Resistance: 50 Ω/1 kΩ, selectable
Load Resistance: Values 0.1 Ω to 999 kΩ can be entered for direct reading display of output level
Modes: Normal/complement, on/off
Channel Addition (with two HP 81103A output channels)**:**
Simulates digital signals with interference pulses, or 3 or 4 level communications signals. Added waveform at Output 1.
Output 2 disabled. 48/500 Ω source selectable.
For Selected 48 Ω Source Resistance
Amplitude:
0 to 19.5 Vp-p. Bipolar signals limit between 10 Vp-p (0.2 V/10.3 V peak levels) and 14 Vp-p (+7 V/–7 V peak levels).
Minimum Transitions:
Channel 1: 2.5 ns typ. (optimized for speed so that fast interference pulses can be added to "clean" channel 2 data)
Channel 2: 7.5 ns typ.
For Selected 500 Ω Source Resistance
Amplitude: 0 to 20 Vp-p
Minimum Transitions: 30 ns typ. (both channels)
Pattern Capabilities: 2 to 4096 bits. Edit capabilities include prbs 2^n–1, where n is selectable from 7 to 12. Value 12 is CCITT O.151-compatible.
Format: RZ (width and delay programmable), DNRZ (delay programmable), NRZ

HP 81107A Two Channel Deskew Module

Compensates for unequal propagation times in the test setup, or for slave propagation delay in master/slave setups.
Delay (each channel)**:** 0.00 to 28.00 ns + typ. 6.5 ns

General

HP-IB Capability
Conformity: IEEE-488.2, 1987, SCPI 1992.0
Function Code: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, CO
Storage of Instrument Settings
Current settings are retained on power-down. A default setting is implemented on RCL0 or HP-IB "*RST." Nine locations are available for user settings. Additionally, 40 settings can be stored on a 128 KB PCMCIA memory card (access time ≤ 300 ns), available as HP 8110A Option UFH. Note that a change in instrument configuration invalidates the files (save settings to disk via HP-IB before adding or removing HP 8110A modules.)
Environmental
Temperature: 0° to 55° C operating, –40° to 70° C storage
Humidity: 95% RH at 0° to 40° C
Power: 100 to 240 V ac ± 10%, 50 to 60 Hz; 100 to 120 V ac ± 10%, 50 to 60/400 to 440 Hz
Consumption: 300 VA (max. configuration)
EMC Conformity: CISPR 11, A; EN55011, A; EN50082-1
Size: 426 mm W x 89 mm H x 445 mm D (17 in x 3.3 in x 17.5 in)
Weight: Net, 9.2 kg; shipping, 20.2 kg
Recal. Period: 1 year recommended
Warranty: 3 years

For more information, visit our website: (http://www.hp.com/go/dvt).

Ordering Information

HP 8110A Mainframe (includes English operating and programming manual 08110-91012).
Always order at least one HP 81103A with each HP 8110A.
A second HP 81103A or an HP 81106A or HP 81107A–in any combination–can be ordered at the same time or fitted retrospectively.
HP 81103A Output Module
HP 81106A PLL/Ext. Clock Module
HP 81107A Deskew Module
HP 8110A Options
Opt 0B2 Additional Manual 08110-91012
A user guide of your choice can be obtained with each HP 8110A:
Opt ABD German 08110-91112
Opt ABE Spanish 08110-91412
Opt ABF French 08110-91212
Opt AB0 Taiwan Chinese 08110-91612
Opt ABJ Japanese 08110-91512
Opt ABZ Italian 08110-91312
For further user guide requirements, please order the part number quoted above, not the option number.
Use the English OPM 08110-91012 for programming.
Opt UFH 128 kB Memory Card
Opt UN2 Rear (instead of front) Panel Connectors
Opt 1CN Front Handle Kit (5062-3988)
Opt 1CP Rack Mount/Handle Kit (5062-3975)
Opt 1CM Rack Mount Kit (5062-3974)
Opt 1CR Rack Slide Kit (1494-0060)
Opt 1BP MIL-45662A Cal with Test Data
Opt 0BW Service Manual (08110-91021)
Opt 503 Front and Rear Panel Connectors
HP 08110-91031 Component Level Service Documentation

100 V, 2 A High Power Pulse Generator

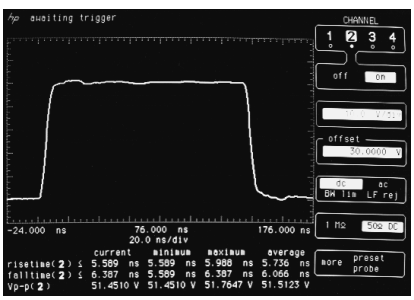
HP 8114A

- 100 V, 2 A pulses into 50 Ω
- 7 ns transitions (50 Ω into 50 Ω)
- Counted burst and external width
- SCPI programming commands
- Variable baseline ± 25 V (Option)
- Inhibit Input

HP 8114A 100 V, 2 A Pulse Generator

Tests High Power Devices Reliably

The HP 8114A programmable pulse generator delivers fast-transition 100 V pulses into 50 Ω loads at rates of up to 15 MHz. In addition to simulating transients and glitches, it is well-equipped to characterize and test devices requiring high voltage or current pulses, such as flash memories, power MOS devices, IR/laser diodes and radar devices.



Typical 2 A pulse into 50 Ω for IR-diode test

Protects Your Device

The HP 8114A gives you fast, clean, and reliable pulses without risking damage to the device-under-test. You can also set voltage, current, and duty cycle limits to prevent accidental damage, and use an external TTL control signal at the Inhibit Input to inhibit/enable the pulse output.

Integrates Easily into Test Systems

SCPI programming commands for HP-IB control and optional rear-panel connectors make the HP 8114A ideal for automated test systems. In addition, the Variable Baseline option allows a dc voltage of up to ±25 V to be added to the pulse baseline, making an additional dc power supply unnecessary. The HP 8114A output is protected against excessive power dissipation.

Specifications

Output: (50 Ω into 50 Ω)
Amplitude: 1.00 Vp-p to 50.0 Vp-p, 20.0 mAp-p to 1.00 Ap-p (doubles when Hi-Z source selected)
Resolution: 3 digits, best case 10 mV
Accuracy: ±1% of amplitude ±0.5% baseline ±100 mV
Baseline: 0 V ±100 mV ±0.5% of amplitude
Variable Baseline Option 001: –25 V to + 25 V, 50 Ω source impedance only
Accuracy: ±1/±100 mV ±0.5% of amplitude
Polarity: Positive or negative baseline selectable
Source Impedance: High impedance or 50 Ω selectable
Max. Short Circuit Current: 2 A

Pulse Performance

Overshoot/Preshoot/Ringing: < 5% of amplitude ±100 mV
Setting Time: < 100 ns typical
Transition Times (10/90% amplitude):
50 Ω into 50 Ω: < 7 ns (amplitude > 5 V); High-Z into 50 Ω: < 12 ns

Timing Parameters

Measured at 50% of amplitude with 50 Ω source impedance into 50 Ω load
Period: 66.7 ns to 999 ms (**Frequency:** 1.00 Hz to 15 MHz)
Accuracy: ± 5% ± 100 ps
Resolution: 3 digits best case 100 ps
Width: 10.0 ns to 150 ms
Duty Cycle: 0.1 % to 100% (maximum duty cycle limited for amplitude > 20 V, worst case 15%)
Accuracy: ± 5% ± 500 ps
Resolution: 3 digits best case 100 ps
Delay: 0.00 ns to 999 ms (maximum value = period –4 ns)
Accuracy: ± 5% ± 1 ns
Resolution: 3 digits best case 100 ps
Fixed Delay: 42 ns (trigger output to output) typical
Double Pulse: (Delay and Double-Pulse are mutually exclusive) 20.0 ns to 999 ms, minimum period 133 ns
Resolution: 3 digits best case 100 ps

Inhibit Input

External TTL signal inhibits the pulse output, holding the output signal at its baseline level.
Edge Mode: An active edge inhibits the pulse signal, reset from front panel or HP-IB.
Level Mode: An active level inhibits the pulse signal, an inactive level enables the signal level.

Trigger Modes

Continuous: Continuous pulse train
Triggered: External Input transition or manual trigger key generates pulse, double-pulse or burst of pulses
Gated: Active level at External Input or manual trigger key enables pulses, double-pulses or burst of pulses
External Width: Width of signal at External Input determines pulsewidth (maximum amplitude 20 V, 50 Ω into 50 Ω)
Burst: Bursts of 2 to 65536 pulse periods can be programmed

General

Operating Temperature: 0° to +55° C
Power: 100 to 240 Vac ± 10%, 50 to 60 Hz; 500 VA max.
Size: 426 mm W x 133 mm H x 422 mm D (16.8 in x 5.2 in x 16.6 in)
Weight: Net, 14 kg; shipping, 17 kg

For more information, visit our website: (http//www.hp.com/go/dvt).

Ordering Information

HP 8114A 100 V, 2 A Pulse Generator*
Opt 001 Variable Baseline ±25 V
Opt UN2 Rear Panel Connectors
Opt 0BW Service Guide
Opt 1CM Rack Mount Kit (5062-3977)
Opt 503 Front and Rear Panel Connectors
Accessories
Opt UFH 128 kB Memory Card

*Memory card not included.

HP 8133A

- Transitions typically < 60 ps
- 1 ps resolution, 350 fs with HP-IB
- Optional data and PRBS capabilities
- Jitter typically < 1 ps
- Optional second pulse channel
- Synchronization of up to three instruments

HP 8133A Timing Generator with Option 002

HP 8133A Timing Generator

When timing is critical, the ability to characterize a digital product begins and ends with accurate edge-placement of the test signal. The HP 8133A makes an outstanding contribution through high resolution, very low jitter and very fast, linear transitions.

These attributes are required in digital designs with clock rates from a few hundred MHz and upwards. Some examples are:

- Circuits for distributing clock signals of several hundred MHz. At these frequencies, parametric effects cause asymmetry so that designers need to test performance under conditions where the duty cycle is not 50%.
- Microprocessor boards—the faster the processor, the more acute the HF problems. At high frequencies, the effects cannot be fully emulated, and therefore measurements on hardware are essential.
- The same applies to fast chip-to-chip communication, especially in integrated designs where discovery of timing problems late in the design cycle can be disastrous.
- Datacom/Telecom chips where clock rates go from several hundred MHz to a few GHz.

The HP 8133A means more efficiency in manufacture as well as design because the tightly-toleranced test signal reduces the reject rate and avoids overspecification.

As mentioned, a fast edge contributes to placement accuracy. On the other hand, if the edge is too fast, measurements can be impaired through unnecessary ringing or reflections. For this reason, a range of transition time converters are available which match the requirements of today's faster technologies and provide signals with very level pulse top, and little or no overshoot.

When several channels must be stimulated at the same time in order to perform a measurement, multi-channel accessory kits allow two or three HP 8133As to be master/slaved for up to six channel operation.

To investigate pattern effects or to make rapid performance checks using the eye-pattern technique with the HP 54120 series oscilloscope, the HP 8133A can be fitted with a pulse/data channel in place of the second pulse channel. This supports 32 bit patterns and the CCITT 0.151 2^{23}–1 prbs.

HP 8133A Configuration Overview

Channel	Standard	Option 001[1]	Option 002[1]	Option 003[1]
1	Pulse channel width or delay	Pulse channel width and delay	Pulse channel width and delay	Pulse channel width and delay
2	None	None	Data channel 32 bit or PRBS	Pulse channel width or delay

[1]Options are mutually exclusive.

Brief Specifications

Please refer to data sheet 5091-7678E for details.

Timing
Frequency: 33.0 MHz to 3.0000 GHz, 100 KHz resolution
Period: 300 ps to 30.000 ns, 1 ps resolution
Accuracy: ± 0.5%, ± 0.1% nominal
Pulse Channel(s)
Square Mode (50% duty cycle):
Delay: 0.000 to 10.000 ns (–5.000 to +15.000 ns in Channel 1 if Option 001, 002, or 003 used)
Pulse Mode:
Delay: No variation (–5.000 to +5.000 ns in Channel 1 if Option 001, 002, or 003 used)
Width: 150 ps to 10.000 ns (max.: period –150 ps)
Duty Cycle: 0.0 to 100.0%, 0 and 100% mean dc at outputs
Accuracy: Typically 30 ps
Delay Drift Against Delay: 50 ps
Phase: –360.0 to +360.0°, subject to delay limits
Outputs, Channels 1 and 2 and (Trigger Output)
Amplitude: 0.30 to 3.00 Vp-p (0.5 to 1.80 Vp-p)
Level Window: –2.00 to +4.00 V (–4.00 to +4.00 V)
Outputs: Differential outputs, invertible (single)
Transition Times: 10% to 90% of amplitude: < 100 ps, 60 ps nominal; 20% to 80% of amplitude: < 60 ps, 40 ps nominal (< 100 ps)
EMC Conformity: CISPR II, EN5501, EN50082-1

For more information, visit our website: (http://www.hp.com/go/dvt).

Ordering Information

HP 8133A Pulse Generator
Opt 001 Delay Channel 1
Opt 002 Pulse/Data Channel 2
Opt 003 Pulse Channel 2
Note: Option 002 and Option 003 contain Option 001. These options are mutually exclusive. Extended warranty options (see page 584) available on request.
Accessories
HP 1250-1462 Adapter SMA (m) to SMA (f)
HP 8120-4948 50 Ω Cable, SMA (m-m)
HP 8710-1582 Torque Wrench, 5 in/lb
HP 8493A Series Attenuator
Opt 003 3 dB
Opt 006 6 dB
Opt 010 10 dB
Opt 020 20 dB
Opt 030 30 dB
HP 11667B Power Splitter
HP 15436A Multi-channel Accessory Kit for three HP 8133As (additional HP 11667B Power Splitter is needed)
HP 15439A Multi-channel Accessory Kit for two HP 8133As
HP 15435A 150 ps Transition Time Converter
See page 402 for other transition time converters.

Data Generator System

HP 80000

- Clock or data rate up to 1 GHz
- 16 or 128 Kb memory per channel
- Delay range ± 2 ns, 2 ps resolution
- Amplitude up to 2.5 V or 3.0 V in –2 V to 3 V level window
- Color touchscreen
- 4 to 80 channels

HP 80000 Data Generator System with two strobe and 16 data channels. With the expansion frames, up to 80 channels can be configured.

HP 80000 Data Generator System

HP-IB

When you need multiple lines of real data to characterize your device, the HP 80000 system delivers everything needed to make the test complete, accurate and reliable. This is because it offers the kind of edge-placement precision that is usually only found in high performance pulse generators —but at up to 1 GHz and over 80 channels.

These features—plus affordability, PRBS and conformance to national and international electromagnetic regulations—have made the HP 80000 system a preferred choice when characterizing fast ICs, modules, or components such as:

- MUX, DAC, memories
- ATM, SONET/SDH, switches

as well as passive devices like HF connectors and computer backplanes.

Rapid performance verification can be carried out with the HP 80000's PRBS and the help of the HP 54750A series oscilloscope—using the eye-pattern technique—or the HP 71600 series BERT, where the HP 80000's unique 2^{23}–1 pseudo-random word sequence allows even MUXs to be BER-tested. The memory is segmentable, so that preamble/data or initialize/data sequences can be set up.

The HP 80000 system consists of a mainframe, an expansion frame, and a choice of modules so that systems with up to 80 channels can be factory-configured or retrofitted. The mainframe includes an internal clock plus synchronous start/stop logic. It has a friendly HP 16500-type user interface and supports two internal disk drives, an HP DeskJet RS232 printer and HP-IB. The mainframe, like the extender, has room for five modules.

The four channel, 1 GHz data modules provide RZ (50% duty cycle) and NRZ formats. Edges can be positioned with 2 ps resolution in a ±2 ns window, independent of clock rate. There is a choice of 16 or 128 Kb per channel.

The clock/strobe modules process the mainframe clock to provide normal and complement clock outputs. They also have two channels which can be used as strobes, as clock dividers for multi-phase signals, or for data patterns. 16/128 Kb modules are available.

Specifications

For more information, please consult the *HP 80000 Data Generator System* Brochure, p/n 5091-9396E and the *HP 80000 Data Generator System* Technical Data Sheet, p/n 5091-9397E

For more information, visit our website: (http://www.hp.com/go/dvt).

Ordering Information

HP 80000 Data Generator System Components
HP E2900A 5-slot Mainframe with internal clock
HP E2901A 5-slot Expansion Frame
HP E2902A 1 GHz Clock/Strobe Module
HP E2903A 1 GHz Data Module
HP E2905A 128 Kb 1 GHz Clock/Strobe Module
HP E2906A 128 Kb 1 GHz Data Module
Accessories
HP 15432B 250 ps Transition Time Converter
See page 402 for other transition time converters.
HP 1250-1462 Adapter SMA (m) to SMA (f)
HP 8120-4948 50 Ω Cable, SMA (m-m)
HP 8710-1582 Torque Wrench, 5 in/lb
HP 1182A/1181A Testmobile Carts for Instruments
HP 13242G RS-232C Cable for HP DeskJet

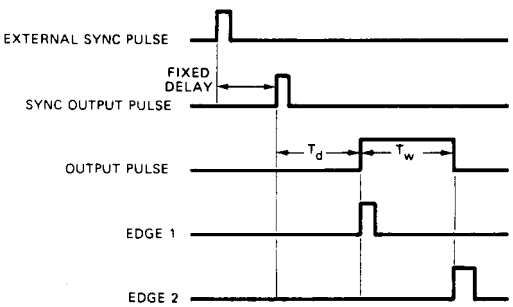
HP 5359A

- Precise digital delays, 0–160 ms
- 50 ps increments
- Jitter <100 ps
- Programmable
- Fully synchronous to external trigger
- Automatic calibration

HP 5359A

HP 5359A Time Synthesizer

The HP 5359A time synthesizer provides two extremely precise low-jitter time delays. These delays, Td and Tw, are individually selectable using the keyboard. Step values of 50 ps or greater set Td or Tw to be delays of up to 160 ms.



The HP 5359A has many applications. It can be used for the calibration of Radar, Loran, DME, and Tacan Systems, for precision generation of delayed sweeps in oscilloscopes, and for extremely accurate "time positioning" control of external gates on frequency counters. In component and circuit test, the instrument can be used for extremely accurate delay in line simulation.

Condensed Specifications

Modes

External trigger mode: Selects the delays from the sync out to the beginning of the output pulse, and the width of the output pulse.
Internal trigger mode: Selects the "period" or "frequency" and the width of the output pulse.
Events mode: Substitutes external input (to 100 MHz) for the internally counted clock (delay and width must both be specified in terms of events instead of time).
Triggered frequency mode: The same as internal frequency mode except the output is a bursting beginning in synchronism with an external trigger signal, and continuing for the duration of this signal.
Calibrate mode: Performs an internal calibration to remove the effects of internal delay differences.

Range

Delay Td: 0 ns to 160 ms
Width Tw: 5 ns to 160 ms (width and delay ≤ 160 ms)
Period: 100 ns (or width + 85 ns) min.; 160 ms max.
Frequency: Same as corresponding "period"

Repetition Rate: 10 MHz max.
Accuracy: ± 1 ns ± time base error (± 100 ps ±time base error after external calibration)
Insertion Delay: Fixed at < 150 ns; selectable as < 50 ns for delays > 100 ns
Jitter: Typical 100 ps rms; maximum 200 ps rms (delays to 10 ms)
External Trigger Input: –2 V to + 2 V, slope selectable
Sync Output: 1 V at 50 Ω; 5 V at 1 MΩ. Width 35 ns nominal.
Output Pulse

Amplitude: 0.5 V to 5 V, into 50 Ω
Polarity: Positive or negative
Offset: –1 V to 1 V or OFF
Transition Time: < 5 ns
Note: External voltage must not be applied. Offset and amplitude voltage into 50 Ω may be displayed.

EDGE 1 & 2 OUTPUTS (rear panel): Occur in Sync with leading edge of output pulse (same specification as Sync out)
HP-IB: All controls except trigger levels are programmable
Time Base

High Stability Oven Oscillator
Frequency: 10 MHz
Aging Rate: < 5 x 10^{-10}/day
Temperature: < 4.5 x 10^{-9}, 0° to 50 °C
Line Voltage: < 1 x 10^{-10}, ± 10% from nominal

Size: 426 mm W x 133 mm H x 521 mm D (16.75 in x 5.25 in x 20.50 in)
Weight: 13.6 kg (30 lb)
Power Requirements: 100, 120, 220, or 240 Vac + 5%–10%, 48 to 66 Hz, less than 250 VA
Front Handles: Supplied with instrument

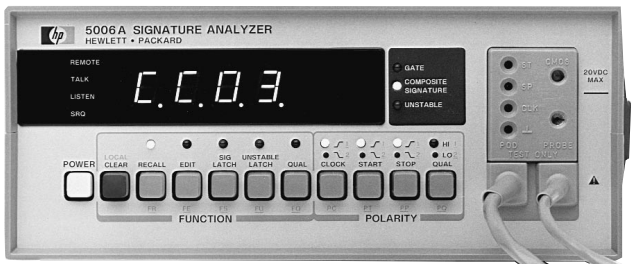
Ordering Information

HP 5359A Time Synthesizer
Opt W30 Extended Repair Service (see page 584)
Opt W32 Calibration Service (see page 584)
HP 10870A Service Kit

Signature Multimeter and Analyzer

HP 5005B
HP 5006A

- Digital and analog measurements
- Single-probe measurements of logic signals, voltage, frequency
- 25 MHz multiple-logic family signature analysis
- Full at-speed testing of digital products
- Composite signatures
- Signatures compared with signature memory



HP 5006A

HP 5005B

HP 5006A and HP 5005B Digital Troubleshooting

HP-IB

Signature Analysis

Signature analysis is a fast and accurate method for troubleshooting digital circuits. Finding faults is reduced to tracing signal flow and comparing measured signatures to printouts or computer-stored signatures. A signature is a 16 bit-cyclic redundancy code (CRC) generated for blocks of data. Instead of entire bit streams, only signatures are compared to detect errors.

HP's patented signature analysis technique enables the HP 5005B or HP 5006A to generate a compressed, four-digit "fingerprint" or signature of a digital data stream at a logic node. Any fault associated with a device connected to the node will force a change in the data stream and produce an erroneous signature.

The Technique

Troubleshoot with signature analysis by probing a circuit, reading the display, and comparing to the known-good signature. Reference signatures can be generated by probing an operational circuit, or by external stimulation.

Many features of the HP 5005B and HP 5006A simplify troubleshooting procedures:

- Compatibility with multiple-logic families: preset threshold levels (TTL, CMOS, and ECL for the HP 5005B; TTL and CMOS for the HP 5006A) and adjustable thresholds (+12.5 V to –12.5 V) simplify use with a wide variety of logic devices.
- 25 MHz clock frequency: signature analysis is possible for high-speed circuits such as CRT controllers.
- Qualified signature mode: fault isolation in complex products can be done quickly by windowing the signature collection to specific modules or devices with no major test setup changes.
- HP-IB programmability: every HP 5005B and HP 5006A measurement and control function can be programmed through HP-IB.

Time Savers

Two features save time when troubleshooting without a computer-aided system: composite signatures, and signature memory. A composite signature is the binary sum of individual signatures. The HP 5005B and HP 5006A compute composite signatures for any grouping of digital signals (such as bus or IC). Only the composite signature need be compared to a documented reference signature if all signals for that group are good.

Signatures are stored in memory after the probe switch is pushed. The memory stores the last 32 readings. Signatures can be compared in groups, not after every probe, by reviewing memory in the RECALL mode.

HP 5005B Signature Multimeter

HP-IB

Total checkout of a digital system often requires characterizing both digital data activity and analog signal parameters. The HP 5005B signature multimeter offers, in a single instrument, a measurement set optimized for digital troubleshooting applications. Digital multimeter functions for checking power supplied and circuit board integrity, universal counter features for measuring clock frequencies and time intervals between signals, and a means for verifying the analog integrity of active digital signals are all included in the HP 5005B signature multimeter.

Digital Multimeter

Certain digital problems result from analog circuit failures: a low power supply voltage, an open or shorted circuit path, a faulty A/D or D/A converter. Each may contribute to a system failure. The HP 5005B contains a 4½-digit dc voltmeter, ohmmeter, and differential voltmeter. Performance is tuned for analog measurements necessary for digital troubleshooting.

Frequency Counter

The HP 5005B counter functions provide totalize and frequency measurements to 50 MHz and time-interval measurements with 100 nanosecond resolution. Intended to extend digital troubleshooting capabilities, the counter functions can characterize one-shots and timers (time-interval measurement), test interrupt lines, reset lines and RS-232 asynchronous interfaces (totalize), and verify clock and clock driver circuitry (frequency measurement).

Voltage Threshold

Logic level degradation is a common and troublesome malfunction in digital products. The HP 5005B's peak-voltage measurement mode provides a simple, direct method for measuring the logic high and logic low voltages of active digital signals.

When in peak-voltage measurement mode, the HP 5005B characterizes and displays either the greatest (positive peak) or lowest (negative peak) voltage probed. Selection of positive-peak or negative-peak modes displays the appropriate measured threshold for comparison against the specifications of the logic family.

Multifunction Probe

The HP 5005B multifunction probe automates access to the signature analyzer, multimeter, and counter functions through a single probe. Signal multiplexing to the appropriate function is internal to the HP 5005B. A switch located on the side of the probe allows the operator to trigger automatic measurement. The analog parameters and functional digital operation can be characterized by probing the same point.

HP 5005B and HP 5006A Specifications

Common Signature Specifications
Display: 4 digits. Characters 0-9, ACFHPU.
Probe: Logic level lamps: high, low, open, pulsing; minimum pulse width: 10 ns
Fault Detection: 100% of single-bit errors; 99.998% of multiple-bit errors
Minimum Gate Length: 1 clock cycle between START and STOP
Maximum Gate Length: No limit
Minimum Timing Between Gates: 1 clock cycle between STOP and START
Data Probe Timing
Setup Time: 10 ns (data to be valid ≃ 10 ns before clock edge)
Hold Time: 0 ns (data held until clock edge)
START, STOP, QUAL Timing
Setup Time: 20 ns (signals valid ≃ 20 ns before clock edge)
Hold Time: 0 ns (data held until clock edge)
CLOCK Timing
Maximum Clock Frequency: 25 MHz
Minimum Pulse Width: 15 ns in high or low state

HP 5006A Unique Specifications

Input Impedance
Probe: 50 kΩ to ground nominal
Pod: 100 kΩ to ground nominal
Overload Protection
Probe: ± 150 V continuous
± 250 V intermittent
250 Vac for 1 minute
Pod: ± 20 V continuous
± 140 V intermittent
± 140 Vac for 1 minute
CMOS Sense: 20 Vdc maximum
TTL Thresholds
Probe: Logic one: 2 V + .2 – .3; logic zero: 0.8 V + .3 – .2
Pod: 1.4 V ± .6
CMOS Thresholds
Logic One: 70% of sensed voltage
Logic Zero: 30% of sensed voltage
Other
Lamps: Key status: recall, edit, signature latch, unstable latch, qualify mode, timing polarities. Programmable (Option 040): remote, talk, listen, SRQ. Status: composite signature, gate, unstable.
Selectable Power: 115 V + 10 to 25% ac line, 48 to 440 Hz, 230 V + 10 to 15% ac line, 48 to 66 Hz, 25 VA maximum
Operating Environment: Temperature, 0° to 55° C; humidity, 95 % RH at +40° C; altitude, 4600 m (15,000 ft)
Size: 216 mm W x 89 mm H x 279 mm D (8.5 in x 3.5 in x 11 in)
Weight: Net, 2.4 kg (5.3 lb); shipping, 4.1kg (9 lb)

HP 5005B Unique Signature Specifications

Quality Mode: Data clock qualified by external signal. DATA probe input impedance ≃ 50 kΩ to the average value of "0" and "1" threshold settings (± 6 V max.); 15 pF
Front Panel Indicators: Flashing GATE light indicated detection of valid START, STOP, CLOCK conditions. Flashing UNSTABLE light indicates a difference between 2 successive signatures and possible intermittent faults
Logic Thresholds
Preset Thresholds: TTL, ECL, CMOS
Adjustable Thresholds: Each threshold can be adjusted to ± 12.5 V in 50 mV steps; accuracy is ± .2 V
Logic Threshold Circuitry: Operative during NORM, QUAL, kHz, TOTLZ and ms measurements

HP 5005B Multimeter Specifications

Frequency
Display: 5 digits
Ranges: 100 kHz, 1 MHz, 10 MHz, 50 MHz autoranged
Resolution: 1 LSD (1 Hz on 100 kHz range)
Accuracy: ± 0.01% of reading ± 1 count
Minimum pulse width ≃ 10 ns in high or low state
Gate time ≃ 1s, fixed
Input impedance ≃ 50 kΩ to the average value of "0" and "1" threshold settings (± 6 V max.); 15 pF
Totalizing
Display: 5 digits
Range: 0 to 99, 999 counts
Resolution: 1 count
Maximum input frequency ≃ 50 MHz with a minimum pulse width of 10 ns and a minimum pulse separation of 10 ns
Minimum START/STOP pulse width ≃ 20 ns
DATA input impedance ≃ 50 kΩ to the average value of "0" and "1" threshold settings (+6 V max.); 15 pF
START/STOP input impedance ≃ 100 kΩ; 15 pF

Time Interval
Display: 5 digits
Ranges: 10 ms, 100 ms, 1 s, 10 s, 100 s, autoranged
Resolution: 1 count (100 ns on 10 ms range)
Accuracy: ± 0.01% of reading ± 2 counts
Minimum START/STOP pulse width ≃ 20 ns
START, STOP input impedance ≃ 100 kΩ

Resistance
Display: 4 or 5 digits, depending on range
Ranges: 30 kΩ, 300 kΩ, 1 MΩ, 3 MΩ, 10 MΩ, autoranged
Accuracy: at 15° C to 30 ° C

Range	Full Scale	Accuracy	Display Resolution
30 kΩ	29.999 kΩ	± 1% of reading ± 2 Ω	1 Ω
300 kΩ	299.99 kΩ	± 1% of reading	10 Ω
1 MΩ	999.9 kΩ	± 1% or reading	100 Ω
3 MΩ	2999. kΩ	± 10% of reading	1 kΩ
10 MΩ	10000. kΩ	± 10% of reading	10 kΩ

Input impedance ≃ 20 kΩ to ± 2 V

DC Voltage
Display: 4½ digits
Ranges: ± 25 V, ±250 V, autoranged; referenced to earth ground
Accuracy: at 15° to 30° C

Range	Accuracy	Resolution
25 V	± 0.1% of reading ± 2 m V	1 mV
250 V (<100 V)	± 0.25% of reading ± 20 m V	10 mV
250 V (≥ 100 V)	± 0.25% of reading ± 20 m V	100 mV

Input impedance ≃ 10 MΩ

Differential Voltage
Reading: Reads voltage at probe; displays difference between reading and voltage at the time ΔV key was depressed
Specifications: See DC voltage. Range is determined by the larger of the two compared voltages.

Peak Voltage
Display: 3½ digits
Range: 0 – ± 12 Vp
Resolution: 50 m V
Accuracy: ± 2% of reading ± 5% of p-p signal ± 100 mV
Minimum peak duration ≃ 10 ns
Maximum time between peaks ≃ 50 ms
Input impedance ≃ 100 kΩ; 15 pF

Other
Data Probe Protection
Continuous Overload
DCV, ΔV, kΩ Modes Only: ± 250 V ac/dc
All Other Modes: ± 150 V ac/dc, 20 V rms at input frequencies > 2 MHz
Intermittent Overload: ± 250 V ac/dc (up to 1 min.) all modes
Timing Pod Protection
Continuous Overload: ± 100 V ac/dc, 20 V rms (input frequencies > 2 Mhz)
Intermittent Overload: ± 140 V ac/dc (up to 1 min.)
Operating Temperature: 0° C to +55° C
Power: Selectable 100 V, 120 V, 220 V or 240 V ac line (+5 to 10%), 48 to 66 Hz, 35 VA maximum
Weight: Net, 5.5 kg (12.0 lb); shipping, 8.7 kg (19 lb)

Ordering Information

HP 5005B Signature Multimeter
Opt 910 Additional Manual
HP 5006A Signature Analyzer
Opt 40 HP-IB Interface
Opt 910 Additional Manual
HP 5060-0173 Half Rackmount Kit, HP 5006A

Microprocessor Emulators

HP Software Performance Analyzer Models **HP 64708A/B–1487A**
5091-3207E
HP 64700 Embedded Debug Environment System Overview
5962-7171E
Adapters and Accessories for Probing HP Emulators and Preprocessors
5091-8886E

Logic Analyzers

Timing Characterization Using the **HP 16571/18A** with Intel Pentium Processor Measurement Examples, Note #1261
5091-8798E
Accessories for HP Logic Analyzers
5963-3376E
Designing a Custom Interface for a Logic Analyzer using HP User Definable Design Tools, Application Note 1244-1
5091-8839E

Digital Verification Tools

HP E2910A Brochure
5964-1621E
HP 2910A Technical Data
5965-1438E
Digital Testing Under Real-World Conditions? **HP 8110A** Application Brief
5091-7601E
HP 80000 and **HP 16500A** Digital Stimulus and Response Application Lab #6
5091-5481E
HP 8114A Pulse Testing 980-nm Pump Laser-Diodes in Optical Fiber Amplifiers
5963-6988E
HP 8114A 100 V/2 A Programmable Color Brochure
5965-1111E
(PN) E6280A PNNI Signalling Test Software for the Broadband Series Test System
5965-9079E
(PN 16522A) Digital Verification with the HP 16522A Pattern Generator
5964-6347E

Many of these literature pieces are available at:
http://www.hp.com/go/tmc98

Tunable Laser Sources

HP 8167B
HP 8168D
HP 8168E
HP 8168F

- Output power up to +8 dBm
- Tuning linearity ±1 pm possible
- Up to 3 year full warranty
- Auto-realignment of laser cavity for even better reliability

HP 8167B and HP 8168D/E/F Tunable Laser Sources

Tunable laser sources are basic tools for characterizing and testing optical amplifiers and components. The HP 8167B addresses the 1300 nm transmission window; the HP 8168D/E/F operate in the 1550 nm window. A built-in side mode filter ensures that a true single-mode laser line is generated for every wavelength point, eliminating any possible multimoding. All tunable lasers provide independent control of output power and wavelength. The user does not need to monitor values with additional instruments. Wavelength scans, which require an output power that is stable over time and flat across all wavelengths, can be performed reliably, accurately and quickly. In manufacturing applications, the instrument can be integrated into a fully-automated production test environment for precise, repeatable high-speed testing. In a manual setup, built-in application software supports single or dual channel loss, return loss, and coupling ratio measurements of around 1300 nm or 1550 nm on pigtailed or connectorized devices, depending on the configuration selected.

For more information, refer to the *Lightwave Test and Measurement Catalog* and the tunable laser source data sheet, p/n 5964-9000E.

Ordering Information

HP 8167B Tunable Laser Source
HP 8168D Tunable Laser Source
HP 8168E Tunable Laser Source
HP 8168F Tunable Laser Source
Options (not available for all instruments and in all combinations)
Opt 021 Straight Contact Output Connector
Opt 022 Angled Contact Output Connector
Opt 023 Angled Non-Contact Output Connector (Diamond HMS-10/HP/HRL)
Opt 003 Built-in Variable Attenuator
Opt 007 Polarization Maintaining Fiber
HP 81000AI/FI/GI/KI/NI/PI/SI/VI/WI Connector Interface

HP 81600 Series 200/210 EDFA Test System

Please refer to *Lightwave Test and Measurement Catalog*.

Specifications

	HP 8167B NEW	HP 8168D	HP 8168E	HP 8168F
Wavelength range	1255 nm to 1365 nm	1490 nm to 1565 nm	1475 nm to 1575 nm	1450 nm to 1590 nm
Absolute wavelength accuracy, typical	±0.1 nm	±0.2 nm	±0.1 nm	±0.1 nm
Relative wavelength accuracy	±0.035 nm, typical ±0.001 nm *	±0.1 nm	±0.035 nm, typical ±0.001 nm *	±0.035 nm, typical ±0.001 nm *
Wavelength resolution	0.001 nm	0.1 nm	0.001 nm	0.001 nm
Wavelength stability	< ±100 MHz	< ±1 GHz	< ±100 MHz	< ±100 MHz
Wavelength repeatability	±0.035 nm, typical ±0.001 nm *	±0.1 nm	±0.035 nm, typical ±0.001 nm *	±0.035 nm, typical ±0.001 nm*
Linewidth (typical) **broadened** (effective, typical)	100 kHz 30 to 500 MHz	100 kHz 30 to 500 MHz	100 kHz 50 to 500 MHz	100 kHz 50 to 500 MHz
Source spontaneous emission	< – 45 dB/ 0.1 nm	< – 40 dB/ 0.1 nm	< – 45 dB/ 0.1 nm	< – 55 dB/ 0.1 nm
Sidemode suppression ratio	> 40 dB	—	> 40 dB	> 50 dB
Maximum output power	+ 3 dBm	– 4 dBm	0 dBm	+ 7 dBm
Minimum output power	– 7 dBm (– 47 dBm with #003)	– 10 dBm	– 10 dBm (– 50 dBm with #003)	– 7 dBm (– 47 dBm with #003)

* Performance when controlled with appropriate wavelength meter

HP E5574A
HP 11896A
HP 8169A

- 0.005 dBp-p PDL/PDG measurement accuracy
- Complies with Fiber Optic Test Procedure FOTP 157
- 2.2% power measurement accuracy
- No PDL reference measurement required
- ±0.002 dB insertion loss variation with adjustment (HP 11896A)
- 1250 nm to 1600 nm coverage (HP 11896A)
- Synthesis of states of polarization (HP 8169A)

HP E5574A

HP 11896A and 8169A

HP E5574A Optical Loss Analyzer

The HP E5574A optical loss analyzer is a complete solution for the loss/gain characterization of active and passive optical components. At the touch of a button, you can measure the various contributions to the total loss of your device—all together in one affordable instrument. It is especially optimized for polarization-dependent and gain measurements. Whether you are concerned with the ease-of-use in manual applications on the bench or with the highest quality and measurement speed on the production floor, this optical loss analyzer is the perfect tool.

The HP E5574A optical loss analyzer offers flexible solutions. A variety of Fabry-Perot laser sources can be ordered. For swept wavelength measurements, an external tunable laser source or a white light source is also available.

A pigtailed optical output provides polarization-dependent loss measurements with the highest performance. Two other customer- exchangeable connector interface options for straight or angled contact connectors provide superb flexibility. A selection of optical heads covers the 800 to 1700 nm wavelengths and power levels between +27 and –90 dBm. For the best PDL measurement performance between 1250 and 1600 nm, the HP 81521B Option 001 Optical Head should be used.

Specifications

Wavelength Range (with external source)**:** 1250 to 1600 nm
Display Resolution: 0.0001 dB
Absolute PDL/PDG Uncertainty:
±0.005 dB +0/–2.5% of measured PDL (for PDL ≤0.2 dB);
±0.005 dB +0/–5% of measured PDL (for 0.2 dB <PDL ≤5 dB)
Absolute PDCR Uncertainty:
±0.01 dB +0/–5% of measured PDCR (for PDCR ≤0.2 dB);
±0.01 dB +0/–10% of measured PDCR (for 0.2 dB <PDCR ≤5 dB)
Repeatability for PDL/PDG: ±0.001 dB ±2% of measured PDL
Repeatability for PDCR: ±0.002 dB ±4% of measured PDCR
PDL/PDG/PDCR Range: 0 to 5 dB
Max. Insertion Loss of DUT: 20 dB

Ordering Information

One connector adapter (HP 81000xA) per optical head and one connector interface (HP 81000xI) for both the optical output and optical input are required for each HP E5574A.
HP E5574A Optical Loss Analyzer
Opt 013 1310 nm Fabry-Perot Laser Source
Opt 015 1550 nm Fabry-Perot Laser Source
Opt 135 Dual Wavelength Laser Source
Opt 020 Bare Fiber Pigtail Output
Opt 021 Straight Contact Connector Output
Opt 022 Angled Contact Connector Output
Opt 521 Add Second HP 81521B Option 001 Optical Head

HP 11896A Polarization Controller

The HP 11896A adjusts polarization and not power. Its optical fiber loop design provides all states of polarization with extremely small optical insertion-loss variations (±0.002 dB) over a wide spectral range (1250 to 1600 nm). This performance combination maximizes measurement accuracy for power-sensitive applications like polarization-dependent loss and gain. This is because the measurement uncertainty contributed by the polarization controller is minimized.

HP 8169A Polarization Controller

The HP 8169A provides polarization synthesis relative to a built-in linear polarizer. The internal quarter-wave plate and half-wave plate are individually adjusted to create all possible states of polarization. Predeterministic algorithms within the HP 8169A enable the transition path from one state of polarization on the Poincare sphere to another to be specified along orthogonal great circles. These features are important because device response data can be correlated to specific states of polarization input to the test device.

Specifications

Note: Fiber pigtail interface assumed in all cases.

	HP 11896A	HP 8169A
Operating Wavelength Range (nm):	1250 to 1600	1470 to 1570
Insertion Loss:	<1.5 dB	<1.5 dB
Variation with Adjustment:	<±0.002 dB	<±0.03 dB
Variation with Wavelength:	<±0.1 dB	<±0.1 dB

Ordering Information

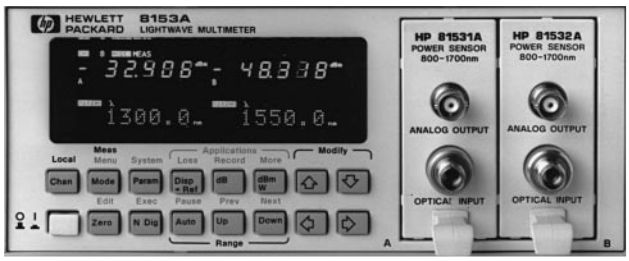
HP 11896A Lightwave Polarization Controller
Standard instrument includes FC/PC connector interfaces
Opt 025 One Meter Pigtail Fiber w/ FC/PC Connector Interfaces
HP 8169A Lightwave Polarization Controller
(Polarization controller must be ordered with connector option)
Opt 020 Pigtailed Fiber Ports
Opt 021 Straight Contact Connector Output
Opt 022 Angled Contact Connector Output
HP 81000A1/F1/G1/K1/N1/P1/S1/V1/W1 Connector Interfaces

High Performance Optical Attenuator/Lightwave Multimeter

HP 8156A
HP 8153A

- 0.05 dB attenuation accuracy, 0.001 dB resolution
- 0.02 dBp-p polarization sensitivity
- Optional monitor output
- Back reflector mode
- User-exchangeable plug-in modules for tailor-made measurements

HP 8156A



HP 8153A

HP 8156A Attenuator

The HP 8156A is a high performance attenuator for single-mode and multimode applications.

Options are available to select the desired return loss performance up to 60 dB. An optional 13 dB monitor output allows you to measure the signal power at the output of the attenuator. Using the built-in back reflector mode and an external reference reflector (HP 81000BR), the HP 8156A can be used as a programmable back reflector to measure component and system sensitivity against reflections.

The attenuation range is 60 dB with 0.001 dB resolution between 1200 nm and 1650 nm. Due to a novel single filter design, no ranging occurs. This completely eliminates dark spots or potential attenuation overshoots or undershoots. Attenuation accuracy is typically better than ±0.05 dB with a polarization sensitivity of less than 0.02 dB peak-to-peak.

For more detailed information, see the *Lightwave Test and Measurement Catalog*.

Specifications

	HP 8156A Opt 100	HP 8156A Opt 101/201	HP 8156A Opt 121/221	HP 8156A Opt 350
Wavelength range	1200 to 1650 nm			
Fiber type	single-mode			50 μm multimode
Attenuation range	60 dB			
Resolution	0.001 dB			
Return loss **Insertion loss** (typical)*	>35 dB 4.5 dB	>45 dB/>60 dB 2.5 dB	>45 dB/>60 dB 3.3 dB	>22 dB 3.0 dB
Attenuation accuracy (typical)	±0.1 dB	±0.05 dB	±0.05 dB	±0.08 dB
Polarization sensitivity (typical)	<0.075 dBp-p	<0.02 dBp-p	<0.03 dBp-p	—
Repeatability (typical)	±0.005 dB			
Switching time	20–400 ms			
Maximum input power	+23 dBm			

*Includes insertion loss of two HMS-10 connectors.

Size: 212.3 mm W x 89 mm H x 345 mm D (8.36 in x 3.5 in x 13.6 in)
Weight: Net, 5.3 kg (11.7 lb); shipping, 9.6 kg (21.2 lb)

Ordering Information

Two connector interfaces (three for Option 121/221) are required for each HP 8156A

HP 8156A Optical Attenuator Mainframe
- **Opt 100** Standard Performance Version
- **Opt 101** High Performance Version
- **Opt 121** Monitor Output, 45 dB Return Loss
- **Opt 201** High Performance, High Return Loss Version
- **Opt 203** Back Reflector Kit for Option 201*
- **Opt 221** Monitor Output, 60 dB Return Loss
- **Opt 350** 50/125 μm Multimode

HP 81000AI/FI/GI/KI/NI/PI/SI/VI/WI Connector Interfaces

* Kit consists of one each: 81000SI, 81000FI, 81113PC, 81000UM, and 81000BR.

HP 8153A Lightwave Multimeter

The HP 8153A lightwave multimeter mainframe offers two slots for plug-in modules. Since modules can be combined in any configuration, the instrument can be used a 1/2 channel power meter, a 1/2 channel light source, a loss test set, or even as a return loss test set.

Four different power sensor modules, with different sensitivities from –70 dBm down to –110 dBm, cover the 450 nm to 1700 nm wavelength range. Each is individually calibrated over its entire wavelength range and is traceable to NIST and PTB for precise optical power measurements. Their excellent linearity and the high stability of the source modules provide the basis for precise determination of optical insertion loss for both single-mode and multimode components.

The external power sensors (optical heads) cover the power range from +27 to –90 dBm. They are especially suitable for obtaining the highest requirements in absolute accuracy, e.g. for calibration services, and also for open beam measurements.

The source modules offer very good short-term and long-term stability. The high output power can be internally attenuated by up to 6 dB. All sources are able to output CW or pulse-modulated light (internal modulation at 270 Hz, 1 kHz, or 2 kHz).

Ordering Information

HP 8153A Lightwave Multimeter Mainframe
HP 81530A Si, +3 to –100 dBm, 450 to 1020 nm
HP 81531A InGaAs, +3 to –90 dBm, 800 to 1700 nm
HP 81532A InGaAs, +3 to –110 dBm, 800 to 1700 nm
HP 81536A InGaAs, +3 to –70 dBm, 800 to 1700 nm
HP 81534A Return Loss Module, InGaAs, 60 dB/65 dB return loss range, 1250–1600 nm
HP 81533B Optical Head Interface Module
HP 81520A Optical Head, Si, +10 to –100 dBm, 450 to 1020 nm
HP 81521B Optical Head, Ge, +3 to –80 dBm, 900 to 1700 nm
- **Opt 001** 0.003 dBp-p polarization sensitivity, +3 to –64 dBm

HP 81524A Optical Head, InGaAs, +3 to –90 dBm, 800 to 1650 nm
HP 81525A Optical Head, InGaAs, +27 to –70 dBm, 800 to 1650 nm
HP 81551MM 850 nm, LD, Multimode
HP 81552SM 1310 nm, LD, Single-Mode
HP 81553SM 1550 nm, LD, Single-Mode
HP 81554SM 1310/1550 nm, LD, Single-Mode
HP 81542MM 1300 nm, LED, 50 μm Multimode Fiber Output

Protect Your Networks

Installers and operators of fiber optic communications networks are faced with the continuing challenge of managing and maintaining their systems with near-perfect uptime and quality while employing the most cost-effective procedures and equipment available. Through the technology and value leadership of our products and services, Hewlett-Packard can serve as your working partner in this endeavor. We offer a full range of scalable solutions for fault testing, characterization, and reporting—on site, at the bench, or remotely across an entire network.

The HP E6000A Mini-Optical Time Domain Reflectometer (Mini-OTDR) equips the on-site installer or maintenance technician with a complete, highly portable optical fiber test set. This small, lightweight, modular instrument combines high resolution and long-distance, high speed and high dynamic range with one-button operation and an award-winning user interface that extends your technicians' efficiency and effectiveness. Several additional modules and sub-modules can enhance their capabilities without the penalty of added weight.

At the next level of test and measurement capability, the HP 8147 Optical Time Domain Reflectometer (OTDR) combines automatic measurement and analysis capability with preprogrammable procedures that speed up operation. Functionality spans on-site problem-solving, bench-top characterization and remote controlling, while modular architecture allows you to expand its capabilities in keeping with both your needs and your budget.

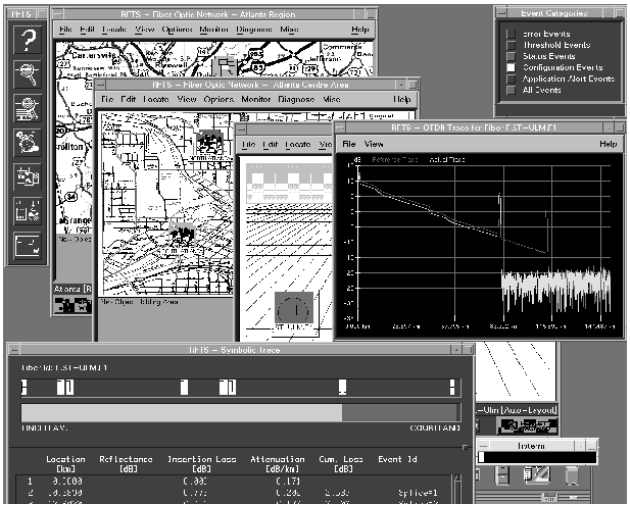
To manage and maintain your entire fiber optic network at maximum uptime and quality with minimum cost, implement the HP 81700 Series 200 Remote Fiber Test and Management System (RFTS). Based on HP OpenView, the HP RFTS is our response to today's need for economic fiber optic network-wide maintenance and documentation, and integrated, open solutions. With the RFTS, you can protect your investment and your revenues while you offer your customers the highest possible quality of service.

For more information, visit our website: (http://www.tmo.hp.com/tmo/datasheets/English/HPE6000A.html).

	Wavelength	Fiber Type	Dynamic Range (dB)	Attenuation Deadzone
HP E6000A Mini-OTDR				
HP E6001A	1310 ± 25 nm	Single-mode	28 dB	25 m
HP E6002A	1310 ± 25 nm	Single-mode	35 dB	20 m
HP E6003A	1310/1550 ± 25 nm	Single-mode	35/34 dB	20/25 m
HP E6004A	1310/1550 ± 25 nm	Single-mode	28/28 dB	25/25 m
HP E6008A	1310/1550 ± 25 nm	Single-mode	40/39 dB	20/25 m
HP E6005A	850/1300 ± 30 nm	Multimode	26/34 dB	10 m/10 m
HP E6009A	850/1300 ± 30 nm	Multimode	18/23 dB	10 m/10 m
HP 8147 OTDR				
HP E4311A	1310 ± 15 nm	Single-mode	29 dB	20 m
HP E4312A	1550 ± 15 nm	Single-mode	28 dB	30 m
HP E4313A	1310/1550 ± 15 nm	Single-mode	29/28 dB	20/30 m
HP E4314A	1310 ± 15 nm	Single-mode	35 dB	20 m
HP E4315A	1550 ± 15 nm	Single-mode	34 dB	30 m
HP E4316A	1310/1550 ± 15 nm	Single-mode	35/34 dB	20/30 m
HP E4317A	1310 ± 15 nm	Single-mode	40 dB	30 m
HP E4318A	1550 ± 15 nm	Single-mode	39 dB	40 m
HP E4319A	1310/1550 ± 15 nm	Single-mode	40/39 dB	30/40 m
HP E4324A	1310/1550 ± 15 nm	Single-mode	42/41 dB	20/30 m
HP 81700 Series 200 RFTS (Medium Performance)				
HP E5544A	1310 ± 15 nm	Single-mode	35 dB	20 m
HP E5545A	1550 ± 15 nm	Single-mode	34 dB	20/30 m
HP E5546A	1310/1550 ± 15 nm	Single-mode	35/34 dB	30 m
HP E5551A	1625 ± 15 nm	Single-mode	33 dB	30 m
(High Performance)				
HP E5548A	1550 ± 15 nm	Single-mode	39 dB	40 m
HP E5549A	1310/1550 ± 15 nm	Single-mode	40/39 dB	30/40 m

HP 81700
Series 200

- Automatic testing of fiber optic links
- Both dark and active fiber testing
- Centralized storing and evaluating of fiber information
- TMN-compliant OpenView-based system



HP 81700 Series 200 Remote Fiber Test and Management System

The HP 81700 Series 200 is a modular, distributed system that takes advantage of open communication protocols to integrate easily into telecom networks. The system consists of processor, measurement and communications hardware, along with the operating and application software. It can be tailored to suit all requirements, from a single site standalone system to a multiple remote site system which is fully integrated into a telecom network management strategy.

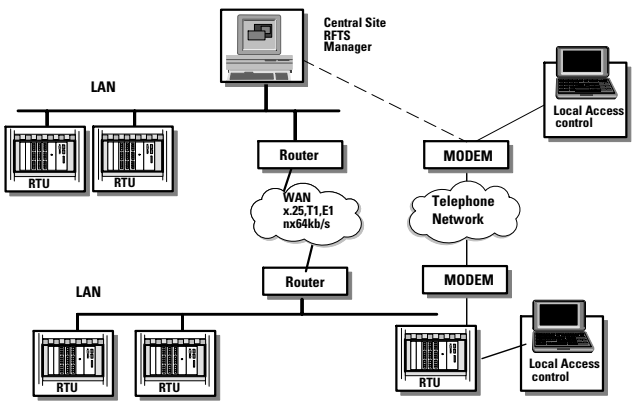
The system uses remote units to collect and analyze OTDR measurements of optical fibers. These signatures are then compared with stored reference measurements to determine if any changes can be detected. This ongoing process of measurement and comparison produces a comprehensive view of the status of the optical fiber network. Significant changes or failures are reported to the central manager. User-definable alarm thresholds ensure that any gradual deterioration of fiber performance is reported before a breakdown of service occurs.

The system RTU/OTAU hardware consists of a cardcage that fits a central office rack and provides various networking capabilities to access the remote measurement units. The measurement unit contains OTDR modules which are available for 1310 nm, 1550 nm and 1625 nm wavelengths. With a choice of a 36 dB to 42 dB dynamic range, the most appropriate price/performance option for a particular application can be selected. Switch modules from 1 x 4 to 1 x 96 can be integrated into the same cardcage. The OTDR modules support both “dark” and “active” fiber testing.

A “manager” takes command of the entire remote testing configuration and can interface with the operations support system of the network. The manager performs functions including trouble ticketing, fast alarming, geographic reference to events on the cable route, auto-configuring measurement hardware and storing network maps. The HP 81700 Series 200 RFTS clearly presents information for fiber management documentation. Customer-specific topology is stored for both monitored and non-monitored fibers throughout the whole cable network. The multi-user concept for the GUI interface provides access to fiber information and reference measurement setups from central sites to many different groups of users. The HP 81700 Series 200 can be fully integrated into a standardized Telecommunications Management Network environment and is an element manager for the network element “fiber”, which meets the requirements of standard ITU-T M.3010, based on the OSI model.

Remote fiber test systems improve network quality as they check fiber links automatically on a regular basis. Information is stored centrally, allowing link degradations to be identified and located quickly to minimize downtime.

System Components and Interconnections



Specifications

Central Wavelengths: 1310 nm, 1550 nm, 1625 nm
Attenuation Deadzone: 20 to 40 m
Dynamic Range: 36 dB to 42 dB
OTDR Modules:

1310 nm	36 dB
1310/1550 nm	36 dB
1625 nm	36 dB
1550 nm	42 dB
1310/1550 nm	42 dB

Switch Modules: 4, 8, 16, 24, 32, 48, 72, 96 channels
Insertion Loss: Typically 1 dB
Return Loss: 40 dB
Cardcage: 9 slots
Controller: Pentium 166
Power Supply: –36 V to –60 V dc
Dimensions: 418 mm H x 426 mm W x 218 mm D
(16.5 in H x 16.8 in W x 8.6 in D)

Key Literature

Color Brochure, p/n 5964-1822E
Technical Specifications, p/n 5965-1479E

Ordering Information

Please contact your Hewlett-Packard representative for ordering information and prices.

HP 8147
HP E6000A

- High resolution and dynamic range in each module
- Pre-programmable procedures
- Full on-line analysis and remote operation
- Exceptionally flexible

HP 8147

HP 8147 Optical Time Domain Reflectometer

The HP 8147 is a high performance optical time domain reflectometer for installation, commissioning and bench applications. It is designed for fast and accurate measurement and analysis of a fiber link, all at the touch of a single button.

"Easy Mode" lets you pre-program complete procedures. So, with a couple of keystrokes, you get standardized measurements. That way, regardless of the operator's experience level, you get accurate and repeatable results every time.

Extended in-depth analysis including two-way measurements, delta measurements and comparison of up to four traces, is now available online. A return loss graph allows you to see the reflectance of individual events at a glance, as well as the total return loss of the link.

The HP 8147 remote capability provides for the centralized operation, collection and analysis of results from remotely-stationed OTDRs. As a result, you can maximize the use of scarce test expertise throughout your network.

At only 9 kg (20 lbs), the HP 8147 can be easily carried into those awkward places.

A variety of performance classes can now be selected to ensure you have just the right performance for your application. Many standard interfaces and options are available to ensure that the OTDR can be configured to your exact needs.

Ordering Information

At least one user-exchangeable Connector Interface (HP 81000xl) is required for the module.

E4310A Optical time domain reflectometer mainframe
- **Opt 001** DC input: 11–30 V
- **Opt 002** Thermal printer
- **Opt 003** Color screen, VGA-LCD
- **Opt 004** HP-IB interface
- **Opt 005** LAN interface
- **Opt AB2** Chinese user interface

E4311A 1310 nm single-mode module (29 dB)
E4312A 1550 nm single-mode module (28 dB)
E4313A 1310/1550 nm single-mode module (29/28 dB)
E4314A 1310 nm single-mode module (35 dB)
E4315A 1550 nm single-mode module (34 dB)
E4316A 1310/1550 nm single-mode module(35/34 dB)
E4317A 1310 nm single-mode module (40 dB)
E4318A 1550 nm single-mode module (39 dB)
E4319A 1310/1550 nm single-mode module (40/39 dB)
E4320A Virtual remote and analysis software
E4324A 1310/1550 nm single-mode module (42/41 dB)

- Fast and accurate fault characterization
- One button automatic measurement and analysis
- Small, rugged and lightweight
- Excellent resolution
- Ultra high dynamic range

HP E6000A

HP E6000A Mini-Optical Time Domain Reflectometer

The HP E6000A Mini-OTDR maximizes your network uptime by locating and characterizing faults quickly and accurately. The unrivalled combination of 16,000 data points and a minimum sample spacing of 8 cm allows the powerful analysis algorithm to determine the exact location and characteristic of an event. Add to this the 20 m attenuation deadzone, and you really can measure and resolve closely-spaced events along the whole fiber link.

Its one button operation, combined with its intuitive user interface, makes it easy even for those with minimal training to quickly make advanced, reliable OTDR measurements.

Its high dynamic range of more than 40 dB not only gives you the possibility to look at long stretches of fiber, but also helps you increase the speed at which you can accurately determine a certain event.

The HP E6000A, however, goes beyond a Mini-OTDR. Its fiber break locator mode looks exclusively for breaks, and these are then quickly displayed. The real-time mode gives you instant feedback on parameter changes you make, so that the optimal setup can be found quickly.

Additional Modules

The HP E6000A Mini-OTDR is not just a high performance OTDR for single-mode fiber networks. Additional modules and sub-modules enhance its capabilities, without adding any significant weight. The modules simply plug into the existing instrument, making the Mini-OTDR the right tool for versatile, optical fiber test measurements.

Multimode Modules

These modules are designed to test all popular multimode fibers at both 850 nm and 1300 nm wavelengths. With an event deadzone of less than three meters, the HP E6005A multimode module offers a dynamic range of up to 34 dB.

For more information, visit our website: (http://www.tmo.hp.com/tmo/datasheets/English/HPE6000A.html).

HP 8147
HP E6000A

Optical Power Meter Sub-Module

This high performance, miniature and extremely light (130 g) sub-module provides a measurement range of +10 dBm to –70 dBm with 5% accuracy, 0.01 dB resolution and automatic zeroing. The Power Meter can be used to perform end-to-end loss testing, characterize optical passive components and test transmitter power levels.

A simple user interface and a hold data function make this Power Meter easy-to-use. A reference power level can be stored at each wavelength for loss measurements when the source is not available. It can even detect various modulation frequencies used to identify the wavelength being sent by the source. Now it's possible to perform end-to-end loss testing without communicating with the other end of your link.

The Power Meter has high return loss and low polarization-dependent loss. This ensures accurate measurements, especially for high coherent laser sources, such as in Dense Wavelength Division Multiplexing (D-WDM) and CATV applications. It is fast, providing more than three updates each second. Its non-contact ferrule enhances reliability and facilitates cleaning in the field.

Visual Fault Finder Sub-Module

This visible light source helps you to identify bends, breaks and stress points along individual fibers at the patch panel. The bright red light allows you to locate these faults within the deadzone of an OTDR, and at distances of up to 5 km. The Visual Fault Finder can be used to identify fibers within a cable and also to check the quality of your patchcords and connections. The 1 Hz modulation causes the light to flash, making it easier to identify fibers and locate faults.

Optical Fiber Test Set–Everything in Your Hands

The Mini-OTDR from Hewlett-Packard provides much more than just the fastest OTDR measurements; all the HP OTDR modules also act as powerful stabilized continuous wave (CW) light sources, and with the Power Meter Sub-Module in place, you're able to perform loss and power measurements. Within half a minute, you can switch from locating a break with the Visual Fault Finder to checking the multimode LAN.

All the OTDR modules use HP Connector Interfaces, which are easy to clean, interchangeable and provide flexibility.

At less than 2.8 kg (6.2 lbs), the HP E6000A, with its rugged design, is ideal to be carried even into those inaccessible places. Containing the most advanced smart battery technology, you never need be caught without power. The battery delivers exact information on the charge status—with an accurate on-screen "fuel gauge". A full recharge takes less than 3 hours.

There's no need to switch instruments, for multimode or single-mode measurements; with the HP Mini-OTDR, you have a complete optical fiber test set in one instrument.

For more information, visit our website:
(http://www.tmo.hp.com/tmo/datasheets/English/HPE6000A.html).

Key Literature

Color Brochure, p/n 5965-1256E
Technical Specifications, p/n 5965-1289E

Ordering Information

At least one user-exchangeable Connector Interface (HP 81000xI) is required for the module.

E6000A Mini-OTDR Mainframe
- **Opt 002** Hardcase
- **Opt 003** Color Display
- **Opt 004** Software Upgrade Kit
- **Opt AB0** Traditional Chinese user interface
- **Opt AB2** Simplified Chinese user interface
- **Opt AB9** Portuguese user interface
- **Opt ABD** German user interface
- **Opt ABE** Spanish user interface
- **Opt ABF** French user interface
- **Opt ABJ** Japanese user interface
- **Opt AB8** Turkish user interface
- **Opt ABZ** Italian user interface
- **Opt AKB** Czech user interface

E6001A 1310 nm single-mode module (economy) (28 dB)
- **Opt UK6** Calibration Report

E6002A 1310 nm single-mode module (high performance) (35 dB)
- **Opt UK6** Calibration Report

E6003A 1310/1550 nm single-mode module (high performance) (35/34 dB)
- **Opt UK6** Calibration Report
- **Opt 022** Angled Connector

E6004A 1310/1550 nm single-mode module (economy) (28/28 dB)
- **Opt UK6** Calibration Report
- **Opt 022** Angled Connector

E6005A 850/1300 nm multimode module (high performance) (26/34 dB)
- **Opt UK6** Calibration Report

E6006A Optical Power Meter Sub-Module
- **Opt UK6** Calibration Report

E6007A Visual Fault Finder Sub-Module

E6008A 1310/1550 nm ultra high performance single-mode module (40/39 dB)
- **Opt UK6** Calibration Report
- **Opt 022** Angled Connector

E6009A 850/1300 nm multimode module (economy) (18/23 dB)
- **Opt UK6** Calibration Report

HP 81000AI/FI/GI/HI/KI/SI/VI/WI Connector Interfaces

HP E597xA Handheld Fiber Optic Test Equipment
Please refer to Product Overview 5963-6656E.

- Flexible solution platforms
- High accuracy
- Custom capabilities
- Fast throughput

HP 81600A
HP 83464A
HP 83465A
HP 83467A
HP 83467C
HP 83470A
HP 86060 Series

10 Gbit/s Parametric Test Systems

50 GHz Lightwave Component Test Systems

EDFA Test Systems

Hewlett-Packard leverages its expertise in lightwave, microwave and high-speed digital instrumentation, and insight into relevant measurement issues, to provide measurement solutions that extend beyond the capabilities of individual instruments. These system solutions are used to quickly and accurately characterize the components and subsystems needed for lightwave transmission systems.

Available systems include:

- Passive optical component test (including WDMs)
- Erbium-doped fiber amplifier test
- Chromatic and polarization mode dispersion test
- High-speed lightwave/microwave component test
- SONET/SDH physical layer test to 10 Gbit/s

HP 83464A WDM and Passive Optical Component Test Systems

With a variety of source and receiver combinations, HP can offer the utmost in accuracy and throughtput for WDM and other passive optical component testing. HP's in-depth instrument and measurement knowledge is available through easy-to-use software that makes WDM and passive component testing fast and easy.

HP 83465A and 81600A Erbium-Doped Fiber Amplifier (EDFA) Test Systems

HP's optical and electrical EDFA test systems utilize different measurement techniques, including time-domain extinction ratio and polarization nulling, to meet the varied needs and customer-specific requirements of EDFA testing.

An in-depth knowledge of EDFA testing is leveraged and provided through an array of EDFA test solutions and capabilities. Any of HP's EDFA platforms can be expanded into highly-efficient production systems that meet your manufacturing needs.

HP 83467A Chromatic Dispersion (CD) Test Systems

HP's chromatic dispersion test systems are based upon the modulation phase-shift/delay measurement technique that has been demonstrated to be the preferred solution in system, sub-system, and component test applications. The CD systems provide the utmost in accuracy and flexibility. Polarization mode dispersion (PMD) can be easily added.

HP 83467C 50 GHz Lightwave Component Analysis (LCA) Test Systems

The HP 83467C 50 GHz lightwave component analysis (LCA) test systems consist of a specially-developed lightwave test set to compliment the HP 8510C network analyzer and system software. The system provides electro-optical (E/O and O/E), optical (O/O) and electrical (E/E) transmission and reflection measurements to 50 GHz at either 1550 nm or 1310 nm.

HP 83470A SONET/SDH Parametric Test Systems to 10 Gbit/s

Hewlett-Packard provides unique measurement solutions through its instrument offerings in communications waveform test, error performance analysis and jitter test to 10 Gb/s. With the addition of optical transmitters and optical receivers with clock and data recovery, Hewlett-Packard can provide customized transmitter, receiver and/or transmission link measurement solutions at SONET/SDH rates up to OC-192/STM-64.

Custom System Capabilities

Hewlett-Packard is committed to meeting customer needs by providing measurement solutions suited for specific requirements. These systems can range from the simple to the very complex. In addition, Hewlett-Packard offers a wide variety of services including consultation, design, manufacturing, installation, and support. Please contact your local HP sales representative to discuss how HP might best be able to address your needs.

HP 86060 Series of Lightwave Switches

The HP 86060 series of programmable lightwave switches cover a broad range of switching capacity and provide easy signal routing for accurate and repeatable measurement automation. These switches provide an important building block for implementing automated test systems.

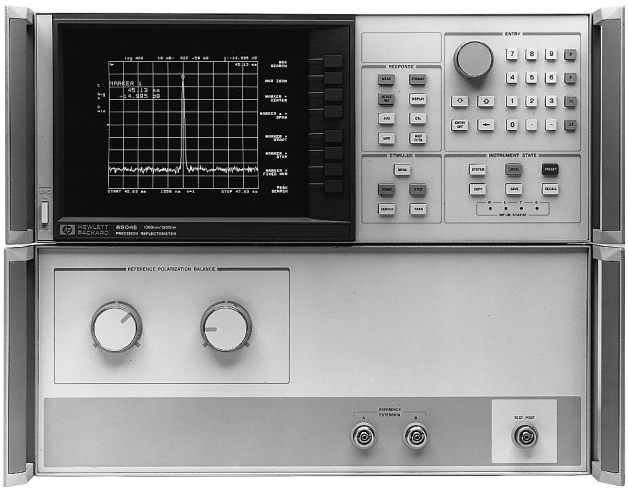
HP's switch family features an easy-to-use manual interface and a visual signal routing display. These switches can be easily integrated into automated test systems using SCPI-compatible commands via HP-IB or RS-232 interfaces.

For more complete information order the Lightwave Test and Measurement catalog. See detailed description on page 638.

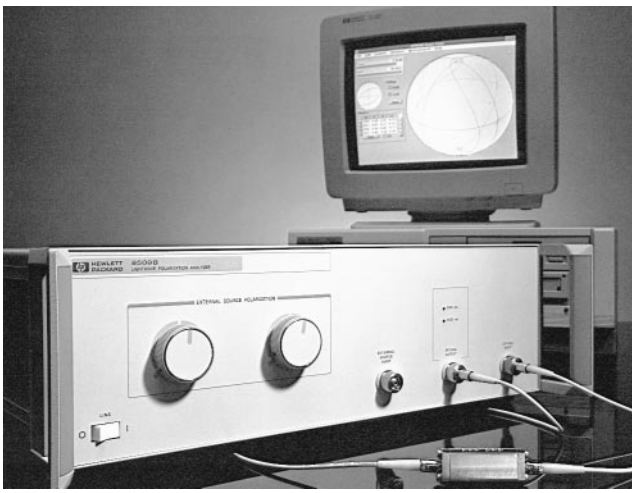
Precision Reflectometer and Polarization Analyzers

HP 8504B
HP 8509A
HP 8509B

- Return loss measurement range beyond 80 dB
- 25 μm two-event resolution (in air, 16 μm in glass)
- 1300 and 1550 nm wavelengths
- 1 mm to 400 mm scan widths
- Two automated polarization-mode dispersion (PMD) measurements; Jones matrix eigenanalysis and swept wavelength
- Calibrated, real-time measurements of state and degree of polarization
- Fast, automatic measurements of polarization-dependent loss in optical components



HP 8504B



HP 8509B

HP 8504B Precision Reflectometer

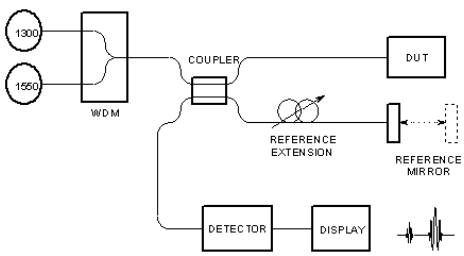
The HP 8504B precision reflectometer provides state-of-the-art lightwave reflection measurements. Individual reflections are measured and displayed as a function of distance or position. Return loss measurements beyond 80 dB are achievable, even when larger reflections are present in the measurement path. Two reflections can be closer than 25 μm (equivalent distance in air) and still be individually identified. Engineers and scientists now have a tool to precisely locate, identify, and quantify individual reflections within lightwave components and assemblies. Designs are optimized easily in the development phase. In product manufacturing, problems are solved quickly as even very small faults and discontinuities are found easily. Calibrated measurements are performed in seconds using a simple user interface and a rapid scan rate.

The HP 8504B precision reflectometer measures connectorized components in single-mode fiber. (Performance is good, but not optimum in multimode fiber.) The measurement span can be varied from 1 mm to 40 cm. The location of the 40 cm measurement window can be offset by adding the appropriate length of extension cable. Measurements are made using internal 1300 nm and 1550 nm light sources.

The HP 8504B can also be an important tool in preventing and solving component failure modes. Determining the precise location of a crack or break in a small optical assembly is easily achieved.

In addition to measuring reflections, there are also a variety of other applications including source coherence functions, precision length measurements, and characterization of the effects of birefringence (including polarization mode dispersion and fiber beat length).

Block diagram of HP 8504B



For more complete information, order the Lightwave Test and Measurement Catalog. See detailed description on page 638.

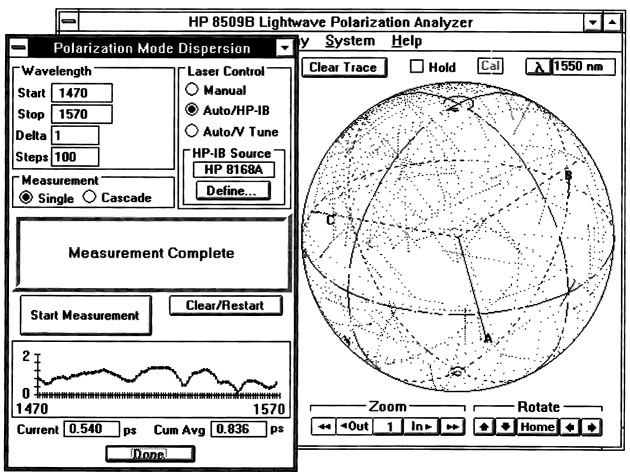
HP 8509A/B Lightwave Polarization Analyzers

The HP 8509 lightwave polarization analyzer system offers calibrated polarization measurements of optical signals and components. These capabilities are provided by innovations in hardware, software, and mathematics.

Hardware contributions include a four-diode detection scheme covering 1200 nm to 1600 nm. Single-wavelength, 1300 and 1550 nm Fabry-Perot lasers, and an automatic three-state polarization generator are provided within the HP 8509B. External single-wavelength or swept-wavelength sources can also be used.

System software delivers an easy-to-understand data display of simultaneous, numeric and graphic formats featuring average power, degree of polarization, Poincare sphere, polarization ellipse, Jones matrix, Stokes parameters, and polarization-maintaining fiber launch conditions.

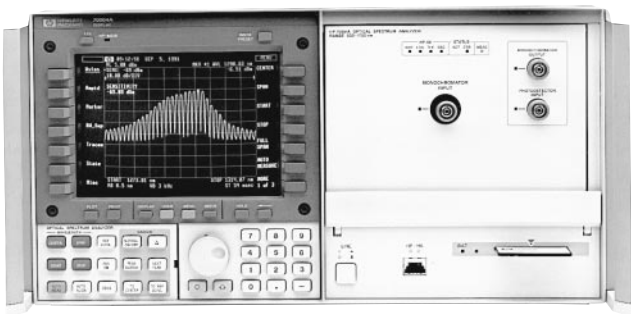
Mathematical innovation in Jones matrix analysis automate and simplify the measurements of polarization mode dispersion, polarization dependent loss, and polarization reference frames.



A polarization-mode dispersion graph is generated automatically as the system computer conducts the measurement.

HP 71450B
HP 71451B
HP 71452B
HP 83437A
HP 83438A

- Spectral measurements from 600 to 1700 nm
- Unique double-pass monochromator
- Real-time sweep rates
- –90 dBm sensitivity and 60 dB dynamic range
- Two-year calibration cycle
- Excellent amplitude accuracy, low polarization dependency for WDM testing
- Wavelength and amplitude calibration across full measurement range
- Optional current source and white light source
- Five modes of operation (HP 71451B)



HP 71451B

HP 71450B, 71451B, and 71452B Optical Spectrum Analyzers

The HP 71450B, 71451B, and 71452B are grating-based optical spectrum analyzers that display the amplitude of light versus wavelength over the 600 to 1700 nm wavelength range. These instruments make fast spectral measurements of LEDs, Fabry-Perot lasers, DFB lasers, and Erbium-doped fiber amplifiers. Capable of sweeping 40 nm in 50 ms and the full frequency range in 500 ms, they can save hours of measurement time in the laboratory or on the production floor.

A unique double-pass monochromator provides the optical spectrum analyzers with the high dynamic range of double-monochromator instruments (–55 dBm at 0.5 nm from the peak) and the sensitivity of single-monochromator instruments (better than –90 dBm). They also offer high amplitude and wavelength accuracy as well as polarization insensitivity.

The optical spectrum analyzers are housed in a single, 9-inch-high mainframe. They operate in temperatures from 0° to 55° C, and they meet rigorous environmental tests, including those for shock and vibration. The analyzers maintain full calibration for two years, even after normal transportation—across the room or across the country.

Measurement Versatility

Many features are found in the HP 71450B, 71451B, and 71452B. Modification of screen data allows immediate wavelength position or span adjustments. Fully-variable spans with full control over sweep speeds, sensitivity, and resolution, and the choice of automatic or manual settings, make the analyzers easy to use. In addition, automatic features include an auto-measure function that locates the signal, zooms in, and centers the display, and an auto-align feature that automatically centers the light on the photodiode for optimum amplitude accuracy.

Three advanced functions measure and characterize LEDs and DFB and Fabry-Perot lasers. The LED measurement identifies the spectral FWHM value, mean-wavelength position, and peak-power density of the LED. The Fabry-Perot function measures the spectral FWHM, center wavelength, mode spacing, and total power of the laser. One-button measurements of DFB lasers include center wavelength, automatic side-mode suppression ratios, peak power, and stop-band characterization.

The optical spectrum analyzers save data in several ways. Displayed information can be transferred directly to a printer or plotter, and trace and instrument setups can be saved internally in the standard 1 MB memory, stored on a memory card, sent over HP-IB to an external disk drive, or captured on a PC with the OSA capture program.

HP 83437A and 83438A

WDM Testing

The HP 71452B is optimized for both active (EDFA) and passive (e.g. WDM filter) component testing. The performance in the 1550 nm window (1542 nm to 1562 nm) has been enhanced to provide a ± 0.05 dB polarization sensitivity with a scale fidelity of 0.05 dB and an improved wavelength accuracy of ± 0.2 nm. Also included as standard are three EDFA measurement personalities: ASE Interpolation, Time Domain Extinction (TDE), and Noise Gain Profile (NGP). The ASE Interpolation and TDE personalities provide a quick and easy way to measure large signal gain, noise, and a variety of parameters at a single wavelength. A complete WDM component test kit (Option 031) is available which includes the Erbium ASE source, polarization controller, and optical spectrum analyzer.

Five Modes of Operation with the HP 71451B

The HP 71451B extends the standard optical spectrum analysis capability by adding four measurement ports: monochromator input, photodetector input, monochromator output, and transimpedance amplifier input. An internal transfer switch, automatic fiber alignment, and access to the photodetector and transimpedance amplifier allow the HP 71451B to be operated in five modes: OSA, preselector, stimulus-response, power meter, and photodetector.

HP 83437A Broadband Light Source
HP 83438A Erbium ASE Source

In conjunction with an OSA, the incoherent light sources HP 83437A and 83438A allow you to measure insertion loss, crosstalk, bandwidth, polarization dependencies, and other parameters of passive optical components versus wavelength.

Built to order, the HP 83437A can incorporate up to four edge-emitting LEDs (EELEDs), with five available wavelengths (1200 nm/–17 dBm, 1310 nm/–13 dBm, 1430 nm/–13 dBm, 1550 nm/–13 dBm, 1650 nm/–17 dBm). The peak power density of each EELED in a single-mode fiber is more than 25 dB stronger than that of a white light source. It is also the ideal noise source for the NGP technique mentioned above.

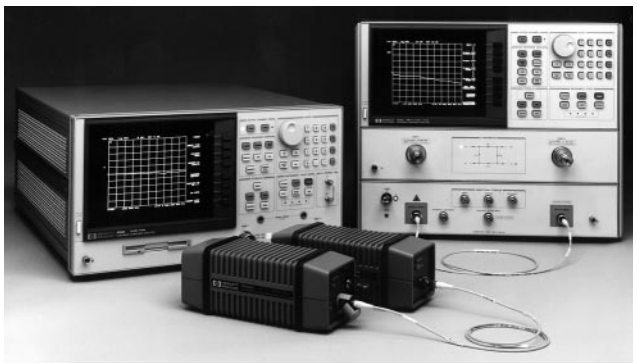
The HP 83438A provides more than +6 dBm in the 1550 nm window, allowing you to characterize advanced components such as isolators, circulators, add/drop multiplexers, gratings, or demultiplexers for dense wavelength-division multiplexing (DWDM) systems.

For more complete information, order the Lightwave Test and Measurement Catalog. See detailed description on page 638.

8

HP 8702D
HP 8703A
HP 71400C
HP 71401C
HP 70810B
HP 83420A

- 300 kHz to 20 GHz modulation frequency
- 1300 or 1550 nm operation
- Calibrated frequency response measurements of high-speed optical, electro-optical, and electrical components
- RIN measurements to –165 dB/Hz
- Interferometer for laser linewidth and chirp measurements



HP 8702D and 8703A

Lightwave Component Analyzers

The HP 8702D and 8703A precisely characterize the swept modulation frequency response of wide bandwidth fiber optic system elements such as lasers, LEDs, photodiodes, and electro-optical modulators. Both the HP 8702D and 8703A operate at a fixed wavelength and sweep the frequency of the intensity modulation signal over the bandwidth you select.

The HP 8702D has 1300 and 1550 nm lightwave sources and receivers as well as an 850 nm receiver. The 8703A can operate at 1300 and 1550 nm. These sources and receivers are characterized to allow calibrated measurements of electro-optical test devices.

When used to measure linear electrical components, such as filters, amplifiers, and transmission lines, the lightwave component analyzers have the full measurement capability of a microwave network analyzer. Typical measurements are bandwidth, insertion loss/gain, phase, impedance, match, and group delay.

HP 8702D Lightwave Component Analyzer

HP-IB

300 kHz–3 GHz (850 nm) 300 kHz–6 GHz (1300, 1550 nm)
The HP 8702D offers several significant improvements in versatility, performance and productivity. A few of these are:

- improved optical calibration accuracy
- built-in 3.5-inch floppy disk drive with LIF/DOS formats
- integrated S-parameter test set
- serial and parallel printer interfaces
- test sequencing for automated measurements
- faster CPU and increased non-volatile memory

HP 8703A Lightwave Component Analyzer

HP-IB

130 MHz–20 GHz (1300 and 1550 nm)
The standard configuration includes an internal 1300 nm Fabry-Perot (FP) laser and one 1300/1550 nm receiver. Optional 1300 or 1550 nm DFB internal laser sources are also available. The external lightwave source input (Option 100) is used with the HP 83424A or 83425A lightwave CW sources for additional 1550 or 1300 nm DFB wavelength flexibility.

HP 83420A Lightwave Test Set

Includes a 1300 nm FP laser, modulator, receiver, and directional coupler. Basic lightwave component analyzer tests from 130 MHz to 20 GHz can be made when the HP 83420A is combined with an external controller and an HP 8510, HP 8719/8720 Option H80, or HP 8757 microwave analyzer system.

HP 71400C with HP 70810B

HP 71400C and 71401C Lightwave Signal Analyzers

HP-IB

Calibrated Measurement of Intensity Modulation to 22 GHz

The HP 71400C combines a high-performance microwave spectrum analyzer with a wideband, sensitive optical receiver. This system measures modulated light on single-mode optical fibers from 100 kHz to 22 GHz. Optical modulation, noise, and average power are presented on a fully-calibrated display.

With the HP 11980A fiber-optic interferometer, the analyzer can also measure linewidth. With an interferometer and a gated source, the analyzer can measure chirp and FM characteristics of distributed-feedback (DFB) and other single-line lasers.

This system is also a fully-functional microwave spectrum analyzer with all the capability of the HP 71210C. Because the lightwave signal analyzer is part of the HP 70000 modular measurement system, its measurement capabilities can be expanded easily. For example, you can add a tracking generator module for modulation response measurements to 18 GHz, or an optical spectrum analyzer for wavelength analysis.

The HP 71400C measures intensity modulation up to 22 GHz and operates over wavelengths from 1200 to 1600 nm or, with Option 850, from 750 to 870 nm. It can achieve an optical sensitivity of better than –60 dBm. The analyzer also offers average-power measurement, displayed both as a real-time vertical power bar and as a digital readout. Full calibration of both average power and modulation power makes this system a reference receiver for measuring and characterizing optical detectors and receivers.

A program for relative intensity noise (RIN) measurement is included. This program subtracts thermal noise and shot noise components of the measurement and calculates to –165 dB/Hz.

The HP 71401C has an upper frequency limit of 2.9 GHz but the same functions and features as the HP 71400C. Both models provide lightwave optical or electrical units in watts or decibels, and microwave units for electrical spectrum analysis.

HP 70810B Lightwave Receiver Module

The HP 70810B lightwave section is a one-slot lightwave receiver module for the HP 70000 modular measurement system. The module has a built-in average power meter and attenuator, a wavelength range of 1200 to 1600 nm (750 to 870 with Option 850), a detected modulation bandwidth of 100 kHz to 22 GHz, and a built-in, 32 dB RF amplifier that gives an optical sensitivity of –60 dBm in a 10 Hz bandwidth. It can be used in standalone applications as a lightwave receiver housed in an HP 70000 mainframe. In this configuration, the electrical output is the detected intensity modulation in its amplified and uncorrected state.

For more complete information, order the Lightwave Test and Measurement Catalog. See detailed description on page 638.

HP 11982A
HP 83440B
HP 83440C
HP 83440D
HP 83446A
HP 83446B

- DC-coupled optical-to-electrical converters
- Bandwidths from dc to 30 GHz
- Fast-pulse response
- Optical receiver for BERT or oscilloscope
- Clock and data recovery at 2488 or 622 Mb/s
- High sensitivity

HP 83440 Series

HP 11982A

HP 83446B

DC-Coupled Optical Converters

Optical communication systems that incorporate time-domain instruments often require optical-to-electrical (O/E) converters in order to make optical pulse and wavelength measurements. Whether to use an unamplified or an amplified O/E converter depends on the measurement application. If signal power levels are high enough, a simple photodiode-only converter such as the HP 83440 offers well-behaved pulse response performance. To measure low power signals, an RF-amplified O/E converter such as the HP 11982A may be required.

In frequency-domain applications, O/E converters allow frequency-domain instruments such as network and spectrum analyzers to accept optical signals for basic lightwave measurements. Users can measure, quantify, and model modulation characteristics such as spectral purity, harmonic content, and noise spectral density.

HP 83440 Series Unamplified Lightwave Converters

The HP 83440 series offers a variety of bandwidth options for converting incoming modulated optical power or optical pulses into electrical current. Ideal for optical pulse parameter measurements, these fully-integrated hermetic InGaAs photodetectors feature very low noise and pulse aberrations, fast, accurate O/E conversion, and a standard user-interface compatible with most electrical instruments. The converters mount directly on test-instrument front panels. Simple internal structure ensures low-signal distortion for improved output-signal fidelity, a novel optical launch ensures low optical reflection, and integral dc-bias regulation ensures stable frequency response performance.

The HP 83440 series can be used with high-speed digitizing oscilloscopes to accurately measure rise and fall time, overshoot, undershoot, ringing, peak power (pulse amplitude), pulse width, amplitude noise, and extinction ratio. The HP 83440 series also makes excellent mask measurements when sufficient optical power is available.

The HP 83440B Option 050 provides 50 Ω output required for use with external SDH Bessel-Thomson filters such as the HP 87441 family.

When using the HP 83440 with an ac-coupled instrument (except Option 050), a bias tee such as the HP 11612A or, alternatively, a 3 dB fixed attenuator on the output is required to provide a dc-bias return path.

HP 11982A Amplified Wide Bandwidth Lightwave Converter

A wide-bandwidth, sensitive O/E converter for characterizing lightwave systems and components, the HP 11982A combines a PIN photodetector with a low-noise dc-coupled preamplifier to create a general-purpose front end. It covers wavelengths from 1200 to 1600 nm and bandwidths from dc to 15 GHz. With 300 V/W conversion gain and 0.05 percent input optical reflections, it significantly improves the sensitivity of the measurement system. The converter comes with a calibration chart of instrument-specific data for making corrected frequency-response measurements.

Combine the HP 11982A with an HP 83480 series digital-communication analyzer to make optical eye-pattern and impulse-response measurements. Use the results to verify optical and optoelectronic components and optical system level performance.

The HP 11982A can be used with an electrical spectrum analyzer to display optical modulation power as a function of frequency. Intensity modulation, distortion, and laser intensity noise are also measured. The Option 001 memory card programs an HP 8590 E series spectrum analyzer with frequency-response corrections, and menus for easy, accurate lightwave measurements to 22 GHz. Using this converter with the HP 11980A interferometer, you can measure linewidth (with a gateable modulation source), chirp, and frequency modulation of single-line lasers.

HP 83446A/B Lightwave Clock/Data Receivers

The HP 83446A/B lightwave clock/data receivers are used to extract clock and data signals from SDH/SONET optical signals operating at 2488 Mb/s (STM-16/OC-48) or 622 Mb/s (STM-4/OC-12) rates, respectively. The HP 83446A/B operate over the full range of power levels specified in SDH/SONET standards (–27 dBm sensitivity) at both 1300 nm and 1550 nm wavelengths, using multimode or single-mode fiber. Designed for use with high-speed BERTs such as the HP 71603B bit-error rate tester, BER testing can now be performed directly on optical signals. A third port routes the high-gain avalanche photodiode output to the front panel, previous to clock/data regeneration for analysis of the optical waveform. An electrical input allows clock and data recovery from a 2488 Mb/s (83446A) or 622 Mb/s (83446B) electrical signal.

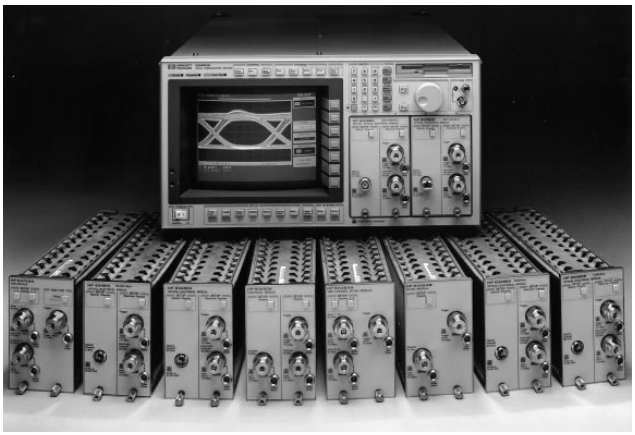
For more complete information, order the Lightwave Test and Measurement Catalog. See detailed description on page 638.

Digital Communications Analyzer

HP 11898A
HP 83480A
HP 83481A
HP 83482A
HP 83483A
HP 83484A
HP 83484B
HP 83485A
HP 83485B
HP 83486A
HP 83487A

- Automated mask and template measurements
- Integrated optical channels for accuracy and ease of use
- High-measurement throughput
- Filtered measurements for compliance test or full bandwidth for waveform analysis
- Fast statistical waveform analysis
- Wide range of standard telecom and datacom masks and templates

HP 83480A



HP 83480A with plug-in modules

NEW

HP 83480A Digital Communications Analyzer

HP-IB

The HP 83480A represents a significant advancement in the instrumentation used to view waveforms in high-speed digital communications. Industry-standard tests including mask and template tests as well as eye-diagram analysis including extinction ratio are made using easy-to-use, built-in measurements. For measuring optical signals, lightwave receivers are integrated into the instruments to provide highest accuracy and waveform fidelity.

With up to 50 GHz of bandwidth, the HP 83480A can be used on low-rate tributary signals through 10 Gb/s optical waveforms. A new capability, Option 100, increases trigger bandwidth to beyond 10 GHz and provides gated triggering for optical re-circulating loop experiments.

Industry Standard Masks and Templates

Achieve high-throughput waveform testing with both optical and electrical masks and templates including SDH, SONET, Gigabit Ethernet, and Fibre Channel standards. For guardband testing, use mask margins. Custom/user-defined masks can also be generated. Masks are automatically aligned and scaled.

Integrated Optical Receivers

The HP 83480A is a modular platform with a family of optical receivers with very high-speed internal photodiodes (2.5 GHz, 20 GHz, or 30 GHz bandwidths). For filtered measurements, filters are switched in with a simple keystroke to produce a calibrated reference receiver, or switched out for full bandwidth waveform analysis.

The HP 83480A can accept one or two plug-in modules for up to four measurement channels. Modules have two electrical channels or one optical channel and one electrical channel. The following optical/electrical plug-ins have 9/125 μm single-mode optical interfaces for 1310 and 1550 nm applications. The HP 83481A has a 20 GHz electrical channel and a 2.5 GHz optical channel with 155 and 622 Mb/s switchable filters. The HP 83482A provides a 40 GHz electrical channel and a 30 GHz optical channel. The HP 83485B provides a 40 GHz electrical channel and a 10 Gb/s filtered channel.

Two optical/electrical plug-ins have 62.5/125 μm optical interfaces for both single-mode and multimode measurement applications. For 1310 and 1550 nm applications, the HP 83486A has a 2.5 GHz optical channel with 155 and 622 Mb/s switchable filters for SDH/SONET/ATM applications or 1063 and 1250 Mb/s switchable filters for Fibre Channel and Gigabit Ethernet. For 850 nm applications, the HP 83487A has a 2.5 GHz optical channel with 1063 and 1250 Mb/s switchable filters. Both modules also have a 20 GHz electrical channel.

Accurate Eye-Diagram Analysis

Integrated optical receivers are the key to accurate eye-diagram analysis of lightwave signals. Internal photodiodes have well-behaved frequency responses which are not degraded by external cabling and adapters. This yields the highest in waveform fidelity and measurement accuracy. Extinction-ratio measurements are accurate and repeatable.

General-Purpose Oscilloscopes

In addition to digital communications analysis, the HP 83480A can be used as a general-purpose, high-speed, sampling oscilloscope. The HP 83483A electrical plug-in provides two 20 GHz electrical channels, the HP 83484A has two 50 GHz electrical channels. Add TDR capability to the HP 83480A with the HP 54753/4/5A. The HP 11898A module extender provides a 1.5 meter extension cable for placing the electrical module adjacent to the high-speed circuit-under-test.

For more complete information, order the Lightwave Test and Measurement catalog. See detailed description on page 638.

- Characterize WDM spectra during installation and maintenance
- Simultaneously measure up to 100 wavelengths and powers
- ±3 ppm wavelength accuracy
- 20 GHz wavelength resolution
- Signal-to-noise ratio measurements

HP 86120B

HP 86120B Multi-Wavelength Meter

The HP 86120B multi-wavelength meter, like other Michelson interferometer-based wavelength meters, allows you to measure the average wavelength of the input signal. In addition, the HP multi-wavelength meter—with advanced digital signal processing—accurately and easily differentiates and measures up to 100 discrete wavelengths. Unlike other optical wavelength meters, the HP 86120B can simultaneously measure the individual powers of the discrete wavelengths, offering the following measurement capabilities:

- 1 to 100 wavelengths and powers
- Average wavelength and total power
- 3 ppm wavelength accuracy (0.005 nm at 1550 nm)
- 20 GHz wavelength resolution
- Calibrated for elevation in air or vacuum
- Wavelength units in nm, Thz, or wave number (cm-1)
- Amplitude units in dBm, mW, or μW
- SNR and averaged SNR for WDM SONET/SDH systems
- Rugged design to withstand even strong shocks and vibration

Laser Manufacture and Test

The superior wavelength and amplitude measurement capabilities of the HP 86120B multi-wavelength meter enable you to maximize the performance of your components in the factory. You can measure DFB, FP, and multiple DFB-laser wavelengths and amplitudes during burn-in, environmental evaluation, final test, and incoming inspection.

Transmission Systems

Combining measurement performance with a rugged and portable package, the multi-wavelength meter lets you easily and accurately verify the optical carrier performance of transmission systems by measuring wavelength, power, and signal-to-noise ratios during design, installation, monitoring, and maintenance.

WDM Systems and Components

With the HP 86120B, you can simultaneously resolve the individual optical carriers and accurately confirm wavelengths, powers, channel spacing, drift, and signal-to-noise ratios in WDM components and systems both in the lab and in the field.

Lightwave Test and Measurement Catalog

The *Lightwave Test and Measurement Catalog* has information and specifications on HP's full line of lightwave test equipment and accessories. Measurement tutorials in the catalog cover:

- Standards, Calibration, and Traceability
- Power Measurements
- Wavelength Measurements
- Spectral Measurements
- Optical Amplifier Testing
- Testing DWDM Components
- Polarization Measurements
- Return Loss Measurements
- Frequency-Domain Measurements
- Time-Domain Measurements
- Error Performance and SONET/SDH Analysis
- Field Service and Installation
- Common Opto-Electronic Signal Relationships

A product matrix, at the front of the catalog, helps you find the Hewlett-Packard instrument to meet your lightwave measurement needs.

To receive your free copy, complete and return the business reply card at the end of this catalog or call your local HP sales office and ask for literature number 5965-5480. Visit HP on the World Wide Web (http://www.hp.com/go/tmcatalogs), and order a copy.

Overview

Lightwave Test & Measurement Catalog 1997
5965-5480E

Optical Component Test

EDFA HP 81600 Series 200 Are You Certain of Your Measurements?
5091-7728E
EDFA Testing—Problems and Solutions
5963-2273E
Testing PDG and PMD of EDFAs
5963-3716E
HP E5574A Optical Loss Analyzer Sources Configuration Guide
5963-6886E
Brochure
5963-6889E
Technical Specifications
5964-1524E
HP 8167A, HP 8168D/E/F Tunable Laser Sources Brochure
5964-8999E
HP 8167B, HP 8168D/E/F Tunable Laser Sources Configuration Guide
5964-9001E
HP 11896A and **HP 8169A** Polarization Controllers Technical Data Sheet
5962-0017E
PDL Measurements Using the **HP 8169A** Polarization Controller.
5964-9937E
HP 8153A Configuration Guide
5963-3366E
HP 8153A Modular System for Optical Power Loss and Return-Loss Measurements Brochure
5963-7132E

HP 8153A Technical Data Sheet
5962-9321E
HP 8156A Optical Attenuator Brochure
5091-7758E
HP 8156A Optical Attenuator Configuration Guide
5963-3367E
HP 8156A Optical Attenuator Technical Data Sheet
5962-8631E
Lightwave Test & Measurement Catalog 1997
5965-5480E

(PN 8167B) Tunable Laser Source HP 8167B, HP 8168D, HP 8168E, HP 8168F
5964-9542E
(PN 8168E/F) HP 8168E and HP 8168F Tunable Laser Sources
5965-5877E
(PN 11896-2) Polarization-dependent Loss Measurements Using Modular Test System Configurations
5965-5720E
(PN 81534A) Measuring the Return Loss of Fiber Optic Components–HP 81534A Return Loss Module
5091-2639E

Field Installation & Maintenance

HP 8147 Optical Time Domain Reflectometer Configuration Guide
5964-1987E
Technical Specifications
5964-1986E
Ultra High Performance OTDR Module HP E6008A, Photo Card
5965-0021E
Power Meter Sub-module HP E6007A and Visual Fault Finder Sub-module HP E6007A, Photo Card
5966-0022E
Multimode OTDR Modules HP E6005A, HP E6009A, Photo Card
5966-0023E

Lightwave Test System Solutions

HP 86060 Series of Lightwave Switches Product Overview
5964-9008E
HP– Your Partner for Lightwave System Solutions
5964-9007E
Lightwave Test & Measurement Catalog 1997
5965-5480E

Precision Reflectometer & Polarization Analyzers

Lightwave Test & Measurement Catalog 1997
5965-5480E
HP 8504B Lightwave Component Return Loss Measurements Brochure
5963-6730E
HP 8509A/B Lightwave Polarization Analyzer Technical Specifications
5091-6258E

(PN 8504-1) Measurements of Lightwave Component Reflections with the HP 8504B Precision Reflectometer
5963-7191E
(PN 8509-1) Polarization Measurements of Signals and Components
5091-2879E

Many of these literature pieces are available at:
http://www.hp.com/go/tmc98

Spectrum, Component & Signal Analyzers

Lightwave Test & Measurement Catalog 1997
5965-5480E
HP 11980A Fiber-Optic Interferometer Data Sheet
5091-0471E
HP 11982A Amplified Lightwave Converter Data Sheet
5952-2166E
HP 70880A, 71400C, 71401C LW Personality Data Sheet
5091-5541E
HP 71400C, 71401C, 70810B LW Signal Analyzers Data Sheet
5091-7030E
HP 8702B LW Component Analyzer Flyer
5952-0822E
HP 8702B LW Component Analyzer Ordering Guide
5091-0920E
HP 8702B LW Component Analyzer System Technical Specifications
5091-0493E
HP 8703A LW Component Analyzer Ordering Guide
5952-0824
HP 8703A LW Component Analyzer Technical Specifications
5952-1754E
Comprehensive Characterization of Your Optical Sources, Components and Amplifiers Brochure
5963-7317EUS

HP 71450B, 71451B, 71452B Optical Spectrum Analyzers Brochure
5963-7041E
HP 71450B, 71451B, 71452B Optical Spectrum Analyzers Data Sheet
5963-7040E
HP 83420A LW Test Set,
HP 83421A LW Source
HP 83422A LW Modulator,
HP 83423A LW Receiver
Technical Specifications
5952-3525

(PN 71452-3) HP 71452B Optical Spectrum Analyzer—EDFA Noise Gain Profile and Noise Gain Peak Measurements
5965-7148E
(PN 71452-2) HP 71452B Optical Spectrum Analyzer—EDFA Testing with the Time Domain Technique
5963-7147E
(PN 71400-1) Lightwave Signal Analyzers Measure Relative Intensity Noise
5091-2196E
(PN 71450) HP 71452 Optical Spectrum Analyzer—EDFA Testing with the Interpolation Technique
5963-7146E
(PN 71452-4) HP 71452B Optical Spectrum Analyzer—Synchronizes Its Internal Activities With External Signals
5964-6416E

Digital Communication Analyzers

Lightwave Test & Measurement Catalog 1997
5965-5480E
HP 71501B Jitter and Eye-Diagram Analyzer Brochure
5965-0801E
HP 83440B/C/D High-Speed Lightwave Converters Technical Specifications
5091-5536E
HP 83441A/B, 83442A Lightwave Receivers Technical Specifications
5091-6448E
HP 83475B LW Comm Analyzer Brochure
5964-3933E
HP 83480A 9 Methods for Faster High-Speed Digital Communication Design Brochure
5965-1668E
HP 83480A Series Digital Communication Analyzer Product Overview
5964-2238E

Optical Wavelength Meter

HP 86120B Multi-Wavelength Meter Brochure
5965-3665E
HP 86120B Multi-Wavelength Meter Technical Specifications
5965-3667E

This page has been
intentionally left blank

Test Solutions For Communications Networks

With the most comprehensive technology resources available anywhere, Hewlett-Packard can provide complete and integrated solutions that combine instruments, software, and computers to meet your test needs at every phase of the network life cycle. HP offers telecommunication and data communication test equipment to help you design state-of-the-art, high quality, communication products. We also offer the tools you need to test, monitor, troubleshoot and eliminate operational problems on your network, no matter what its size or type.

From handheld testers to network monitoring systems, HP equipment is easy to use and rugged enough to stand up to years of use in the field, factory, or lab. Backed by HP's unparalleled worldwide support, this total capability enables you to maintain your network's quality of service and uptime, and to enjoy a low overall cost of ownership.

You can also take advantage of training programs designed to give your workforce the skills and information necessary for accurate testing. These include:

- On-site seminars
- Computer-based training
- Video-based training

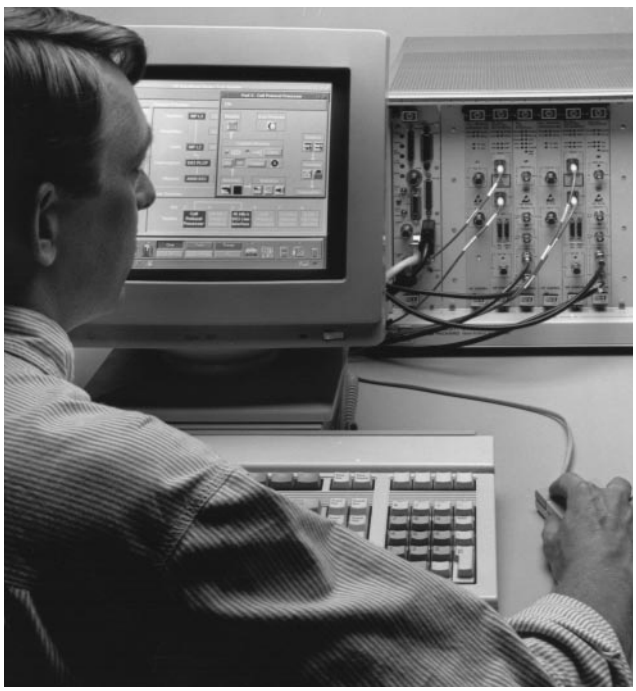
Networking technologies such as Frame Relay, T1/E1, X.25, LAN, and broadband for local-area and wide-area network testing are only a few of your options.

Protocol Analyzers

Protocol analyzers are instruments that monitor the traffic on a network to determine that it conforms to the specific set of rules, procedures, and conventions that are the expected "protocols" for that particular network and layer. There are different instruments designed for specific networks; these include: LAN, WAN/ISDN, and ATM/BISDN.

LAN

HP offers powerful, convenient test solutions for managing local-area networks. The HP Internet Advisor® product family combines a complete set of measurement tools with multitasking to create powerful instruments for stress testing application and for isolating and solving Ethernet, Token Ring, and FDDI problems.



Broadband protocol testers handle ATM signaling and digital video testing.

WAN/ISDN

A comprehensive array of protocol analyzers, including the HP Internet Advisor, test WAN and ISDN networks, supporting X.25, X.75, X.21, Frame Relay, SMDS, ISDN (basic and primary), SNA and most synchronous and asynchronous protocols. Field-portable units provide cost-effective troubleshooting capabilities for installing and maintaining networks. The portable testers can be operated remotely, singly or in groups, to make the most efficient use of your expert resources.

ATM/B-ISDN

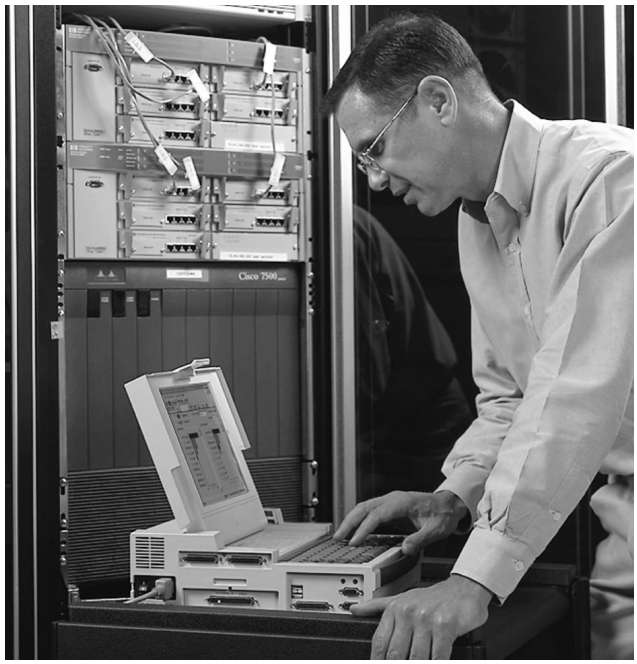
For the rapidly growing broadband technologies, HP offers complete physical layer and protocol test solutions for all layers, including the ATM, the ATM Adaptation Layer (AAL) and the broadband services. Modular, VXI-based test systems enable BISDN transmissions and interface testing, ATM transport characterization and broadband protocol development, verification and conformance testing.

Transmission Impairment Measuring Sets (TIMS)

It is necessary to make analog measurements on a network in order to analyze its ability to transmit signals on the physical layer. These measure frequency response, noise and cross talk. The results displayed indicate the health, or acceptability, of the network. HP offers a single box solution for this need.

Digital Transmission Testers

The fundamental measure of performance, or quality, in digital systems is the probability of any transmitted bit being received in error. This is the purpose of digital pattern generators and error detectors, often referred to as "bit error rate testers" or BERTs. HP offers the highest performance family of these instruments for sycnchronous (SONET/SDH) and plesiochronous (PDH) networks.



Portable protocol analyzer isolates operational problems on data communications networks.

PDH

HP manufactures a full line of products for use in the installation, maintenance, and troubleshooting of telecommunications networks. For ITU-T networks, rugged, handheld test sets and portable analyzers cover (CEPT) digital hierarchy at rates to 140 Mb/s. Configurations include telecom/datacom analyzers, an inexpensive frame alignment signal (FAS) monitoring system, and test sets for bit error rate, performance, and jitter measurements. Functional testing of SDH/PDH network equipment is available at rates to 622 Mb/s (STM-4) and includes ATM transmission tests.

For North American networks, HP offers handheld testers for T1 and fractional T1, and for ATM and DS1, DS3, or OC3. Portable analyzers include comprehensive T1, fractional T1, and DDS measurement capabilities and optional datacom testing. At higher speeds, compact STS-1, DS3, and DS1 test sets provide error analysis and alarm monitoring on framed and unframed signal formats.

SONET/SDH

HP's SONET and SDH analyzers perform accurate, reliable tests on network equipment and transmission services. Low-cost and portable units troubleshoot SONET equipment at rates up to 155 Mb/s or, optionally, to 622 Mb/s. Modular, VXI-based systems include a general-purpose lab instrument that tests in both SONET and SDH transmission standards, operating to 2.488 Gb/s (OC-1, 3,12, 48, and STM-1,4, 16). Other VXI modules include signal sources, switches, and analyzers for SONET tributary DS1, DS3, and STS-1) production test. They combine to create daisy chain, fully parallel, and channel-at-a-time test architectures that are easily integrated into production-line or ATE systems. Special, high performance models for bit rates to 12 GB/s, where lightwave transmission dominates, allow you to define cost-effective configurations for manufacturing and R&D uses. This lets HP offer error performance analyzers that feature high quality waveforms for component testing, and have user-programmable test patterns for simulating multiple SONET or SDH format frames at the 2.488 Gb/s transmission rate.

LAN

Handheld media scanners help you isolate wiring problems on LANs, including Ethernet, 10BASE-T, Token Ring, and ARCNET networks.

Network Monitoring Systems

HP offers computer controlled distributed systems that monitor network performance and report results at a central location. This creates the ability to achieve accurate fault diagnosis and location quickly, thereby allowing field crews to go to the right place and fix problems on the first call. HP offers monitoring systems for network technologies such as:

- Common channel signaling (SS7)
- Interoffice fiber trunks (lightwave)
- Customer premises datacom (LAN)
- Network timing

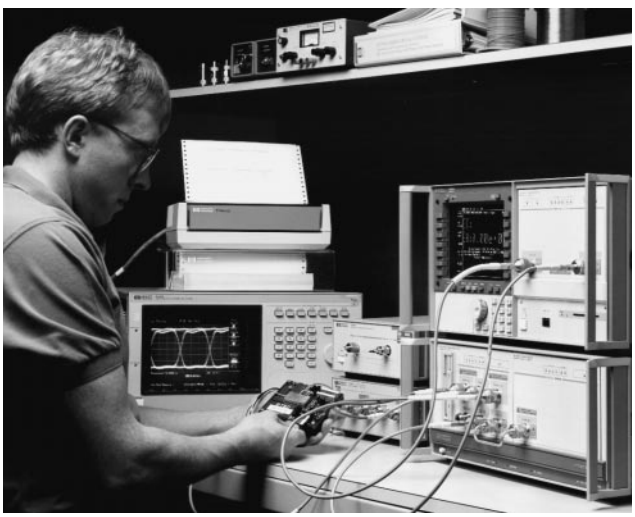
For more information on these options, contact your local HP office, or see instructions at the bottom of the page.

Communications Products Covered in Other Sections of This Catalog

HP offers a comprehensive line of network test, measurement and timing products to satisfy your needs in all types of networks, and all phases of their life cycle. Please also see the following for more information:

- Cellular testers (see pages 466-494)
- Microwave radio testers (see page 465)
- Lightwave transmission testers (see pages 442-449)
- Network synchronization units (see pages 498-511)

HP offers a full line of portable digital transmission analyzers.



For lightwave applications, HP error performance analyzers cover rates to 12 Gb/s.

Protocol Analyzers

The PT Series of Stimulus-and-Response Protocol Testers

The Professional's Protocol Tester

PT Series stimulus-and-response protocol testers are the professional's choice for telecom and datacom product development, quality assurance, performance testing, field trials, type approval, network monitoring and troubleshooting, and conformance testing. Based on a multiprocessor architecture, PT Series testers can be configured with a wide range of software and line interfaces to simultaneously test multiple WAN, ISDN, SS7 or LAN interconnect protocols over multiple ports. The PT Series can help you:

- Bring new products and services to market faster by finding protocol implementation errors quickly and accurately
- Gain a competitive edge by providing your customers with even more reliable products and services
- Participate in field trials confidently, knowing that your products have been rigorously tested and should perform well
- Evaluate new products thoroughly for interoperability, simulated in-service performance levels, and compliance with protocol standards before purchase and installation
- Maintain telecom and datacom networks by quickly isolating faults

Dedicated High-Performance Protocol Tester

- Designed and built to monitor and emulate communications protocols
- SDL-oriented Test Manager helps customize applications

Cost-Efficient Multiport Testing

- Can be configured with 1 to 4 WAN ports
- Single and dual T1/E1 ports
- Single and dual ISDN BRA S/T ports
- Combinations of all of the above

Powerful Multiprocessor Architecture

- 3 to 7 x 68000 processors plus up to 2 x 68030 processors
- 1.1 GB hard drive and 1 or 2 x 2DD/2HD floppy disk drives
- 6 to 14 MB of RAM memory

Conformance Test Software

- ISDN executable test suites for North American and European requirements
- Frame relay executable test suites for PVC and SVC
- X.25 executable test suites
- TTCN productivity tools

Remote Control Saves Travelling

- Automates testing through external programs for unattended operation
- Can be virtually remotely controlled from HP Series 400 and 700 workstation hosts
- Remotely connects over leased line, modem dial-up, X.25, X.25 PAD or TCP/IP
- Exchanges files and redirects printer output to host workstation
- Host can simultaneously connect to any selected 10 testers from a maximum of 64 per session
- Testers can communicate with each other through the host
- Logs activity between host and all connected testers

Supports All Major WAN Physical and Electrical Interfaces

- Supports RS-232, V.35, V.36 (RS-449), V.11 (RS-422), RJ45 and RJ48
- Supports ISDN BRA R and S/T reference points
- Supports three T1 and three E1 framing formats

Simultaneous Access to All Channels

- ISDN BRA 2B+D channels
- T1/E1 4 x DS0 or fractional channels
- T1/E1 subrates from 8 to 56 kbps/channel
- T1 access to FDL

Applications Available on All Channels

- BSC 3270 and SDLC/SNA
- X.25, X.29, and X.75
- Q.921, Q.931, Q.933, FRF.4, and ARINC746
- SS7 ITU-T, ANSI, Bellcore with Level 2/3, SCCP, TUP, TUP + ISUP, International ISUP, TCAP, and OMAP
- Frame Relay, SDMDS, and DXI
- Rate adaption V.110 (80 bit frame) and V.120
- PPP and Multilink PPP simulation and monitoring

Supports All Message-Oriented Signalling Standards

- Customizable support for Q.931, Q.933 and V.120
- Loadable and customizable protocol stack for SS7
- User-defined decode for encapsulated protocols

PTremote Manager

Multiple PT Series protocol testers can be remotely coordinated for network-wide, multiprotocol, stimulus-and-response testing from a single UNIX® workstation running our PTremote Manager software. You can set triggers and filters, broadcast commands, download scripts, and upload captured data and reports. PTs are fully programmable, so you can have them trigger on an event and notify your workstation and/or other PTs if it occurs. And since the PTremote Manager can launch a UNIX shell script and run a program, you could have all kinds of tie-ins to script libraries, report generators, databases, and network management control systems. See for yourself how multiple stimulus-and-response testers can save you even more valuable testing time.

Model	Unattended Operation	Automated Testing	Max. Speed	Hard Drive	Floppy Drive/s	Form Factor	CRT	Keyboard	Power	Test Ports WAN	BRA	T1/E1
PT500	•	•	256 kb/s	•	2	Desktop	•	•	110/220 VAC	1/2	1/2	1 Monitor 2 Emulation
PT502	•	•	2.048 Mb/s	•	2	Desktop	•	•	110/220 VAC	1/2	—	1/2
PT540	•	•	256 kb/s	•	2	Desktop	•	•	110/220 VAC	4	—	—
RTA	•	•	256 kb/s	•	1	Rackmount	Optional	Optional	110/220 VAC 48/60 VDC	The RTA is a rackmount version of any of the above		

HP J2300C

HP Internet Advisor

The HP Internet Advisor gives you the capabilities you need to identify and solve problems correctly the first time you connect, anywhere in the internetwork. To maximize network uptime, the HP Internet Advisor helps you isolate network problems before they occur. With the capability to baseline network behavior, the Internet Advisor provides critical information for intelligently optimizing, reconfiguring, fine-tuning and expanding enterprise networks. These functions, along with add-on interfaces and modules, give you the ability to:

Connect

Connect in virtually any network environment, including internetworked LAN, WAN and ATM environments and through the World Wide Web. Slide-in modules and undercradles provide access to all major interfaces, allowing you to connect to any network technology—now, and in the future.

Capture

Capture all of the data in your network at even the highest speed, allowing complete visibility of network problems. The use of RISC processors and custom hardware ensures that you get all the data you need for fast problem solving.

Comprehend

The HP Internet Advisor reveals problems reliably, automatically analyzes collected data, tells you what the problems are, who is causing them and what you need to do to solve them.

Solve Network Problems the First Time

- Automatic expert analysis and network health reporting
- Vitals help you anticipate and solve problems before they occur
- Commentators point you to the source of the problem in plain English
- LAN over WAN analysis
- LAN over ATM analysis
- Customizable statistical analysis
- Extensive on-line help

Networking Technologies supported by the HP Internet Advisor

LAN

- 10 Mbps Ethernet
- Fast Ethernet
- Gigabit Ethernet
- Switched Ethernet
- Token Ring
- FDDI

WAN

- Frame Relay
- ISDN
- X.25
- SMDS
- Encapsulated LAN over WAN
- PPP
- Legacy WAN

ATM

- OC-3/STM-1
- 155 Mbps UTP
- DS-3/E3
- DS-1/E1

Oracle® Commentator

HP Internet Advisor LAN Oracle Commentator software gives you the expert analysis capabilities you need to successfully manage Oracle distributed relational databases running in a client/server environment on Ethernet, Fast Ethernet (including switched and full-duplex), Token-Ring and FDDI networks. With the Oracle Commentator, you can view summary information of significant network events and then drill down to get an easy-to-understand description of events, including an explanation of probable causes and suggestions for correcting the problem.

IP Switching Software

Hewlett Packard's IP Switching Analysis Software (IP-SAS) for the HP Internet Advisor is designed to assist network planners in the process of evaluating and migrating to switched IP network technology. IP-SAS installs directly on any HP Internet Advisor running Windows 95 and a supported LAN interface.

- Ipsilon-certified for accurate network modeling
- Automated Data Collectors
- Powerful reporting capabilities with point-and-click ease
- Support for your current network environment

SQL Server Commentator Software

HP Internet Advisor LAN SQL Server Commentator software gives you the expert analysis capabilities you need to successfully manage SQL Server distributed relational databases running in a client/server environment on Ethernet, Fast Ethernet (including switched and full-duplex), Token-Ring and FDDI networks. In addition to standard protocol-decode capability, the SQL Server Commentator gives you real-time expert analysis of all of SQL's TDS protocol events, including Login Accept/Failed, Excessive Failed Logouts, Logout, Slow Login, Slow Server Response, Frame Containing and Error.

Sybase Commentator Software

The HP Internet Advisor LAN helps you identify, understand and resolve Sybase application anomalies faster and more easily. In addition to standard protocol-decode capability, the Sybase Commentator gives you real-time expert analysis for Sybase's TDS protocol, including Login Accept/Failed, Slow Login, Slow Server Response, Connection Error/Attention, Excessive Urgent Data, and Excessive Transaction Rate.

Built-in, Fully-Integrated Personal Computer

The HP Internet Advisor includes a fully integrated Pentium® PC with 32 Mbytes of PC RAM, a built-in pointing device, dual PCMCIA slots and a hard disk that can be upgraded to 3 Gbytes. Because the HP Internet Advisor is a comprehensive test and analysis tool for multiple technologies, it saves you the expense of buying separate pieces of test equipment. When your customers add new applications and architecture, you won't have to invest in all new equipment either. The Internet Advisor offers plug-in modules and undercradles to keep you up-to-date with the latest technologies when you need it.

HP Internet Advisor LAN

The HP Internet Advisor LAN transforms data into meaningful diagnostic information, constantly monitoring the traffic on your Ethernet, Token-Ring or FDDI local area networks. The HP Internet Advisor LAN also offers many powerful troubleshooting tools, including drill-down capability, complete seven-layer protocol decodes, active stimulus/response tests and a large collection of network performance statistics. However, in most situations, the drill down capability is all you need to identify the cause of the problem — and resolve it the first time you connect.

HP Internet Advisor WAN

To install, maintain, or troubleshoot a wide area network, you need to test for many things: physical errors, equipment inoperability, and traffic problems. The HP Internet Advisor WAN offers integrated WAN and LAN protocol analysis capabilities, along with bit error rate testing, stimulus and response measurements, and statistical analysis capability to help you solve your networking problems the first time.

HP Internet Advisor ATM

No matter where you are in the process of bringing up your ATM network, the HP Internet Advisor ATM gives you the tools to identify and resolve network problems quickly the first time. To install or troubleshoot an ATM link, you need to test for many things: physical congestion, equipment interoperability, ATM cell congestion, and even LAN traffic problems. The HP Internet Advisor ATM offers integrated ATM, WAN and LAN protocol analysis capabilities you require to get a good look at the physical layer, the data link layer, and the upper layer protocols.

HP Internet Reporter

The HP Internet Reporter automatically generates presentation-quality tables, charts and reports on statistics collected on almost any network. Useful for a wide variety of baselining and benchmarking tasks, the HP Internet Reporter will help you evaluate network operation, isolate traffic-related problems, evaluate the impact of hardware or software changes and plan for future growth.

- Build historical trends to anticipate problems and bottlenecks before they occur
- Benchmark applications and network devices
- Cost-justify network upgrades (gateways, controllers, bridges, routers, switches, lines, etc.)
- AutoReport feature makes report generation as easy as selecting a data file, choosing a report type, and pressing the GO! button. AutoReport does the rest.
- Internet Reporter's tables are stored in a Microsoft® Excel format so that you can perform custom analysis of your network data when you desire
- Frame relay DLCI and X.25 LCN statistics are broken out into individual and cross-referenced tables, charts, and reports, giving you a view of your virtual circuits you never imagined possible

Ordering Information

HP J2300C Internet Advisor WAN
HP J2301B Internet Advisor WAN–T1
HP J2302B Internet Advisor WAN–E1
HP J3446C Internet Advisor LAN–Fast Ethernet
HP J3754C Internet Advisor Platform
HP J2306B Internet Advisor LAN–Ethernet Undercradle
HP J2309B Internet Advisor LAN–Ethernet/TR Undercradle
HP J2522B Internet Advisor LAN–Ethernet
HP J2523B Internet Advisor LAN–Ethernet/TR
HP J2524A FDDI Undercradle
HP J2901A Gigabit Ethernet Undercradle
HP J3444A Internet Advisor LAN-Fast Ethernet Undercradle
HP J2905B Internet Advisor WAN–ISDN BRI S/T/U
HP J2909A Internet Advisor ATM DS-3/E3 Module and Software
HP J2912A Internet Advisor ATM OC-3c/STM-1 Module and Software
HP J2913A Internet Advisor ATM–155 UTP Module and Software
HP J3445A 100 Base Fx interface for J3444A
HP J3710A Oracle® Commentator Software
HP J3711A Sybase® Commentator Software
HP J3713A SQL® Server Commentator Software
HP J3307A Internet Reporter–LAN/WAN/ATM
HP J3506A IP Switching Software
HP J3715A Web Enabled Software
HP J2899A UAF Internet Advisor Software Subscription

HP 37900D
HP 37900E

- Flexible architecture extends to all telecom protocols
- Auto-configure hardware and software
- Up to 24 links and 40 duplex timeslots monitor and emulate
- Replacement for HP 37900D
- Multilink tester for SS7 network signaling
- Plain text decoding of Level 2, 3 and user parts of signaling messages
- Automatic tracing of SS7, ISDN, and wireless messaging sequences

HP 37900E

HP 37900D

HP 37900E Signaling Test Set

NEW

The HP 37900E signaling test set (available May 1998) is a rugged, portable PC-based instrument (approximate weight 7 kg, 15.5 lbs) providing monitor and emulation of SS7, ISDN, X.25 and V.5 protocols. It can handle up to 40 duplex protocol streams carried on one to 24 links. The HP 37900E is targeted at the telecommunications protocol test market particularly SS7-based protocols in both wireless and fixed/wireline networks. The test set can be used for emulating protocols as well as monitoring live traffic and deriving measurement statistics.

The HP 37900E synchronizes to the connected links automatically, and monitors the signaling traffic, making it very simple to use. The user interface is graphical and based on MS Windows 95®. A comprehensive set of applications (validation, sequencing, statistics, etc.) provides users with all the tools needed to maintain the health of their signaling networks.

Developers and manufacturers will find the optional graphical TTCN-based emulator tools simple to use, with rich functionality and excellent performance. Complex message sequences and message contents can be created in minutes for any supported protocol. The HP 37900E is also able to monitor high-speed signaling links at the T1/E1 rate.

Supported Protocols

Supported protocols include: ITU-T Blue/White Book, ANSI 92/Bellcore, CLASS 93, LIDB, #800, PVN, BT IUP94, PCS, GSM Phases 1, 2, 2+, Swiss variant, China variant, Chile variant, ITU-T Q.921/931, V5.1/V5.2, X.25 (Levels 2 & 3), X.75, R1, R2, and many others.

Physical Interfaces (Line Interface Modules)

E1 (75 ohm), E1 (120 ohm balanced), T1, V.35, DS0/DS0A, RS-232/449/X.21

Ordering Information

HP 37900E Signaling Test Set

HP 37900D Signaling Test Set

The HP 37900D signaling test set makes it easy to install, test and troubleshoot SS7 wireline and wireless signaling networks.

Monitoring

The HP 37900D monitors up to four bi-directional signaling links simultaneously. For in-service performance measurements, the dedicated triggers and filters enable the HP 37900D to collect the signaling messages required and to display real-time signaling interactions. Messages associated with a particular event, for example, calls from a specified telephone number, can be collected. The captured messages are decoded into plain text descriptions, and the captured messages can be stored for later analysis. Link performance can be measured using the statistics software package.

Emulation

The optional emulation capability allows the HP 37900D to perform individual or automatic conformance, capability, and regression or acceptance tests, on up to eight links simultaneously.

Installation and Maintenance of Wireless and Fixed Networks

The HP 37900D is an ideal tool for installing and maintaining fixed and wireless networks. It supports the following protocols: GSM, PCS, IS41, MAP, ITU-T, ETSI, ANSI, Bellcore, AIN, INAP, V5, X.25, ISDN BRI and PRI, and national variants.

Key Literature

5962-9814E Technical Specification
5963-5062E Configuration Guide
5964-2196E Brochure

Ordering Information

HP 37900D Signaling Test Set

Digital Transmission Testers

2 M Test Set, Telecom Analyzer

HP 37742A
HP 37722A

- Full-capability transmitter and receiver
- 2 Mb/s and n x 64 kb/s
- 6-hour battery operation
- Remote control and printer output

HP 37742A

- Complete range of in- and out-of-service telecom installation and maintenance measurements in one tester
- Low-cost, rugged, easy to use
- Adaptable to future requirements—no need to buy new test sets
- Powerful results storage and analysis: including distributed network monitoring capability

HP 37722A

HP 37742A 2 M Test Set

The HP 37742A is a handheld 2 Mb/s test set with all the features normally found only in larger instruments. It is easy to use, with full 2 Mb/s transmission and measurement, compatibility with CRC4 frame formats, and built-in monitor speaker. The HP 37742A is used by telephone companies, utilities, and end users for installation and maintenance of 2 Mb/s circuits.

9

Applications

The HP 37742A is used for the installation and maintenance of 2 Mb/s circuits at:

- Telephone exchanges
- Repeater interfaces
- Customer premises

Measurement Summary

Measurements: Level, line attenuation, bit errors, code errors, frame errors, CRC errors
G.821 Analysis: For bit and frame-bit errors; error seconds, error-free seconds, severely-errored seconds, degraded minutes, available seconds, unavailable seconds
Alarm Detection: Signal loss, AIS, frame loss, multi-frame loss, pattern loss, remote frame loss, remote multiframe loss, error ratio threshold exceeded
Transmitter
Framing: PCM31, PCM30 (CAS), with or without CRC4 multiframe, unframed
Test Patterns: PRBS; 2^9, 2^{11}, 2^{15}, normal and inverted, fully programmable 8-bit word
Error Add: Bit, code, frame, CRC; alarm generation, signaling, and overhead bits setup
Receiver
Timeslot map and timeslot display

Ordering Information

HP 37742A 2 M Test Set (including wrist strap, shoulder strap, soft carrying pouch with shoulder strap and carrying handle, ac adapter, VF cable, and operating manual)

Accessories
HP 15730A Thermal Printer (230 V)
HP 15733A Thermal Printer (110 V)

HP 37722A Telecom Analyzer

The HP 37722A telecom analyzer offers installation and maintenance (in-service and out-of-service), bit error, and signal measurements on CEPT digital circuits in a portable, rugged package. M2100 measurements are standard, M2110/M2120 optional. The HP 37722A provides framed pattern generation and measurements at 704 kb/s, 8 Mb/s, and 2 Mb/s, and n x 64 kb/s testing. It offers many other features to help increase productivity and network uptime: event storage in text and graphic form, n x 64 kb/s testing, timeslot monitor including all signaling bits display, and framing/frame word. Options add framed/unframed 704 kb/s and 8 Mb/s, n x 64 kb/s timeslot access, sub-64 kb/s testing, slips and wander, and tone generation and measurement.

The HP 37722A is easily upgraded to the HP 37732A telecom/datacom analyzer (see page 443). The HP 37722A can be used as part of a distributed network analysis system, by combining it with the HP E4540A distributed network analysis software (see page 443).

Specifications

Full Transmit and Receive Capability
Interfaces: 64 kb/s codirectional, 704 kb/s, 2.048 Mb/s, 8.44 Mb/s
Measurements: Bit errors, code errors, frame errors, CRC errors, REBEs (E bits), slips, round trip delay
Error Analysis: G.821 standard, user-defined and Annex D, M.2100
Timeslot Access: External drop/insert of 64 kb/s timeslot to VF ports or n x 64 kb/s (n = 1 to 6) to X.21 datacom port: internal tone generation/measurement and talk/listen
RS-232 Remote Control and Printer Interface
Universal ac Power Supply
Size: 340 mm W x 190 mm H x 208 mm D (13.4 in x 7.7 in x 8.2 in)
Weight: 4.5 kg (10 lb)

Ordering Information

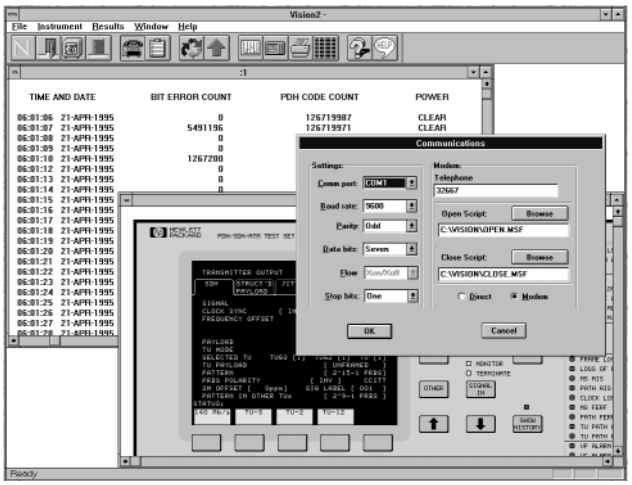
HP 37722A Telecom Analyzer
Opt 002 8 Mb/s (framed and unframed)
Opt 003 704 kb/s (framed and unframed)
Opt 004 Small Siemens Connectors
Opt 005 Sub-Rate Testing, Timeslot Access and Tones
Opt 006 Timeslot Access and Tones
Opt USS HP E4540A DNA Firmware

Accessories
HP 15901A Opt 001 Datacom Module With V.24, V.11/X.21-Leased, V.35 Interfaces

- Combined telecom and datacom testing in one analyzer; no need for separate test sets or plug-ins
- Eight interfaces in one analyzer
- Powerful results storage without using printer
- Rugged, portable, easy to use

HP 37732A

- Low-cost distributed network analysis software
- Controls the HP 37XXX range of portable test sets
- Creates a multisite remote monitoring and results retrieval system



HP E4540A

HP 37732A Telecom/Datacom Analyzer

The HP 37732A is a lightweight, field-portable, and rugged test set that combines the full telecom testing capability of the HP 37722A telecom analyzer (see page 442) with datacom testing. The HP 37732A telecom/datacom analyzer consists of the HP 37722A and the HP 15901A Option 001 datacom module.

The HP 37732A provides testing at V.24, V.35, V.11/X.21-leased interfaces at rates up to 2 Mb/s. It also provides a full range of BER/BLER measurements, control-circuit timing analysis with transitions diagrams on the screen, a built-in V.24 breakout box, and an internal synthesizer. It offers event storage in text and graphic form. The HP 37732A reduces test time and speeds problem resolution by simplifying test setup. It presents results in easy-to-read and easy-to-record ways that make it easy to pinpoint the cause of a problem.

There is also the HP E4540 distributed network analysis software for results management and remote instrument control.

Applications

- Installation of digital telecom circuits and services
- Long-term network monitoring
- Maintenance and troubleshooting

Specifications

Telecom testing, remote control, power supply, and size specifications as HP 37722A (see page 442).
Datacom Interfaces: V.24, V.35, V.11/X.21-leased
Data Rates: 50 b/s to 2.048 Mb/s (synchronous: built-in synthesizer); 50 b/s to 19.2 kb/s (asynchronous)
V.24 Breakout: Patch points, monitors, voltage sources, and switches
V.11/V.35: Activity indicators on data, clock, and control circuits
Test Patterns: 63-bit, 511-bit, 2047-bit, 2^{15}–1, 2^{20}–1, all 1s, all 0s, 8 to 1024-bit user-definable word, FOX word
Measurements: Errors, BER, block, block-errors, BLER, error seconds, % EFS, Tx and Rx frequency, alarm seconds, clock slips, alarms, G.821 analysis
Control-Circuit Timing: Measures times between selectable start/stop events; timing range 100 ms, 1s, 10s
Transition Diagrams: For RTS, CTS, DTR, DSR, and DCD
Weight: 5.9 kg (12.5 lb)

Ordering Information

HP 37732A Telecom/Datacom Analyzer
Opt 002 8 Mb/s (framed/unframed)
Opt 003 704 kb/s (framed/unframed)
Opt 004 Small Siemens Connectors
Opt 005 Sub-Rate Testing, Timeslot Access and Tones
Opt 006 Timeslot Access and Tones
Opt USS HP E4540A DNA Firmware

HP E4540A Distributed Network Analyzer Software

The HP E4540A allows the creation of a low-cost distributed network analysis system to reliably gather information about network performance from remote test sets. It avoids the large commitment of time and resources needed to implement a dedicated network management system—an important benefit with network technologies changing so rapidly. The HP E4540A distributed network analyzer software controls HP's range of HP 377XXX PDH/SDH/ATM and jitter test sets, and allows the creation of an extensive measurement and data analysis system. With this PC software it is possible to control one instrument (at a local or remote site) or a number of instruments in a multi-site system.

With network technologies evolving rapidly, it is difficult to keep up to date with ever-changing test procedures. The HP E4540A interactive diagnostics allow the maximum use of scarce test engineering expertise. The expert at the central control site, using virtual instrument displays, can interactively work with technicians at the remote site. Test sequences simplify complex testing of new technologies. Key HP E4540A features include:

- No software expertise required to use the HP E4540A
- Robust automatic results retrieval for monitoring network performance
- Transfer of results into MS Windows® applications for analysis, or to produce graphs and reports
- Simplified installation and maintenance testing using stored test sequences and configurations
- Real-time update of keystrokes at remote site and central site

The HP E4540A analyzer software is Windows-based, operating on a PC or laptop, and connects to the remote site via Hayes® compatible modems, or using the LAN remote control port available on HP 37717 B/C.

Ordering Information

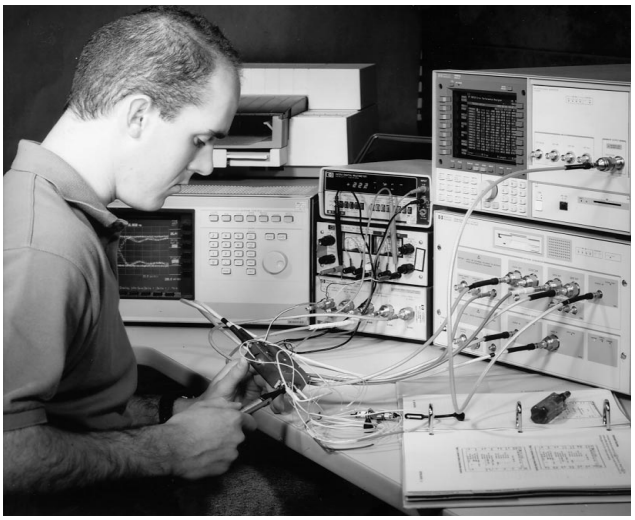
HP E4540A Distributed Network Analyzer
Opt 0A9 10 User License
Opt UAT Unlimited User License
Note:
Opt USS Distributed network analyzer firmware required in HP 377XXX test set

Digital Transmission Testers

Gigabit Error Performance Analyzers and Pattern Generators

HP 71603B
HP 71604B
HP 71612A
Series
HP 71501C

- User-programmable patterns with screen-based editor
- Hitless switching between two programmed patterns
- Trigger anywhere in pattern
- Automatic setting of clock/data phase and data decision threshold
- Advanced eye-diagram analysis
- Full jitter analysis capabilities
- Fast transition times, low jitter
- Burst-mode capability for fiber-loop testing
- 4 sub-rate outputs for WDM testing
- Location of specific errored bits



HP 71612A

HP 71603B 3 Gb/s Error Performance Analyzer

The HP 71603B error performance analyzer consists of pattern generator (HP 71604B), synthesized clock source and error detector modules configured in the HP 70000 modular measurement system (MMS). The HP 71603B covers the range 100 Mb/s to 3 Gb/s and features automatic clock/data alignment for rapid setup of the error detector. The HP 71603B makes measurements on waveforms badly distorted by noise, jitter, intersymbol interference through the high-resolution setting of decision threshold, and phase adjustment.

HP 71604B 3 Gb/s Pattern Generator

The HP 71604B covers the range 100 Mb/s to 3 Gb/s and features pseudo-random test patterns up to 2^{31}–1 bits long. Users can program and run variable length test patterns from 1 bit to 4 Mb long on MS-DOS-compatible disks.

Applications

Component test
GaAs and high-speed silicon; optical components

Module/system test
SONET and SDH; broadband video and ATM; submarine cable; high-speed LAN and computer peripheral communication

Specifications (typical)

Bit Rate: 100 Mb/s to 3 Gb/s
Rise Time: (20% to 80%): < 90 ps
Patterns: 2^7–1 to 2^{31}–1, user patterns to 4 Mb
Data and Data Outputs: 0.25 V to 2 V p-p amplitude; +1 V to –3.75 V range
Data Input Sensitivity: < 50 mV @ 2.5 Gb/s
Decision Threshold Voltage: +1 V to –3 V, resolution 1 mV
Clock/Data Delay: ± 1 ns; resolution 1 ps
Measurements: Error count, ratio, errored-intervals, G.821 analysis, eye width and height

Ordering Information

HP 71603B Error Performance Analyzer
HP 71604B Pattern Generator

Individual modules can be ordered separately.

HP 71612A Series 12 Gb/s Testers

The HP 71612A series of 12 Gb/s products includes an error performance analyzer, pattern generator, and error detector, with similar functionality to the 3 Gb/s series. User pattern length has been increased to 8 Mb, and this series offers Error Location Analysis. The HP 71612A Option UHF error performance analyzer and Option UHG pattern generator have four sub-rate pattern outputs at one quarter of the output rate.

Applications

The increased speed and pattern size allow the simulation of SONET and SDH frames at the STM-64/STS-192 transmission rate and margin testing up to 12 Gb/s. The burst mode feature allows fiber-optic loop tests, while Error Location Analysis allows the identification of pattern dependent errors for user defined patterns.

Specifications (typical)

Bit Rate: 1 to 12 Gb/s (optional 100 Mb/s to 12 Gb/s)
Patterns: Same as the HP 71603B with user patterns extended to 8 Mb
Transition Times: (10% to 90%) <30 ps
Jitter: <20 ps p-p
Data and Data Outputs: 0.5 V to 2 V p-p amplitude; +1.5 V to –3.0 V range
Data Input Sensitivity: <100 mV @10 Gb/s
Decision Threshold Voltage: +1 V to –3 V: resolution 1 mV
Clock/Data Delay: ±1 ns up to 500 MHz; 1 clock period 500 MHz to 12 GHz
Measurements: Same as HP 71603B with the addition of optional Error Location Analysis

Ordering Information

HP 71612A Opt UHF Error Performance Analyzer
HP 71612A Opt UHG Pattern Generator
HP 71612A Opt UHH Error Detector

Add Jitter Analysis Capability to the HP 71603B or 71612A

Full jitter analysis capability can be achieved with either the HP 71603B or 71612A with the addition of the HP 71501C. Measurements include jitter transfer, jitter tolerance and jitter generation over the full data rate range of the error performance analyzer.

HP E4543A Q-Factor and Eye-Contour Software

This PC-based software automates measurements made by the HP 71612A/71603B, providing rapid analysis of eye-diagrams in optical line systems. The HP E4543A software controls the acquisition of measurement data and interprets and displays the eye contour and Q-factor which can be used to estimate very low BER.

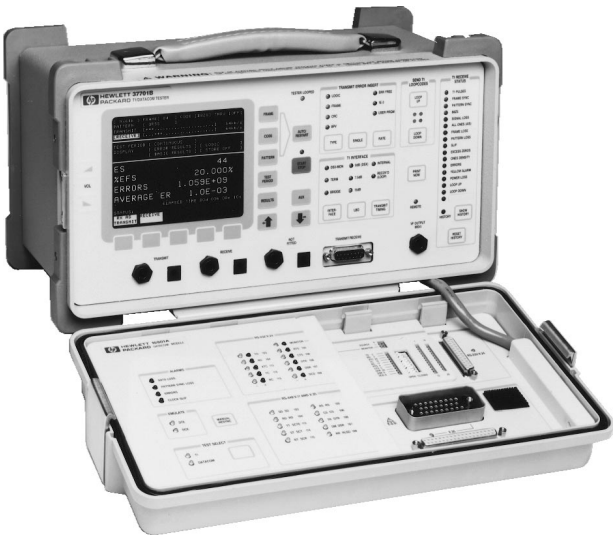
HP E4544A SONET/SDH Functional Test Software

This PC-based software allows the user to construct SONET/SDH frames up to OC-192/STM-64 and load them into the pattern memory of the HP 71612A/71603B. Frames can be edited to inject specific parity errors and alarm conditions.

Ordering Information

HP E4543A Analysis Software
HP E4544A Functional Test Software

- Complete T1, fractional T1, DDS and datacom testing
- Graphical display of test results
- Automated setups for ease of use



HP 37701B

HP 37701B T1/Datacom Tester

The HP 37701B T1/datacom tester offers complete T1 and fractional T1 bit-error and signal measurements. It also generates tones in a channel and allows VF signals in any timeslot to be monitored. Test results are presented using easy-to-read bar charts allowing quick analysis of the circuit trouble. Tests can be performed using auto-configure or user-prestored setups for fast and easy testing. Optional pulse shape and clock slip analysis allow quick, graphic interpretation of distortion and timing problems. DTE/DCE interface and measurements can be added for datacom testing.

HP 37702A Digital Data Tester

The HP 37702A digital data tester has all the functions of the HP 37701B plus DDS capabilities in one unit. It performs the full range of DDS testing from simple in-service tests to complete installation and acceptance tests. Built-in T1 channel access allows access to a signal in any timeslot.

Applications

Installation and maintenance of T1, FT1, or DDS facilities at:
- Central offices
- Outside plant
- Customer premise

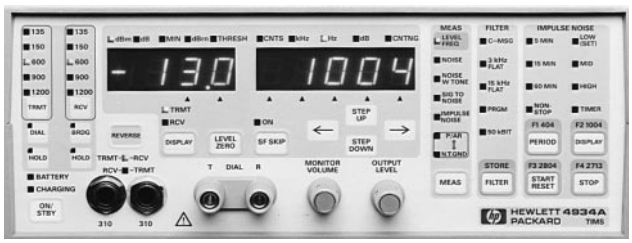
Measurement Summary

T1: Auto code, frame, and pattern detection, error monitoring, BER testing, alarm, and event generation, ESF decode and encode, DS1 signal level and frequency, fractional T1 n x 56 or n x 64 kb/s contiguous or non-contiguous
DDS: (DS0A, DS0B) BER testing, error correction, error monitoring, loop back operation and MJU control

Ordering Information

HP 37701B T1/Datacom Tester
HP 37702A Digital Data Tester
Opt 001 Pulse Shape, Clock Slips, Wander
Opt 002 Datacom Measurements
Opt 003 12 V Battery Operation (HP 37701B only)
Opt 004 DS0B Interface (HP 37702A only)
Opt V01 Virtual Remote

- Complete analog testing to North American and CCITT standards
- Testing of voice-grade data circuits, program circuits, metallic digital circuits
- Six-hour battery operation (optional)



HP 4934A

HP 4934A TIMS

The HP 4934A transmission impairment measuring set (TIMS) increases installation and maintenance productivity for telephone companies and service providers through its ease of use, portability, and ruggedness. Measurements include:
- Level/frequency up to 110 kHz (200 kHz option)
- Noise and noise-to-ground
- Noise-with-tone and signal-to-noise ratio
- Three-level impulse noise
- P/AR
- RS-232 remote control

(Optional battery with typical 6 hours of operation.)

Note: RS-232 not available with J01/J02

HP 4934A J01/J02 TIMS

The HP 4934A TIMS Option J01 and J02 are versions of the instrument with measurements for installation and maintenance of voice frequency or wideband leased lines to CCITT specifications. Option J01 is for countries with 820 Hz holding tone and Option J02 is for countries with 1020 Hz holding tone. Measurements are to CCITT specifications:
- Level/frequency to 110 kHz
- Circuit noise
- Noise-with-tone and signal-to-noise ratio
- Optional three-level impulse noise (quiet or tone)

(Optional battery with typical 6 hours of operation.)

Ordering Information

HP 4934A TIMS, including Front-Panel Cover, Power Cord, 2 HP 15513A Test Cords (with WECO 310 Jack Plugs)
Opt 001 Battery Pack with Built-In Charger
Opt 010 Deletes Test Cords
Opt 021 200 kHz Wideband Upgrade (includes RS-232)
Opt 022 Wideband Retrofit Kit (includes RS-232)
Opt J01 Replaces North American Features and Connectors with CCITT; 820 Hz Holding Tone: Deletes Test Cords
Opt J02 Same as J01, except 1020 Hz Holding Tone

Accessories
HP 15513A 1 m Cable, WECO 310 Jack Plug Each End
HP E6321A Soft Carrying Case for 4934A
HP 18182A 1.5 m Cable, WECO 310 Jack Plug to Alligator Clips

Digital Transmission Testers

T-Carrier Test Sets

HP 37741A
HP E8505A

- Handheld, field tester
- Extensive T1/FT1
- Automatic configuration and results reporting
- Save and recall of setups and test results

HP 37741A

HP E8505A

HP 37741A DS1 Tester

The HP 37741A is a handheld T1 test set with all the features normally found in larger instruments. The test set has full T1 and fractional T1 transmit and receive capabilities and is compatible with all frame formats. For simplified operation, the HP 37741A has an auto key that automatically sets test mode, framing, line coding, and performs pattern detection and synchronization. Test results are easily read using the combination of the LCD display and bi-colored LEDs. Test results are stored for later printing or uploading to a PC. The rugged design of the unit ensures that the HP 37741A will tolerate the rough environment typical of a handheld tester.

Applications

T1 and FT1 testing for:
- Maintenance
- Circuit provisioning
- Equipment installation

Measurement Summary

T1: BER testing, alarm detection and injection, error injection, detection of framing, pattern, code, CRC or BPV errors, control of Teltrend and Westell addressable line and office repeaters, loopback control codes, auto-detection of FT1 facilities (n x 56 and n x 64 kb/s) and T1 line level and frequency

Ordering Information

HP 37741A DS1 Tester with Carrying Pouch, AC Adapter, Bantam Cables, and Operating Manual

Accessories
HP 15726A PC Remote Control Software
HP 15727A Thermal Printer
(Includes 110 Vac adapter)

CERJAC HDSL Installer's Assistant

The CERJAC HDSL Installer's Assistant offers a wide range of capabilities for HDSL circuit installation and maintenance including:

- HDSL plug-in card powering and verification
- Load coil detection
- Cable loss measurement
- T1 BERT

The CERJAC HDSL Installer's Assistant is a field-portable, rugged unit which accepts Central Office, Doubler, and remote unit HDSL plug-in cards. The plug-in cards are powered from the built in AC power supply, or they may be line powered. The unit can verify proper operation of the HDSL cards with each other. Easily accessible front panel break jacks allow connection to the circuit. If the circuit does not come up properly with the plug-ins, the technician can access the cable pairs at any point in the span to sectionalize the problem to an individual part of the cable span.

After the pre-turn-up tests are completed and the HDSL plug-ins are installed, the technician can use the built-in T1 BERT tester for final turn up and trouble shooting. Using a pair of CERJAC HDSL Installer's Assistants, it's a simple matter to generate an end-to-end HDSL signal on the cable span.

Ordering Information

E8505A CERJAC HDSL Installer's Assistant
E8506A Cable Kit for E8505A
E8507A Softside Carrying Case for E8505A

HP E448XA
HP E449XA

- R&D, manufacturing test or network "keep-alive" application platform

HP E448XA, E449XA

CERJAC Communications Products

This family of modular communications products is designed to provide telephone companies and network providers with a cost-effective way to maintain service while installing new T-Carrier and SONET-based network equipment. It consists of a compact, standardized, multi-purpose equipment shelf and plug-in product modules, which are each packaged separately. Communications modules, which are shipped ready-to-use, include:

- DS1 Bridge Amplifier
- E1 Bridge Amplifier
- DS3 Bridge Amplifier
- STS-1 Bridge Amplifier
- DS3 Bridge Repeater
- DS3 Signal Source
- STS-1/DS3 Signal Source

Applications and Features

The CERJAC communications products can be used to support applications including:

- Standard cut-over, reconfiguration and emergency restoral
- Re-routing of service around construction sites
- Extension of cross-connect distance
- Generation of "keep-alive" signals for spare fiber and radio routes

Intuitive controls and output connectors are conveniently located on each module's front panel, so the communications product family requires a minimum of operator training and is easy to use. And because any combination of plug-in modules can be mixed within a single shelf, users can configure a general-purpose portable tool, or support specific applications, as required.

Ordering Information

E4488A
Opt 001 12-slot, 33 cm (13 in) rackmount
Opt 002 12-slot portable
Opt 003 16-slot 48 cm (19 in) and 58 cm (23 in) rackmount
E4489A STS-1/DS3 signal source for use in E4488A
Opt 001 Add single channel error burst
Opt 002 Add Stratum-3 on-board STS-1 clock
E4490A DS3 bridge amplifier
E4491A DS3 bridge amplifier with monitor
E4492A DS3 bridge repeater
E4493A DS3 signal source
Opt 001 Add single channel error burst
E4494A DS1 bridge amplifier
E4495A DS1 bridge amplifier with monitor

- Remote testing and maintenance device for DS3 services
- Quickly isolates network or customer equipment problems
- Cuts costs by reducing the need to dispatch technicians

CERJAC NIU 1-slot, 3-slot, 12-slot

CERJAC DS3 Network Interface Unit

The CERJAC DS3 Network Interface Unit (NIU) serves as a demarcation point between the network and customer premises equipment (CPE). The NIU features loopback capabilities that can be used for remote test and maintenance, verification at customer service turn-up, and quick isolation of network or customer equipment problems.

Applications

- Resides at the demarcation point between the customer premises and carrier network.
- Provides the ability to run a BERT between the Central Office and the NIU residing on the customer premises to isolate network/customer equipment problems.

Measurement Summary

Responds to ANSI T1.404, Network-to-Customer Installation "reserved for network use" loopback Far-End Alarm and Control (FEAC) codewords. Monitor ports available for on-site monitoring of network and customer equipment signals.

Ordering Information

HP E4586A CERJAC DS3 NIU Interface Card Plug-in
HP E4587A 1-slot NIU Housing
Opt 001 248 Vdc Power Supply (115 Vac)
HP E4588A 3-slot NIU Housing for 23-inch Rack
HP E4589A 12-slot NIU Housing for 19-inch or 23-inch Rack

Digital Transmission Testers

North American Standards

HP E4594A
HP E6325A
HP E6327A
HP E6334A

- Windows™ graphical user interface
- SLC-96 testing
- Full and fractional T1 BER testing
- Full drop-and-insert voice frequency testing

CERJAC T1 Test Advisor Family

All versions of the T1 Test Advisor provide users with capabilities for simultaneous control of two full-duplex drop-and-insert transmitters and receivers. The product's intuitive Windows graphical user interface, combined with context-sensitive help and on-line manuals, makes the T1 Test Advisor extremely easy to use, even for occasional users. Optional plug-in modules provide support for datacom testing capability while also providing an easy method of extension. Upgradeability is accomplished either by a disk containing new software and firmware, or over a dial-up telephone line. Results and set-ups can be stored to disk for later analysis. SLC96 testing includes TR-TSY-000008 SLC modes and makes full use of graphics to ensure easy hook-up and testing. The T1 Test Advisor supports full and fractional T1 testing and comes standard with two transmitters and two receivers. This test functionality is available in a number of physical packages. For T1 standards (ANSI), these products are the E4594A, E6325A, E6327A and E6334A.

Applications

The T1 Test Advisor's main screen provides vital at-a-glance information for quick circuit "check-ups," including alarms, alarm history and results summary. Other tab displays provide information on level and frequency of the T1 signal, comprehensive BERT results, and allow drop-and-insert of tones and data. Optional data modules allow BER testing at V.35, RS-232, RS-449 and EIA-530A.

HP E4594A CERJAC T1 Test Advisor

CERJAC T1 TELCO Undercradle for the Internet Advisor

Gives enhanced T1 test capability including additional stress patterns, loopback codes, and SLC-96 testing. The E4592A, E4593A, E4597A, E4598A and E4599A plug-in modules can all be fitted and used with E4594A.

HP E6325A CERJAC T1 Test Advisor

An existing notebook PC can be used with the E6325A configuration of the T1 Test Advisor. It's ideal for "drop-box" applications at customer sites that require long-term monitoring via modem.

HP E6327A CERJAC T1 Test Advisor

Test personnel can also utilize an existing notebook PC with the E6327A configuration of the T1 Test Advisor. The ruggedized metal shell offers protection for the PC during transport, and a rechargeable battery is included for operation at sites where AC power is not available.

HP E6334A CERJAC T1 Test Advisor

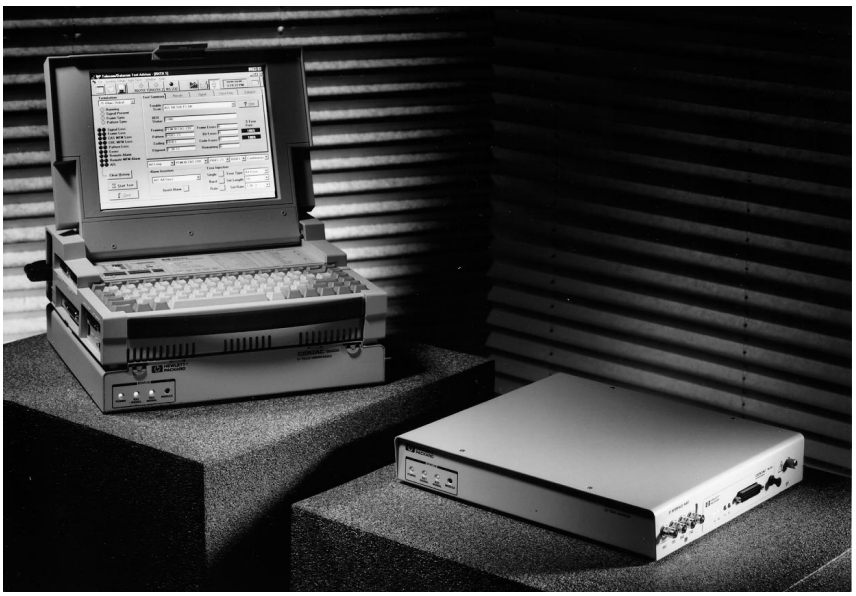
Designed specifically for service providers who need extensive T1 physical-layer testing capabilities, the HP E6334A integrates the full range of test functionality of HP's popular T1 Test Advisor with a fully-functional personal computer, all in a ruggedized, portable housing. Undercradles and software supporting additional test capabilities can be added to the instrument in the future, as user test requirements expand.

Ordering Information

E4594A CERJAC T1 Telco Undercradle
E6325A T1 Test Advisor
E6327A T1 Rugged Test Advisor
E4592A V/F Plug-in Module (for E4594A, E6325A, E6327A)
E4593A RS-232 Plug-in Module
(for E4594A, E6325A, E6327A)
E4597A V.35 Plug-in Module (for E4594A, E6325A, E6327A)
E4598A RS-449 Plug-in Module
(for E4594A, E6325A, E6327A)
E4599A EIA-530A Plug-in Module
(for E4594A, E6325A, E6327A)
E6334A CERJAC T1 Test Advisor with Integrated PC
E6336A VF module (for E6334A)
E6338A RS-232 module (for E6334A)
E6339A RS-449 module (for E6334A)
E6340A V.35 module (for E6334A)
E6341A EIA-530 module (for E6334A)
E6328A NI-CAD rechargeable battery (for E6325A)
J2305A Softside Carrying Case (for E4594A and E6334A)
E6326A Custom Softside Carrying Case (for E6325A)
E6333A Custom Softside Carrying Case (for E6327A)

HP E6323A
HP E6349A

- Windows graphical user interface
- Two independent transmitters and receivers
- Full and fractional 2Mb/s BER testing
- Full drop-and-insert voice frequency testing



CERJAC E1 Test Advisor Family

The 2 Mb/s test products are designed to work with the T1 products. Together, they provide flexible, modular solutions for expanding business needs. Like the T1 test products, the 2 Mb/s products are extremely easy to use, even for the occasional user, with intuitive Windows-based interfaces, context-sensitive help functions and on-line manuals.

The 2 Mb/s Test Advisor product family includes a range of product options so users can select the configuration that best fits their needs. Versions include "stand-alone" and undercradle for use with the Internet Advisor.

All HP CERJAC 2 Mb/s test solutions include G.821 Error Analysis as well as M2100, M2110, and M2120 Error Analysis. The products are dual-port testers that enable technicians to simultaneously control two full-duplex drop-and-insert transmitters and receivers. All include a built-in log that captures up to 3300 separate, user-selected error events.

HP E6323A CERJAC E1 TELCO Undercradle for the Internet Advisor

Provides enhanced physical layer testing capability in the form of external clock measurement of level and frequency and more extensive BER measurements. The E4593A, E4597A, E4598A and E4599A plug-in modules can all be fitted and used with E6323A.

HP E6349A CERJAC E1 Test Advisor

An existing notebook PC can be used with the E6349A configuration of the E1 Test Advisor. It is ideal for "drop-box" applications at customer sites that require long-term monitoring via modem.

Applications

The 2 Mb/s Test Advisor's main screen provides vital at-a-glance information for quick circuit "check-ups," including alarms, alarm history and results summary. Other tab displays provide information on level and frequency of the 2 Mb/s signal, comprehensive BERT results, and allow drop-and-insert of tones and data. Optional data modules allow BER testing at V.35, RS-232, RS-449 and EIA-530A.

Ordering Information

E6323A CERJAC E1 TELCO Undercradle
E6349A CERJAC E1 Test Advisor
E4593A RS-232 Plug-in module for E6323A and E6349A
E4597A V.35 Plug-in module for E6323A and E6349A
E4598A RS-449 Plug-in module for E6323A and E6349A
E4599A EIA-530 Plug-in module for E6323A and E6349A
J2305A Softside carrying case
(for the Internet Advisor and E6323A combination)
E6326A Custom softside carrying case for E6349A

SONET/SDH Test Sets

Communications Performance Analyzers, SONET/SDH/PDH/ATM Test Set

HP 37717B
HP 37717C
HP 37724A
HP 75000 Series 90

- Single-unit solution for SDH, SONET/SDH, PDH, PDH/DSn, ATM Test, and jitter generation and measurement up to 2.488 Gb/s
- In-service and out-of-service measurements
- Monitors PDH and SDH overhead framing, parity, and alarm information
- Easy results interpretation with new color interface
- ATM cell generation and analysis, and ATM services layer test
- Pointer sequence generation to ITU-T G.783
- Works with HP E4540A distributed network analysis software
- Comprehensive jitter test capability

HP 37717C

HP 37717B/C Communications Performance Analyzers

These offer modular, upgradeable one-box solutions for installation, field maintenance, commissioning and manufacturing. Rugged and portable, they allow full functional testing of SDH, PDH and ATM equipment, including jitter generation and measurement. The HP 37717C has color display, graphics printer, and dual-standard SONET/SDH capability. The HP 37717B monochrome version provides a budget solution, with a 24-column printer. Both have a 3.5-inch disk drive for results retrieval and storage, firmware upgrades, and results export to PC applications.

The HP 37717B/C family of communications performance analyzers offer one-box, field-portable testers for installation, maintenance and commissioning of today's hybrid PDH/SDH and ATM transport networks and network equipment at SDH rates from STM-4 (622 Mb/s) through STM-1 (155 Mb/s) to STM-0 (52 Mb/s). Optical 1310 nm and 1550 nm interfaces are supported as well as electrical interfaces at all rates. A range of PDH rates from 140 Mb/s to 704 kb/s are also supported. The measurement capability is configured using a modular architecture, allowing fully flexible configurations and full upgradeability—thus protecting your investment in test equipment.

The instrument can be configured to simultaneously include PDH, SDH, ATM and jitter, or it can be can be configured to be PDH only, SDH only or ATM only with or without jitter generation and measurement. The HP 37717B monochrome version (with internal 24-column printer) provides a budget solution. The more powerful HP 37717C has color display and optional graphics printer.

Use the HP 37717C to perform in-service non-intrusive monitoring of live traffic, or test the network's protection switching mechanisms, perform out-of-service BER measurements or fully test ATM physical and cell layers and B-ISDN protocol stack layers. Functionally test PDH/SDH multiplexors, regenerative repeaters, digital cross connects etc., as well as ATM switches, routers and rate converters. Stress network elements by performing frequency offset, auto-jitter tolerance, auto-jitter transfer and output jitter measurements to ITU-T recommendations. Important parametric tests such as protection switch times, frequency, delay and optical power measurement are also supported.

SDH

The SDH modules operate at STM-0, STM-1 and STM-4, with optical interfaces at 1310 and 1550 nm. Combined with the structured PDH module, mux/demux BER tests from 622 Mb/s to n*64 kb/s are possible. In-or out-of-service tests on PDH, SDH transmission lines, or PDH payloads carried in SDH systems, are supported. The operation of SDH network alarms, error monitors, protection switches, pointer processors and de-synchroniser circuits can be verified with this module. Drop/insertion of PDH payloads to/from the SDH signal and an error output are also available. SDH Alarm and Channel Scan, protection switch times, mixed payloads and comprehensive through-mode features make this product the industry standard.

PDH

PDH rates of 704 kb/s and 2, 8, 34 and 140 Mb/s and an error output are provided in the basic PDH module. The structured PDH module gives 2, 8, 34 and 140 Mb/s rates.The structured module provides full-structured PDH capability, including PDH alarm generation, spare bits generation, and full mux/demux BER from 140 Mb/s to n*64 kb/s (n = 1 to 31). An alarm scan capability graphically points to problem areas within the signal structure; a telephone handset connection gives full talk/listen capability.

Jitter and Wander

A range of jitter modules gives full PDH, SDH and ATM jitter generation/measurement. 2, 8, 34, 140 Mb/s, 155 Mb/s (STM-1 electrical and optical) and 622 Mb/s (STM-4 optical) rates are supported. Automatic jitter tolerance verification of SDH (ITU-T G.958/G.825) and PDH (ITU-T G.823) network elements is possible. Automatic jitter transfer testing of SDH (ITU-T G.958) and PDH (ITU-T G.823) network elements is provided using narrowband selective filtering for high accuracy. Tests are made according to ITU-T O.171 and can measure the large jitter transients that accompany pointer movements in SDH networks. Generate pointer sequences (to ITU-T G.783), with the appropriate SDH module, and measure the effect on the tributary outputs using the tributary jitter measurement module. RMS jitter measurements (to ITU-T G.958) with 12 kHz HP filter are supplied. Wander generation is available at 2Mb/s and at STM-1/STM-4 to ITU-T G.825. Wander measurement is available at 2 Mb/s.

ATM Cell and Service Layer Test

The ATM cell module gives transmit and receive capability at the physical and cell layers, and through-mode monitor for convenient access. Transmit features include independently settable channels to simulate live traffic profiles, full access to the header values, test patterns for the payload, and alarm/error generation. Measurements cover parameters such as cell loss, delay, non-conforming cell count, and misinsertion, HEC errors, and OAM alarms.

The ATM services test module allows the test of all B-ISDN protocol stack layers. It monitors adaptation layers AAL-1, -3/4, and -5; VP/VC rate history; Channel View; Benchmark Traffic; and stored cell streams. Tests for native LAN connectivity: 10 Mb/s Ethernet LAN interfaces are optional. This capability is only available in the HP 37717C.

SONET/SDH Dual Standard Test NEW

The HP 37717C optionally provides dual-standard testing for both SONET and SDH standards up to 622 Mb/s. Combined with DS1/DS3 and ITU-T PDH interfaces, the HP 37717C offers a truly worldwide test solution in one box, helping network equipment manufacturers improve the flexibility of their production lines and reduce costs. Testing to ANSI and ITU-T standards is provided in a single instrument.

Deregulation has also increased the need to interface SONET to SDH networks. SDH networks therefore need to support North American DS1/DS3 (DSn) payloads and interfaces, and map them correctly into SDH according to the ITU-T standard G.707. The HP 37717C fully tests all the ITU-T G.707 mapping routes (AU-3 and AU-4) used at international gateways, as well as testing the DSn/PDH circuits themselves.

Additionally, network equipment manufacturers and operators can check Automatic Protection Switch (APS) times on SONET/SDH rings and linear networks to Bellcore and ITU-T standards. With this capability, network operators and equipment manufacturers can ensure customers will suffer minimal service disruption when protection switching takes effect.

Multi-Rate Tester to OC-48/STM-16 NEW

The HP 37717C fitted with 2.5 Gb/s options provides all the interfaces under one handle from OC-48/STM-16 thru OC-12/STM-4, OC-3/STM-1, OC-1/STM-0 to PDH/DSn rates of 140 Mb/s, DS3, and 34 Mb/s down to 2 Mb/s/DS1. As this new capability is provided using the same HP 37717C mainframe, the user interface and test features mimic the lower-rate product thus avoiding costly staff retraining.

STM-16c and STM-4c concatenated payloads, protection switching tests plus mixed payloads for networks carrying mixed rates of traffic (2 Mb/s and 34 Mb/s), comprehensive overhead access, pointer processing plus multirate jitter generation and measurement, provide all necessary test for evaluating new services carried in SONET/SDH networks.

A range of multirate optical interface options are supported providing 1310 nm, 1550 nm and dual (combined 1310/1550 nm) wavelengths. The 2.5 Gb/s product can be ordered with or without jitter capability.

Distributed Network Analyzer

Use with the HP E4540A distributed network analysis software, to create a results management and remote instrument control system (see page 443).

Specifications

Interfaces
Unstructured PDH: 0.7, 2, 8, 34 and 140 Mb/s to G.703
Structured PDH: DS1, DS3, 2, 8, 34, 140 Mb/s to G.703
SDH: STM-0e, STM-1e, STM-0o, STM-1o and STM-4o
STM-16o (1310 nm and 1550 nm)
SONET: STS-1, STS-3, OC-1, OC-3, OC-12, OC-48 (1310 and 1550 nm)

Ordering Information

HP 37717B/C Communications Analyzer
Accessories
HP 15744A Optical Power Coupler
HP 15770A Rackmount Kit
HP 15772B Hard Robust Transit Case
HP E4540A Distributed Network Analysis Software
HP 15910B Soft Vinyl Carrying Case

HP 37724A SDH/PDH Test Set

The HP 37724A is a comprehensive field portable SDH/PDH test set for applications from 2 Mb/s up to 622 Mb/s (STM-4).

Ordering Information

HP 37724A SDH/PDH Test Set

HP 75000 Series 90 SONET/SDH Test System for 2.488 Gb/s and WDM

The HP 75000 Series 90 SONET/SDH test system can now be configured for WDM system test. Multiple optical STM-16/OC-48 transmitters set at appropriate wavelengths conforming to SONET/SDH standards can be combined with receivers and optical switches to provide a very flexible and scalable test configuration. WDM tributaries can be tested individually with automatic optical switching, or tributaries can be fully loaded to check for WDM channel interaction. A range of optical Tx wavelengths is available around 1550 nm using DFB laser technology. The Series 90 system can also be configured for jitter testing at 2.488 Gb/s. The Series 90 analyzer is controlled by a PC using the MS Windows® 95 environment. For OC-192/STM-64 electrical testing, please refer to page 444.

Ordering Information

HP 75000 Series 90 SONET/SDH Test System

HP E4487A
HP E4595A

- Tests all T-Carrier transmission rates
- Full transmit and receive functions
- Expandable to SONET STS-1

CERJAC 31XE

- Field-portable, SONET testing
- Automatic setup and results reporting
- 3.5-inch DOS compatible disk drive

CERJAC MTS LITE

CERJAC 31XE

The CERJAC 31XE is a complete DS3 test set that offers a wide range of optional features including DS0, DS1, FT1, E1, and SONET, ATM and T-carrier testing. DS0 and E1 timeslot drop-and-insert as well as jitter, signal measurements at DS3, DS1, E1, and STS-1, and DS-3 pulse mask measurements are also available. The modular configuration of the 31XE offers a cost-effective means of addressing current requirements while maintaining the flexibility to expand to future network applications.

Applications

In-service or out-of-service T-Carrier, SONET/STS-1 and ATM testing for troubleshooting, fault isolation, service verification and acceptance testing in central office or field applications.

Measurement Summary

DS3: Error monitoring, BER testing, alarm and error generation, Far-End Alarm and Control (FEAC), framing auto detection, DS3 jitter and DS3 signal power measurement, pulse mask
DS1/FT1/E1/FEI: Error monitoring, BER testing, alarm and error generation, framing auto-detection, Fractional T1/E1 testing, DS1 and E1 jitter and signal level measurement, ESF datalink and CDI (DS1 idle) testing
DS0/TS0: BER and tone testing, data monitoring
STS-1: Error monitoring, BER testing, DS3 and VT1.5 mapping, jitter and signal power measurement
ATM: Variable rate cell generation for STS-1, DS3, DS1 or E1 rates, cell delay, cell loss, traffic and performance analysis. ATM header generation, PLCP framing, error and alarm generation and monitoring
VT1.5: Async and byte sync DS1/DS0 testing
M13: DS1/DS0 and E1/TS0 mapped testing

Ordering Information

HP E4487A CERJAC Series 31XE with DS3 only
Opt UHR IEEE-488 and RS-232 Interface (SCPI)
Opt UQZ Second DS3 Receiver
Opt UQT DS1 Rx/Tx, Drop and Monitor from DS3
Opt UQU DS1 Insert
Opt UQV DS0 Drop-and-Insert (requires Option UQT)
Opt URN E1 Testing with Drop-and-Insert from DS3
Opt URP TS0 Testing
Opt UR5 STS-1 Rx/Tx with DS3 Mappings
Opt UQA VT1.5 Mapping
Opt UQP DS3 Jitter Measurement
Opt UQQ DS1 Jitter Measurement
(requires Option UQP 1UQT)
Opt UQR E1 Jitter Measurement
(requires Option UQP 1URN)
Opt URZ Advanced ATM Testing
Other options available
E6322A Remote DS3 Pulse Mask Graphic Software
E6347A Remote Front Panel Software
E6348A Remote Event Logging Software

CERJAC MTS LITE SONET Maintenance Test Set

The CERJAC MTS LITE provides OC-12, OC-3/3c, OC-1, and EC-1 (STS-1/B3ZS) monitoring and testing capabilities in a compact, lightweight, and rugged package. Its large graphics display, numerous LEDS, "AUTO" and "Troublescan" capabilities provide quick and accurate verification of a network configuration and quality. The 3.5-inch high-density DOS-compatible floppy drive is used to save and recall output data and user configurations and to download new firmware. Preprogrammed TEST SEQUENCES enable users to quickly perform complex stimulus/response tests. The CERJAC MTS LITE incorporates the latest in SONET integrated circuit technology and is packaged in a modular chassis with expansion slots for easy upgrades.

Applications

The CERJAC MTS LITE is the ideal test set to monitor, stress, and change SONET overhead. Its STS-1 and STS-3C payload BERT capability is perfect for installation and acceptance testing. The CERJAC MTS LITE complements existing DS-3 and DS-1 test set with its DS-3 and VT1.5 (async and byte sync) drop and insert capabilities. Using the built-in RS-232 and HP-IB, it can be controlled by SCPI or HP Virtual remote software running on a PC/AT or workstation.

Measurement Summary

- SONET section, line and path overhead modification, monitoring, error insertion and analysis.
- Pointer adjustment and monitoring.
- Generation and display of Automatic Protection Switch (APS) messages.
- Clear channel BERT at STS-1 and STS-3c.
- Path trace generation and monitoring.
- Receive optical power and electrical peak measurements.
- Section and line DCC external drop and insert.
- Built-in speaker and VF orderwire interface.

Ordering Information

HP E4595A CERJAC MTS LITE SONET Test Set
Opt 001 622 Mb/s OC-12
Opt 002 DS-3 External Drop and Insert
Opt 003 VT1.5 Async and Byte Sync
Opt 005 HP-IB and RS-232 SCPI
Opt 010 ST Connectors
Opt 012 SC Connectors
Opt V01 Virtual Remote
HP 15744 Optical Splitter
Opt 012 FC-PC Trio
Opt 014 ST Trio
Opt 018 SC Trio
HP E6393A Hard Carrying Case
HP 15710A Soft Carrying Case

HP E4480A

- Field-portable test set for SONET, ATM and T-Carrier testing
- Flexible configuration for evolving network testing needs
- Available OC-12c/3c and ATM testing capabilities

CERJAC 156MTS

CERJAC 156MTS SONET/ATM/T-Carrier Maintenance Test Set

The field portable, lightweight CERJAC 156MTS combines SONET, ATM and T-carrier testing for installation, qualification and maintenance testing from OC-12 to DS0. The unique design of the CERJAC 156MTS provides a wide array of options to support the demands of the network as it expands and evolves. With its "AUTO" and "Troublescan" capabilities the CERJAC 156MTS quickly synchronizes to complex network configurations and reports the configuration and errors on a high contrast display and numerous LEDS. The CERJAC 156MTS is the single solution that provides complete SONET, ATM and T-Carrier in monitor, terminal and pass-through configurations.

SONET applications:
- SONET testing from OC-12/3/1 and STS-1/B3ZS interfaces
- STS-12c/3c payload testing
- Transmission and multiplexer testing
- Alarm stimulus/response testing
- Transport overhead and path trace programming and display
- STS-1 jitter measurements
- Error injection and analysis

ATM applications:
- STS-12c/3c1, DS3, DS3/PLCP, E1, DS1 ATM payload testing
- Foreground and background channel testing
- Cell loss, cell delay and inter-arrival cell delay measurements
- Cell capture with filtering
- AAL0 and AAL1 BERT testing
- Automatic VP/VC scan

T-carrier applications:
- Full DS3/DS1/FT1/E1/FE1/DS0 transmission testing
- DS1/DS0 testing via M13 or VT1.5 async and byte sync
- DS1 CDI testing
- E1/TS0 testing and DS3 mapped E1 testing
- DS3, DS1 and E1 jitter measurements
- DS3 pulse mask measurements
- DSI in-band and out-of-band loopup and loopdown testing

Measurement Summary

Frame Formats
SONET: STS-12/12c/3/3c/1
DS3: M13, C-bit and unframed
DS1/FT1: D4, ESF, SLC, MBLT and unframed
E1: TS0, TS0/16, TS0/CRC, TS0/16/CRC and unframed

Mappings
ATM: AAL0 and AAL1, DS1 and DS3 to ANSI T1.105 and Bellcore GR-253. DS1 VT1.5 async and byte sync.

Optical Interfaces: 622.08 Mbs (OC-12), 155.52 Mbs (OC-3), 51.84 Mbs (OC-1). 1310 and 1550 nm IR and LR laser available
Electrical Interfaces: 51.84 Mbs (STSX1/B3ZS), 44.763 Mbs (DSX3/B3ZS), 2.048 Mbs (E1/ AMI/HDB3), 1.544 Mbs (DSX1/AMI/B8ZS)
Timing References: Internal Stratum 3, DS1 Bits, loop timing and external
Drop and Insert Interfaces: STS-1, DS3, E1, DS1, DCC, V/F
Payloads: STS-12c, STS-12c/ATM, STS-3c, STS-3c/ATM, DS3, DS3/ATM, DS3/ATM-PLCP, DS3/DS1/DS0, DS3/E1/DS0, VT1.5/DS1/DS0, DS1/DS0 and E1/DS0

Internal Generated Patterns
QRSS, PRBS: 2^{31}–1, 23^{2}–1, 2^{20}–1, 2^{15}–1, 2^{11}–1, 2^{9}–1, 2^{6}–1, all 1's, all 0's, 3 in 24, 0/1, 55octet and fixed user patterns

Alarm Testing
SONET: LOS, LOF, LOCLK, AIS-L, RDI-L, LOP-P, AIS-P, RDI-P, AIS-V, LOP-V, RDI-V
ATM: LOS Cell sync, SCNR, LOPAT, VP AIS and RDI, VC AIS and RDI
DS3: LOS, FFM, OOF, LOP, AIS, CV
DS-1: LOS, OOF, LOP, AIS, Yellow, COFA, Ones density, CDI (Idle)

Error Add and Monitor
SONET: BPV, Frame, B1, B2, B3, REI-L, REI-P, data, VT1.5 BIP and REI-V
ATM: HCS, data, PLCP
DS-3: BPV, Frame, data, C1, C2, C3, X-bit, FEBE
DS1: BPV, Frame, CRC, data

Overhead Testing
Section: A1, A2, C1, E1, F1 and D1-D3
Line: K1, K2, D4-12, Z1, Z2, E2
Path: B3, C2, G1, F2, Z3-Z5
VT: V4, V5

APS Message Testing: Message displayed in test form to Bellcore GR-253
Path and VT Path Trace: Generates and monitor user programmable 64 byte sequence
STS and VT Pointer Monitoring: Increment/decrement and new pointer
Interchangeable optical connectors available
Receive optical power
Receive electrical peak detect
RS-232 remote front panel
RS-232 and IEEE SCPI controllable
RS-232 printer
Internal results and configuration storage
Field downloadable software upgrades via RS-232

Ordering Information

HP E4480A: CERJAC 156MTS
- **Opt 201:** Base jitter measurement
- **Opt 202:** DS-3 pulse mask measurements
- **Opt 203:** STS-12c and STS-12c/ATM testing (requires Opt. UQK)
- **Opt 206:** 1550 nm IR rear-panel laser
- **Opt UHR:** IEEE-488 and RS-232 SCPI interface
- **Opt UQA:** VT1.5 mapping
- **Opt UQG:** OC3/3c/1 testing with 1310 nm IR optics
- **Opt UQK:** OC12/3/3c/1 testing 1310 nm IR optics
- **Opt UQZ:** 2nd DS3 RX and TX
- **Opt URQ:** E1/TS0 testing with D&I from DS-3
- **Opt URR:** DS3 testing with D&I from STS-1
- **Opt URS:** DS1/DS0 testing with D&I from DS-3
- **Opt URZ:** Advanced ATM testing
- **Opt USO:** Fractional T1 testing
- **Opt H15:** STS1 jitter measurement (requires Opt. 201)
- **Opt UQP:** DS3 jitter measurement (requires Opt. 201)
- **Opt UQQ:** DS1 jitter measurement (requires Opt. 201)
- **Opt UQR:** E1 jitter measurement (requires Opt. 201)

HP E6322A: DS-3 pulse mask graphic software
HP E6347A: Remote front panel software
HP E6348A: Remote event logging software

HP E4200B
HP E4210B

- New OAM analyzer/generator
- New PNNI, UNI 4.0 emulation and conformance test, and NNI signalling solutions
- New powerful frame generator with frame relay interworking conformance tests
- New 0–622 Mb/s ATM stream processor for full bandwidth 622 Mb/s ATM traffic generation

HP E4200B/E4201B Broadband Series Test System (HP 75000)

HP Broadband Series Test System

The HP Broadband Series Test System (BSTS) is the industry-standard for ATM and BISDN testing. It provides the depth and breadth required for R&D and quality assurance, type approval, and conformance testing of ATM, signalling, LAN interworking, WAN interworking, and more. It offers:

- The widest variety of standard interfaces
- The broadest, most comprehensive range of signalling capabilities
- The most complete range of automated conformance test suites
- Time-saving features for monitoring, emulation, simulation, load generation, performance, and automated conformance testing

The BSTS is a modular UNIX-based test system. Flexible architecture allows you to start with a basic, cost-effective configuration. The line interfaces provide more than just physical access; they test the physical, convergence and ATM layers. If you add the HP E4209B Cell Protocol Processor, you can test ATM and AAL layers in real time. You can add services test software, such as signalling emulation, and the tester will behave as an active device in the network. Generate an SVC request from the network, and once that request has been granted, maintain the SVC connection and conduct further functional or performance verification.

Specialized test modules such as the HP E4219A ATM Network Impairment Emulator let you check the response of your network and devices by injecting real-world ATM impairments such as cell delay, cell loss, and cell error.

There are two basic systems to choose from. The HP E4210B Form-13 mainframe is a rackmounted chassis with 11 open slots for modules. The HP E4200B Form-7 transportable base, with a built-in monitor and keyboard, is ideal for field trials. HP BSTS modules and software applications are the same for both systems.

X-Windows networking via TCP/IP at the Ethernet port is supported, which means that you can use the BSTS to solve problems remotely, or multiple users can share the same BSTS.

True R&D Power

Each BSTS product is built without shortcuts according to the industry's full standard specifications—which means you can rely on the BSTS to catch problems other test equipment may not detect. It also means that the emulation software provides the full reference emulation according to standard specifications to emulate either the network or user devices. You can use the emulation protocol library to build customized test scripts using graphical menus that reflect terminology used in the standard specifications. The Tcl Tool Kit helps you create GUIs for scripted tests easily.

Real-Time Testing of OAM Protocol on 124 Channels

The HP E6270A OAM Protocol Tester is a powerful, dedicated module for the HP BSTS that provides real-time verification of the ATM Operations and Maintenance (OAM) protocol. The OAM Protocol Tester can generate F4 and F5 OAM cells and user traffic on up to 124 channels. Key features include a 124-channel user-traffic generator with automatic insertion of OAM cells, a real-time, two channel receiver for simultaneous VP/VC testing, and real-time measurement of key performance-monitoring statistics. The OAM Protocol Tester helps ensure the proper implementation and functioning of the OAM protocol's powerful features for performance monitoring, in-service fault detection, and fault localization.

Solutions for the Complete ATM Signalling Stack NEW

If you are deploying ATM equipment and services over switched virtual circuits (SVCs), the BSTS has new automated, reference-based tools for evaluating and troubleshooting implementations against the latest ATM Forum signalling standards. Software test applications provide comprehensive reference emulation for UNI and ILMI, plus a wide range of NNI and PNNI capabilities. Automated conformance test suites ensure correct implementation of the ATM Forum's UNI 3.0, 3.1, and 4.0 signalling and UNI 3.0 and 3.1 ILMI address-registration specifications.

622 Mb/s ATM Transmission and Protocol Testing NEW

A new 622 Mb/s (OC-12) solution provides the BSTS with comprehensive higher layer and signalling test capabilities. This 2-module solution consists of the HP E1618A 622 Mb/s Optical Line Interface and the HP E1609A 0–622 Mb/s ATM Stream Processor. It supplies full-rate OC-12c ATM generation and analysis, ATM and AAL5 traffic generation, 622 Mb/s real-time statistics, and access to the Cell Protocol Processor (CPP) and other test modules.

AAL-2 Support

The new HP E4212B software adds AAL-2 testing as well as AAL-1, AAL-3/4, AAL-5, and CLNAP. AAL-2 support has been added for testing voice and wireless traffic over ATM using the mini cell embedded in AAL-2. The software also includes a traffic generator with assorted traffic profiles.

Eight Solutions for Frame Relay Interworking NEW

Eight products make up a powerful series for testing frame relay interworking. The HP E4206A and HP E4207A are high performance dual-port frame generators for T1/E1 and V-interfaces. The HP E4216A Frame Relay test software generates PVC-based test traffic with encoding and decoding of DL-CORE frames. The HP E6278A Frame Relay SVC Protocol Viewer decodes signalling messages for functional verification of SVC applications. The HP E7840A Frame Relay over ATM Service and Network Interworking Test Suite supplies 94 automated test cases for testing equipment conformance according to Bellcore's SR-3989 Test Plan. The HP E4215B decodes encapsulated LAN over Frame Relay. The E4212A/B AAL Test Software providing interworking tests for FR/ATM interworking testing.

HP E4200B
HP E4210B

All the breadth and depth you need

The HP Broadband Series Test System has all the breadth and depth you need for fast, efficient testing of ATM technologies—including signalling, LAN interworking, WAN interworking, and digital video.

ATM Testing

HP E4209B Cell Protocol Processor (CPP)
HP E4212A AAL Test Software
HP E4212B AAL Test Software (with AAL-2 support)
HP E1609A 0–622 Mb/s ATM Stream Processor
HP E6270A OAM Protocol Tester
HP E4223A ATM Policing and Traffic Characterization Test Application
HP E1696A 155 Mb/s (STS-3c/STM-1) Optical Load Generator
HP E4219A ATM Network Impairment Emulation Module

ATM Conformance Test Suites
HP E7820A UNI 3.0 ATM Layer Conformance for Intermediate Systems
HP E7821A UNI 3.0 ATM Layer Interoperability for Intermediate Systems
HP E7822A UNI 3.0 ATM Layer Conformance for End Systems
HP E7830A UNI 3.1 ATM Layer Conformance for Intermediate Systems
HP E7831A UNI 3.1 ATM Layer Interoperability for Intermediate Systems
HP E7832A UNI 3.1 ATM Layer Conformance for End Systems

Signalling Testing

HP E4214B UNI Signalling Test Software
HP E4217B NNI B-ISUP Signalling Test Software
HP E6280A PNNI Signalling Test Software
HP E6273B ILMI Emulation Test Software

Signalling Conformance Testing
HP E7823A UNI 3.0 Core Signalling Conformance, Network Side
HP E7833A UNI 3.1 Core Signalling Conformance, Network Side
HP E7833C UNI 3.1 Complete Signalling Conformance, Network Side
HP E7834A UNI 3.1 Core Signalling Conformance, User Side
HP E7842A ATM Forum UNI 3.0/3.1 ILMI Address Registration User Side
HP E7843A ATM Forum UNI 3.0/3.1 ILMI Address Registration Network Side
HP E7844A UNI 4.0 Core Signalling Conformance, Network Side
HP E7845A UNI 4.0 Core Signalling Conformance, User Side

MPEG over ATM

HP E6271A MPEGscope ATM Test Application
HP E4219A ATM Network Impairment Emulator
HP E4226B MPEG-2 Protocol Viewer Test Software

WAN Interworking

Frame Relay
HP E4206A T1/E1 Frame Processor
HP E4207A V Interface Frame Processor
HP E4216A Frame Relay Test Software
HP E6278A Frame Relay SVC Protocol Viewer
HP E6279A Frame Relay Over HSSI Test Software
HP E7840A Frame Relay/ATM Interworking Test Suite

LAN over Frame Relay
HP E4215B LAN Protocols Test Software

Frame-based UNI
HP E6275A FUNI Test Software

SMDS
HP E4211A SMDS Test Software

SMDS DXI
HP E4213B SMDS DXI Test Software

LAN Interworking

LAN Emulation
HP E6272B LAN Emulation Test Software
HP E7293B ATM Forum LAN Emulation 1.0 Service Test Suite

LAN
HP E4215B LAN Protocols Test Software

Productivity Tools

HP E7310A TTCN Productivity Tools
HP E7313A HP-ITEX TTCN Editor
HP E7311A Protocol Test Execution Manager
HP E7312A Protocol Test Automation Manager
HP E5576A Test Manager Integration Kit
HP E55938B/C TTCN Translator
HP E7329A Test Manager API

Line Interfaces

SONET/SDH
HP E1616A 1.5/45 Mb/s (DS1/DS3)
HP E1697A 155 Mb/s (STS-3c/STM-1) Optical
HP E4205A 155 Mb/s (UTP-5)
HP E1612A 155 Mb/s (STS-3c/STM-1) Electrical
HP E1617A 52 Mb/s (STS-1/STM-0) Optical
HP E1618A 622 Mb/s (STS-12c/STM-4) Optical
HP E4210 Option 004 622 Mb/s ATM Analyzer Bundle
HP E4210 Option 040 622 Mb/s Real-Time ATM Analyzer Bundle

PDH
HP E1610A 34 Mb/s (E3)
HP E1613A 6.3 Mb/s (J2) Electrical
HP E1614A 6.3 Mb/s (J2) Optical
HP E4201A 2.048 Mb/s (E1)

Other
HP E1619B 25.6 Mb/s (4B/5B)
HP E1698A 100–140 Mb/s (TAXI 4B/5B)
HP E4204A HSSI Line Interface

For More Information

New modules and software test applications for the BSTS are introduced frequently. For up-to-date product information and specifications, visit our site on the World Wide Web (http://www.hp.com/go/bsts). For a copy of the HP Broadband Series Catalog, contact your local HP sales office and request publication number 5965-4721E.

HP E4829B

- For verification and debugging of today's cell-based communication designs such as ATM chips, hubs, switches and cross-connects
- Connects to 8/16 bit parallel interfaces like UTOPIA or similar proprietary ones
- Handles proprietary cell structures with a length of 16 to 128 words
- Mix of real-time generated and memory-based cell data
- Four independent traffic generators
- Real-time cell analysis includes HEC, CRC-10, BER and Cell Delay Variation (CDV)

HP E4829B Parallel Cell/Traffic Generator and Analyzer System

The HP E4829B parallel cell/traffic generator and analyzer system is a comprehensive verification and debugging tool for today's cell-based communication designs such as ATM chips, ASICs, hubs, switches and cross-connects. Connecting to parallel interfaces like the 8/16 bit wide UTOPIA or similar proprietary ones, the system meets the requirements of design verification of chips, ASICs and sub-modules, as well as speeding up board/system debugging and root cause analysis.

The concept of building up cells out of single real-time generated and memory-based data segments allows the handling of standard ATM cells as well as proprietary ones, e.g. ATM cells with additional routing tags (see Figure 1).

Four independent traffic generators support CBR and burst-cell traffic, including single, periodic and random cell burst. Full deterministic cell traffic can be set up.

The cell trigger capabilities allow the user to detect dedicated cells, cell patterns, CRC-10 and HEC errors at real-time as an event. Single or multiple events can be combined to start cell acquisition, event count or real-time processing such as time stamp analysis for the measurement of cell delay variation.

Application Examples

- Validation of cell delay variation of switch fabrics under various load conditions
- Stimulation and analysis of proprietary cell formats
- Bring up and debug Line Interface cards (LIFs)
- Verification of UTOPIA implementation of PHY and ATM layer chips/ASICs

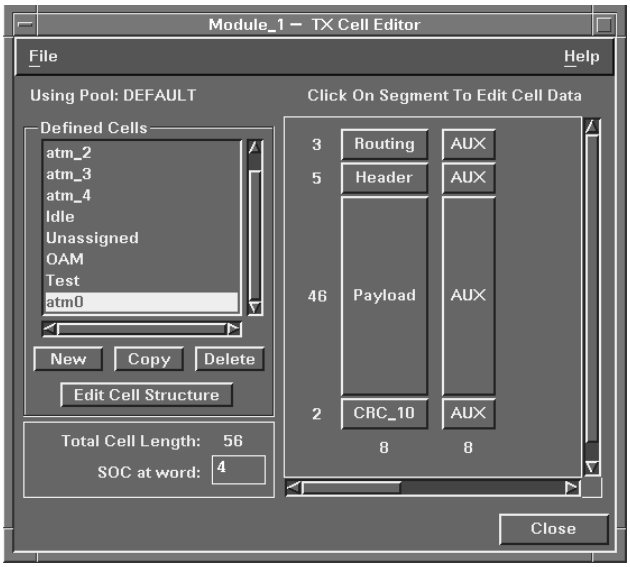


Figure 1: The flexible cell concept handles proprietary cell formats

Modular System

The VXI-based system can be configured for solutions with up to eight ports, which is ideal for switch fabric loading and verification. A single port holds one Transmitter (TX) and one Receiver (RX).

Two different pairs of PODs for custom/UTOPIA Level 1 or UTOPIA Level 2 (MultiPHY) interfaces are available. Both are active TTL-compatible.

The HP E4829B is a complementary product to the HP E4200/E4210 broadband series test system, the industry-standard ATM transmission and protocol tester. The parallel cell/traffic generator and analyzer modules can be added to existing HP E4200/E4210 systems.

Operating Specifications

Interface: 8/16 bit data, Start Of Cell (SOC), Data Valid, Parity and eight auxiliary signals
Handshake: UTOPIA Level 1 Rev. 2.01; UTOPIA Level 2 according to Chapter 4.2 and 4.3. Data Valid/Data Enable signal in custom mode.
Data Clock: 90 kHz to 52 MHz, internal or external
Cell Structures: User-defined by single cell segments, cell length 16 to 128 words
Cell Segments: UNI/NNI ATM Header including real-time generated HEC, CRC-10, 32-bit time stamp, PRBS and memory
Transmit Data Memory: 128 KWord
Traffic Generator: Four independent traffic generators to determine the cell distribution of a sequence of cells continuously by varying:
- **T_{cell}** : the distance between two cells
- **T_{pause}** : the distance between two cell bursts
- **Count:** number of cells within one cell burst

Cell Trigger Masks: Eight independent trigger cell masks; mask can be set independently for each single bit of a cell
Cell Acquisition: 128 KWord acquisition memory
Real-Time Analysis: Count, CRC-10 errors, HEC errors, bit error rate (BER), cell delay variation

For more information, visit our website: (http://www.hp.com/go/dvt).

Key Literature

Product Overview 5964-1667E
Technical Data 5963-9923E
Configuration Guide 5964-1605E

Ordering Information

HP E4829B 1 Port Entry System
As Extension to the HP E4200B/E4210B

- Dispatched and distributed ATM testing
- PVC and SVC ATM installation instrument
- Comprehensive ATM monitor and simulate
- Physical layer monitor and simulate
- Selection of interfaces from 1.5 Mb/s to 155 Mb/s
- AAL 1, 3/4, 5 monitor and simulate
- Extensive LAN and WAN over ATM analysis
- QoS and Traffic Performance Testing
- Compatible with the HP Broadband Series Test System (HP 75000)

HP E5200A

HP E5200A Broadband Service Analyzer

Hewlett-Packard's portable, dual-port E5200A Broadband Service Analyzer enables leading communications companies to deploy and maintain the latest broadband equipment and services simply and accurately. The service analyzer puts you in control immediately by providing service-focused measurements, not just test technology. The testing approach used by the service analyzer represents a fundamental change in measurement methodology from transport and protocol testing to one that gives a service-related view of network problems.

Applications

The HP E5200A Broadband Service Analyzer is a powerful and flexible measuring instrument designed to:
- minimize troubleshooting time
- help meet service delivery requirements
- characterize end-to-end Quality of Service
- enable rapid turn-up of both PVC and SVC ATM networks

Making a Complex Technology Accessible

Whether you have five days' or five years' experience in ATM technology, the HP E5200A Broadband Service Analyzer lets you test your ATM equipment or new installation thoroughly. The Link Monitor automatically detects and monitors ATM channels for content and errors. The Channel Monitor provides detailed, real-time analysis of any channel on the link. Online help offers suggestions on the source of the problem and possible solutions.

Real-Time Multi-Layer Correlation

The service analyzer performs 13,345 simultaneous, real-time measurements on 2048 channels on two ports to report traffic profile and vital alarms and errors, including end-to-end service level AAL errors. The Channel Monitor gives you a graphically-correlated view of the measurements for a selected channel. You can see immediately if service level problems are related to problems in other layers of the protocol stack.

Adaptable to any Environment

The service analyzer can be taken to an installation site to perform out-of-service testing. It comes with a carrying case with room for two additional interface pods, cabling, documentation, and optional PC display.

Compatible with the HP Broadband Series Test System

The HP E5200A Broadband Service Analyzer is compatible with the HP Broadband Series Test System — the industry standard broadband research and development test tool. Compatible data formats and scripts mean that field people can work closely with lab experts. You can take field data to the lab for further analysis, or take advanced test programs to the field.

Load Generation, Dispatched and Distributed Testing

The HP E5200A Broadband Service Analyzer can be scaled from a single port ATM instrument right up to a 20 port load generator. Additionally, the unique architecture of the service analyzer enables display on Win95 and HP-UX.

Specifications

Link Monitor: Allows navigation of a network reporting real-time channel alarms and errors including physical, ATM, AAL, and OAM measurements. Automatic detection of VPs/VCs and determination of AAL types. Bandwidth, bandwidth utilization, and top ten talkers.

Number of Channels: 2048 VPI/VCIs (performed continuously on every cell at up to 155 mb/s, real-time, total on two ports)

Channel Measurements: Cell count/bandwidth, AAL type, OAM alarm condition, errored cell count, high priority cell count, sequence number errors, PDU counts, cell loss count. Further, in-depth measurements can be made on any selected channel on the link.

QoS and Traffic Performance Testing: Automated SMARTtests provide one-touch Quality of Service testing. Tests include cell loss, cell error ratio, cell loss ratio, cell misinsertion, cell transfer delay and cell delay variation. Additionally, a dual-bucket GCRA traffic policing test, cell interarrival test, remote cell loss test, and network stress tests provide a complete insight into network performance.

Macro Programming: Macros are a programming tool using the industry standard Tcl language. Macros can be created using the service analyzer's inbuilt recorder. Macros can be saved to disk and distributed for use on multiple HP E5200A Broadband Service Analyzers.

Data Capture: Data can be captured, viewed, saved to a file, or used to regenerate traffic. Captured data can be processed in order to extract detailed reassembly information.

Simulate: A powerful and flexible traffic simulator allows you to customize data to be injected into a network, or select from predefined patterns and traffic types. Multiple traffic distributions are available and stress testing on multiple channels is made easy.

Data Services Analysis: Filtering at the frame layer on IP addresses (on PVC or SVC Networks) is made easy, and full details of the ATM and AAL layer can be obtained including LAN and frame relay protocols running over ATM.

UNI Signaling Analysis: Full bi-directional UNI Signaling Emulation test suites are available (UNI 3.0/3.1/Q.2931). Decode suites are continuously evolving on the service analyzer.

Physical Interfaces: Interface pods provide the connection to a number of network technologies and line rates and facilitate testing at the physical layer. Interfaces are interchangeable and you can have a mix of interfaces in the one unit. Interface connectivity options include:
- DS1/DS3 (1.5 Mb/s, 45 Mb/s)
- E1 (2.048 Mb/s)
- E3 (34 Mb/s)
- J2 (6.3 Mb/s)
- OC-3/STM-1 singlemode and multimode optical (155 Mb/s)
- STM-1/STS-3c electrical (155 Mb/s)
- ATM 25.6 (25.6 Mb/s)
- 155 UTP-5 solution (155 Mb/s)

Key Literature

Broadband Service Analysis–Coping with the Network Management Test Challenge, p/n 5965-1377E
HP E5200A Broadband Service Analyzer Brochure, p/n 5965-1378E
HP E5200A Broadband Service Analyzer Technical Data, p/n 5966-0714E

Ordering Information

HP E5200A Broadband Service Analyzer
HP E5120A Interface Pod, DS1/DS3
HP E5121A Interface Pod, E3
HP E5122A Interface Pod, OC-3/STM-1 Optical (FC/PC)
HP E5123A Interface Pod, STM-1/STS-3c Electrical (coax)
HP E5124A Interface Pod, OC-3/STM-1 Optical (SC)
HP E5125A Interface Pod, E1 Electrical
HP E5126A Interface Pod, J2 Electrical
HP E5129A Interface Pod, 25.6 Mb/s

Communications Performance Analyzer

HP 37717C

- ATM testing and LAN connectivity measurements
- Physical layer testing with jitter generation and analysis
- In-service and out-of-service testing supported for installation and maintenance or manufacturing test applications
- ANSI, ETSI and ATM Forum standards supported
- Full remote management with HP E4540 Distributed Network Analyzer software
- Portable and rugged; lid-based graphical printer available
- Designed to be soft-upgradeable, making it future proof
- Modular and configurable to suit your ATM test needs

HP 37717C Communications Performance Analyzer

The HP 37717C Communications Performance Analyzer provides solutions for broadband testing from the physical layer up to service layers. The modular nature of this flexible instrument allows it to be configured to match a wide range of applications including installation and maintenance and manufacturing test applications. It can operate at all the most common ANSI and ETSI wide-area transmission rates.

In-Service ATM Analysis

Use the Channel View feature to find and identify up to 1023 active virtual channels on an ATM link, including even single cell events. Observe real-time cell rate/count simultaneously on all found channels. Post analysis of each active channel is performed automatically to identify the AAL or OAM cell type in use; ATM layer alarms are also displayed. Perform detailed analysis at the ATM or higher layers. Monitor real-time in-service cell delay variation graphically using 1-point CDV measurements and count non-conforming cells to I.356. Analyse I.610 performance management OAM cells to obtain cell loss and misinsertion results from live traffic. Analyse AAL errors to gain a useful indication of problems at the ATM layer.

Out-of-Service ATM Analysis

Generate and analyse O.191 Test Cells to obtain measurements for 2-point CDV, cell loss, cell misinsertion and cell errors, according to I.356. Generate up to ten virtual channels, each with a user-definable profile of constant, Poisson or bursty traffic. In addition to Test Cells, generate and analyze single cell or cross-cell (segmented) pseudo-random binary sequences. Inject single or double header errors or payload impairments and generate and identify ATM layer alarms using the F4 and F5 OAM flows.

Physical Layer Features, including Jitter

Analyze physical layer errors, perform G.826 analysis and generate physical layer impairments, generate and identify physical layer alarms. Measure the received clock rate and optical power, and offset the analyzer's internally-generated clock rate. Generate and analyze physical layer jitter which, together with the frequency offset capability, make this analyzer an important tool for checking the jitter tolerance of ATM interfaces.

Ethernet Connectivity

Check LAN over WAN connectivity on Ethernet networks. Use "pings" and Ping History to check the end-to-end service.

Specifications

For information on jitter generation and analysis, and other features of the HP 37717C, see page 450.

Physical Layer (general)
- **Interfaces:** DS1 (1.5Mb/s), DS3 (45Mb/s, direct and PLCP mapped ATM), E1 (2Mb/s), E3 (34Mb/s), E4 (139Mb/s), OC-3c (155Mb/s), STM-1e / STM-1o (155Mb/s)

Physical Layer Generation
- **Alarm Generation:** LOS, LOF, AIS, RAI/RDI
- **Error Add:** DS1: FAS, BPV/code, CRC-6; DS3: FAS, MFAS, BPV/code, parity (P bits), CP (parity), FEBE, EXZ; DS3 PLCP: B1, FEBE, C1, frame; E1: FAS, BPV/code, CRC-4, REBE; E3: BPV/code, BIP
- **DS3 FEAC:** DS3 Loopback control

Physical Layer Analysis
- **Alarm Indication:** LOS, LOF, AIS, RDI/RAI, Loss of DS3 PLCP Frame, Loss of CRC multiframe, DS3 FEAC

ATM Generation
- **Cell Headers:** UNI and NNI, all fields programmable
- **Traffic Generation:** 1 foreground and 9 background virtual channels, each independently settable in bandwidth and distribution (constant, Poisson, bursty (adjustable rate during burst); foreground payload: Test Cell (O.191), PRBS-15, PRBS-23, S-PRBS-9, user-programmed repeating byte
- **Error Add:** Single and double header error; payload bit error
- **Alarm Generation:** VP-RDI, VP-AIS, VC-RDI, VC-AIS

ATM Analysis
- **Channel View Capture:** All VPs (or range) or VCs up to 1023
- **Channel View Display:** Cells/s, cell counts, % bandwidth (numerically and histographically), AAL type or OAM cell type, ATM alarm
- **Payload Analysis:** Test Cell (O.191) related results (to I.356): cell loss count/ratio, cell misinsertion count/rate, cell error count/ratio, mean transfer delay, 2-point cell delay variation; PRBS (as above) bit errors
- **Rate History:** Up to 1000 samples showing histographically the minimum, mean and maximum cell rate within each sample period (1 second to 1 hour)
- **AAL Analysis:** AAL-1: lost cells, corrected and uncorrected SNP errors, count of SAR-PDUs; AAL-3/4: SAR-PDU CRC-10 errors, lost cells, segment type errors, count of received CPCS-PDUs, count of received and aborted SAR-PDUs; AAL-5: CPCS-PDU CRC-32 errors, length errors, length over-run errors, received and aborted CPCS-PDUs
- **PM-OAM Analysis:** Cell loss/misinsertion, BEDC errors
- **In-service Analysis:** 1-point cell delay variation (to I.356)
- **Alarm Indication:** VP-RDI, VP-AIS, VC-RDI, VC-AIS

LAN Connectivity
- **LAN type:** 10 Mb/s Ethernet
- **Interface:** UTP (RJ45) and AUI
- **Network Protocol:** IP
- **LAN Generation:** Single packet manually initiated, continuous ping rate up to 10 per second, end-to-end packet load, variable packet load level from 1 to 550 packets per second, file transfer simulation (bulk transfer-approx. length 1M byte)
- **LAN Measurement:** Ping response time, ping packet return count, ping packet loss count, Ping History — graphically displays results over time, verification of file transfer.

Ordering Information

HP 37717C Communications Performance Analyzer

* Prices depend heavily on option mix.

Protocol Analyzers

3 Dimensional Network Testing AC
5963-1054EN
Announcing New Multiprong Testing Brochure
5091-7635E
Frame Relay Message Sets Technical Specifications
5963-0085EN
Frame Relay Test Software Technical Specifications
5963-6653EN
Frame Relay/SMDS Seminar Book Solution Note
5963-9501E
Group 4 Fax Testing Product Note
5091-2002E
Hewlett-Packard Protocol Testers Brochure
5091-7634E
Integrated FR Testing with PT502 Data Brief
5091-2003E
Integrated SMDS Testing with PT502 Data Brief
5091-2006E
ISDN Primary Rate Testing Solution Note
5963-2013EN
ISDN Testing Data Brief
5091-2141E
Executable Test Suites for PT Series Technical Specifications
5963-1090EN
Protocol Testing at Bank of Montreal Solution Note
5962-9750EN
PTremote Manager Technical Data Technical Specifications
5962-8747E
PT Series Technical Specs Technical Specifications
5963-0082E
V3.0 Test Software Technical Specifications
5963-0086EN
X.25 Protocol Testing Tech Data Technical Specifications
5962-8746EN
X.25/X.32/X.75 Testing with HP PTs Brochure
5091-7847E
HP PT Series Protocol Testers
5091-7634E

(PN) SS7 Protocol Testing with PT Series Protocol Testers (PT500)
5962-9408EUS

Digital Transmission Testers

CERJAC NIU Quick Isolation of DS3 Network Problems
5963-2316EUS
3-Slot and 12-Slot Equipment Shelves for E4586A DS3 NIU
5963-7141EUS
HP E485XA Serial Cell Generator and Analyzer
5963-9924A
HP 37741A Your Handheld Solution to T1 and FT1 Test
5962-9221E
HP 37701B Take a New Look at Combined T1 and Datacom Testing
5091-8851E
HP 37702A Take a New Look at Combined T1 and DDS Testing
5091-8850E
HP 37717B/C Accurate ATM Cell and Services Testing for Today's Hybrid PDH/SDH/ATM Networks Data Sheet/Brochure
5965-4968E
HP 37717B/C Accurate SDH Testing for Today's Hybrid PDH/SDH/ATM Networks Data Sheet/Brochure
5964-1664E
HP 37717B/C Multi-Application Testing in a Modular Portable Test Set —To Ease Your Networks Migration to SDH and ATM Data Sheet/Brochure
5964-0106E
HP 37724A SDH/PDH Test Set Data Sheet/ Brochure
5091-8844E
HP 37742A 2M Test Set Data Sheet/Brochure
5091-2038E
HP 37722/32A "Test Your Telecom and Datacom Circuits with One Instrument" Brochure
5965-3192E

CERJAC Series 31XE Technical Data
5964-2463EUS
HP 37722/32A Configuration Guide
5965-3194E
HP 37722/32A Technical Specifications
5965-3193E
HP E4540A DNA Software "Distributed Testing of PDH, SDH and ATM" Brochure
5964-2240E
HP 71603B Brochure
5965-1431E
HP 71612A Brochure
5963-5269E
HP 37778A Product Overview
5965-7588E
CERJAC T1 Test Advisor T1 Testing Just Got Easier Brochure
5965-4765E
CERJAC T1 Test Advisor Product Overview (booklet and demo diskette)
5965-1629E
CERJAC E1 Test Advisor Brochure
5965-6115E
CERJAC 4934A TIMS Get Your Data Circuits Up and Running Brochure
5964-5977E
HDSL Installer's Assistant Brochure
5965-8937E

(PN E4540A) Automated Test Sequences for More Effective Testing of SDH and ATM Networks
5965-4911E
(PN E4540E) Interactive Diagnosis for More Effective Support of SDH and ATM Networks
5965-4912E

SONET/SDH Test Sets

CERJAC MTS LITE SONET Testing Starts Here
5964-0012EUS
CERJAC 156 MTS Installation and Maintenance Testing for SONET, ATM and T-Carrier
5964-8926E
HP 75000 Series 95 SONET/SDH Tributary Test Solutions Data Sheet/Brochure
5091-6805E
HP 75000 Series 90 Technical Specification
5965-5817E
TS-2000 Brochure
5964-3920E
HP 75000 Series 95 Technical Specifications
5962-6173E
HP 37717C Brochure
5964-0106E
HP 37724A Brochure
5091-8844E
HP 37714A Configuration Guide
5965-3051E
HP 37778A Product Overview
5965-7588E

(PN E4480A) Enhanced, Portable SONET, ATM and T-Carrier Testing
5965-3653E
(PN E4480A/87A and E4595) Enhanced, Easy-to-Use SONET and T-Carrier Testing
5965-3650E
(PN E4480A/87A) ATM Enhancements
5965-3654E
(PN E4480A/87A) Graphical Control, Measurement and Analysis
5965-3648E
(PN 37778A) Avoiding Synchronization Problems in SDH Networks
5965-4910E
(PN 37717B/C-5) PDH Digital Radio Test
5965-4885E
(PN 37717B) Tributary Jitter Testing of SDH Network Equipment Using ITU-T G.783 Pointer Sequences
5965-4862E
(PN 37717B/C) Automatic Verification of Network Equipment to ITU-T Jitter Tolerance Recommendations
5965-4863E
(PN 37717B/C) Physical Layer Jitter Testing in an ATM Environment
5965-4861E
(PN 37717B/C) Resolve Finger-Pointing Problems on 140 Mb/s Transport Signals
5965-4886E
(PN 37717B/C-1) Pointer Sequence Generation and Tributary Jitter Measurement to ITU-T Standards
5965-4862E
(PN 37717B/C-2) Automatic Verification of Network Equipment to ITU-T Jitter Tolerance Standards
5965-4863E
(PN 37717B/C-5) Resolve Finger-Pointing Problems on 140 Mb/s Transport Signals
5965-4886E
(PN 37717C-3) Physical Layer Jitter Testing in an ATM Environment
5965-4861E
(PN E4505A-1) Investigating Synchronization Problems in SDH Networks
5965-4910E
(PN E4505A-2) Test Sequences for More Effective Testing of SDH and ATM
5965-4911E
(PN E4505A-2, 37717B/C) Interactive Diagnosis For More Effective Support of SDH and ATM Networks
5965-4912E

ATM/Broadband Test Systems

1993 B-ISDN Seminar Handbook Primer
5962-8794E
1994 B-ISDN Seminar Handbook Primer
5962-0011E
1995 Broadband Communications Map
5963-9489E
HP Broadband Series Test System Product Information
5966-0035E
Implementing ATM Signalling Solution Note
5963-7514E
MPEG-2 Digital Video Technology Solution Note
5963-7511E

Traffic Policing Solution Note
5963-7510E
WAN Interworking with ATM Solution Note
5963-7512E
HP E4829B Product Overview
5964-1667E
HP E4829B Technical Data Sheet
5963-9923E
Ease Your Network's Migration to ATM Brochure
5965-4968E
ATM Testing and LAN Connectivity Measurements Under One Handle Brochure
5965-1259E
HP E5180A Broadband Launch Pad Photo Card
5965-1379E
HP E5200A Broadband Service Analyzer Technical Data
5965-1376E
Broadband Service Analysis–Coping with the Network Test Challenge White Paper
5965-1377E
HP Broadband Series Test System Product Information
5966-0035E

(PN E1618A/E1609A) UNI Signalling Load Test Products
5965-9096E
(PN E4200, 10, 17A) NNI Signalling Test Software Helps Ensure Seamless ATM Networks
5965-6307E
(PN) ATM Policing and Traffic Characterization (E4200B/10B, E4223A)
5964-9039E
(PN) E1618A/E1609A 622 Mb/s Optical Line Interface
5965-9095E
(PN) E4214B Enhanced UNI Signalling Test Software
5965-9078E
(PN) E4217B NNI Signalling Test Software
5965-9077E
(PN) Proceedings of the 1995 B-ISDN/ATM Protocol Testing Seminar (E4200B, E4210B)
5964-3579E
(PN E4821A, E4829B, E4885A) Implementation of UTOPIA Level 2 for Parallel Cell/Traffic Generator and Analyzer
5965-4856E
(PN E4829B) Cell Transfer Time Measurement Using the Parallel Cell/Traffic Generator and Analyzer
5965-5297E
(PN E482xA/B, E4889A) Real Time Bit Error Rate Analysis at Parallel Interfaces (UTOPIA) with HP E4829B
5965-4855E
(PN) E6280A PNNI Signalling Test Software for the Broadband Series Test System
5965-9079E

Network Management/Monitoring Systems

(PN J3430A-2) How to Integrate HP NETMetrix/UX v4.5x With SunNet Manager 2.2.2 (J3430A-J3443A)
5965-1505E
(PN J3430A-5) HP NetMetrix/UX Protocol Decodes
5965-1507E
(PN J3430A-6) Extending HP OpenView Beyond the TCP/IP Protocol and Simple Status Monitoring with HP NetMetrix/UX (J3430A/31A/32A/33A)
5965-2744E
(PN J3318A) How to calculate a Payback Analysis for HP NetMetrix Distributed WAN Monitoring System
5965-5924E
(PN J3430A) Network Summary and Global Performance Web-based Reporting Using HP NetMetrix Reporter
5965-9266E

This page has been
intentionally left blank

Wireless Communications Instruments & Systems

Table of Products versus Systems and Measurements

Hewlett-Packard Wireless Solutions

Legend
1 RF source only.
2 Supports FLEX, FLEX-TD, and POCSAG.
3 Audio measurement only.
4 HP 8920 does LTR, MPT 1327, and EDACS formats.
5 Analog only.
6 Off-the-air monitoring.
7 RF source only, analog only.

Digital Systems

Products	CDMA	CDMA (PCS)	CDPD	CT2-CA1	CT3	DCS 1800	DECT	GSM 900	Paging	PCS 1900	PDC	PHS	TDMA (NADC)	TDMA (NADC) PCS	TETRA
11759C RF Channel Simulator	●	●	●	●	●	●	●	●		●	●	●	●	●	●
307X Series Board Test System	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
37741/42 Transmission Test Set	●	●	●			●		●		●	●		●	●	●
37900D Signal Test Set	●	●				●		●		●			●	●	●
4291A RF Impedance Analyzer	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
4352S VCO/PLL Test System	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
4396A RF Network/Spectrum Analyzer	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
53310 Opt 031/Opt 305 Modulation Domain Analyzer	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
58000 Series Time/Frequency Reference Distribution System	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
663XX DC Power Sources	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
84000 Series RFIC Test System	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
85150B MDS/E4600 Series IV Design System	●	●	●	●	●	●	●	●	●	●		●	●	●	●
8560 Series Portable Spectrum Analyzer															
8590 Series Portable Spectrum Analyzer	●	●		●		●	●	●		●	●	●	●	●	
8648A Opt 1EP Signal Generator									2						
8648 and ESG Series Signal Generators															
8711/12/13/14C, 8757 Scalar and Vector Network Analyzers															
8752/53, 8720, 8510 Vector Network Analyzers															
11846B Signal Generator											●	●	●		
8643/44/47/56/57/62/63/64/65 Signal Generators															
8901A/B Modulation Analyzer															
8903B/E Audio Analyzers															●
8920A/B/D/DT RF Communications Test Set			●								●	●	●	●	●
8921A Cell Site Test Set, Analog, TDMA, CDMA, CDPD Options													●	●	●
8922S/M GSM MobileTest Set						●		●		●					
8923B DECT Test Set							●								
8924C CDMA Mobile Station Test Set	●	●													
8935 CDMA PCS Cell Site Test Set		●													
89400 Series Vector Signal Analyzers	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
8991A Peak Power Analyzer				●	●	●	●	●		●	●	●	●	●	
94000 Mixed Signal LSI Test System	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
E2507B Multiformat Communications Signal Simulator[1]	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
E4900 Series Spectrum Monitoring System[6]	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
E7450A RF Coverage Measurement System	●	●													
EPM-441 Series Power Meter	●	●													●
ESA-L1500 Series Portable Spectrum Analyzer															
ESG-D Series Digital Signal Generators	●	●				●	●	●		●	●	●	●	●	●
RF Components	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
X-RAY Test System	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Analog Systems

Products	AM	AMPS/EAMPS	FM/ΦM	JTACS	NAMPS	NMT 450/900	NTACS	TACS/ETACS	TRUNKING
11759C RF Channel Simulator	●	●							
307X Series Board Test System	●	●	●	●	●		●	●	●
37741/42 Transmission Test Set		●		●	●		●	●	
37900D Signal Test Set	●	●	●	●	●		●	●	●
4291A RF Impedance Analyzer	●	●	●	●	●		●	●	●
4352S VCO/PLL Test System	●	●	●	●	●		●	●	●
4396A RF Network/Spectrum Analyzer	●	●	●	●	●		●	●	●
53310 Opt 031/Opt 305 Modulation Domain Analyzer	●	●	●	●	●		●	●	●
58000 Series Time/Frequency Reference Distribution System	●	●	●	●	●		●	●	●
663XX DC Power Sources	●	●	●	●	●		●	●	●
84000 Series RFIC Test System	●	●	●	●	●		●	●	●
85150B MDS/E4600 Series IV Design System	●	●	●	●	●		●	●	●
8560 Series Portable Spectrum Analyzer	●		●						
8590 Series Portable Spectrum Analyzer	●		●						
8648A Opt 1EP Signal Generator	●		●						
8648 and ESG Series Signal Generators	●		●						
8711/12/13/14C, 8757 Scalar and Vector Network Analyzers									
8752/53, 8720, 8510 Vector Network Analyzers									
11846B Signal Generator									
8643/44/47/56/57/62/63/64/65 Signal Generators	●	●	●	●	●	●	●	●	●
8901A/B Modulation Analyzer									
8903B/E Audio Analyzers	●	●	●	●	●		●	●	●
8920A/B/D/DT RF Communications Test Set	●	●	●	●	●		●	●	4
8921A Cell Site Test Set, Analog, TDMA, CDMA, CDPD Options		●			●			●	
8922S/M GSM MobileTest Set									
8923B DECT Test Set									
8924C CDMA Mobile Station Test Set		●			●				
8935 CDMA PCS Cell Site Test Set		●			●				
89400 Series Vector Signal Analyzers	●	●	●	●	●	●	●	●	●
8991A Peak Power Analyzer									
94000 Mixed Signal LSI Test System	●	●	●	●	●		●	●	●
E2507B Multiformat Communications Signal Simulator[1]									
E4900 Series Spectrum Monitoring System[6]	●	●	●	●	●	●	●	●	●
E7450A RF Coverage Measurement System									
EPM-441 Series Power Meter	●	●	●	●	●		●	●	●
ESA-L1500 Series Portable Spectrum Analyzer	●		●						
ESG-D Series Digital Signal Generators	●		●						
RF Components	●	●	●	●	●		●	●	●
X-RAY Test System	●	●	●	●	●		●	●	●

Measurements

Products	Call Processing	Device Trans./Reflection	Device Complex Imped.	Device Group Delay	Fading Simulation	Functional Test	In-Circuit Test	Receiver Out-of-Channel	Receiver In-Channel	Signaling/Protocol	Spectrum Analysis	Spectrum Monitoring	Transmitter Power	TX Frequency	TX Mod. Quality	TX Ampl. Envelope	R&D	Manufacturing	Field Services
11759C RF Channel Simulator					●												●		
307X Series Board Test System						●	●											●	
37741/42 Transmission Test Set										●									●
37900D Signal Test Set										●									●
4291A RF Impedance Analyzer			●														●	●	
4352S VCO/PLL Test System		●		●													●	●	
4396A RF Network/Spectrum Analyzer		●	●	●							●		●			●	●		
53310 Opt 031/Opt 305 Modulation Domain Analyzer															●		●		
58000 Series Time/Frequency Reference Distribution System		●	●			●		●	●		●		●		●		●	●	●
663XX DC Power Sources		●	●	●				●	●		●		●				●	●	
84000 Series RFIC Test System		●	●	●				●	●		●		●				●	●	
85150B MDS/E4600 Series IV Design System		●	●	●	●			●	●		●		●	●	●	●	●		
8560 Series Portable Spectrum Analyzer		●									●		●	●		●	●		
8590 Series Portable Spectrum Analyzer		●									●		●	●	●	●	●	●	●
8648A Opt 1EP Signal Generator						●											●	●	
8648 and ESG Series Signal Generators									7								●	●	
8711/12/13/14C, 8757 Scalar and Vector Network Analyzers		●	5	5													●	●	●
8752/53, 8720, 8510 Vector Network Analyzers		●	●	●													●	●	
11846B Signal Generator								1	1								●		
8643/44/47/56/57/62/63/64/65 Signal Generators								7	7								●	●	
8901A/B Modulation Analyzer													●	●	●		●	●	
8903B/E Audio Analyzers								3	3								●	●	
8920A/B/D/DT RF Communications Test Set	●					●		●	●				●	●	●		●	●	
8921A Cell Site Test Set, Analog, TDMA, CDMA, CDPD Options						●		●	●		●		●	●	●				●
8922S/M GSM MobileTest Set	●					●		●	●		●		●	●	●	●	●	●	●
8923B DECT Test Set	●					●		●	●		●		●	●	●	●	●	●	●
8924C CDMA Mobile Station Test Set	●					●		●	●		●		●	●	●		●	●	●
8935 CDMA PCS Cell Site Test Set						●		●	●		●		●	●	●				●
89400 Series Vector Signal Analyzers											●		●	●	●	●	●		
8991A Peak Power Analyzer													●			●	●		
94000 Mixed Signal LSI Test System					●													●	
E2507B Multiformat Communications Signal Simulator[1]					●			●	●								●	●	
E4900 Series Spectrum Monitoring System[6]											●	●		●					●
E7450A RF Coverage Measurement System											●	●		●					●
EPM-441 Series Power Meter													●				●	●	●
ESA-L1500 Series Portable Spectrum Analyzer											●		●	●			●	●	●
ESG-D Series Digital Signal Generators								1	1								●	●	
RF Components																	●	●	
X-RAY Test System																		●	

HP 11758V
HP 11770A
HP 11757B
HP 3708A

- Performs important installation and maintenance measurements
- Easy to use
- Portable and rugged construction
- Group delay and amplitude flatness measurement option

HP 11758V

HP 11758V Digital Radio Test System

The HP 11758V combines several popular HP instruments into one portable system. This combination provides you with an all-in-one portable system that is ideal for the installation and maintenance of microwave radios, and is especially suitable for work in rugged terrain or remote areas.

The HP 11758V can be configured to have all your necessary measurement functions available during radio installation and maintenance. The spectrum analyzer can even control other HP-IB instruments to automate measurements for quicker and more reliable results.

Test Functions

Spectrum Analysis: 50 kHz to 22 GHz (26 GHz optional)
Swept Source: 300 kHz to 2.9 GHz (options to 24 GHz)
Group Delay and Amplitude Flatness: 300 kHz to RF source maximum frequency (Option 201)
Multipath Signature Test Set: 40 MHz to 90 MHz (options to190 MHz)
Power Meter: 10 MHz to 18 GHz (options to 26 GHz)
Frequency Counter: 50 kHz to 22 GHz (options to 26 GHz)
Intermodulation Test Signal: 70 and 140 MHz bands available and more

Key Literature

Data Sheet, p/n 5091-4651E

HP 11757B Multipath Fading Simulator/ Signature Test Set

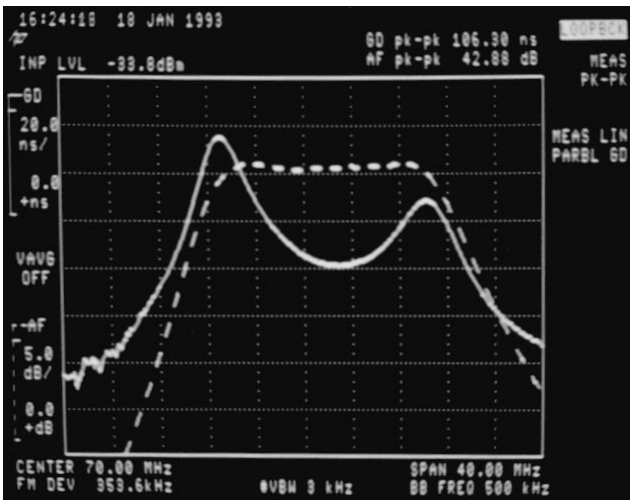
- Automatic multipath signature measurements
- Measures and prints static M-curves, dynamic M- and S-curves, recovery signatures, recovery times, and dispersive fade margin
- High-performance, lightweight, and economical

The HP 11757B characterizes the equalizers in modern digital microwave radios by introducing a precisely-controlled notch in and around the radio's transmission bandwidth. This allows precise measurements of the equalizers' ability to compensate for multipath fading. The HP 11757B records the measurement automatically on a built-in printer.

Key Literature

Data Sheet, p/n 5091-1052EN
Application Note 355-1, *Tools for Digital Microwave Radio Installation and Maintenance*, p/n 5962-9920E

- An economical way to add high-performance, end-to-end group delay measurements to your spectrum analyzer
- Ideal for digital radio, satellite, and cable testing
- Measures any two-port device between 300 kHz and 2.9 GHz



HP 11770A Link Measurement Personality

Accurately-adjusted group delay and amplitude flatness is critical to the proper performance of virtually every wideband digital or analog communication network. The HP 11770A link measurement personality adds group delay and amplitude flatness measurement capabilities to the HP 11758V, with Option 201, (or to an HP 8593E/94E/95E/96E spectrum analyzer configured with Option 111 group delay and amplitude flatness plus tracking generator). This makes it ideal for testing digital and analog terrestrial radios as well as other broadcast and transmission media like satellite and cable networks.

When this personality is installed in a spectrum analyzer, the HP 11770A is far more portable than any previous solution that makes the same group delay and amplitude flatness measurements, plus it maintains the ease-of-use features you expect from standalone test equipment. This measurement configuration also provides important link analysis functions at a significantly lower cost when compared to using separate pieces of test equipment. DADE and return loss measurements can also be made with the optional switch and bridge.

Key Literature

Data Sheet, p/n 5091-4652E

HP 3708A Noise and Interference Test Set

- Carrier tracking maintains accurate and repeatable C/N and C/I conditions
- 10 to 200 MHz bandwidth accommodates 70/140 MHz IFs

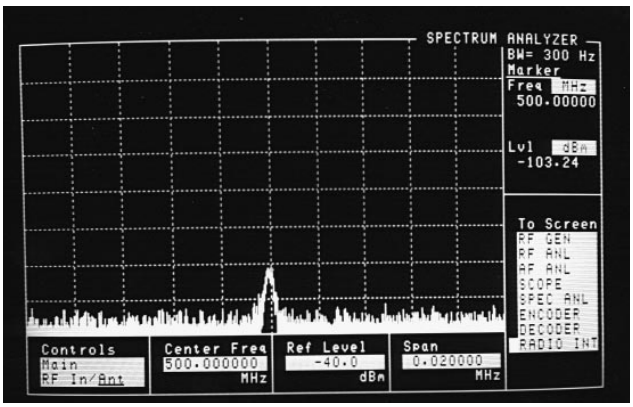
The HP 3708A provides an accurate method of assessing performance of microwave radio and satellite systems by providing carrier-to-noise (C/N) and carrier-to-interference (C/I) to make C/N and C/I versus Bit-Error Ratio (BER) measurements. The HP 3708A can also be used to assess performance of digital TV forward error correction (FEC) by checking the tolerance of quasi-error-free systems to injected noise and interference.

Key Literature

Data Sheet/Brochure, p/n 5953-5433

HP 8920A
HP 11807A

HP 8920A



HP 8920A Spectrum Analyzer displaying signal at –103.2 dBm (1.54 μV). Sensitive Receiver: 2 μV sensitivity (typically < 1 μV), available through the ANT IN port, allows for off-the-air monitoring of low-level signals. For measuring high-power signals, the HP 8920A can accept 100 W intermittently (for 10 seconds) or 60 W continuous.

HP 8920A RF Communications Test Set

The HP 8920A is a full-feature, one-box test set designed to meet service and repair needs in the cellular and land mobile communications market. Combining 22 instruments, the HP 8920A offers full functionality needed in testing cellular phones, land mobile radios, and communications systems up to 1 GHz.

Test and Troubleshoot Faster

The HP 8920A decreases test and troubleshooting time by simplifying standard measurement tasks and providing extensive capability in one box. Transmitters and receivers are simply characterized with single-key RX, TX, and duplex tests. Measured results are displayed on a single screen as either digital measurements or analog bar graphs. All settings and measurements are easily accessed and changed using the front-panel knob, and all settings can be saved in nonvolatile save/recall registers or on a SRAM card media for future access.

Spectrum Analyzer with Tracking Generator and Adjacent Channel Power

The HP 8920A's optional synthesized spectrum analyzer measures signals from 400 kHz to 1 GHz with variable spans from 5 kHz to 1 GHz (full span). Display resolution is selectable from 1, 2, or 10 dB per division. The tuneable marker provides automatic readout of frequency and amplitude, or of relative frequency or amplitude from a reference. The tracking generator included with the spectrum analyzer allows for swept characterization of devices with fully settable amplitude and sweep spans (to 1 GHz). The newly added adjacent channel power measurement capability includes both variable bandwidths and variable frequency offsets. Typical performance is –70 dBc.

Signaling Encoder and Decoder

The optional signaling encoder and decoder support all common signaling formats, including tone sequential, digital paging, DTMF, trunking, and cellular signaling. Common standards are list-selectable and easily modified for different user formats. The decoder displays the tone or digital sequence transmitted, and the duration of the tone or tone pair. For digital paging transmitters, the decoder will display the address/code, the message, and the transmission rate.

HP 11807A Radio Test Software

The HP 11807A is an easy-to-use software solution for automatic testing of radio receivers and transmitters. Running on the HP 8920A's built-in IBASIC computer, the HP 11807A offers a complete selection of tests for land mobile radios, cellular phones, and communication systems. Its flexibility and modularity allows the user to select and change test sequences, test parameters, and pass/fail limits without programming expertise. All test results are displayed on the screen and can be documented with hard-copy printouts when an external printer is added.

The HP 11807A system support tests (Option 100) give technicians automated test capability for commonly performed tasks on communications systems. System support tests include cable-fault location, intermodulation-products calculation, frequency scanning, and field-strength measurement.

International Cellular Phone Testing Solutions

The HP 8920A is capable of testing the world's most common cellular phones by using the HP 11807A radio test software. Three levels of testing are available: manual phone troubleshooting, quick functional checkout, and full parametric testing to system specifications. Cellular formats supported include AMPS, NAMPS, NADC (DAMPS), TACS, NTACS, JTACS, NMT 450, and NMT 900. HP 8920A Option 004 is required for cellular phone tests with HP 11807A software.

Trunked Radio Testing

Three HP 11807A software options are available for testing trunked mobile radios. The options support LTR, EDACS, and MPT 1327 trunked radio equipment with a variety of automated tests available to the user.

Through software control, the HP 8920A will test the ability of a radio to establish a link on a trunked system and can retrieve trunking parameters programmed into a mobile radio. The user can choose from manual operations or automated test sequences for full characterization. Detailed printouts of the radio's performance, with failures highlighted, are output when a printer is used with the HP 8920A. (HP 8920A Option 003 is required for printouts.)

HP 8920A Option 004 is required for trunked system tests with HP 11807A software.

Key Literature

HP 8920A Brochure, p/n 5963-5197E
HP 8920A Price List, p/n 5964-3808EUS
HP 11807A/E Product Overview, p/n 5965-2783E
Service Applications/Brochure, p/n 5952-2795
Manufacturing Application/Brochure, p/n 5952-2796
Cellular Applications/Brochure, p/n 5091-7627

HP 8920B Option 800

HP 8920B RF Communications Test Set

The HP 8920B is a full-function test set based upon the HP 8920A design but with increased measurement speed, accuracy, and larger user memory (928 kbytes standard). The HP 8920B uses PCMCIA memory cards for data storage and radio test programs. The HP 8920B has the functionality, speed, and accuracy for testing land mobile radios, cellular telephones and other communications systems while improving throughput and quality in manufacturing.

HP 8920B Option 800 – HP 83206A TDMA Cellular Adapter

The HP 83206A TDMA cellular adapter (HP 8920B Option 800) provides a complete π/4 DQPSK signal generator, π/4 DQPSK modulation analyzer, data source, and BER analyzer for TDMA measurements on DAMPS (IS-54) and DCCH (IS-136) phones. The HP 83206A supersedes the HP 83201B TDMA cellular adapter (HP 8920B Option 500) for making measurements on TDMA dual-mode DAMPS phones, adding digital control channel test features to fully characterize DCCH phones. This option replaces the HP 8920D for TDMA mobile test.

HP 83236B PCS Upgrade Path

Extend DCCH test capabilities for future PCS phone test by adding the HP 83236B PCS interface to translate DCCH measurement capability to the International and U.S. PCS bands. Power measurement accuracy and speed are maintained at PCS band frequencies with an internal power meter for measurements on CW and TDMA (π/4 pulsed or continuous) signals. HP 8920B Option 801 is an order convenience option that includes the three units needed for PCS mobiles using IS-136 format. Includes: HP 83206A and HP 83236B host firmware integrates the functions of these three units. Also order Options 001, 004, 006, 051, with Option 800 to do IS-136 TDMA mobile test.

The HP 8920B Increases Throughput

The HP 8920B combines a faster processor, increased user memory, and other new features to gain measurement speed over standard HP-IB instruments and the HP 8920A.

Test Time Execution Comparison

HP 8920B compared to:	Typical test time decrease
Stand alone HP-IB instruments	15%
HP 8920A with internal IBASIC programs	30%
HP 8920A program load from memory cards	90%

HP 8920B Has High Performance and Accuracy as Standard Features

Along with speed enhancements, the HP 8920B has signal generator level accuracy or ±1dB at the duplex port and power measurement accuracy or ±5% for levels from 1 mW to 60 watts at the RF In/Out port. Residual FM is less than 7 Hz rms, CCITT. For audio tests, the variable frequency notch filter from 300 Hz to 10 kHz is standard. The FM deviation accuracy is 3.5% and FM distortion less than 0.5%. HP-IB, RS-232, and Centronics ports are standard.

New Call Processing

Cellular phone testing with the HP 8920B has a whole new look and feel with the new call processing subsystem. New front-panel screens simplify manual testing as well as HP-IB programmability. In call-processing mode, the HP 8920B emulates a cellular base station, allowing you to automatically establish and maintain a cellular link between the test set and cellular phone. Use the front-panel knob to register the phone, originate a call, page the phone, hand-off to other channels, change power and release calls as well as make fast parametric measurements while the phone is on a voice or traffic channel.

Easier Programming

The new call-processing subsystem also creates a more user-friendly programming interface for automated cellular phone test. High-level HP-IB commands such as “page” and “register” simplify code generation for phone test.

HP VEE programmers will also benefit with the addition of HP 8920B-HP VEE drivers.

HP 11807E Radio Test Software

The HP 11807E radio test software family offers easy-to-use software programs for automatic testing of radio receivers and transmitters. The HP 11807E software family is the same set of tests as included in the HP 11807A family, but on PCMCIA cards to work with the HP 8920B. A complete selection of tests are available for land mobile radios, cellular telephones, and trunked radio communications systems. The new Option 024 software package is available to test cellular on PCS mobiles using AMPS, NAMPS, DAMPS, and DCCH/PCS formats.

Cellular Telephone and Trunked Radio Testing

The HP 8920B is capable of testing many of the world’s analog cellular and trunked radio systems using the software packages in the HP 11807E family. Cellular systems include: AMPS/EAMPS/NAMPS, TACS/ ETACS, JTACS/NTACS, and NADC-TDMA dual-mode, both DAMPS (IS-54) and DCCH (IS-136). The trunked radio system packages are LTR and EDACS (the trunked packages include FM tests).

Flash ROM Makes Firmware Upgrades Simpler

The HP 8920B firmware is contained in Flash ROM which can be upgraded via a PCMCIA card from the front panel in 2 minutes. The upgrade card can be reused. This helps maintain better process control on your production line by keeping the latest firmware version current with minimum downtime.

Key Literature

HP 8920B Brochure, p/n 5965-4832E
HP 8920B Technical Specifications, p/n 5965-1573E
HP 8920B Configuration Guide, p/n 5965-3296E
HP 8920B Price List, p/n 5965-1574EUS
HP 11807A/E Product Overview, p/n 5965-2783E

HP 8920A
HP 8920B
HP 8920DT
HP 83201B
HP 83206A
HP 83215A
HP 83215B
HP 83236B
HP 11807A
HP 11807E
HP 11807F

HP 8920DT

HP 8920DT Digital RF Communications System

The HP 8920DT system provides parametric test capability for cellular radios using the Personal Digital Cellular (PDC) and Personal Handy Phone System (PHS) formats. The required instruments used in the system are the HP 8920B, HP 83201B, HP 83215A/B, and the HP 11807F control software. The HP 83215A PDC/PHS interface and HP 83215B PHS-only interface provide accurate frequency conversion to bring the test signals into the range of the HP 8920B. The 83201B TDMA Cellular Adapter adds the specific digital signal processing needed for PDC and PHS. The HP 11807F radio test software controls the system to test PDC and PHS radios according to RCR STD-27E (PDC) and STD-28 (PHS). For additional capability, instruments such as spectrum analyzers and signal generators can be added to the system and will be controlled by the system software.

HP 83206A TDMA Cellular Adapter

The HP 83206A TDMA cellular adapter (HP 8920B Option 800) provides a complete π/4 DQPSK signal generator, π/4 DQPSK modulation analyzer, data source, and BER analyzer for TDMA measurements on DAMPS (IS-54) and DCCH (IS-136) phones. The HP 83206A supersedes the HP 83201B TDMA cellular adapter (HP 8920B Option 500) for making measurements on TDMA dual-mode DAMPS phones, adding digital control channel test features to fully characterize DCCH phones.

10

Key Literature

HP 8920DT Product Overview, p/n 5963-5519E

Ordering Information

HP 8920A RF Communications Test Set
- **Opt 001** High-Stability Timebase
- **Opt 102** Spectrum Analyzer with Tracking Generator and ACP
- **Opt 103** HP-IB/RS-232/Parallel dc Current Measurement
- **Opt 004** Tone/Digital Signaling
- **Opt 007** Low-Level RF Power Measurement
- **Opt 008** Cellular Mobile RF Power Measuring Range
- **Opt 010** 400 Hz High-Pass Filter
- **Opt 011** CCITT Weighting Filter
- **Opt 012** 4 kHz Bandpass Filter
- **Opt 013** C-Message Weighting Filter
- **Opt 014** 6 kHz Bandpass Filter
- **Opt 019** Variable Frequency Notch Filter
- **Opt 020** Radio Interface Card
- **Opt 050** Dual-Mode Rear-Panel Connectors

HP 11807A Radio Test Software
- **Opt 001** North American FM Tests
- **Opt 002** European PM Tests
- **Opt 003** AM Tests
- **Opt 004** AMPS/EAMPS/NAMPS Cellular Tests
- **Opt 005** TACS/ETACS/NTACS Cellular Tests
- **Opt 006** NMT Cellular Tests
- **Opt 007** JTACS Cellular Tests
- **Opt 008** AMP/NAMPS/TDMA Dual Mode Cellular Tests
- **Opt 009** "Over-the-Air" TDMA Dual-Mode Cellular Phone Tests
- **Opt 010** LTR®[1] Trunked Radio Tests
- **Opt 011** EDACS2 Trunked Radio Tests
- **Opt 012** MPT 1327 Trunked Radio Tests
- **Opt 100** System Support Tests

HP 8920B RF Communications Test Set
- **Opt 001** High-Stability Time Base
- **Opt 004** Tone/Digital Signaling
- **Opt 006** 10 W to 50 μW Power Measurement Range
- **Opt 007** Low-Level RF Power Measurements
- **Opt 010** 400 Hz High-Pass Filter
- **Opt 011** CCITT Weighting Filter
- **Opt 012** 4 kHz Bandpass Filter
- **Opt 013** C-Message Weighting Filter
- **Opt 014** 6 kHz Bandpass Filter
- **Opt 020** Radio Interface Card
- **Opt 031** Delete Handle and Cover
- **Opt 051** Dual-mode Rear-Panel Connectors
- **Opt 102** Spectrum Analyzer with Tracking Generator and ACP
- **Opt 500** HP 83201B Option 003 TDMA Cellular Adapter
- **Opt 800** HP 83206A IS-136 TDMA Cellular Adapter
- **Opt 801** Adds HP 83206A and 83236B for IS-136 Tests
- **Opt 1CM** Rackmount Kit Without Handle
- **Opt AXK** Rackmount Kit with Option 500 or 800
- **Opt H08** High-level RF Power Measurements to 100 watts continuous
- **Opt 0B0** Delete Manual Set

HP 83206A IS-136 TDMA Cellular Adapter

HP 83236B PCS Interface
- **Opt AX4** Rack Flange Kit Without Handles

HP 11807E PCMCIA Radio Test Software for 8920B
- **Opt 001** North American FM Tests
- **Opt 002** European Phi-M Test
- **Opt 003** AM Tests
- **Opt 004** AMPS/EAMPS/NAMPS Cellular Tests
- **Opt 005** TACS/ETACS Cellular Phone Tests
- **Opt 007** JTACS/NTACS Cellular Phone Tests
- **Opt 008** TDMA Dual-Mode Cellular Phone Tests
- **Opt 009** AMPS/EAMPS/NAMPS/TDMA Dual-Mode Cellular Phone Tests
- **Opt 010** LTR Trunked Radio Tests
- **Opt 011** EDACS Trunked Radio Tests
- **Opt 014** AMPS/NAMPS/DAMPS/DCCH Dual-Mode TDMA Cellular Phones
- **Opt 024** AMPS/NAMPS/DAMPS and DCCH/PCS TMDA Cellular Phones
- **Opt 100** System Support Tests

HP8920DT Digital RF Communication System capability is provided using the following primary instruments plus required options:

HP 8920B RF Communication Test Set
HP 83215A RF Interface
HP 83215B PHS (only) RF Interface
HP 83201B TDMA Cellular Adapter
HP 11807F Radio Test Software with Option 021 or Option 022

Some of the following additional instruments may be necessary to perform some tests:

HP 8595E Spectrum Analyzer
HP 85720C PDC Measurement Personality
HP 85726B PHS Measurement Personality
HP 34401A Digital Multimeter
HP ESG-D300A E4432A Digital and Analog Signal Generator
HP 8643A Synthesized Signal Generator
HP 6642A or HP 6643A DC Power Supply
HP 83219A Test Format Upgrade

[1] LTR is a registered trademark of E. F. Johnson Company.
[2] EDACS is a trademark of Ericsson GE Mobile Communications, Inc.

HP 8921A

HP 8921A Cell Site Test Set

The HP 8921A cell site test set is a highly-portable, integrated solution for the installation and maintenance of AMPS and TACS cell sites. The HP 8921A incorporates more than twenty powerful instruments into a compact, 38-pound package. The integral IBASIC controller in the HP 8921A runs the HP 11807B cell site test software to fully automate base station test and adjustment procedures. Automation combined with accurate measurements increases technician efficiency to speed installation and maintenance procedures.

HP 8921A Features Summary

- AM/FM signal generator
- AM/FM modulation analyzer
- Duplex offset generator
- RF power meter
- RF frequency counter/frequency error meter
- Audio frequency counter and power meter
- AC/DC voltmeter
- SINAD/SNR/distortion meter
- Two variable frequency AF generators
- Digital oscilloscope
- Built-in IBASIC controller
- Spectrum analyzer with tracking generator
- Adjacent channel power meter
- Signaling encoder and decoder
- High-stability timebase
- DC current meter
- HP-IB/RS-232/parallel remote interfaces
- Upgradability to TDMA, CDMA, CDPD, or PCS test capability
- Optional cellular base station test software
- Optional Amps cellular phone test software
- Optional radio interface card
- Optional Ericsson PCM reference

Upgrading for New Formats

Beyond testing analog AMPS and TACS base stations, the HP 8921A is ready to grow with your measurement needs for digital cellular systems with upgrades available for:

- TDMA
- CDMA
- CDPD
- PCS (1710–1990 mHz)

High-Performance Spectrum Analyzer

The spectrum analyzer of the HP 8921A has the wide dynamic range and synthesized frequency accuracy previously found only in expensive stand-alone spectrum analyzers. Wide dynamic range allows the HP 8921A to locate low level signals in the presence of high power transmitters. Synthesized frequency accuracy translates into high confidence that you've located the correct signals.

With frequency spans ranging from 1 GHz to as narrow as 5 kHz, the HP 8921A has the flexibility to look at the entire RF spectrum and then zoom in on the desired signals. The marker function displays the frequency and amplitude of any displayed signal. The marker-to-peak function displays the frequency and amplitude of the largest on-screen signal with a single keystroke.

Built-in Tracking Generator

The HP 8921A spectrum analyzer also includes a built-in tracking generator for tuning base station duplexers. With +13 dBm power output (over range), use the tracking generator as an input stimulus to the duplexer. The calibrated level of the spectrum analyzer ensures accurate adjustment of duplexers. Using the marker function of the spectrum analyzer, the rejection of the duplexer can be measured at any point of the filter response. Antenna return loss can be quickly and accurately measured onsite with the HP 8921A tracking generator. Using the tracking generator to drive the antenna through an external VSWR bridge, the reflected power can be measured on the HP 8921A spectrum analyzer. Other measurements performed with the tracking generator include insertion loss and frequency response of filters, cables, or attenuators. The tracking generator features calibrated output level from –137 to +7 dBm and variable frequency offset for IF to RF conversion measurements. Coupled with 1, 2, and 10 dB per division spectrum analyzer ranges, normalization, and marker capability, the tracking generator makes the HP 8921A ideal for all types of measurements and adjustments.

Automated Base Station Maintenance

For complex base station maintenance, the HP 11807B cell site test software, running on the HP 8921A's internal controller, guides the user through each step of the procedure. Graphical displays show connection diagrams and highlight key adjustment points when required. Technicians spend less time learning and more time testing with the HP 8921A cell site test set.

Another software package, the HP 11807B Option 120, provides AMPS system information. The software uses the HP 8921A to scan for and decode local control channels, display system data, and measure key transmitter characteristics.

Key Literature

HP 8921A Brochure, p/n 5965-1579E
HP 8921A Technical Specifications, p/n 5965-7062E
HP 8921A Configuration Guide, p/n 5965-7061E
HP 8921A Price List, p/n 5965-7063E
Also available are videos showing automated testing of cell site equipment:
Optimize Motorola Cell Sites Fast, p/n 1000-1300
Install and Maintain Ericsson Cell Sites Fast, p/n 1000-1297
Install and Maintain AT&T Cell Sites Fast, p/n 1000-1304

HP 8921A Option 600, 602, 603

HP 8921A Option 500, 502, 503

HP 8921A Option 600, 602, 603 CDMA/CDPD Cell Site Test System

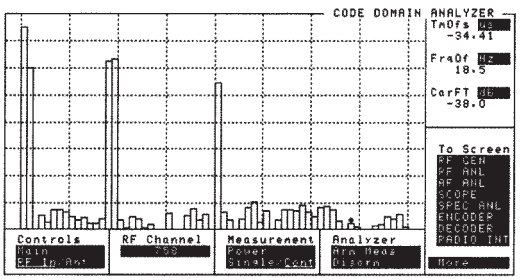
Option 600 for the HP 8921A adds the HP 83205A CDMA cellular adapter to the cell site test set to provide testing of CDMA (IS-95A and IS-97) base station equipment. This system provides signal generation and analysis of QPSK/OQPSK signals. The system measures power in each Walsh-coded signal, code channel timing, and code channel phase relative to the pilot.

The HP 83205A CDPD test option quickly and accurately tests key RF parameters on both the forward-channel transmitter and the reverse-channel receiver. CDPD software, included with all CDPD hardware, automates transmitter, receiver, and system tests—making it easy to standardize system maintenance with fast and accurate test procedures.

HP 8921A Option 600 Features Summary

All HP 8921A standard features, plus:

- Measurements of waveform quality "ρ" (rho), frequency error, time offset, and carrier feedthrough
- Code domain power, timing, and phase analysis
- Average power and CDMA channel power measurements
- CDMA QPSK/OQPSK RF source with data buffer and IS-95 reverse link coding
- Built-in AWGN (Added White Gaussian Noise) source for calibrated E_b/N_o settings



HP 83205A CDMA/CDPD Cellular Adapter

For those who already own HP 8921As, the HP 83205A Option 003 CDMA/CDPD cellular adapter can be added to upgrade the unit to perform the CDMA/CDPD tests described above for the HP 8921A. Note: Older HP 8921As may require an upgrade for complete CDMA capabilities.

HP 8921A Option 500, 502, 503 TDMA/CDPD Cell Site Test System

The HP 8921A Option 500 adds the HP 83204A to the HP 8921A to provide testing of TDMA (IS-136) base station equipment. This unit adds π/4 DQPSK signal generation and analysis to the powerful analog features of the standard HP 8921A. A custom screen provides control of the TDMA source and provides selection of several measurement modes, making all test results visible in one place.

The HP 83204A CDPD test option quickly and accurately tests key RF parameters on both the forward-channel transmitter and the reverse-channel receiver. CDPD software, included with all CDPD hardware, automates transmitter, receiver, and system tests—making it easy to standardize system maintenance with fast and accurate test procedures.

HP 8921A Option 500 Features Summary

All HP 8921A standard features, plus:

- Measurements of TDMA modulation accuracy, including phase error, magnitude error, and error vector magnitude (EVM)
- Measurements of I/Q origin offset and frequency error
- Measurements of adjacent and alternate channel power
- TDMA power measurement
- π/4 DQPSK signal generator
- π/4 DQPSK modulation analyzer
- Continuous/pulsed RF power meter
- Bit-error rate meter
- Baseband data source

HP 83204A TDMA/CDPD Cellular Adapter

For those who already own the HP 8921A cell site test set, the HP 83204A Option 003 TDMA/CDPD cellular adapter can be added to upgrade the unit to provide TDMA (IS-136) and CDPD tests on cell site equipment. Once added, all TDMA test features described above are available for manual use as well as under HP 11807B software control.

HP 83202A Interface Kits

Order the HP 83202A base station connection kit to receive the necessary cables, connectors, and adapters to connect the HP 8921A to a specific type of base station. Available options include connection kits for Motorola, General Electric/Nortel, Ericsson, and AT&T base stations. The 83202A provides everything needed to test base stations with the HP 8921A. Some connection kits also include an interface/switch box to more fully automate the testing process.

HP 83202A Base Station Connection Kits

- Option 032 Ericsson RBS 884 Connection Kit
- Option 040 Motorola Connection Kit
- Option 042 Ericsson Connection Kit
- Option 043 AT&T Connection Kit
- Option 044 GE and Nortel Connection Kit
- Option 070 Motorola AMPS/NAMPS MicroC•I•T•E Connection Kit
- Option 083 Lucent PCS Connection Kit

HP 83236B
HP 11807B

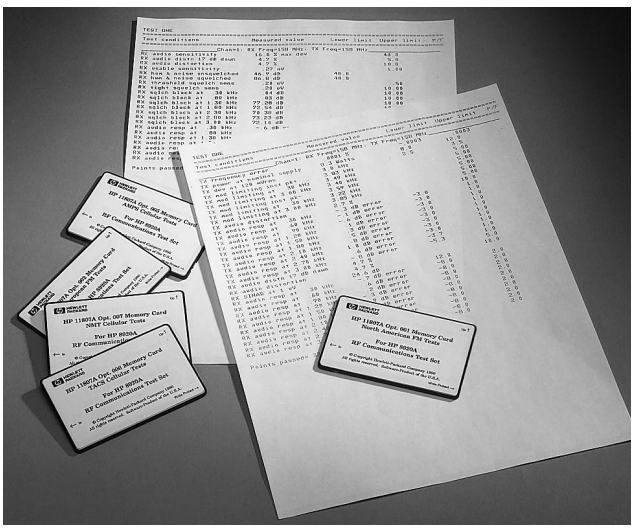
HP 83236B PCS Interface

HP 83236B PCS Interface

The HP 83236B PCS interface extends the HP 8921A CDMA and TDMA measurement capability to the International and U.S. PCS bands. The HP 83236B is controlled via HP-IB from an external controller or from the HP 8921A internal IBASIC controller. The HP 83236B hardware can be integrated with existing HP 8921A systems in the field.

HP 11807B Software for Automated Base Station Maintenance

Developed from manufacturers' recommended maintenance procedures, the HP 11807B cell site test software ensures complete test and adjustment of cell sites. Standardizing system maintenance with the HP 8921A and HP 11807B software increases system integrity. The fast measurement speed of the HP 8921A and HP 11807B software results in less off-line time for each transceiver during maintenance work. Since all cells are uniformly tested using the same test procedure, problems are detected earlier.



Hewlett-Packard has automated testing solutions for the following manufacturers' equipment:

- Motorola HDII, HDII/NAMPS, LD series, TACS, ETACS, UTACS, EUTACS, and MicroC•I•T•E AMPS/NAMPS
- GE standard, extended frequency, and compact RCU series
- Ericsson 882 and 882M analog, microcell, 882D DTRM, and 883, 883M TACS/ETACS, and 884
- Lucent Autoplex Series II analog, LMT microcell, and TDMA/CDMA
- Nortel DRU and P-series
- Hughes GMH 2000 AMPS

In addition to the automated maintenance procedures, the HP 11807B Option 120 provides detailed analysis of AMPS cellular networks. An automated application using the HP 8921A's receiver and decoder, the package displays a wealth of AMPS system data. The system can find local AMPS control channels and display decoded forward control channel data. Other modes decode reverse control channel data, follow calls, and perform measurements on sites or mobiles (see product overview, p/n 5963-6891 EUS).

Total HP Support for Your Cell Site Test Needs

HP offers a variety of options to support cell site testing and keep your solution up to date with the latest technology. The HP 11807B software Option +36H Start-Up Assistance provides one day of on-site training for up to five people. Additional HP consulting/training is also available as needed. Option +SAJ Software Update Subscription keeps your software current by ensuring you get all software enhancements/updates sent to you automatically.

Key Literature

HP 8921A Brochure, p/n 5965-7062E
HP 8921A Technical Specifications, p/n 5965-7062E
HP 8921A Configuration Guide, p/n 5965-7061E
HP 8921A Price List, p/n 5965-7063E
Also available are videos showing automated testing of cell site equipment:
Optimize Motorola Cell Sites Fast, p/n 1000-1300
Install and Maintain Ericsson Cell Sites Fast, p/n 1000-1297
Install and Maintain AT&T Cell Sites Fast, p/n 1000-1304

Ordering Information

AMPS/TACS and CDMA/TDMA/CDPD Cell Site Test
HP 8921A Cell Site Test Set
- **Opt 011** CCITT Weighting Filter
- **Opt 020** Radio Interface Adapter
- **Opt 042** Ericsson PCM Reference
- **Opt 500** TDMA Cell Site Test System
- **Opt 501** TDMA PCS Cell Site Test System
- **Opt 502** CDPD MDBS Cell Site Test System
- **Opt 503** TDMA/CDPD MDBS Cell Site Test System
- **Opt 600** CDMA Cell Site Test System
- **Opt 602** CDPD MDBS Cell Site Test System
- **Opt 603** CDMA/CDPD MDBS Cell Site Test System
- **Opt W30** Three-Year Warranty

HP 83204A TDMA Cellular Adapter
- **Opt 001** TDMA Cellular Adapter, upgradeable to CDPD
- **Opt 002** CDPD Cellular Adapter, upgradeable to TDMA
- **Opt 003** TDMA/CDPD Cellular Adapter

HP 83205A CDMA Cellular Adapter
- **Opt 001** CDMA Cellular Adapter, upgradeable to CDPD
- **Opt 002** CDPD Cellular Adapter, upgradeable to CDMA
- **Opt 003** CDMA/CDPD Cellular Adapter

HP 83236B PCS Interface

Software for Automated Base Station Maintenance
HP 11807B Cell Site Test Software
- **Opt 040** Motorola AMPS/NAMPS Test Software
- **Opt 041** General Electric AMPS Test Software
- **Opt 042** Ericsson AMPS/TDMA Test Software
- **Opt 043** AT&T AMPS/TDMA Test Software
- **Opt 044** Nortel AMPS/TDMA Test Software
- **Opt 045** Hughes AMPS Test
- **Opt 050** Motorola TACS/ETACS/UTACS Test Software
- **Opt 052** Ericsson TACS Test Software
- **Opt 070** Motorola AMPS/NAMPS MicroC•I•T•E
- **Opt 083** Lucent PCS CDMA BS Test Software
- **Opt 093** Lucent PCS TDMA BS Test Software
- **Opt K84** Nortel PCS CDMA BS Test Software
- **Opt 120** AMPS Call Analysis, Logging and Monitoring Software

Base Station Connection Kits
HP 83202A Base Station Connection Kit
- **Opt 032** Ericsson RBS 884 Connection Kit
- **Opt 040** Motorola Connection Kit
- **Opt 042** Ericsson Connection Kit
- **Opt 043** AT&T Connection Kit
- **Opt 044** GE and Nortel Connection Kit
- **Opt 070** Motorola MicroC•I•T•E

10

- New generation of base station test equipment
- Improve technician efficiency and enhance system performance
- New User Interface
- Rugged, portable design

HP 8935 CDMA Cellular/PCS Base Station Test Set

NEW

The HP 8935 is a full featured, one-box test set designed to meet the needs of installation teams, service providers, and network equipment manufacturers. Building on the success of our third generation of cell site test equipment, and incorporating HP's pioneering efforts in CDMA measurement techniques, this new generation of test gear heavily incorporates feedback from cellular and PCS users. For example, the HP 8935 utilizes a new, larger, bright electro-luminescent display for easily read data. A new convenient connector section allows unobtrusive, out-of-the-way hook up. A suitcase form factor provides better portability. The HP 8935's new "rugged design" combines a membrane keypad, a gasketed display, stand up operation, filtered airflow and an enclosure to help protect itself from bumps and shocks.

More importantly, the new HP 8935 incorporates a less intimidating, more user-friendly interface with Windows type pull down menus. This new interface, coupled with the HP 8935's faster measurement speed and automated software for Lucent, Nortel and Samsung PCS base stations (additional NEMs forthcoming), results in less off-line time and improved system performance. Errors due to test variability are reduced, and measurement data can be output to a printer or to the PCMCIA memory card. Additionally, the HP 8935's firmware is user-upgradeable with a PCMCIA card to Flash PROM. New features and capabilities can be added without returning the unit to a service center. To round out HP's new instrument, the HP 8935 options include new PCS CDMA technician training programs to provide install teams and service providers with a complete CDMA base station solution.

HP 8935 Key Feature Summary

- Signal quality measurements
  - Rho (ρ)
  - Time offset
  - Frequency error
  - Carrier feedthrough
- Code domain measurements
  - Code domain power
  - Code domain timing
  - Code domain phase
- Average power
- Return loss (SWR) measurements
- Channel power
- Cable fault location measurements
- Error vector magnitude, magnitude error, phase error
- Reverse channel source with data buffer
- AWGN (built-in calibrated E_b/N_o levels)
- Support for CDMA reference clocks and triggers
- Output power/monitoring/adjustment
- Ruggedized design
- Large, electro-luminescent screen (important for outdoor testing)
- Convenient connector placement
- One-button user interface keys
- Pull-down menus
- Optional automation software
- User-upgradeable firmware–PCMCIA to Flash PROM
- AM/FM signal generator
- AM/FM modulation analyzer
- Duplex offset generator
- RF power meter
- RF frequency counter/frequency error meter
- Audio frequency counter and power meter
- Spectrum analyzer with tracking generator (200 kHz–1GHz, 1.7–2 GHz)
- DC current meter
- HP-IB/RS-232/parallel remote interfaces
- High-stability time base
- AC/DC voltmeter
- Digital oscilloscope
- Built-in I-BASIC controller

Rugged Design

The mechanical design of the HP 8935 addresses the physical requirements of today's PCS base stations which may be exposed to the elements. Ruggedized attributes include:

- Membrane keypad–resists moisture and dirt, easily cleaned, high reliability
- Gasketed display–to keep out moisture for weather resistance
- Stand-up operation–needed for outdoor cell sites with no place to set equipment
- Low center of gravity–minimizes tip-overs when unit is standing
- Filtered air flow–keeps dirt/dust out of instrument for improved reliability/safety

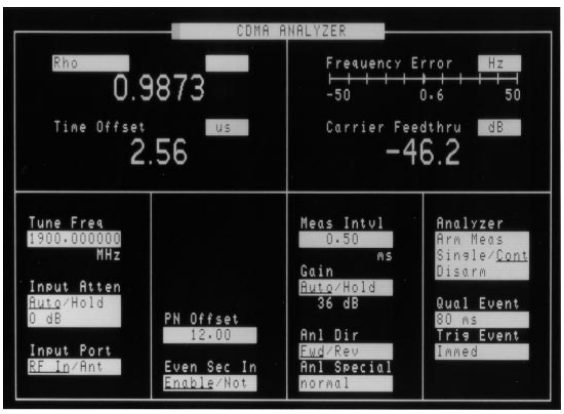
Portability

The newly-enhanced mechanical design provides a "suitcase" form factor that is less bulky and more manageable. Total weight of the unit measures 44 lbs. No additional add-on boxes are required to implement receiver testing.

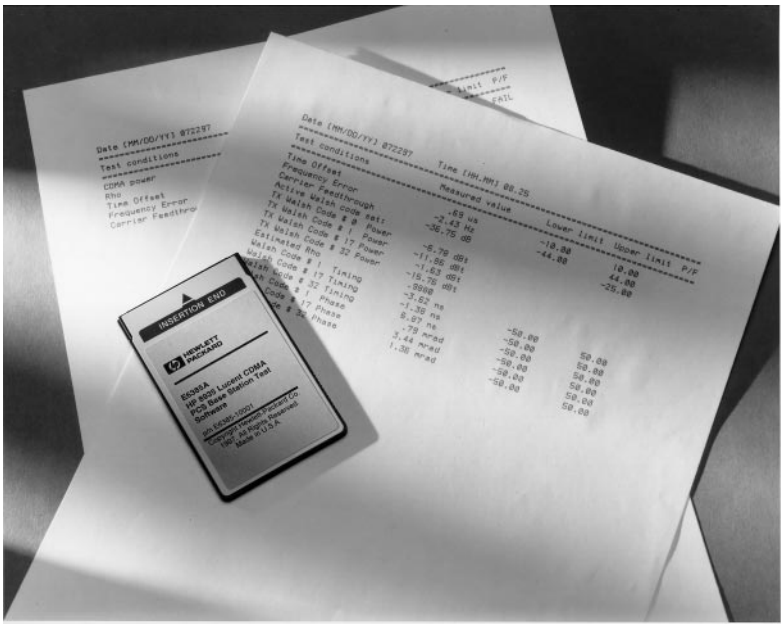
Key Literature

HP 8935 Brochure, p/n 5966-0339E
HP 8935 Technical Specifications, p/n 5966-0512E
HP 8935 Configuration Guide, p/n 5966-0686E
HP 8935 Price List, p/n 5966-0689EUS

New User New Interface



The new user interface provides "pull-down" menus which replace the lower right hand corner menu system. This increases usable viewing space making it less congested and easier to read.



HP 8935 Software for Automated Base Station Installation and Maintenance

Developed from manufacturer's recommended installation and maintenance procedures, the HP 8935 cell site test software ensures complete cell site testing. Software enhancements for Lucent, Nortel, and Samsung base stations provide structured automated testing. A simple menu-driven user interface requires less technical expertise to retrieve consistent, reported measurements. Less skilled technicians can make measurements with the same confidence as their highly skilled/experienced counterparts.

Lucent PCS CDMA Cell Site Software Highlights

- Installation and maintenance
- Automated CDMA test procedures
- Simple, menu-driven user interface
- Output reports for detailed analysis and recordkeeping
- PN offset search
- In-service transmitter testing
- Automated MSC control via a modem connected to test set
- Insertion loss measurements

Nortel PCS CDMA Cell Site Software Highlights

- Automates the installation procedure developed by Nortel
- Automated CDMA test procedures
- Simple, menu-driven user interface
- Pre-configures test set for ease of use
- Automates cable and other RF component loss measurements
- PN offset search
- Ability to perform spectrum clearing check
- Ability to perform receiver functionality tests (Nortel implemented dependent)

Total HP Support for Your Cell Site Test Needs

HP offers a variety of options to support cell site testing and to keep your solution up-to-date with the latest technology. HP also offers start-up assistance and formal training programs. Additional HP consulting/training is also available as needed.

Key Literature

Lucent Software Brochure, p/n 5965-9845E
Nortel Software Brochure, p/n 5966-1224E
Samsung Software Brochure, p/n 5966-1182E

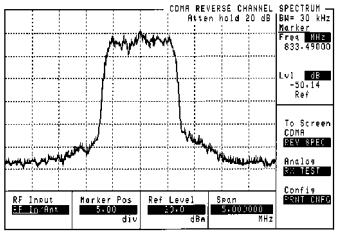
HP 8935 Interface Kits

Order the HP 8935 base station connection kit to receive the necessary cables, connectors, and adapters to connect the HP 8935 to a specific type of base station. Available options include connection kits for Lucent Technologies and Nortel.

Ordering Information

HP 8935 CDMA Cellular/PCS Base Station Test Set
E6380A (HP 8935) CDMA Cellular/PCS Base Station Test Set
Opt 1D5 High Stability Frequency Reference
Opt OBK Paper and CD ROM Manual
Opt OBC Manual on CD ROM Only
Opt 023 Lucent CDMA Cellular Base Station Software

HP 8924C



HP 8924C CDMA Mobile Station Test Set

The HP 8924C CDMA Mobile Station Test Set provides the key set of measurements to manufacture high quality Dual Mode CDMA mobile telephones in a single box. Acting as a calibrated, high performance CDMA base station, the HP 8924C verifies not only the parametric performance of CDMA phones, but also the functional aspects of phone performance. The HP 8924C is optimized to provide high accuracy measurements with the speed required for efficient manufacturing. The standard HP 8924C tests IS-95A-compliant CDMA phones for use with systems that operate from 500 MHz to 1000 MHz. In addition to its CDMA functionality, the HP 8924C includes full AMPS, NAMPS and TACS analog phone test capability. To extend the capabilities of the HP 8924C to test PCS CDMA phones, order Option 601 with the HP 8924C. This option adds the HP 83236B PCS Interface to cover the 1700 to 2000 MHz frequency range. When attached, the PCS Interface is transparently controlled by the HP 8924C. Together, the HP 83236B PCS Interface and HP 8924C appear as one instrument for both manual and HP-IB control applications. With the HP 8924C, you save space and cost by making both analog cellular and CDMA digital cellular/PCS measurements with one instrument.

CDMA Base Station Simulator

The HP 8924C includes a full QPSK signal generator that follows the TIA IS-95A CDMA air interface specifications for base stations. The CDMA Signal Generator supports an AWGN (Additive White Gaussian Noise) source as well as up to two CDMA sectors. Sector A supports the following CDMA channels: Pilot, Sync, Paging, Traffic, and OCNS. Sector B offers only a Pilot channel, Traffic channel and OCNS channel. Absolute power is individually settable for the AWGN source, Sector A, and Sector B in terms of total power in a 1.23 MHz bandwidth. The total CDMA signal generator power is the sum of these three settings.

Using industry standard ASIC's, the HP 8924C supports the protocol required to emulate a CDMA base station sufficiently for mobile station test. The HP 8924C also includes a full OQPSK demodulator for CDMA mobile station transmitter and Frame-Error-Rate receiver measurements. Since CDMA mobiles are tested with a cabled connection to the test equipment, the HP 8924C does not support over-the-air signal reception.

Functional CDMA Mobile Test

The HP 8924C supports both mobile or base station initiated call connect and disconnect. Enter the required RF channel number, wait for the mobile to acquire service, connect the CDMA mobile to the HP 8924C, and press the call key to make a CDMA phone call. To check voice quality, the HP 8924C offers a voice echo mode. When active, the voice echo mode delays and then re-transmits to the mobile-under-test any audio spoken into the CDMA mobile. An operator can quickly verify voice quality by speaking into the phone and then listening to the echoed audio in the mobile's handset.

CDMA Transmitter Tests

Transmitter tests include fast, DSP-based average power measurements from +38 dBm down to –10 dBm, and accurate channel power measurements down to –50 dBm. The tuned channel power measurement reports the power in a 1.23 MHz measured at the internal IF of the HP 8924C. By calibrating the tuned channel power measurement against the average power measurement, the HP 8924C achieves accurate low level CDMA power measurements. These two power measurement modes allow accurate verification of maximum power, minimum power, open loop power control, and closed loop power control.

The HP 8924C measures transmitted waveform compatibility by the IS-98A recommended correlated power method "ρ" (rho). This measurement returns the percentage of transmitted power that correlates to the desired code. In addition, the "ρ" measurement reports the frequency error, modulation phase and amplitude error, and the carrier feedthrough.

CDMA Receiver Tests

The key performance parameter for CDMA mobile station receivers is Frame-Error-Rate performance with and without the presence of AWGN. The built-in, high accuracy AWGN generator in the HP 8924C guarantees that FER tests provide a true picture of a CDMA mobile to correctly demodulate a signal in the presence of high interfering noise. The HP 8924C fully supports service Options 002 and 009 (RF loopback mode) to test receiver FER performance. The HP 8924C optimizes FER measurement time by employing confidence limit technology. With confidence limits, FER measurements are made in the fastest possible time. Simply set the target frame error rate and confidence limit and start the test. The HP 8924C then uses a statistical model to determine if the CDMA phone has passed the test. An HP innovation also extends the confidence limit methodology to stop the test early if the phone fails the confidence limit with the requested confidence interval. Early termination on FER tests eliminates wasted time when testing clearly defective mobiles. The HP 8924C supports FER measurements at all four data rates: full, half, quarter, and eighth for both 9600 bps and 14400 bps voice channels.

Softer Handoff Verification

With two configurable CDMA sectors, the HP 8924C verifies the ability of a CDMA mobile to support softer handoffs. Softer handoff is similar to soft handoff and only differs in that the HP 8924C sends identical power control bits to both CDMA cell sectors. The HP 8924C displays the mobile reported signal strength to allow verification of its ability to acquire and accurately measure pilot power of other signals used for soft handoff. This advanced capability in a single instrument provides a low cost method of verifying soft handoff functionality without the expense of two base station simulators.

Analog Capabilities

In addition to its powerful CDMA test capabilities, the HP 8924C retains full analog cellular test capability. Based on the HP 8920B RF Communications Test Set, the HP 8924C is backwards compatible with most HP 8920B HP-IB commands. The HP 8924C includes as standard equipment many optional features of the HP 8920B such as: a high stability timebase, a CCITT filter, a 6 kHz bandpass filter, and spectrum analyzer/tracking generator. In addition, the HP 8924C supports easy CDMA to analog handoffs and "one-button" analog cellular call processing for AMPS, NAMPS, TACS, and JTACS phones . These analog features not only allow the HP 8924C to test dual mode phones, but also provides an effective suite of measurement tools for radio troubleshooting.

HP 83217A Dual Mode Mobile Station Test Software

Besides its many measurement functions, the HP 8924C includes a programmable IBASIC controller. This controller allows the creation of custom measurement software. For those who do not wish to write their own software, Hewlett-Packard offers the HP 83217A Dual Mode Mobile Station Test Software. The HP 83217A automates cellular mobile measurements using the HP 8924C. Automated testing improves consistency and reduces operators errors resulting in lower operation costs and improved product quality.

The HP 83217A offers two options for testing cellular mobile stations. Option 001 supports testing of mobiles that are AMPS, NAMPS, and CDMA dual mode, while Option 002 supports testing of TACS, ETACS, and CDM dual mode mobiles. Option 003 supports testing of NTACS, JTACS, and CDMA dual mode phones, while Option 004 supports PCS CDMA/ AMPS, or NAMPS dual mode, dual band phone testing. These software packages provide a comprehensive suite of analog and digital tests that can be freely arranged to fit specific requirements. Test points, test limits, and test sequences can be stored for future retrieval.

Analog Mode Specification Summary

Signal Generator

RF Frequency Range
Standard: 30 MHz to 1000 MHz
With Option 601: 800 MHz to 960 MHz, 1710 MHz to 1990 MHz

Output
RF In/Out Connector
Level Range
Standard: –127 to –10.5 dBm into 50 ohms
With Option 601: –130 to –20 dBm into 50 ohms
Level Accuracy
Standard: ±1.2 dB (Level >= –127 dBm)
With Option 601: ±1.8 dB @ 25° C ±10° C
Reverse Power
Standard: 3 watts continuous
With Option 601: 10 watts continuous
Duplex Out/RF Out Only Connector
Level Range
Standard: –127 to +3.5 dBm into 50 ohms
With Option 601: –130 to –10 dBm into 50 ohms
Level Accuracy
Standard: ±1.0 dB (Level >= –127 dBm)
With Option 601: ±1.8 dB @ 25° C ±10° C
Reverse Power: 200 mW maximum

Maximum FM Deviation (rates > 25 Hz)
Standard: 100 kHz; 501 MHz to 1000 MHz
With Option 601: 100 kHz; 800 to 960 MHz, 1710 to 1990 MHz

RF Analyzer

Frequency Measurement Range
Standard: 30 MHz to 1000 MHz
With Option 601: 800 MHz to 960 MHz, 1710 MHz to 1990 MHz

RF Power Measurement (RF in/out connector only)
Measurement Range
Standard: –10 dBm to +35 dBm (0.1 mW to 3 W)
With Option 601: –13 dBm to +40 dBm (50 μW to 10 W)
Accuracy
Standard: ±5% of reading ±0.01 mW from 15° C to 35° C
With Option 601: ±5% of reading ±2.5 μW from 13° C to 33° C

Spectrum Analyzer

Frequency Range:
Standard: 30 MHz to 1000 MHz
With Option 601: 800 MHz to 960 MHz, 1710 MHz to 1990 MHz
Resolution Bandwidth (coupled to span): 300 Hz to 300 kHz
Display Range: 80 dB

AF Analyzer

Frequency Measurement
Measurement Range: 20 Hz to 400 kHz
Accuracy: ±0.02% + resolution + reference oscillator accuracy
SINAD Measurement
Fundamental Frequency Range: 300 Hz to 10 kHz ±5%
Accuracy: ±1 dB for Fc=300 to 1500 Hz, using the 15 kHz LPF
Residual THD+Noise: –60 dB or 150 μV, whichever is greater

Oscilloscope

Frequency Range (–3 dB BW): 2 Hz to 50 kHz
Scale/Division: 10 mV to 10 V
Time/Division: 10 μs to 100 ms

Remote Programming

HP-IB: Hewlett-Packard's implementation of IEEE Standard 488.2
RS-232: 3-wire RJ-11 connector used for serial data in and out
Centronics Port: Industry standard parallel printer port

Ovenized Reference

Aging Rate: <0.005 ppm pk-pk/day, <±0.1 ppm per year

CDMA Mode Specification Summary

CDMA Call Processing Functionality

Protocol Stack: IS-95, IS-95A, TSB-74, and J-STD-008
Service Option Modes: SO 001, SO 002 (9600 bps loopback), SO 003, SO 009 (14400 bps loopback), and SO 32768
Traffic Channel Data Rates: 9.6 kbps or 14.4 kbps
Call Control: BS call originate, BS call disconnect, MS call originate, MS call disconnect
Hand-off Support: CDMA to CDMA Hard (RF Frequency), CDMA Softer, CDMA to Analog (intraband), and CDMA PCS to Analog Cellular

CDMA Signal Generator

CDMA Channels
Additive White Gaussian Noise
Sector A – includes the following channels: Pilot Channel, Sync Channel, Paging Channel, Traffic Channel, and OCNS Channel
Sector B – includes the following channels: Pilot Channel, Traffic Channel,and OCNS Channel

Frequency Range
Standard: 501 MHz to 1000 MHz, usable from 30 to 248.9 MHz
With Option 601: 800 MHz to 960 MHz, 1710 MHz to 1990 MHz

Composite Signal Output Level Range
Standard:
RF In/Out: –109 dBm/1.23 MHz to –21.5 dBm/1.23 MHz
Duplex Out: –109 dBm/1.23 MHz to –7.5 dBm/1.23 MHz
With Option 601:
RF In/Out: –109 dBm/1.23 MHz to –20.01 dBm/1.23 MHz
RF Out Only: –109 dBm/1.23 MHz to –10.01 dBm/1.23 MHz

Composite Signal Output Level Accuracy (AWGN off)
Standard: ±1.5 dB, typically ±1.0 dB
With Option 601: ±1.8 dB at 25° C ±10° C , typically ±1.0 dB

Relative CDMA Channel Level Accuracy: 0.2 dB

CDMA Analyzer

CDMA Average Power Measurement
Input Frequency Range:
Standard: 30 MHz to 1000 MHz
With Option 601: 800 MHz to 960 MHz, 1710 MHz to 1990 MHz
Measurement Range (RF in/out connector only):
Standard: –10 dBm to +35 dBm (0.1 mW to 3 W)
With Option 601: –13 dBm to +37 dBm (50 μW to 5 W)

Measurement Accuracy
Standard: ±5% of reading ±1 μW from 15° C to 35° C
With Option 601: ±5% of reading ±2.5 μW from 13° C to 33° C

CDMA Channel Power Measurement
Measurement Range: –50 to +10 dBm/1.23 MHz
Calibration: Must be cross calibrated to Average Power Meter

CDMA Modulation Measurement
Input Level Range:
Standard: –20 dBm to +35 dBm, usable to –30 dBm
With Option 601: –25 dBm to +37 dBm, usable to –35 dBm
"ρ" **Measurement Accuracy:** "ρ" ±0.003.
Frequency Error Measurement Accuracy: ± 30 Hz
Other Reported Parameter with "ρ" Measurement: Static Timing, Carrier Feedthrough, Amplitude Error, Phase Error

CDMA Frame Error Rate Measurement
FER Measurement Method: Data loopback using Service Option 002 or 009 supporting Confidence limits per TIA IS-98A
FER Reported Parameters: Measured FER, Number of Errors, Number of Frames tested, Pass or Failed Confidence limit

General Specifications

Dimensions (HxWxD)
Standard: 177 H x 426 W x 574 D mm (7 x 16.75 x 23 inches)
With Option 601: 254 H x 426 W x 574 D mm (3.4 x 13 x 19 inches)

Weight
Standard: 27 kg, 59 lbs
With Option 601: 32.6 kg, 72 lbs

Operating Temperature: 0° C to +55° C

Power
HP 8924C: 100 V to 240 V, 50/60 Hz, nominally 400 VA
HP 83236B: 90 V to 132 V, 198 V to 264 V, 47 to 63 Hz, 100 VA

Ordering Information

CDMA Mobile Station Test Set
HP 8924C CDMA Mobile Station Test Set
Opt 011 ETACS CCITT Filter
Opt 601 PCS CDMA Mobile Station Test System
Opt OBW Service Documentation
Opt OB1 Add Manual Set
Opt AX4 Rack Flange Kit
Opt W30 3 Years of Customer Return Repair Service
Opt W50 3 Years of Customer Return Repair Service

CDMA CDMA Dual Mode Mobile Station Test Software
Must order one and only one option per unit HP 83217A
HP 83217A CDMA Dual Mode MS Test Software
Opt 001 AMPS/NAMPS/CDMA
Opt 002 TACS/ETACS/CDMA
Opt 003 NTACS/JTACS/CDMA
Opt 004 PCS CDMA/NAMPS/AMPS

Mobile/Cellular Radio Test Sets

GSM900, DCS1800, and PCS1900 Test Sets

HP 8922A
HP 8922B
HP 8922S
HP 8922M

- Complete GSM/DCs mobile station test sets
- Designed to minimize prodution/service costs
- Built-in toolkit of instruments
- E-GSM capability
- Fast and easy to use
- Accurate and repeatable GSM measurements
- Built-in IBASIC controller for easy automation

HP 8922M

HP 8922A/B/S/M GSM Test Sets

The HP 8922A, 8922B, 8922S, and 8922M are integrated test solutions for the prodution and servicing of GSM900, DCS1800, and PCS1900 radios. These test sets are based on a common, expandable platform. The HP 8922A is a tool box with the necessary hardware to test the RF characteristics of GSM modules. For base station testing, the HP 8922B builds on this platform by adding a large memory and reference section to provide baseband data patterns to control the built-in 0.3GMSK source. The HP 8922S is a standalone GSM mobile station tester. For service applications it includes a GSM base-station emulator and all the signaling capability to fully test a mobile without additional equipment. For manufacturing applications, the HP 8922M adds high-speed testing and additional flexibility to maximize production throughput.

Minimize Production/Service Testing Costs

The HP 8922M is built for manufacturing, with accurate and repeatable measurements; it provides the minimum test times under HP-IB remote control. The HP 8922S is tailored to the demanding needs of incoming inspection and mobile repair. It has all of the ingredients necessary to minimize the cost per phone, a rich set of features which balances fast testing with a built-in toolkit of instruments, and automatic test software. Features are bound together with an intuitive menu-driven user interface. Sharing a common RF measurement architecture, the HP 8922S/M guarantees consistent test results during each stage of a phone's life, minimizing the chances of good phones being rejected at incoming inspection, maximizing the quality of new and repaired phones. Both products are developed from the industry standard HP 8922H.

GSM Radio Test Solutions

The HP 8922 contains a complete set of instrumentation for testing the RF sections of GSM radios. In addition to the frequency agile 0.3 GMSK RF generator, the RF analyzer has an agile local oscillator, coherent data demodulator, pulse demodulator, FM demodulator, global method analyzer for phase and frequency error, synthesized spectrum analyzer, and pulse power meter. The HP 8922B adds a large programmable RAM and phase-lock-loop timing generator for generating long GSM data patterns. The HP 8922S/M adds a bit-error-rate tester (BERT) for performing GSM receiver measurements, channel CODEC, and call control protocol to setup a phone call and maintain the link while performing measurements. Echo mode is facilitated by the voice CODEC for functional testing of a mobile, and the electrical man machine interface (EMMI) is implemented for controlling the mobile and supporting the digital audio interface (DAI). Flash memory on the HP 8922M allows easy upgrades.

Complete Tool Set

Aside from their complete complement of GSM measurements, the HP 8922 contains general-purpose tools useful for module test, troubleshooting, and debugging activities. The tools include a digital oscilloscope, CW RF synthesizer, spectrum analyzer, CW RF frequency counter, CW and peak RF power meter, ac voltmeter, dc voltmeter, 1 kHz distortion/SINAD meter, audio frequency counter, and synthesized audio source. The sum of these capabilities makes the HP 8922 an extraordinarily powerful tool for the manufacture, installation and repair of GSM radio equipment.

HP 83212C GSM/DCS1800/PCS1900 Mobile Test Software

The HP 83212C is an easy-to-use software solution for automatic testing of GSM900, DCS1800 and PCS1900 mobile stations. Running on the HP 8922S/M's built-in IBASIC controller, the HP 83212C offers a comprehensive set of tests ideal for incoming inspection and repair of GSM phones. Its flexibility and modularity allow you to select and change test sequences, test parameters, and pass/fail limits without programming expertise. Procedures can be simply saved on RAM cards and distributed to colleagues, guaranteeing consistent test methods. All test results are displayed on the screen and can be documented with hardcopy printouts when an external printer is added. Three levels of testing are available with the HP 83212C: manual mobile station troubleshooting, quick functional checkout, and full parametric testing. Automating your measurements provides repeatable results while allowing the user to test more mobile stations in less time. This increase in throughput lowers your testing cost.

HP 83220A/E DCS/PCS Test Sets

Adding an HP 83220A/E expands the capabilities of the HP 8922 family to comprehensively test DCS1800 and PCS1900 equipment. The HP 83220E provides a cost-effective solution for mobile testing. The HP 83220A tests both mobiles and base stations. All features of the HP 8922 are retained.

HP 8922A
HP 8922B
HP 8922S
HP 8922M

HP 8922S/M Specifications

RF Generator

Frequency Range: 10 MHz to 1000 MHz
Frequency Resolution: 1 Hz
Switching Speed: 577 μs
0.3 GMSK Modulation[1]: External clock and data
Pulse Modulation[1]: Normal and 30 dB
Output Power: –16 to –127 dBm

RF Analyzer

Frequency Range: 10 MHz to 1000 MHz
Frequency Resolution: 1 Hz (100 kHz in hop mode)
Switching Speed: 577 μs
Coherent Data Demodulation[1]: 0.3 GMSK at 270.833 Kb/s, 1 timeslot/frame
Analog Demodulation[1]: FM and pulse
Global Method: rms and peak phase error, frequency error
Amplitude Envelope: Rise, fall, and burst flatness over useful bits
Peak Transmitter Power: +10 dBm to +45 dBm (– 5 dBm to 41 dBm on HP 8922F/H)
Output RF Spectrum Measurements[2]: Due to modulation and switching transients
CW Frequency Counter: 10 MHz to 1000 MHz

Spectrum Analyzer[2]

Frequency Range: 10 MHz to 1000 MHz
Frequency Accuracy and Stability: Same as timebase
Display Range: 80 dB
Other Features: External trigger, marker

Digital Oscilloscope

Frequency Range: 2 Hz to 50 kHz
Sweep Times: 10 μs to 100 ms in 1, 2, 5, 10 steps

Audio Analyzer

Frequency Range: 20 Hz to 400 kHz
AC Voltage Range: 0 to 30 V_{rms}
DC Voltage Range: 100 mV to 42 V
THD + Noise: 1 kHz ± 5 Hz
Sinad: 1 kHz ± 5 Hz

Audio Source

Frequency Range: DC to 25 kHz
Output Level Range: 0.1 mV_{rms} to 4 V_{rms}

Reference Oscillator

External Reference Input Frequency: 13, 10, 5, 2, or 1 MHz
External Reference Output: 10 and 13 MHz

Remote Programming

HP-IB: IEEE-488.2
RS-232: 300, 1200, 2400, 4800, 9600, and 19200 baud

Internal Programming

Programming Language: Hewlett-Packard Instrument BASIC
Program Storage: 32 KB to 512 KB external memory cards

General Specifications

Size: 426 mm W x 177 mm H x 574 mm D (16.75 in x 7 in x 23 in)
Weight: 32 kg (70 lb)
Operating Temperature: 0° to + 55° C
Storage Temperature: – 40° to + 75° C
Power: 100, 120, 220, 240 Vac, 48 to 440 Hz, ±10% of line voltage

GSM Functionality

Broadcast Channel Capability: BCCH + CCCH or BCCH + CCCH +SDCCH/4
Control Channels: BCCH + CCCH, BCCH + CCCH + SDCCH/4, SDCCH/8 (non-hopped), SACCH/FACCH
Traffic Channels: TCH/FS
Call Control Capabilities: BS originated call (FS), MS originated call (FS), MS camp on, BS call disconnect, MS call disconnect
Timing: Auto, manual, uplink-downlink offset measurement
Hopping: Cyclic only, two MA tables with offsets
Digital Audio Interface (DAI)[1]: Normal operation and test of acoustic devices and A/D & D/A
Electrical Man Machine Interface[1]: Control via HP-IB
Speech Encoding/Decoding: Full rate speech (FS)
Echo Mode
HP 8922S: 1 second delay
HP 8922M: user selectable delay, 0 to 5 seconds
Bit/Frame Error Rate Measurements: Class Ia, Ib, and II bits. New fast BER measurement has been added.
MS Power Output Level Control: 0 to 19, 30, 31 with RF analyzer auto adjust
Measurement Coordination: Flexible control of burst, ARFCN, and timeslot
SACCH MEAS Results: RXLEV, RXQUAL, timing advance
SMS Cell Broadcast, IMSI attach/detach

HP 8922B Additional Specifications

Data Buffer

Frame Control RAM: Memory for 102 unique GSM frames
Data RAM: 64 KB FIFO for active timeslot (load via GPIO)
Hop RAM: 32 KB for controlling HP 8922B frequency hopping

GSM Reference

External Reference Input Frequencies: 13, 10, 5, 2, 1 MHz, bit clock, or frame clock

HP 83220E Specifications

Frequency Range: 1805 to 1990 MHz

Ordering Information

HP 8922A GSM RF Test Set
HP 8922B GSM BS Test Set
HP 8922S GSM MS Service Test Set
HP 8922M GSM MS Test Set
HP 83212C GSM/DCS1800 PCS1900 MS Test Software
HP 83220A DCS/PCS MS/BS Test Set
HP 83220E DCS/PCS MS Test Set
Options for HP 8922A, 8922B, 8922S, and 8922M
Opt 001 High-Stability Timebase
Opt 002 Transit Protection (front panel cover, accessory pouch, and extended rear feet)
Opt W30 3 years Return Repair Service
Options for HP 8922A and 8922B
Opt 910 Provides a total of two sets of Operation Manuals and Service Manuals
Opt 913 Rackmount Flange Kit
Opt 915 Adds Service Manual
Options for HP 8922S and 8922M
Opt 006 Spectrum Analyzer
Opt 007 GSM900 Test SIM Card
Opt 008 GSM900 Test Micro SIM Card
Opt 012 GSM/DCS1800/PCS1900 MS Test Software (HP 83212C)
Options for HP 83220A/E and 8922S/M
Opt 0B1 Provides a total of two sets of Users Guides and Service Manuals (Users Guide only for A/E)
Opt AX4 Rackmount Flange Kit
Opt 0B3 Adds Service Manual

[1]Not applicable to HP 8922S
[2]Requires Option 006, Spectrum Analyzer, on HP 8922S/M

10

DECT Test Set

HP 8923B

- Test RF modules or fully assembled DECT PPs (Portable Parts) and FPs (Fixed Parts)
- Fast, accurate, repeatable measurements
- Measurements compliant with the DECT standards
- Easy to use

HP 8923B

HP 8923B DECT Test Set

The HP 8923B DECT test set is an integrated, one-box test solution for Digital European Cordless Telecommunications. The test set provides the functionality and the measurement speed required to meet the needs of high-throughput testing, essential in DECT production. In R&D applications it provides the measurement accuracy and traceability required to ensure a very high level of confidence during PP or FP design.

The HP 8923B includes the following key DECT measurements:

- Bit-error ratio/word error ratio
- Carrier power
- Power versus time (Top 40 dB)
- Center frequency, frequency deviation and drift
- Timing jitter
- Audio tests

To establish communication with the EUT (equipment-under-test), the HP 8923B implements protocol in the form of MAC (Medium Access Control) layer test messages. The use of MAC-layer test messages is the ETSI (European Telecommunications Standard Institute) recognized method of controlling the EUT during testing. The HP 8923B MAC-layer protocol supports the following features:

- Call setup on a defined slot and channel
- Identity extraction from the EUT
- Channel and timeslot handover
- Test patterns as defined in the DECT CTR-06 standard along with a user-definable test pattern
- Flexibility for propriety signalling (escape test message)

When testing RF components of the EUT, the tests can be made without MAC protocol. In this application, the HP 8923B can synchronize to the RF rise of the signal, or an external TTL trigger may be used to initiate the measurements.

These two approaches to testing mean that the HP 8923B can be used in various stages of the test process, e.g., calibration and test of RF modules, final testing of the assembled phone, or rework of faulty phones and modules.

Maximize Your Production Efficiency

The measurement techniques adopted in the HP 8923B are chosen to minimize the test time for the key DECT tests without compromising measurement integrity. All transmitter measurements are implemented using digital signal processing which delivers fast and repeatable measurement results. This measurement repeatability ensures that when the HP 8923B is used in module test, final test and re-work, inefficiencies caused by 'no-fault-founds' are minimized. All HP 8923B functions are accessible over HP-IB, allowing easy integration into production line test systems. THe HP 8923 firmware can be upgraded from a PCMCIA card, without removing the instrument covers. New firmware may be installed with minimal disruption to production.

Ease of Use

The HP 8923B user interface has been carefully designed to allow the user to quickly learn how to operate the instrument effectively and carry out the key measurements. The screen layouts are clear, and softkey menus make it easy to access the main measurement functions and parameters. These ease-of-use benefits ensure that the HP 8923B can be used manually in repair and re-work stations with the minimum of operator training.

Test System Integration

Hewlett-Packard can provide customized test solutions based around the HP 8923B tailored to your individual test requirements. This means that the HP can coordinate and manage:

- System integration
- Spares management
- Verification and testing to your requirements
- Delivery to agreed time scales
- Identical systems delivered and supported world-wide
- Revision and change control to ISO 9002

Contact your local HP sales representative for details.

HP 8923B Specifications

The following describe the instruments warranted performance and apply after a 30-minute warmup period. These specifications are valid over its operating/environmental range unless otherwise noted.

DECT Source Specifications

RF Carrier Frequency[1]
Range: 1880 to 1990 MHz at DECT channels
Frequency Drift Across the Burst: Negligible
(I/Q modulation technique used)
Accuracy: ± 5 kHz

RF Carrier Level
Range: –100 dBm to –10 dBm
Resolution: 0.1 dB
Accuracy: ± 1.0 dB
Reverse Power: 2 W continuous
SWR: 1.5:1

Transmitter Test Specifications

Note: The user is required to provide a signal from the device-under-test which matches the following criteria:
Frequency Presented to the HP 8923B: Within ± 200 kHz of DECT channel frequency
Amplitude Presented to the HP 8923B: Within ± 6 dB of HP 8923B setting
Normal Transmitted Power (NTP) Measurement
Range: –10dBm to +30 dBm
Accuracy: ± 0.6 dB ± noise effects (0.015 mW)
Power versus Time Template Measurement
Measurement Range: –10 dBm to +30 dBm
Dynamic Range: 40 dB
GFSK Measurement
Level: –10 dBm to +30 dBm
Peak Frequency Deviation Error:

Input Amplitude Setting Uncertainty	Frequency Deviation Measurement Uncertainty
± 1 dB	10 kHz
± 3 dB	12 kHz
± 6 dB	16 kHz

Centre Frequency Measurement Error: ± 1 kHz
Frequency Drift Measurement Error: < 1 kHz for drift < 20 kHz
Timing Jitter
Measurement Accuracy: 4 ns

Receiver Test Specifications

Residual Bit Error
Ratio: 10^{-6} for PRBS 2^9 –1 (ITU-T 0.153)

Audio Source Specifications

Frequency
Range: 20 Hz to 21 kHz
Accuracy: 0.03% of setting
Level
Range: 0 V to 2 V_{pk-pk}
Output Impedance: 70 Ω
Accuracy: ± (4% of setting + resolution)

[1] Frequency = Fo -c x1728 kHz where Fo = 1897.344 MHz, c = 0,1,2,3,....9

Audio Analyzer Specifications

DC Voltmeter
Accuracy: (1% of reading + dc offset)
DC Offset: 45 mV
Audio Frequency Counter
Range: 30 Hz to 400 kHz
Accuracy: (0.05% + resolution + reference accuracy) for input > 30 mV
AC Voltmeter
Frequency Range: 50 Hz to 50 kHz
Input Impedance: 100 Ω
Input Range: 10 mV to 5 V
Digital Oscilloscope
Accuracy: ± 1.5% of reading +0.1 division
(For scale settings: 100 mV/div to 1 V/div)
Frequency Range: DC to 50 kHz

Reference Specifications

Standard Frequency Reference
Stability: 1 ppm (0 to 55° C)
Aging: 2 ppm/year
Warmup Time: < 30 seconds to be within 2 ppm of final frequency
Precision Frequency Reference (Option 1D5)
Stability: < 2.5 x 10^{-9} ppm/°C (0 to 55° C)
Aging: < 5 x 10^{-10} ppm/day after 24 hour warm-up; < 0.1 ppm/year for continuous operation
Warm-up Time: Within 5 x 10^{-9} ppm of final value 10 minutes after turn on at 25° C
External Interfaces
HP-IB: IEEE-488.2
RS-232: Serial port through RJ-11 connector used for serial data in and out
Baud Rates: 300, 1200, 2400, 4800, and 9600 baud
External Signal Generator Control: Data, clock and trigger signal to drive an external RF signal generator
Synch in/Synch out: Two RJ-11 connectors that allow multiple HP 8923Bs to be connected in series to ensure that all transmissions are time synchronized
Internal Programming
Programming Language: Hewlett-Packard Instrument BASIC

General Specifications

Size: 426 mm W x 177 mm H x 574 mm D (16.75 in x 7 in x 23 in)
Weight: 32 kg (70 lb)
Operating Temperature: 0° to 55°
Power: 100, 120, 220, 240, Vac, 48 to 440 Hz, ± 10% of line voltage

Ordering Information

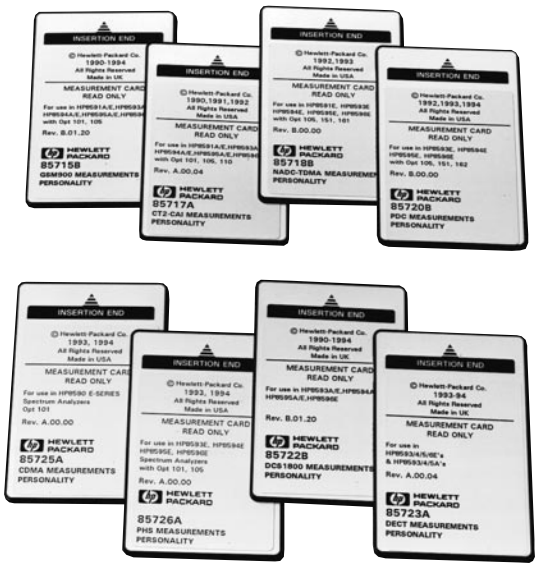
HP 8923B DECT Test Set
Opt 0BF Programming Reference Manual
Opt AV4 Users Manual
Opt 0B3 Service Manual
Opt 1D5 High-Stability Frequency Reference
Opt 1CP Rackmount and Handle Kit

10

Measurement Personalities for HP 8590 Series Spectrum Analyzers

Overview

- One-button measurements customized for your application
- Easy to use
- Solutions available for: CDMA, GSM, DCS1800, PCS1900, DECT, CT2-CAI, NADC-TDMA, PDC, PHS



Measurement Personalities for Customized Transmitter Testing

Measurement personalities are software programs provided on ROM-based memory cards that customize your HP 8590 series spectrum analyzer to perform complex transmitter tests simply and quickly with the push of a button from easy-to-follow screen menus. They automatically set the analyzer controls and perform calculations required to test to the industry standard for the communications format.

Quick, Easy, One-Button Measurements

Using a measurement personality with an HP 8590 series spectrum analyzer reduces complex transmitter systems or component measurements to single-button operations. Easy-to-use softkey menus are labeled with familiar format-specific measurement names.

Power, Frequency, Timing, and Modulation Accuracy

With a properly-configured spectrum analyzer, most personalities allow you to perform power-, frequency-, timing-, and modulation-accuracy measurements of your signal. Measuring modulation quality for some of the formats requires a digital demodulator option in the spectrum analyzer: for example, error vector magnitude (EVM) for $\pi/4$ DQPSK signals of NADC-TDMA, PDC and PHS, and global phase and frequency error for 0.3 GMSK signals of GSM900, DCS1800 and PCS1900. There are other demodulator option cards for the spectrum analyzer for the 0.5 GFSK signals of CT2-CAI and DECT.

Product Development and Production Troubleshooting

Evaluate your design and thoroughly troubleshoot failures. Measurements can be run continuously, allowing real-time equipment adjustments and troubleshooting. Waveform and graphical results add key visual information to numerical results. Pass/fail messages draw attention quickly to system problems. Test limits can be modified from the front panel, external keyboard, or computer so that you can set your own test goals.

High-Speed Production Testing

Reduce costs with increased test throughput. Since all of the customized measurements are programmable, each is executed with a single command. We've written the code for you.

Reliable Accuracy

Most of our solutions offer an improved amplitude accuracy option on the spectrum analyzer, so you can measure your transmitters with near-power-meter accuracy.

Features to Make Your Measurements Easier

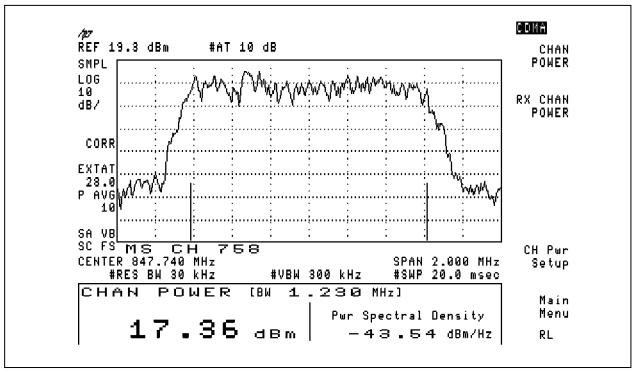
The measurement personalities contain one or more added features to make your measurements even easier such as automatic tuning by channel number, frequency-band monitoring, and combiner tuning. The newest addition to HP's portfolio of measurement personalities for transmitter testing, the HP 85725C for CDMA has an on-screen help feature to guide you through your measurements.

Accessories

For many of the measurements on burst signals, a TTL transition is required to synchronize the measurement system with the transmitter-under-test. The synchronization signal must occur once per frame. If an external signal is unavailable, the HP 85902A burst-carrier trigger may be used. Many other accessories are available from HP to help you make your measurements.

Ordering Information

Refer to the next few pages in the catalog for more details about each of the measurement personalities. See pages 235 to 240 for detailed information about the HP 8590 series spectrum analyzers, all available analyzer options and measurement personalities for other applications.



HP 85725C CDMA Measurement Personality

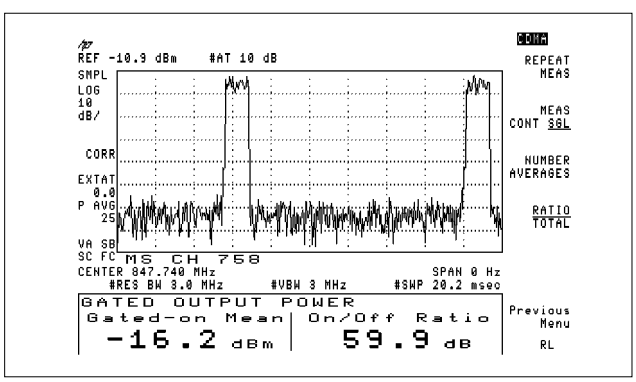
Simplify your measurements of cellular, PCS and other spread spectrum transmitters based on EIA/TIA IS-95, -97, -98 and J-STD-008 standards with the HP 85725C. Both frequency- and time-domain measurements are provided. The C version of this personality adds the adjacent channel power ratio (ACPR) measurement. The HP 85725C is designed with a great amount of flexibility, including on-screen help messages, so measurements can easily be configured to meet your special needs.

Measurements

Frequency Domain
- RF channel power
- Receive RF channel power
- Spurious emissions
- Standby output power (mobile)
- Spectral regrowth
- Occupied bandwidth
- Adjacent channel power ratio (ACPR)

Time Domain
- Gated output power
- Gated output power time response
- Time response of open loop power control

General Frequency- and Time-Domain Measurements
- Channel spectrum
- Monitor channel
- Monitor band
- Time-domain analysis
- Amplitude probability density
- Mean and peak-to-mean power



Built-In Flexibility for PCS and Other Wireless Applications

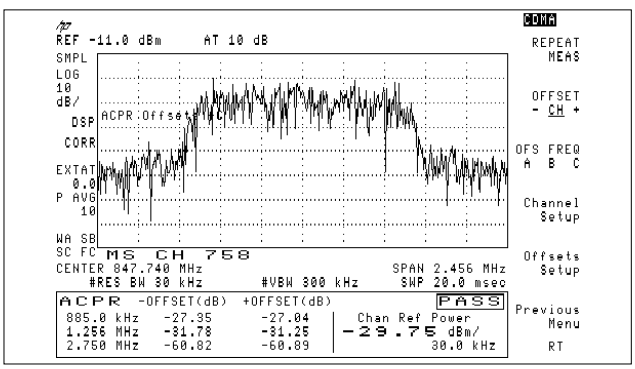
If you are involved with designs at other frequencies, for other services and even using technologies other than IS-95 or J-STD-008, you will appreciate the greater flexibility we have designed into the CDMA personality. You can configure the personality to make the measurements you need to make.

Flexibility Features

- Define your own tuning scheme based on the frequency allocation of your system. The configuration for channel-number tuning has an IS-95A, J-STD-008, ARIB STD-T53, Korean PCS setup and a custom setup.
- Change the pass/fail limit lines from the default settings to meet your requirements. For example, you may want to add test line uncertainty, additional margin or alternative limits.
- Measure your signal channel power in a channel bandwidth other than the IS-95A and J-STD-008 (for example: AMPS, or FCC Part 15). You can easily define the signal measurement bandwidth and viewing span.

New Adjacent Channel Power Ratio (ACPR) Measurement

Easily test Adjacent Channel Power on CDMA components with the new one-button measurement.The flexibility allows the user to make measurements according to the two different Qualcomm definitions, or a faster HP-defined method. Integration bandwidths, resolution bandwidths, and frequency offsets can easily be changed in the ACPR setup menu to fit any application.



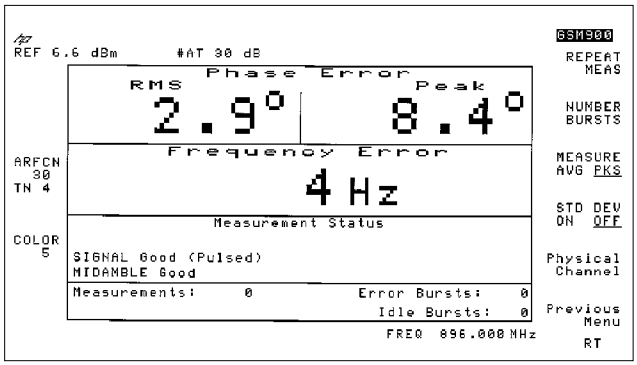
Recommended Configuration

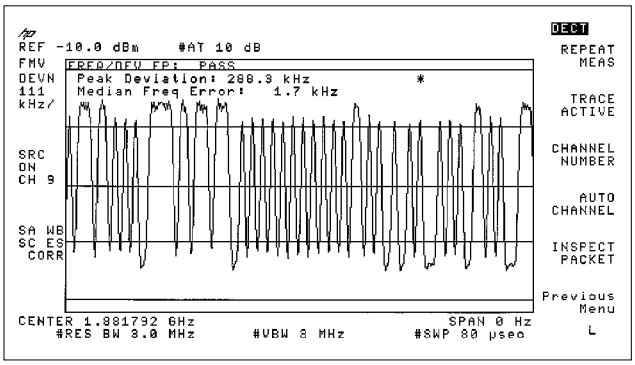
HP 85725C CDMA Measurements Personality
and
HP 8591E, HP 8594E, HP 8595E, HP 8596E, or HP 8593E Portable Spectrum Analyzer with the following options:
With DSP (Opt 151) for high speed measurements
Opt 004 Precision Frequency Reference
Opt 053 Improved Amplitude Accuracy for CDMA Cellular Bands
Opt 151 Digital Signal Processor
Opt 160 PDC/PHS/NADC/CDMA Firmware for Option 151
Without DSP
Opt 004 Precision Frequency Reference
Opt 053 Improved Amplitude Accuracy for CDMA Cellular Bands
Opt 101 Fast Time-Domain Sweeps

Key Literature

Portable CDMA Spectrum Analyzer, p/n 5963-9969E

HP 85715B
HP 85722B
HP 85723A





HP 85715B GSM900 and HP 85722B DCS1800 Transmitter Measurement Personalities

The HP 85715B and 85722B provide all the GSM900 and DCS1800 transmitter measurements specified in the GSM 11.10 (mobile) and GSM 11.20 (base station) recommendations. GSM Phase II specification limits are used and the extended GSM (E-GSM) frequency bands are supported. GSM-based PCS measurements at 1900 MHz may be made using the HP 85722B special Option H19.

Measurements

- Phase and frequency error
- Demodulated data bit display
- Mean transmitted carrier power
- Power versus time
- Output RF spectrum
- Spurious emissions
- Intermodulation attenuation
- Combiner tuning

Recommended Configuration

HP 85715B GSM900 Transmitter Measurements Personality
or
HP 85722B DCS1800 Transmitter Measurements Personality
or
HP 85722B H19 PCS1900 Transmitter Measurements Personality
and
HP 8594E, HP 8595E, HP 8596E, or HP 8593E Portable Spectrum Analyzer with the following options:

With Phase and Frequency Error Measurement
- **Opt 004** Precision Frequency Reference
- **Opt 105** Time-Gated Spectrum Analysis
- **Opt 151** Fast ADC and Digital Demodulator
- **Opt 163** GSM/DCS Firmware for Option 151

Without Phase and Frequency Error Measurement
- **Opt 004** Precision Frequency Reference
- **Opt 101** Fast Time-Domain Sweeps
- **Opt 105** Time-Gated Spectrum Analysis

Related Spectrum Analyzer Options
- **Opt J62** Enhanced Power Measurement Accuracy in the GSM900 Band (880 to 960 MHz)
- **Opt J63** Enhanced Power Measurement Accuracy in the DCS1800 Band (1710 to 1880 MHz)
- **Opt J66** Enhanced Power Measurement Accuracy in the PCS1900 Band (1850 to 1990 MHz)

Key Literature

Portable GSM/DCS Transmitter Measurement Systems, Technical Data, p/n 5091-9025E
GSM900 and DCS1800 Transmitter Testing, White Paper, p/n 5962-9942E

HP 85723A Option H01 DECT Measurement Personality

The HP 85723A Option H01 adds the key DECT measurements to the HP 8590 E-series spectrum analyzers. Option 012 on the spectrum analyzer adds a built-in DECT source which can be used as a stimulus for module testing or sensitivity measurements. The DECT demodulator Option 112 on the analyzer gives the capability to demodulate and analyze GFSK data in the DECT burst.

Measurements

- Carrier power
- Power versus time
- Center frequency
- Frequency deviation
- Adjacent channel power
- Spurious emissions
- Intermodulation attenuation

Recommended Configuration

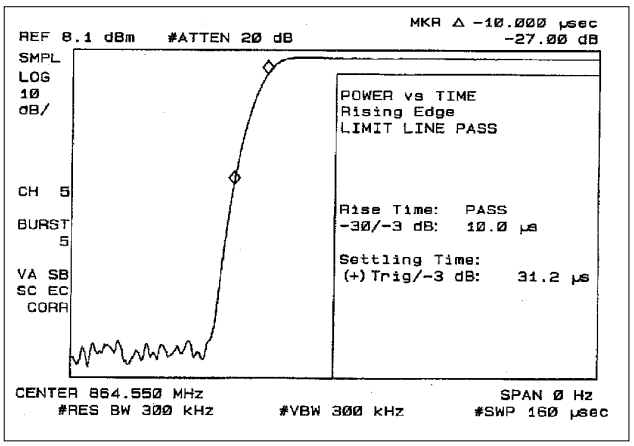
HP 85723A Opt H01 DECT Measurements Personality
and
HP 8594E, HP 8595E, HP 8596E, or HP 8593E Portable Spectrum Analyzer with the following options:
- **Opt 004** Precision Frequency Reference
- **Opt 012** DECT Source
- **Opt 101** Fast Time-Domain Sweeps
- **Opt 105** Time-Gated Spectrum Analysis
- **Opt 112** DECT Demodulator Card

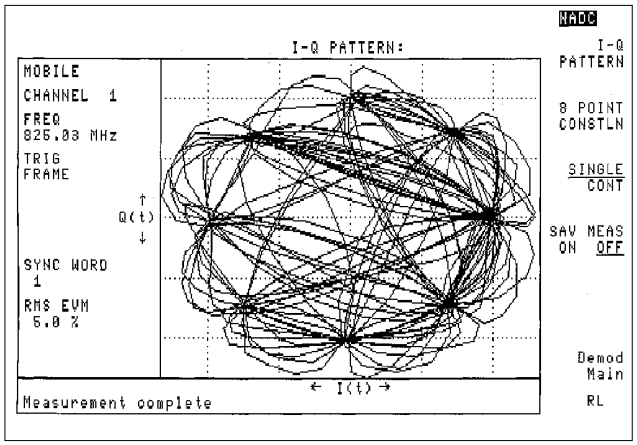
Or as an ordering convenience, the spectrum analyzer may be ordered with Option E67 which contains the options listed above.

Key Literature

HP 85723A Option H01 "Turbo" DECT Measurements Personality Technical Data, p/n 5962-6153E
HP 8590 E-Series DECT Measurement Solutions Technical Data, p/n 5091-7761E

HP 85717A
HP 85718B





HP 85717A CT2-CAI Measurement Personality

The HP 85717A simplifies I-ETS 300-131 and MPT 1375 RF transmitter testing of second-generation cordless telephones with common air interface (CT2-CAI). All of the required transmitter tests are provided by the personality for both cordless fixed parts (bases) and cordless portable parts (handsets). Added flexibility allows you to define your own custom channel tuning plan and band edge frequencies, as well as set up spurious emissions parameters for your particular needs.

Measurements

- Mean carrier power
- Carrier-off power
- Adjacent channel power
- Out-of-band power
- Spurious emissions
- Intermodulation attenuation
- Frequency error and deviation

Recommended Configuration

HP 85717A Measurements Personality
and
HP 8591E, HP 8594E, HP 8595E, HP 8596E, or HP 8593E Portable Spectrum Analyzer with the following options:

Opt 004 Precision Frequency Reference
Opt 101 Fast Time-Domain Sweeps
Opt 105 Time-Gated Spectrum Analysis

For Frequency Error and Frequency Deviation Measurements also order:

Opt 110 CT2 Demodulator Card
or
HP 53310A Modulation Domain Analyzer (requires Option 041 HP-IB interface on the spectrum analyzer)

For Improved Amplitude Accuracy in the CT2-CAI Band Order:

Opt 010 Built-In Tracking Generator
HP 437B Power Meter
HP 8481A or 8482A Power Sensor
HP 8491A/B Opt 006 6 dB Fixed Attenuator

Ordering Information

More information about the HP 8590 E-series spectrum analyzers and all analyzer options, including ordering information, can be found on pages 235 to 240.

Key Literature

HP 85717A CT2-CAI Measurements Personality, p/n 5091-2986E

HP 85718B NADC-TDMA Measurement Personality

Based on the complete set of transmitter measurements required by EIA/TIA IS-54-B, -55-A, and -56-A standards, the HP 85718B provides tests for North American Dual-mode Cellular (NADC) time-division multiple-access radio systems. NADC-based PCS measurements at 1900 MHz (IS-136 standard) can also be made with the HP 85718B. The push of a button allows you to select between IS-54 800 MHz, IS-136 800 MHz, and IS-136 1900 MHz tuning plans.

Measurements

- Carrier power and carrier-off power
- Channel power
- Occupied bandwidth
- Adjacent and alternate channel power leakage
- Attack and release time
- Intermodulation spurious
- Power steps

Modulation Accuracy Measurements

- RMS error vector magnitude (EVM) and peak EVM
- RMS magnitude error and phase error
- Carrier frequency error
- Amplitude droop
- I-Q origin offset

Recommended Configuration

HP 85718B Measurements Personality
and
HP 8594E, HP 8595E, HP 8596E, or HP 8593E Portable Spectrum Analyzer with the following options:

With Modulation Accuracy Measurements

Opt 004 Precision Frequency Reference
Opt 050 Improved Accuracy for NADC Cellular and PCS Bands
Opt 105 Time-Gated Spectrum Analysis (mobiles only)
Opt 151 Fast ADC and Digital Demodulator
Opt 160 PDC/PHS/NADC/CDMA Firmware for Option 151

Without Modulation Accuracy Measurements

Omit **Opt 151 and 160**
Add **Opt 101** Fast Time-Domain Sweeps (mobiles only)

Note: In a configuration without modulation accuracy measurements, the HP 8591E is also supported.

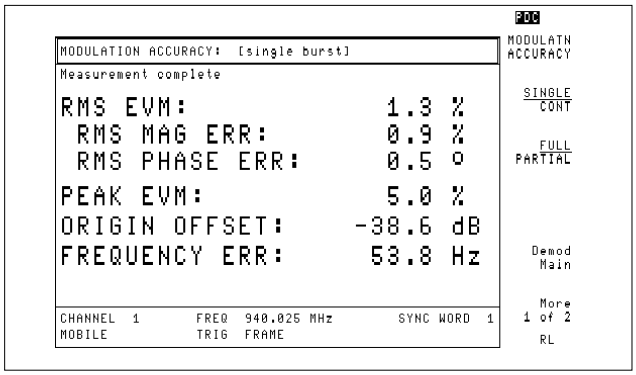
Ordering Information

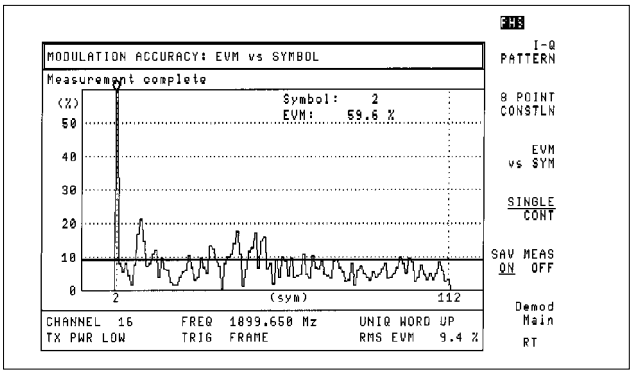
More information about the HP 8590 E-series spectrum analyzers and all analyzer options, including ordering information, can be found on pages 235 to 240.

Key Literature

Portable NADC-TDMA Transmitter Tester, p/n 5962-6217E

HP 85720C
HP 85726B





HP 85720C PDC Measurement Personality

The HP 85720C provides transmitter measurements for Personal Digital Cellular (PDC) time-division multiple-access radio systems. This personality provides tests that are customized based on the RCR STD-27C standard for both high and low PDC frequency bands. Also the HP 85720C test times have been reduced by up to 30 percent as compared to the HP 85720B.

Measurements

- Antenna power
- Carrier-off leakage power
- Channel power
- Occupied bandwidth
- Adjacent channel power leakage
- Burst ramp-up and ramp-down power vs. time
- Transmitter intermodulation
- Spurious emissions
- Power step

Modulation Accuracy Measurements
- RMS error vector magnitude (EVM) and peak EVM
- RMS magnitude error and phase error
- I-Q origin offset
- Carrier frequency error

Recommended Configuration

HP 85720C PDC Measurements Personality
and
HP 8594E, HP 8595E, HP 8596E, or HP 8593E Portable Spectrum Analyzer with the following options:
With Modulation Accuracy Measurements
Opt 004 Precision Frequency Reference
Opt 051 Improved Accuracy for PDC Bands
Opt 105 Time-Gated Spectrum Analysis (mobiles only)
Opt 151 DSP, Fast ADC, and Digital Demodulator
Opt 160 PDC/PHS/NADC/CDMA Firmware for Option 151
Without Modulation Accuracy Measurements
Omit **Opts 151 and 160**
Add **Opt 101** Fast Time-Domain Sweeps (mobiles only)

Note: In a configuration without modulation accuracy measurements, the HP 8591E is also supported.

Key Literature

Portable PDC Transmitter Tester, p/n 5963-9971E

HP 85726B PHS Measurement Personality

The HP 85726B measurement personality provides transmitter tests for Personal Handy Phone System (PHS) radios based on the RCR STD-28 standard. Most tests are also based on the methods of measurement called out by the MKK. In addition to modulation accuracy measurements, this personality has reduced test times by up to 50 percent as compared to the HP 85726A.

Measurements

- Antenna power
- Adjacent channel power
- Burst ramp-up and ramp-down power vs. time
- Carrier-off time leakage power
- Spurious emission
- Occupied bandwidth

Modulation Accuracy Measurements
- RMS error vector magnitude (EVM) and peak EVM
- EVM vs. symbol
- RMS magnitude and phase error
- I-Q origin offset
- Carrier frequency error

Recommended Configuration

HP 85726B PHS Measurements Personality
and
HP 8594E, HP 8595E, HP 8596E, or HP 8593E Portable Spectrum Analyzer with the following options:
With Modulation Accuracy Measurements
Opt 004 Precision Frequency Reference
Opt 052 Improved Amplitude Accuracy for PHS Band
Opt 105 Time-Gated Spectrum Analysis
Opt 151 DSP, Fast ADC, and Digital Demodulator
Opt 160 PDC/PHS/NADC/DCMA Firmware for Option 151
Without Modulation Accuracy Measurements
Omit **Opts 151 and 160**
Add **Opt 101** Fast Time-Domain Sweeps

Key Literature

Portable PHS Transmitter Tester, p/n 5964-0110E

- Accurate, automated ACP measurements on TDMA and TDD signals
- Measure according to NADC-TDMA, PDC, PHS, and other standards
- Measurement accelerators speed up ACP testing
- Carrier on/off power
- Total channel power, percent occupied bandwidth
- Burst-timing measurements

HP 8564E HP 8565E

Accurate and Easy-to-Use Power Measurements Using the HP 8560 E-Series Spectrum Analyzers

Many wireless communications systems today employ burst-carrier techniques such as time-division multiple access (TDMA) and time-division duplex (TDD) to maximize system capacity. The HP 8560 E-series spectrum analyzers offer power measurements for both continuous and burst signals that are accurate, and easy to make. Measurement capability includes adjacent channel power (ACP), carrier power, channel power, and occupied bandwidth. These analyzers provide the greatest measurement flexibility and RF performance, making them powerful tools for R&D designers working with current wireless standards, or on systems with standards still under development.

The HP 8562E Spectrum Analyzer

The HP 8562E Spectrum Analyzer was designed specifically for digital comms. Its frequency coverage of 13.2 GHz means that now you can use the same analyzer for harmonic and spurious testing both in- and out-of-band. The increased dynamic range and third-order intercept (TOI) capability allows wireless communications engineers to test high-performance components in burst operation systems. See pages 241 to 244 for details.

Measurement Utility Increases Speed and Repeatability

The HP 85672A Spurious Response Measurements Utility makes measurements fast and easy with the touch of a button. Works on all 8560 E-Series spectrum analyzers. See page 242 for details.

Adjacent Channel Power

The ability to measure ACP on today's wireless telephones, pagers, and other transmitters is critical in R&D, manufacturing and in the field. The HP 8560 E-series spectrum analyzers provide ACP measurements for a variety of wireless communication systems, including support for NADC-TDMA, PDC, and PHS digital formats. Many of the implementation difficulties of the established standards have been addressed, providing fast, accurate, and easy-to-use ACP measurements.

In addition to the standard analog method for making ACP measurements (used for FM mobile telephones and continuous digital formats), the analyzers support four other methods used for burst-carrier measurements of TDMA and TDD signals:

- Peak (for PDC and PHS)
- Two-bandwidth (for PDC)
- Time-gated (for NADC-TDMA)
- Burst-power (an HP proprietary method)

The burst-power method overcomes many of the problems of the other standards, and is suitable for all formats. These methods can easily be adapted to measure other transmitters besides those used for cellular or cordless telephones. Configuration parameters that can be set by the user include channel spacing and bandwidth, number of alternate channels, burst period and width, and values for root-raised-cosine frequency weighting. Measurement results can be displayed in both graphic and tabular formats for ease of data interpretation and documentation. Measurement accelerators are available that give ACP results in just a few seconds, allowing real-time transmitter adjustments.

METHOD: ANALOG PEAK 2BW BURSTPWR **GATE**		METHODS
ACCELERATOR: **NORMAL** FASTEST		
(ERROR: 0dB <2dB)		ACCELERAT
CHANNEL SPACING: 30.00kHZ		
CHANNEL BANDWIDTH: 33.00kHZ		SPACING/ BANDWIDTH
ALTERNATE CHANNELS: 2		
BURST PERIOD: 20.0ms		BURST/ WEIGHTING
BURST WIDTH: 6.53ms		
FREQ WEIGHTING: **ROOT-RAISED-COS** OFF		ACPSTATE DFL CURR
WEIGHTING T : 41.0 us		
WEIGHTING : .350		
MEASUREMENT STATE: **DEFAULT** CURRENT		PREV MENU

Setup menu for adjacent channel power measurements

Carrier Power

The carrier power feature provides the user with a quick means of measuring the average "on" and "off" power of the burst carrier. This measurement is performed in the time domain, using zero span.

Channel Power

The channel-power feature quickly provides the user with information on total power within a specified channel bandwidth, as well as power density within the channel. This feature greatly simplifies this common measurement, as the spectrum analyzer automatically performs the necessary integration across the desired frequency band.

Occupied Bandwidth

Occupied bandwidth is a way of determining the spectral spread of a signal. It is defined as the bandwidth which contains the specified percent of the total transmitted power. The user may specify the percentage to be anywhere from 0.1 to 99.99 percent.

Burst Timing

Complete timing measurements can be made on the burst-carrier signal using Option 007, which provides digitized, fast time-domain (zero span) sweeps. Using sweep times as fast as 50 µs, edge times, burst width, and time between bursts can easily be measured.

More Information

More information about the HP 8560 E-series spectrum analyzers, including ordering information, can be found on pages 241 to 244.

HP 89441A
HP 89410A
HP 89411A
HP 89450A
HP 89451A

- Flexible digital-modulation analysis
- Advanced time- and frequency-domain analysis
- Offset QPSK (optional)
- Accurate frequency selective power measurements
- Direct burst-carrier settling analysis
- Adaptive equalization for digital comms (optional)

HP 89441A

HP 89441A DC to 2.65 GHz Vector Signal Analyzer

HP-IB

A Signal Analyzer for Communications Designers

Designers of communications systems can now spend their time verifying and improving their designs rather than creating specialized testing tools for each component, new signal, or modulation type. Using vector-signal analysis and advanced DSP techniques, signals that formerly required much time and effort to measure can be viewed with ease.

The HP 89441A offers many types of measurements for characterizing performance or locating problems throughout the block diagrams of transmitters and receivers—from baseband to RF stages. Analyze burst, transient, or modulated signals with simultaneous views of time, frequency, phase, and amplitude. Using this flexibility, measurements such as LO stability, phase noise, and transient characteristics are direct, easy, and reduce the overall amount of required test equipment.

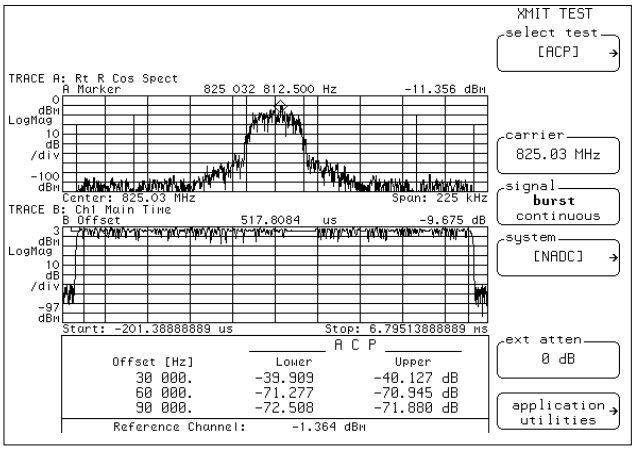
Flexible Vector-Modulation Analysis

Measurements of RF or IF signals are simplified since no external filters, coherent carriers or symbol-timing signals are required. Baseband I and Q signals can also be analyzed simultaneously with the optional second 10 MHz input channel. Modulation including BPSK, QPSK, Offset QPSK, DQPSK, π/4DQPSK, 8PSK, 16-256QAM, VSB, MSK, and 2- to 4-level FSK are supported. Various filter types with adjustable parameters and user-defined filters, in addition to burst length, symbol rate, and carrier frequency can all be selected by the user. To simplify measurements, the parameters for systems such as CDMA, GSM, NADC, PDC, PHS, DECT, and CDPD can be set with a single button.

Measurement results can be displayed in various formats and tables. Constellation, vector, and eye diagrams provide familiar tools for analyzing vector-modulated signals. Detected data tables display the received binary bits and show results of modulation quality including amplitude droop and quadrature error. The vector-modulation analysis option also offers error measurements by generating an ideal reference signal to compare to the received signal. Results include error vector magnitude, phase error, and magnitude error.

Radio Test Personality

The HP 89451A personality adds "one-button" measurements to quickly set up and test NADC, PDC, PHS, and user-defined systems. Occupied bandwidth, adjacent channel power, modulation accuracy, and frequency tolerance are included in the suite of measurements that can be made on burst or continuous signals. Accuracy required for R&D applications, ease-of-use, and measurement speed are all provided as well as the flexibility to change any of the demodulation parameters or access any of the HP 89441A measurement modes to troubleshoot difficult system problems.



Specialized display from the HP 89451A Radio Test Personality

DMCA Radio Test Personality

The HP 89450A DMCA (Digital Multi-Channel Access) personality adds "one-button" tests and modulation analysis of M16QAM signals, meeting the measurement standards outlined in the RCR-32 DMCA radio standard.

Special option H01 provides specific testing capability for the iDEN standard and compatible systems. This includes BER (Bit Error Rate) testing along with carrier, power and digital modulation tests similar to those described for DMCA.

Adaptive Equalization

The adaptive equalization option (AYJ) works with digital demodulation to remove linear errors, such as frequency response and reflections, from transmitted signals. This allows measurements in some impaired channels and can be used to isolate linear vs. non-linear error mechanisms. For more information, see page 251.

CAE Simulator Link

Testing "concurrently designed" systems typically requires waiting for an entire system to be physically prototyped and its subsystems assembled. The HP 89441A analyzer in conjunction with OmniSys CAE System Simulator (part of HP EEsof's Communication Design Suite) reduce overall system development time by emulating signals that the hardware will actually generate—but, before the hardware exists. The built-in arbitrary source can provide this emulated signal as stimulus to subsequent sections of the system that have been completed. Also, real-world measurement results can be used in system simulations prior to prototyping. Compatible data formats in OmniSys and the HP 89441A links theory to reality, lowering system development time barriers.

Solutions for Microwave Frequency Coverage

The HP 89441A is a complete solution for characterizing systems up to 2.65 GHz. To extend the vector-signal analysis capabilities to higher frequencies, the HP 89410A, 89411A, plus an external spectrum analyzer provide microwave coverage.

See page 250 for more detailed descriptions, specifications, and complete vector-signal analyzer ordering information.

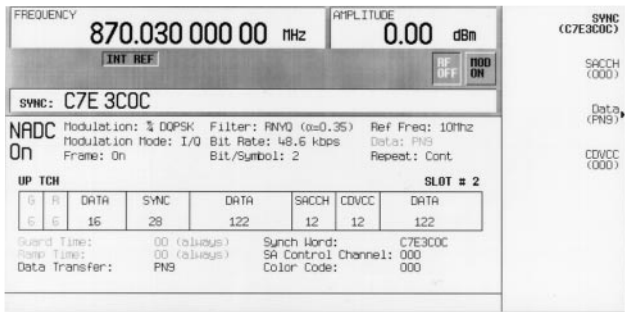
HP ESG-D1000A
HP ESG-D2000A
HP ESG-D3000A
HP ESG-D4000A

- Built-in digital modulation formats for CDMA, DECT, GSM, NADC, PDC, PHS and TETRA (Options HO3, UN3 or UN4)
- <1.75% rms EVM for π/4 DQPSK
- <1.0˚ rms global phase error for GSM
- First alternate channel power of <–65 dBc (NADC) and <–73 dBc (PDC and PHS) are possible
- Rho of 0.998 (typical) for CDMA signals

HP ESG-D4000A

Meet Complex Digital Requirements Using the HP ESG-D Series of Digital Signal Generators

The HP ESG-D series of digital RF signal generators are ideal for testing in a variety of wireless communications applications. Digital receivers or their components can efficiently be tested with the digital modulation capabilities of an ESG-D series with Options UN3/UN4 (Digital Modulation Generator). These options provide GMSK, π/4 DQPSK, and GFSK modulation signals to meet GSM, NADC, PDC, PHS, TETRA and DECT receiver test requirements. Test CDMA mobile components and enable transmitter test by generating QPSK and OQPSK signals with Option HO3. The digital communications standards are accessible at the touch of a button and are easily configured with the simple, straightforward menu structure.



NADC Menu

Excellent Modulation Accuracy and Stability

The excellent modulation accuracy and stability offered by the HP ESG-D series allows you to precisely characterize a receiver that requires digitally-modulated signals. With better than 1.75% rms Error Vector Magnitude (EVM) for π/4 DQPSK signals, and better than 1.0˚ rms global phase error for GMSK signals, operators can confidently perform measurements with minimal measurement uncertainty.

High Spectral Purity

The ESG-D series signal generators are an excellent choice for adjacent channel selectivity measurements of various digital receivers. By providing low SSB phase noise at wide offsets, you can measure out-of-channel characteristics of digital receivers with high spectral purity performance. First alternate channel power is typically <–65 dBc and <–73 dBc for BER testing with continuous modulation of NADC and PDC/PHS receivers (respectively).

Internal Data Generator and Burst Capabilities

A flexible internal data generator reduces the need for external equipment. The ESG-D series provides continuous PN9 and PN15 sequences. You may also choose to create a 4-bit repeating sequence, select an internally-stored user-generated file or input serial data. The burst capabilities of the HP ESG-D series support a variety of digital communica tion standards. The flexible menu structure easily adapts to specific user test requirements.

Flexible Frames and Timeslots

Efficiently evaluate a communications system with easy-to-configure frames and timeslots. Each timeslot within a frame can be configured independently to simulate different types of traffic, control or synchronization channels (or bursts).

More Information

More information about the HP ESG (analog) and ESG-D (digital and analog) series signal generators, including ordering information, can be found on pages 196 and 202.

Audio Analyzer, 20 Hz to 100 kHz; Distortion Analyzer, 20 Hz to 100 kHz

HP 8903B
HP 8903E

- Measures distortion, SINAD, signal-to-noise
- Measures true-rms ac volts, dc volts, frequency
- Low-distortion programmable source
- rms, average, and quasi-peak detection

HP 8903B

- Measures distortion, SINAD
- Measures true-rms ac volts, dc volts, frequency
- rms, average, and quasi-peak detection

HP 8903E

HP 8903B Audio Analyzer and HP 8903E Distortion Analyzer

HP-IB

The HP 8903B audio analyzer and HP 8903E distortion analyzer provide unparalleled versatility and performance for audio measurements from 20 Hz to 100 kHz. The HP 8903B combines the functionality of a low-distortion audio source, high-performance distortion analyzer, frequency counter, ac voltmeter, dc voltmeter, and SINAD meter into one compact package. With microprocessor control of source and analyzer, the HP 8903B can perform stimulus-response measurements, such as signal-to-noise ratio and swept distortion, automatically, with no additional equipment. The HP 8903E distortion analyzer is the analyzer portion of the HP 8903B audio analyzer. (The HP 8903E has no source.)

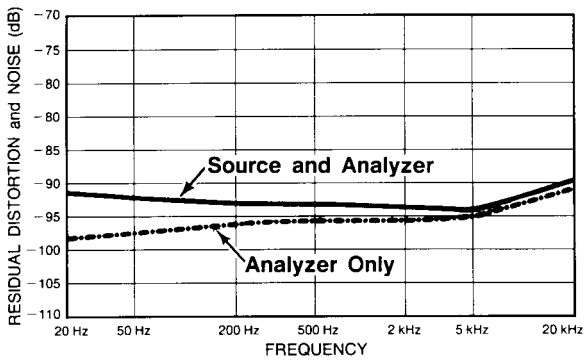
For ease of use, most measurements on the HP 8903B and HP 8903E are made with only one or two keystrokes. Both instruments automatically tune and autorange for maximum accuracy and resolution. For quick identification of input signals, the analyzer counts and displays the input frequency in all ac measurement modes.

Low-Frequency Applications

The HP 8903B/E have many features that make difficult audio measurements easy. These include flexible data display formats, a selectable balanced or unbalanced input, plug-in filters, and automatic notch filter tuning. With the ratio key, you can establish a reference in % or dB and directly make frequency-response and 3 dB bandwidth measurements without computation. A fully balanced analyzer input allows testing of the bridged power amplifiers found in many radios and car stereos, as well as professional balanced audio equipment.

With 2 internal plug-in filter slots and 6 optional filters to choose from, we simplify your audio measurements by providing the filter networks required by international standards. (See the next page for a complete list of filters.) The HP 8903B and HP 8903E both use true-rms detection (for all signals with crest factor 3) for accurate measurement of complex waveforms and noise. Average and quasi-peak detectors are also available. (Quasi-peak is selectable only via HP-IB on the HP 8903E.) Accurate distortion measurements typically can be made down to less than –90 dB (0.003%) from 20 Hz to 20 kHz.

For receiver testing, both instruments have a tunable SINAD notch filter. On the HP 8903B, the filter is automatically tuned to the source frequency. With the HP 8903E, a front-panel key allows the operator to lock the notch filter at any given input frequency.



Typical residual THD + noise for source and analyzer combined (source voltage set to 1.5 V, 80 kHz BW). Dashed line represents typical residual THD + noise for the analyzer only.

HP 8903B and HP 8903E Specifications

System Specifications (HP 8903B only, source and analyzer combined)

Distortion
Residual Distortion and Noise (the higher of):
80 kHz BW: –80 dB (0.01%) or 17 μV, 20 Hz to 20 kHz
500 kHz BW: –70 dB (0.032%) or 50 μV, 20 Hz to 50 kHz; –65 dB (0.056%) or 50 μV, 50 kHz to 100 kHz
Signal-to-Noise
Frequency Range: 50 Hz to 100 kHz
Display Range: 0 to 99.99 dB
Accuracy: ±1 dB
Input Voltage Range: 50 mV to 300 V
Residual Noise (the higher of): –85 dB or 17 μV, 80 kHz BW; –70 dB or 50 μV, 500 kHz BW

Source Specifications (HP 8903B only)

Frequency
Range: 20 Hz to 100 kHz
Resolution: 0.3%
Accuracy: 0.3% of setting

Output Level
Range: 0.6 mV to 6 V open circuit
Resolution: 0.3% or better
Accuracy (open circuit): 2% of setting 60 mV to 6 V, 20 Hz to 50 kHz; 3% of setting 6 mV to 6 V, 20 Hz to 100 kHz; 5% of setting 0.6 to 6 mV, 20 Hz to 100 kHz
Flatness (1 kHz reference): ±0.7% (±0.06 dB), 20 Hz to 20 kHz; ±2.5% (±0.22 dB), 20 Hz to 100 kHz
Distortion and Noise (the higher of):
80 kHz BW: –80 dB (0.01%) or 15 μV, 20 Hz to 20 kHz
500 kHz BW: –70 dB (0.032%) or 38 μV, 20 Hz to 50 kHz; –65 dB (0.056%) or 38 μV, 50 to 100 kHz
Impedance: 600 Ω ±1% or 50 Ω ±2%, front-panel selectable (HP-IB programmable)
Sweep Mode: Log sweep with up to 500 points per decade or 255 points total between entered start and stop frequencies

Analyzer Specifications (Both HP 8903B and HP 8903E)

Distortion
Fundamental Frequency Range: 20 Hz to 100 kHz
Display Range: 0.001% to 100% (–99.99 to 0 dB)
Accuracy: ±1 dB, 20 Hz to 20 kHz; ±2 dB, 20 kHz to 100 kHz
Input Voltage Range: 50 mV to 300V
Residual Distortion and Noise (the higher of):
80 kHz BW: –80 dB (0.01%) or 15 μV, 20 Hz to 20 kHz
500 kHz BW: –70 dB (0.032%) or 45 μV, 20 Hz to 50 kHz; –65 dB (0.056%) or 45 μV, 50 kHz to 100 kHz
Supplemental Characteristics
3 dB Measurement Bandwidth: 10 Hz to 500 kHz
Detection: True-rms or rms-calibrated average

SINAD
Fundamental Frequency Range: 20 Hz to 100 kHz
Display Range: 0 to 99.99 dB
Residual Distortion and Noise: Same as listed under Distortion
Accuracy: ±1 dB, 20 Hz to 20 kHz; ±2 dB, 20 to 100 kHz
Input Voltage Range: 50 mV to 300 V
Supplemental Characteristics
Detection: True rms or rms-calibrated average
Tuning: HP 8903B: Notch filter is tuned to the internal source frequency. HP 8903E: Notch filter is tuned to the counted input frequency. Notch filter hold function available on front panel.

AC Level
Full Range Display: 300 V, 30 V, 3 V, 0.3 V, 30 mV, 3 mV, 0.3 mV
Overrange: 33%, except on 300 V range
Accuracy: ±2%, 50 mV to 300 V, 20 Hz to 20 kHz; ±4%, 0.3 to 50 mV, 20 Hz to 100 kHz; ±4%, 50 mV to 300 V, 20 to 100 kHz
Supplemental Characteristics
AC Converter: True-rms responding for signals with crest factor up to 3, rms-calibrated average detection and quasi-peak
3 dB Measurement Bandwidth: >500 kHz

DC Level
Full Range Display: 300 V, 48 V, 16 V, 4 V
Overrange: 33%, except on 300 V range
Accuracy: ±1.0% of reading, 600 mV to 300 V; ±6 mV, V_{in} 600 mV

Frequency Measurement
Measurement Range: 20 Hz to 150 kHz (20 Hz to 100 kHz in distortion and SINAD modes)
Resolution: 5 digits (0.01 Hz for input frequencies <100 Hz)
Accuracy: ±(0.004% + 1 digit)
Sensitivity: 50 mV in distortion and SINAD modes, 5.0 mV in ac level and signal-to-noise (HP 8903B only) modes

Standard Audio Filters
30 kHz Low-Pass Filter
3 dB Cutoff Frequency: 30 kHz ±2 kHz
Rolloff: Third-order Butterworth; 18 dB/octave or 60 dB/decade
80 kHz Low-Pass Filter
3 dB Cutoff Frequency: 80 kHz ±4 kHz
Rolloff: Third-order Butterworth; 18 dB/octave or 60 dB/decade

Internal Plug-In Filter Options
Both the HP 8903B and HP 8903E have two internal plug-in filter slots, each of which will accept one of 6 optional filters. The standard HP 8903B/E come with 30 kHz and 80 kHz low-pass filters, but with no plug-in filters. The appropriate filter options must be ordered for the analyzers to have any of the filters listed below. Each filter option has two option numbers: the 010 series for the left filter slot and the 050 series for the right filter slot. Each filter option ordered (maximum of two) adds additional cost to the instrument.

	Option Numbers Filter Position	
Filters	**Left slot**	**Right slot**
400 Hz High-Pass	010	050
CCITT Weighting Filter	011	051
CCIR Weighting Filter	012	052
C-MESSAGE Weighting Filter	013	053
CCIR/ARM Weighting Filter	014	054
"A" Weighting Filter	015	055

Analyzer Input
Input Type: Balanced (full differential)
Input Impedance: 100 kΩ ±1% shunted by <300 pF, each side to ground. (In dc-level mode the input resistance is 101 kΩ ±1%.)
Max. Input (maximum peak input voltage, any combination of ac/dc):
HP 8903B: 425 V peak, applied differentially or between either input to ground
HP 8903E: 42 V peak, low side to ground
425 V peak, differentially or high side to ground
CMRR: >60 dB, 20 Hz to 1 kHz, Vin <2 V; >45 dB, 20 Hz to 1 kHz; >30 dB, 20 Hz to 20 kHz

General
Temperature: Operating, 0° to 55° C; storage, –55° to 75° C
Power: 100, 120, 220, or 240 V (+5, –10%); 48 to 66 Hz; 100 or 120 V (+5, –10%); 48 to 440 Hz; 100 VA maximum
Size: 425 mm W x 146 mm H x 462 mm D (16.8 in x 5.75 in x 18.2 in)
Weight: HP 8903B: Net, 12.3 kg (27 lb); shipping, 16.4 kg (36 lb); HP 8903E: Net, 11.8 kg (26 lb); shipping, 15.9 kg (35 lb)

Ordering Information

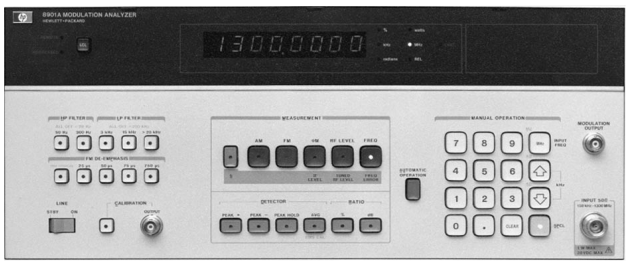
Analyzer Mainframes
HP 8903B Audio Analyzer[1]
Opt 001 Input/Output Connectors on Rear Panel Only
Opt 910 Two sets of Operation/Calibration (08903-90079) and Service Manuals (08903-90062)
Opt 915 Service Manual (08903-90062)
Opt W30 Extended Repair Service
Opt W32 Calibration Service
HP 8903E Distortion Analyzer[1]
Opt 001 Input/Output Connectors on Rear Panel Only
Opt 910 Additional Operation and Calibration Manual (08903-90053) and Two Service Manuals (08903-90065)
Opt 915 Add Service Manual (08903-90065)
Opt W30 Extended Repair Service
Opt W32 Calibration Service
Options for both HP 8903B and HP 8903E
Opt 010 or 050 400 Hz High-Pass Filter
Opt 011 or 051 CCITT Weighting Filter
Opt 012 or 052 CCIR Weighting Filter
Opt 013 or 053 C-Message Weighting Filter
Opt 014 or 054 CCIR/ARM Weighting Filter
Opt 015 or 055 "A" Weighting Filter
Opt 907 Front Handle Kit (5061-9689)
Opt 908 Rack Flange Kit (5061-9677)
Opt 909 Rack Flange Kit (5061-9683) with Front Handles

[1]HP-IB cables not included.

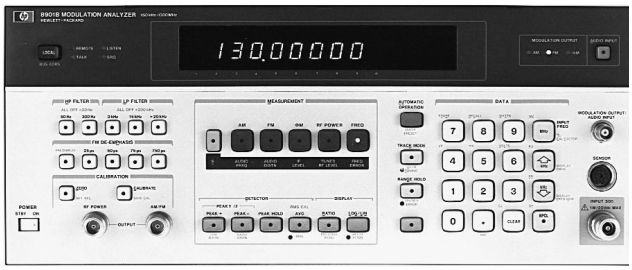
Modulation Analyzer, 150 kHz to 1300 MHz, AM/FM Test Source

HP 8901A
HP 8901B
HP 11715A

- Measures AM and FM to 1% accuracy
- Measures RF frequency
- Measures RF power
- Low internal noise
- Completely automatic



HP 8901A



HP 8901B

HP 8901A and HP 8901B Modulation Analyzers

The HP 8901A and HP 8901B modulation analyzers combine the capabilities of several RF instruments to give complete, accurate characterization of modulated signals in the 150 kHz to 1300 MHz frequency range. Both instruments very accurately measure modulation and recover the modulation signal. They determine RF frequency and measure RF power. The major additional capabilities of the HP 8901B are its improved power-meter accuracy, its ability to use external power sensors, its ability to make adjacent-channel power measurements or carrier-noise measurements (with Options 030 through 037), and its ability to count audio frequencies and measure distortion on 400 Hz and 1 kHz signals. Both instruments are fully automatic and make all major measurements at the press of a key or under HP-IB control.

Transmitter Testing

The HP 8901A/B have the features required to perform standard transmitter measurements. They measure transmitter power, count frequency, and measure the signal modulation very accurately. The HP 8901B also characterizes the demodulated audio signal's frequency, level, and distortion. With Option 030 the HP 8901B can quickly and accurately make adjacent-channel power measurements to CEPT standards.

RF Signal Characterization

The HP 8901A/B are excellent lab and production tools for accurately characterizing RF signals.

Use the HP 8901A/B to make accurate AM/FM and FM/AM conversion measurements of phase- and amplitude-sensitive devices such as bandpass filters and multiple-channel receivers. Excellent isolation between AM and FM make it simple to separate the AM and FM of AM stereo, the incidental AM of FM transmitters, and the AM, FM, and FM components of complex signals.

Automatic Test Systems

The HP 8901A/B are important components of automatic RF test systems. All functions are fully automatic and easily programmed. With these measurements combined into one instrument, interfacing requirements, hardware costs, and software-development time are reduced.

HP 8901A and HP 8901B Specifications

RF Input
Frequency Range: 150 kHz to 1300 MHz
Operating Level: 12 mV rms to 7 V rms
Input Impedance: 50 Ω nominal
Tuning: Manual frequency entry, automatic, or track
Acquisition Time (automatic operation): ~1.5 s
Maximum Safe Input Level (typical): 35 V rms (25 W for source SWR <4), ac; 40 V, dc

Frequency Modulation
Rates: 20 Hz to 200 kHz
Deviations: To 400 kHz
Accuracy:
±2% of reading ±1 digit, 20 Hz to 10 kHz rates, 250 kHz to 10 MHz;
±1% of reading ±1 digit, 50 Hz to 100 kHz rates, 10 to 1300 MHz
Demodulated Output Distortion: <0.1% THD
AM Rejection (for 50% AM at 400 Hz and 1 kHz rates): <20 Hz peak deviation measured in a 50 Hz to 3 kHz BW
Residual FM (50 Hz to 3 kHz BW): <8 Hz rms @ 1300 MHz, decreasing linearly with frequency to <1 Hz rms for 100 MHz and below
Maximum Deviation Resolution: 1 Hz
Stereo Separation (50 Hz to 15 kHz): >47 dB typical

Phase Modulation
Carrier Frequency: 10 to 1300 MHz
Rates: 200 Hz to 20 kHz; typically usable from 20 Hz to 100 kHz with degraded performance
Deviation: To 400 radians
Maximum Deviation Resolution: 0.001 radian
Accuracy: ±3% of reading ±1 digit
Demodulated Output Distortion: <0.1% THD
AM Rejection (for 50% AM at 1 kHz rate): <0.03 radian peak deviation (50 Hz to 3 kHz BW)

Amplitude Modulation
Rates: 20 Hz to 100 kHz
Depth: To 99%
Accuracy
±2% of reading ±1 digit, 50 Hz to 10 kHz rates, 150 kHz to 10 MHz;
±1% of reading ±1 digit, 50 Hz to 50 kHz rates, 10 to 1300 MHz
Flatness (variation in indicated AM depth for constant depth on input signal): ±0.3% of reading ±1 digit
Demodulated Output Distortion: <0.3% THD
FM Rejection (at 400 Hz and 1 kHz rates, 50 Hz to 3 kHz BW): <0.2% AM
Residual AM (50 Hz to 3 kHz BW): <0.01% rms
Maximum Depth Resolution: 0.01%

Frequency Counter
Range: 150 kHz to 1300 MHz
Accuracy: ±3 counts of least significant digit ± reference accuracy
Internal Reference
Frequency: 10 MHz
Aging rate: <1 x 10^{-6}/month (optional: 1 x10^{-9}/day)
Maximum Resolution
HP 8901A: 10 Hz for frequencies <1 GHz;
100 Hz for frequencies ≥1 GHz
HP 8901B: 1 Hz

HP 8901A RF Level (Peak Voltage Responding, RMS Sine Wave Power Calibrated)

Range: 1 mW to 1 W
Instrumentation Accuracy: ±1.5 dB
SWR: ≤1.3, 150 kHz to 650 MHz; ≤1.5, 650 to 1300 MHz
Maximum Resolution: 0.001 mW for levels <0.01 W

HP 8901A
HP 8901B
HP 11715A

HP 8901B RF Level (True RMS)

Frequency Range with HP 11722A: 100 kHz to 2.6 GHz
Power Range: –20 to +30 dBm
RF Range-to-Range Change Error: ±0.02 dB/RF range change from reference range
Input SWR: <1.15, using HP 11722A sensor module
Zero Set (digital settability of zero): ±0.5% ±1 digit of full scale on lowest range (decrease by a factor of 10 for each high range)
RF Power Resolution: 0.1% of full scale in watts or volts mode; 0.001 in dBm or dB relative mode

HP 8901B Selective Power Measurements (Options 030 through 037)

Frequency Range: 10 MHz to 1.3 GHz
Carrier Power Range: +30 to –20 dBm, 12.5, 25 and 30 kHz filters; +30 to –10 dBm, carrier noise filter
Dynamic Range: 115 dB
Carrier Rejection (temp. ≤35° C): >90 dB for offsets ≥1 channel spacing or 5 kHz, whichever is larger
Relative Accuracy: ±0.5 dB, levels ≥–95 dBc or levels ≥–129 dBc/Hz

Power Reference
Power Output: 1.00 mW, factory set to ±0.7%, traceable to the U.S. National Institute of Standards and Technology
Accuracy: ±1.2% worst case (±0.9% rss) for one year (0° to 55° C)

Audio Filters
High-Pass (3 dB cutoff frequency): 50 Hz and 300 Hz
Low-Pass (3 dB cutoff frequency except >20 kHz filter): 3 kHz, 15 kHz, >20 kHz
De-emphasis Filters: 25 μs, 50 μs, 75 μs, and 750 μs

Calibrators (Standard HP 8901B, Option 010 HP 8901A)
AM Calibrator Depth and Accuracy: 33.33% depth, nominal; internally calibrated to an accuracy of ±0.1%
FM Calibrator Deviation and Accuracy: 34 kHz peak deviation, nominal; internally calibrated to an accuracy of ±0.1%

General Characteristics

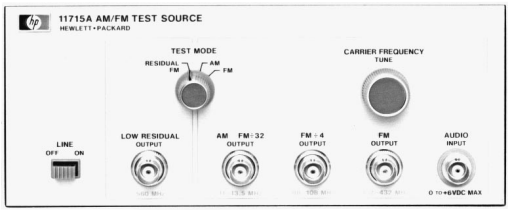
Operating Temperature Range: 0° to 55° C
Power Requirements: 100, 120, 220, or 240 V (+5%, –10%); 48 to 66 Hz; 200 VA max.
Size: HP 8901A: 425 mm W x 190 mm H x 468 mm D (16.8 in x 7.5 in x 18.4 in);
HP 8901B: 425 mm W x 190 mm H x 551 mm D (16.8 in x 7.5 in x 21.7 in)
Weight: HP 8901A: Net, 20 kg (44 lb); shipping, 25 kg (55 lb);
HP 8901B: Net, 23 kg (52 lb); shipping, 31 kg (69 lb)

Ordering Information

HP 8901A Modulation Analyzer[1]
- **Opt 001** RF Connectors on Rear Panel Only
- **Opt 002** 1x10^{-9}/Day Internal Reference
- **Opt 003** Connections for External Local Oscillator
- **Opt 004** Operation from 48 to 440 Hz Power (temp. <40° C)
- **Opt 010** AM and FM Calibrators
- **Opt 907** Front Handle Kit (5061-9690)
- **Opt 908** Rack Flange Kit (5061-9678)
- **Opt 909** Front Handle and Rack Flange Kit (5061-9684)
- **Opt 910** Two Sets of Operating (08901-90135) and Service Manuals (08901-90136)
- **Opt 915** Service Manual (08901-90136)
- **Opt W30** Extended Repair Service
- **Opt W32** Calibration Service

HP 8901B Modulation Analyzer[1]
- **Opt 021** Add HP 11722A Sensor Module
- **Opt 030** High Selectivity (select only 2 filter options) (Options 032 through 037 require Option 030; Option 030 includes Option 003 connections for external local oscillators)
- **Opt 032** 12.5 kHz Adjacent Channel Filter
- **Opt 033** 25.0 kHz Adjacent Channel Filter
- **Opt 034** 30.0 kHz Adjacent Channel Filter
- **Opt 037** Carrier Noise Filter
- **Opt 910** Two Sets of Operation/Calibration (08901-90113) and Service Manuals (08901-90114)
- **Opt 915** Service Manual (08901-90114)
- **Opt W30** Extended Repair Service
- **Opt W32** Calibration Service

[1]HP-IB cables not included.



HP 11715A

HP 11715A AM/FM Test Source

The HP 11715A AM/FM test source provides very flat, wide-bandwidth, and low-distortion amplitude- or frequency-modulated RF signals. Designed primarily for performance tests and adjustments of the HP 8901A/B modulation analyzer and HP 8902A measuring receiver, it will also serve as a high-quality modulated test oscillator where its frequency ranges apply.

The major components of the HP 11715A are a low-noise voltage-controlled oscillator (VCO), 2 digital dividers, and a double-balanced mixer. The VCO is the primary signal source, with a typical frequency range of 330 to 470 MHz at the FM output. FM is produced by directly coupling the external modulation source to the VCO's tune input, providing very wide bandwidth modulation with low phase shift. This design also ensures very little incidental AM.

The HP 11715A can also be used in conjunction with an HP 8901A/B and an HP 8902A as a calibrated signal source for special applications. In particular, the U.S. commercial FM broadcast band of 88 to 108 MHz is covered by the FM 4 4 output of the HP 11715A.

HP 11715A Specifications

FM Outputs
Frequency Range:
- 11 to 13.5 MHz, AM FM 4 32 output
- 88 to 108 MHz, FM 4 4 output
- 352 to 432 MHz, FM output

Peak Deviation:
- >12.5 kHz, 11 to 13.15 MHz carrier
- >100 kHz, 88 to 108 MHz carrier
- >400 kHz, 352 to 432 MHz carrier

Distortion: <0.025% THD (<–72 dB) for

Carrier frequency	Peak deviation	Modulation rate
12.5 MHz	12.5 kHz	<10 kHz
100 MHz	100 kHz	<100 kHz
400 MHz	400 kHz	<100 kHz

Flatness: ±0.1%, dc to 100 kHz rates ±0.25%, dc to 200 kHz rates
Stereo Separation (88 to 108 MHz carrier, 75 kHz peak deviation, 1 kHz rate): >60 dB typical

AM Output
Frequency Range (AM/FM ÷ 32 output): 11 to 13.5 MHz
Depth: To 99%
Distortion:
- <0.05% THD (<–66 dB), 50% AM, 20 Hz to 100 kHz rates
- <0.1% THD (<–60 dB), 95% AM, 20 Hz to 100 kHz rates

Flatness: ±0.1%, 50 Hz to 50 kHz rates; ±0.25%, 20 Hz to 100 kHz rates
Linearity: ±0.1%, <95% AM; ±0.2%, <99%

Ordering Information

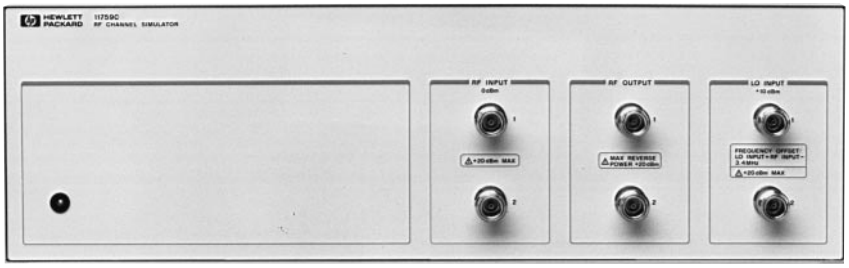
HP 11715A AM/FM Test Source
- **Opt 910** A Total of Two Sets of Operating and Service Manuals (11715-90004)

10

RF Channel Simulator, 40 to 2700 MHz

HP 11759C

- Simulates realistic signal propagation for CDMA, NADC (TDMA or E-TDMA), GSM, PDC, DCS1800, PHS, and more
- Rayleigh, Rice, or Log-normal fading
- RF bandwidth >6.0 MHz
- Doppler to 425 Hz
- Delay intervals to 186 us in 1 ns steps
- PC controlled



HP 11759C

HP 11759C RF Channel Simulator

The HP 11759C RF channel simulator has all the features and performance characteristics that make it ideally suited for testing digital cellular radios under RF multipath conditions. Whether the radio is designed for operation with the CDMA (Option H30), GSM, NADC, DCS1800, or PDC cellular systems, it is easy to simulate the fast and slow fading, time dispersion, and Dopplers experienced in the mobile radio environment. The HP 11759C is also suitable for testing many other analog and digital wireless communications systems with RF bandwidths to 6.0 MHz under multipath fading conditions.

The HP 11759C consists of the applications software and the RF processing hardware. To complete the RF multipath simulation system, two user-supplied components are necessary—a PC acting as a user-interface and a synthesized LO used to determine the RF operating frequency and to supply a 10 MHz clock signal.

Two Multipath Channels Provide Test Flexibility

The HP 11759C contains two independent 40 MHz to 2700 MHz RF channels of three paths each. Each path can be Doppler-shifted or Rayleigh or Log-normal faded, delayed, and attenuated relative to the others. In addition, under Rayleigh fading conditions, the correlation factor for path pairs in the two channels is adjustable from 0 to 1.

For test applications requiring more paths per channel (e.g., GSM or DCS1800), the HP 11759C Option 001 configures the HP 11759C as one channel of six paths. By pairing two HP 11759C Option 001 units and controlling them from a single PC, the full 12-ray testing requirements of the GSM and DCS1800 systems can easily be accomplished. And, to make it even easier, the 12- and 6-ray propagation models are pre-stored in memory for easy recall and setup.

With an external power divider and/or power combiner, and two separate channels available, it is easy to configure the HP 11759C(s) for single-channel 6 (or 12) path tests, co-channel interferer tests, adjacent and alternate channel tests, and space and/or frequency diversity tests. This flexibility is particularly important during the radio R&D phase and also important for manufacturing test and type acceptance testing.

Easy to Use Manually or Remotely

Simple-to-use onscreen menus guide the user through the task of creating complex RF multipath signals for testing a mobile or base station radio. These same menus are accessed remotely by installing a HP-IB interface card in the PC.

HP 11759C Partial Specifications

See Technical Data Sheet for complete specifications.

RF Channel Specifications

Independent RF Channels: 2 of 3 paths each
(1 of 6 paths with Option 001)
RF Input/Output Frequency Range: 40 to 2700 MHz
RF Bandwidth (1 dB): >6.0 MHz typically
Path Insertion Loss: Typically 24 dB ±3 dB
LO Input Frequency Range: RF input frequency less 6 MHz

Channel Simulation Specifications

Number of Independent Paths per Channel: 3 (6, Option 001)
Independent Rayleigh (Classical) fading, Delay, Doppler, and level available on each path
Path Attenuation Range: 0 to 50 dB, in 0.1 dB steps
Path Delay Interval Range: 0 to 186 µs, in 1.0 ns steps
(Delays to 1.48 ms are available by special order)
Simulated Vehicle Speed Range (at 900 MHz): 0 to ±509 km/h
Simulated Doppler Range: 0 to ±425 Hz
Rayleigh (Classical) Amplitude Distribution: Available on all paths for vehicle speeds from 1 to 509 km/h (at 900 MHz)
Repetition Interval: >27 seconds
Deviation from Rayleigh CDF (typical):
<±1.0 dB from +10 to –20 dB relative to the mean power
<±3.0 dB from –20 to –30 dB relative to the mean power
Level Crossing Rate Accuracy (+10 to –30 dB of the mean power level): Typically deviates from theoretical <±5% of the simulated Doppler
Remote Control: Available through optional HP-IB interface card installed in user supplied PC controller

General

Operating Temperature Range: 0° to 55° C
Specifications Warranted: +15° to +35° C
Power: 90 to 132/190 to 264 V; 48 to 66 Hz; 325 VA maximum
Size: 425 mm W x 146 mm H x 620 mm D (16.8 in x 5.7 in x 24.4 in)
Weight: Net, 13.6 kg (30 lb); shipping, 19 kg (42 lb)

Ordering Information

HP 11759C RF Channel Simulator
Opt 001 One Channel of 6 Paths
Opt 002 Rear-Panel-Only RF Connectors
Opt 003 One Channel of 6 Paths with Rear-Panel-Only RF Connectors

HP E4901B System with Option 031 Preamplifier

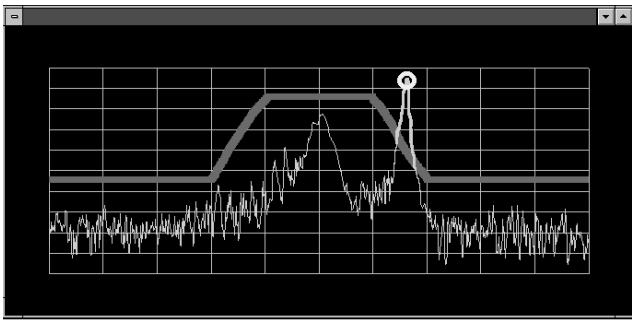
HP E4902B-002 System with Option 013 Antenna

HP E4900 Series Spectrum Monitoring Systems

The HP E4900 series spectrum monitoring systems help to eliminate interference by providing efficient, automatic interference detection. Typical users of this system may include wireless communications service providers (cellular, PCS, wireless LAN, etc.), regulatory agencies, and any other entity that wants to monitor the RF spectrum. Examples of applications include:

- Using signal logging to detect interference signals that may be blocking calls, degrading voice quality, or even dropping calls. Proactive interference detection helps you eliminate churn by identifying interference before your customers do.
- Making occupancy and statistical measurements to characterize the spectral environment. Measurements such as these help you qualify potential cell sites before committing funds and reduce the risk of a delayed rollout.
- Making carrier measurements in order to characterize interfering signals.

Sources of interference may include unlicensed transmitters, harmonics and intermodulation products, incumbent terrestrial microwave links, radar, and industrial activities. The E4900 system is designed to help you effectively detect and possibly identify sources of interference. Useful reports and graphs can be generated by the E4900 system; data can also be exported to your favorite spreadsheet or word processor to create customized reports.



Alarms help capture intermittent interference

HP E4900B-003 System (pull-out tray with laptop PC included in rack)

Key Literature

HP E4900B Series Spectrum Monitoring Systems
Brochure, p/n 5965-3211E
HP E4900B Series Spectrum Monitoring Systems
Technical Specifications, p/n 5965-1266E

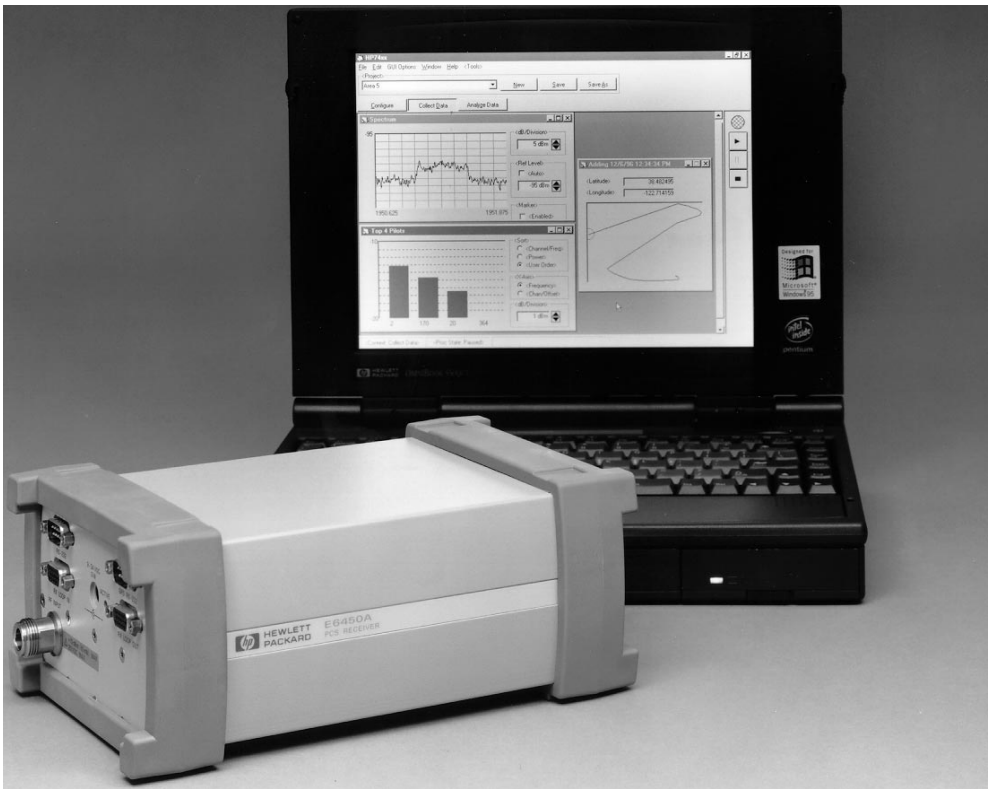
Ordering Information

HP E4900B 1.8 GHz Spectrum Monitoring System
Opt 002 Adds preamplifier and transportable rack
Opt 003 Adds preamplifier, switch, rack, receiver, and recorder
Opt 011 25 MHz to 1.3 GHz antenna
Opt 012 25 MHz to 2.9 GHz antenna
Opt 031 Adds HP 87405A preamplifier
HP E4901B 2.9 GHz Spectrum Monitoring System
Opt 002 Adds preamplifier and transportable rack
Opt 003 Adds preamplifier, switch, rack, receiver, and recorder
Opt 011 25 MHz to 1.3 GHz antenna
Opt 012 25 MHz to 2.9 GHz antenna
Opt 031 Adds HP 87405A preamplifier
HP E4902B 26.5 GHz Spectrum Monitoring System
Opt 002 Adds preamplifier and transportable rack
Opt 011 25 MHz to 1.3 GHz antenna
Opt 012 25 MHz to 2.9 GHz antenna
Opt 013 2 GHz to 18 GHz antenna
HP E4903B Central Site Controller

RF Coverage Measurement System

HP E7450A

- Automated measurements speed RF optimization
- Network-independent measurements reduce optimization time
- Comprehensive CDMA pilot channel measurements
- CW and Channel power measurements
- Spectrum display capability
- Rugged design minimized downtime
- Test configuration is fast and easy



HP E7450A

HP E7450A RF Coverage Measurement System

Your wireless communications network represents a major investment. To see a return as soon as possible, you need to complete the turn-up phase quickly. Fast turn-up of your PCS network requires efficient optimization of RF coverage. The HP E7450A combines the HP E6450A digital PCS receiver and powerful Windows95-based (WindowsNT® compatible) software to make automatic RF coverage measurements that are fast, accurate and repeatable. You'll spend less time driving the network to achieve optimization. After your network is turned up, the HP E7450A helps you maintain customer satisfaction by keeping the RF performance of your network at the highest possible level.

The field testing environment can be a harsh one, so you need test equipment that is rugged and reliable. The HP E6450A receiver was designed to withstand vibration, mechanical shock, and extremes of temperature and humidity, so you can count on minimal downtime.

Specifications

Frequency
Frequency Range: 1850 to 1910 MHz; 1930 to 1990 MHz
Frequency Accuracy: ±1 ppm (20° –30° C); ±2 ppm (0° –55° C)
w/GPS Time Synchronization: ±0.05 ppm characteristic
IF Bandwidth: ±1.25 MHz characteristic
Aging of TCXO: ±1 ppm/year

Amplitude
Accuracy: ±1 dB (20° –30° C); ±2 dB (0° –55° C)
Noise Figure: 8.5 dB typical
Maximum Safe Input Level: +10 dBm, 20 Vdc characteristic
1 dB Compression Point: –25 dBm characteristic
Adjacent Channel Desensitization: –20 dBm typical

Key Literature

HP E7450A RF Coverage Measurement System, Brochure, p/n 5965-7426E
HP E7450A RF Coverage Measurement System, Technical Specifications, p/n 5965-8220E
HP E7450A RF Coverage Measurement System, Configuration Guide, p/n 5965-8219E

Ordering Information

HP E7450A RF Coverage Measurement System
Opt 010 Portable Laptop PC
Opt 210 External GPS/Dead Reckoning System
Opt 211 Cable for Trimble Placer GPS/DR Model 400
Opt 212 Cable for Trimble Placer GPS/DR Model 455
Opt 310 Mapping Software
Opt 410 PCS band antenna-magnetic mount
Opt 500 Rackmount chassis
Opt 510 Vehicle mounting kit (brackets, screws)
Opt 530 Briefcase carrier

HP 8648A
Option 1EP

- 100 kHz to 1.0 GHz
- POCSAG, FLEX, and FLEX-TD
- Pager testing you can depend on

HP 8648A with Option 1EP

Easy, Economical, One-Box Pager Testing Using the HP 8648A Option 1EP

HP-IB

The HP 8648A Option 1EP provides a complete, economical, one-box pager test solution. It includes the digital pager encoder that supports the popular worldwide standard, POCSAG (Post Office Code Standardization Advisory Group), and the newer paging standards, FLEX[1] and FLEX-TD (RCR-43, for Japan).

Offering Key FLEX Specifications

The specifications of the HP 8648A Option 1EP are ideal for the stringent FLEX and FLEX-TD test requirements. It offers 60 Hz frequency shift keying (FSK) deviation accuracy within specific pager service bands. This is the most important FLEX specification. Also, it typically offers 40 Hz carrier frequency accuracy (relative to CW in dcFM).

Faster, Easier Testing

Now test time is reduced and simplified with the HP 8648A's semi-automated features:

- Customize your result with user-defined messages of up to 40 characters
- Reduce test time with 5 built-in test messages
- Increase test reliability with 70 internal storage registers capable of storing the entire protocol configuration

Performance Summary

Frequency: 100 kHz to 1 GHz
Frequency Accuracy with Option 1E5: Typically 0.15 x 10^{-6} x carrier frequency in Hz, or typically 0.092 x 10^{-6} x carrier frequency in Hz within 90 days of calibration
Output Level: +10 dBm to –136 dBm
Output Level Accuracy: 1 dB (> –127 dBm)
Carrier Frequency Accuracy: (relative to CW in dcFM) 100 Hz (typically 40 Hz), deviation < 10 kHz (within one hour after dcFM calibration)

Pager Signaling

Supported Pager Protocols: POCSAG, FLEX and FLEX-TD

[1]FLEX is a trademark of Motorola, Inc.

POCSAG

Speed: 512, 1200, and 2400 bps
Message Format: Tone only, Numeric, Alphanumeric

FLEX/FLEX-TD

Speed: 2 Level FSK: 1600 and 3200 bps; 4 Level FSK: 3200 and 6400 bps
Message Format: Tone only, Numeric (standard and special), Alphanumeric, HEX/binary
Address Type: Short, long (messaging accessible from front panel or HP-IB)
Message Types: Five fixed (built-in), one user-defined message
Length: 40 characters maximum
Repetition Modes: Single, burst, continuous (messaging accessible only over HP-IB)
FLEX/FLEX-TD: 128 frames
POCSAG: 128 batches
Data Rate Accuracy: 5 ppm

Key Literature

HP 8648A Pager Test Option, p/n 5964-6686 E

Ordering Information

HP 8648A Synthesized Signal Generator
Opt 1EP Pager Signalling
Opt 1E5 High-Stability Timebase (FLEX, FLEX-TD only)

Digital Microwave Radio Test Equipment

(PN 3708A-5) Testing Satellite Systems with the HP 3708A
5954-9555

Mobile/Cellular Radio Test Sets

Troubleshooting CDPD MDBS Software
5965-7060

(PN 892X) Techniques for Programming the HP 892X Family of Instruments
5965-6120E
(PN 83236A/B) Writing Control Software for the HP 83236A/B
5965-5626E
(PN 8920-1) Using the IBASIC Programming Environment on the HP 8920 Test Set Family
5963-0046E
(PN 83204A/5A) CDPD Conceptual Overview
5965-6326E
(PN 83204A/5A/21A) CDPD MDBS Cell Site Test Software Troubleshooting
5965-7060E
(PN 8921-1) HP 8921A Cell Site Test Set
5962-9475E
(PN 8320NX/8921A) Step by Step Testing Procedure for PCSI CDPD MDBS Radios
5965-7345E
(PN 8920) Step-by-Step Testing Procedures for PCS/CDPD MDBS
5965-7345E
(PN 8920-1) Using the I-BASICS Programming Environment on the HP 8920 Test Set Family
5963-0046E
(PB 83236A/B) Writing Control Software for the HP 83236A/B
5965-5626E
(PN 8921-2) HP 8921A Cell Site Test Set TACS Base Station Testing
5962-0157

Cellular/PCS Transmitter & Receiver Test Equipment

(PN 89400-1) Frequency and Time-Selective Power Measurements with the HP 89400 Series Vector Signal Analyzers
5091-7194E
(PN 89400-10) Time-Capture Capabilities of the HP 89400 Series Vector Signal Analyzers
5091-8686E
(PN 89400-11) Phase Noise Performance of the HP 89400 Series Vector Signal Analyzers
5963-0039E
(PN 89400-12) Understanding Time and Frequency Domain Interactions in the HP 89400 Series Vector Signal Analyzers
5962-9217E
(PN 89400-14) Using Error Vector Magnitude Measurements to Analyze and Troubleshoot Vector-Modulated Signals
5965-2898E
(PN 89400-2) Measuring Phase Noise with the HP 89400 Series Vector Signal Analyzers
5091-7193E
(PN 89400-3) CDMA Measurements with the HP 89400 Series Vector Signal Analyzers
5091-7196E
(PN 89400-4) Characterization of Digital Communications Channels with the HP 89400Series Vector Signal Analyzers
5091-7195E
(PN 89400-5) Measuring Transmitter Transients with the HP 89400 Series Vector Signal Analyzers
5962-9493E
(PN 89400-6) Translated Frequency Measurements with the HP 89440A
5091-7412E
(PN 89400-7) The Dynamic Range Benefits of Large-Scale Dithered Analog-to-Digital Conversion in the HP 89400 Series VSAs
5091-7668E
(PN 89400-8) Using Vector Modulation Analysis in the Integration, Troubleshooting, and Design of Digital RF Communication Systems
5091-8687E
(PN 89400-9) Downconverted Measurements Using the HP 89410A and HP 89441A
5091-8691E
(PN 89400-9) Downconverted Measurements Using the HP 89410A and HP 89411A
5091-8691E

Cellular/PCS Spectrum Monitoring & RF Measurement Systems

HP E4915A Crystal Impedance Meter
5965-1172E

(PN E4915/6A) Crystal Resonator Measurements Using the HP E4915A/E4916A
5965-1363E
(PN E4916A) Impedance Measurement for Electronic Circuit Design using HP E4916A
5965-6217E

Pager Test Equipment

(PN 8648A-1) Pager Testing Using the HP 8648A with Internal Pager Encoder Option
1EP 5965-1131E
(PN 8648A-2) Servicing and Repairing Pagers Using the HP 8648A Option 1EP
5965-1132

Many of these literature pieces are available at:
http://www.hp.com/go/tmc98

HP Keeps the World's Time

HP's industry-leading cesium frequency standards set and keep the world's time and frequency at national timekeeping bureaus and standards labs around the globe. HP cesium clocks, which provide more than 80 percent of the weighting of Universal Coordinated Time (UTC), virtually define the world's standard second and the stability of the atomic second.

For decades, HP has led the industry, not only with the world's most stable cesium standard, but also with quartz and counter/modulation-domain analyzer (MDA) technology. HP's quartz has reliability greater than 500,000 hours mean time between failures (MTBF). HP's counters provide 20 picoseconds of resolutions per single shot time-interval measurement and MDAs provide 50 picoseconds of time-interval resolution. MDA technology—developed by HP in 1991—allows users in the lab and on communication networks to view signal dynamics without fear of missing events by making continuous, back-to-back measurements.

Today, global positioning system's (GPS) precise time and frequency and breakthrough intelligent oscillator technology (see "HP SmartClock Technology" in "Key Technologies" on page 499) have been added to HP's comprehensive family of timing and synchronization solutions. HP SmartClock Technology adds intelligence in the form of firmware algorithms to oscillators that are referenced to GPS or other time-reference signals. This intelligence improves the performance of low-cost, highly-reliable quartz to near-cesium quality when locked to GPS and to near-rubidium quality during holdover when the primary reference is not available.

High reliability is a key feature of HP SmartClock Technology. Because the technology continuously calibrates the oscillator to GPS and steers the oscillator during holdover when the reference signal is not available, time-consuming and expensive calibration is no longer needed. The combined technologies of GPS, HP SmartClock and quartz have revolutionized timing by making available low-cost, highly-precise solutions.

Timing/Frequency Sources

Different levels of precise time and frequency are provided by sources ranging from the global positioning system (GPS) and cesium atomic clocks to rubidium and quartz clocks:

Cesium: Before GPS and HP SmartClock Technology, the more expensive the frequency source, the better its accuracy. Cesium atomic clocks, for example, maintain accurate frequency indefinitely without the need for calibration. Because cesium oscillators are higher cost, they are applied only to the most critical applications as primary reference clocks at the top of a network's hierarchy. By using cesium, networks and labs gain independence from other potentially less-reliable timing references.

Rubidium: Rubidium atomic oscillators are lower cost than cesium and have excellent short-term stability (ability to consistently produce accurate time and frequency), but require frequent access to a primary reference signal or synchronization source to maintain long-term, cesium-level accuracy.

Quartz: High-quality quartz oscillators are extremely reliable, inexpensive and have excellent short-term stability. But until HP SmartClock Technology, the effects of aging and temperature on signal stability have made quartz oscillators less accurate over time than either cesium or rubidium.

GPS: Global positioning system (GPS) is the satellite system that provides continuous access to precise time and frequency anywhere on Earth. It is available for commercial use at no cost.

Oscillator Continuum

	Cesium	Rubidium	Quartz	Quartz w/GPS
Long-Term Accuracy	$\pm 2 \times 10^{-12}$ for life of cs. beam tube	$\pm 3 \times 10^{-11}$/mo.	$\pm 5 \times 10^{-10}$/day	$< 1 \times 10^{-12}$/day avg. when locked to GPS
Long-Term Aging	N/A	1×10^{-12}/day	1×10^{-10}/day	N/A
Oscillator Reliability (MTBF)*	120,000–150,000 hrs.	50,000–150,000 hrs.	>500,000 hrs.	>500,000 hrs.

*Mean time between failures

Standards Labs

HP's frequency standards and clocks provide accurate frequency, time-interval and timekeeping capabilities to compare against national standards in timekeeping, R&D and standards labs.

Cesium-beam frequency standards are used in labs where the goal is a very high-accuracy primary frequency standard. HP quartz oscillators are used in virtually every frequency-control application, including atomic standards. The excellent short-term stability and spectral purity of the quartz oscillators contributes to the high quality of the output signal. For less demanding applications where some long-term drift can be tolerated, quartz oscillators are used as independent frequency sources.

HP's own standards lab in Santa Clara, CA is designated as the U.S. Naval Observatory (USNO) West Coast time-reference station. The lab maintains an ensemble of three high-performance HP cesium-beam standards to verify timing accuracy using GPS time-transfer techniques.

Communication and Power Utility Networks

Leveraging this expertise and leadership in timing, HP continues to broaden its family of timing synchronization solutions for wireline and wireless telecommunication service providers, power utilities and network equipment manufacturers.

Timing Synchronization Systems and Services

Responding to the needs of customers, HP has taken a comprehensive systems approach to help plan, implement, manage and support the increasingly complex timing synchronization system:

- HP's growing line of *products* improve timing and synchronization to enable networks to operate reliably and accurately at higher speeds. Even with increasing customer loads, quality of service is improved. Products include a cesium primary-reference clock (PRC), quartz or rubidium GPS primary-reference source (PRS), and quartz or rubidium synchronization supply unit (SSU). A complete line of accessories is available.
- *Custom-designed timing subsystems* enable network equipment manufacturers to improve time to market and reduce project risk by outsourcing this increasingly-specialized engineering task. HP acts as the manufacturer's off-site R&D team to design a custom module and move quickly to prototype and high-volume production.
- A *network synchronization audit* uses cesium and MDA technology to quantify timing performance and identify the locations of poor timing.
- *Services* such as synchronization planning help network designers plan and deploy their increasingly complex timing synchronization subsystems.
- HP's *telecom support organization* is specially trained in timing to help carriers keep their synchronization networks running smoothly, 24-hours per day, seven days per week. Network equipment manufacturers also rely on the support organization to provide service for the timing subsystem that is not their core competency.
- *Synchronization network management* software manages synchronization across the entire multivendor network. A major development, HP's software is the first to provide operators a comprehensive view of the synchronization of all network offices and elements, allowing prompt identification of problem areas. The software operates on the telecom industry's defacto platform—HP OpenView—and is the final piece of HP's total network management solution that includes computers, software and interconnectivity products.

Why is Better Timing Needed?

For telecom carriers who are beginning to deploy on a large scale broadband services based on next-generation SONET/SDH, the potential problems are many. When timing or synchronization are inadequate, quality issues range from distorted, unreadable faxes and corrupted or lost data to frozen images on video-conference screens and unintelligible encryption messages requiring re-transmission.

Similarly, wireless carriers—who are increasing capacity and moving from older, analog technologies to next-generation CDMA, TDMA and two-way paging technologies—face timing-related problems of crosstalk and blocked or dropped calls. Wireless carriers are also learning that the timing they receive from the T1 or E1 lines of their wireline counterparts—who are often competitors—does not always provide the accuracy needed.

Frequency Standards and Synchronization Systems Applications

	Wireless Communications	Wireline Telecommunications	Power Transmission	Defense/Aerospace	General Purpose
Network Equipment Manufacturers	**HP 58000 Series and 58503A** Base station frequency and timing synchronization	**HP 58000 Series** **HP 55300A and 55400A** Central office frequency and timing synchronization	**HP 59551A** Fault location Wide area sync for higher capacity	N/A	N/A
Service Providers	**HP 55300A and 58503A** MTSO, BSC, BTS frequency and timing synchronization **HP 55460A and 55461A*** Sync audit and planning services	**HP 5071A and 55000 Series** International Gateway timing **HP 55300A and 55400A** Main Office, Central Office and Local Exchange timing synchronization **HP 55460A and 55461A*** Sync audit and planning services	**HP 59551A** Fault location Wide area sync for higher capacity	N/A	N/A
R&D, Manufacturing and Production Test	**HP 58503A** Frequency and time reference	**HP 58503A and 55300A** Frequency and time references	**HP 58503A and 59551A** Frequency and time references	**HP 58503A and 5071A** Frequency and time references	**HP 58503A** Frequency and time references
Metrology and Calibration	**HP 5071A, 105B and 55000 Series** Frequency standards and ensembles **HP 58503A** Inexpensive time and frequency reference	**HP 5071A, 105B and 55000 Series** Frequency standards and ensembles **HP 58503A** Inexpensive time and frequency reference	**HP 5071A, 105B and 55000 Series** Frequency standards and ensembles **HP 58503A** Inexpensive time and frequency reference	**HP 5071A, 105B and 55000 Series** Frequency standards and ensembles **HP 58503A** Inexpensive time and frequency reference	**HP 5071A, 105B and 55000 Series** Frequency standards and ensemble **HP 58503A** Inexpensive time and frequency reference

* Contact HP for pricing and details on the HP 55460A Sync Audit Service and the HP 55461A Sync Planning Service.

Note: Products in this table are described on the following pages:
HP 105B, page 503
HP 5071A, page 501
HP 55000 Series, page 503
HP 55300A and 55400A, pages 509 and 507
HP 58000 Series, page 506
HP 58503A, page 500
HP 59551A page 510

Key Technologies

The following new technologies have revolutionized timing by making low-cost, highly-precise solutions available to communication networks and in the lab:

Global Positioning System Precise Time

The global positioning system (GPS) provides continuous access to precise time and frequency, at low cost—anywhere on Earth. The 24-satellite global positioning system, designed by the United States as a dual-use system for commercial and military applications, transmits data for precise time and position (latitude, longitude and altitude).

The signal is accurate to within 340 nanoseconds of Universal Coordinated Time (UTC). All ground stations for monitoring and providing master control for the GPS system are based on HP atomic clocks.

HP SmartClock Technology

HP SmartClock Technology adds intelligence to oscillators that are referenced to GPS or other time-reference signals.When locked to a reference signal, HP SmartClock Technology compares the frequency of the unit's oscillator to that of the reference signal and uses this information to adjust the frequency of the oscillator to match the reference signal. Corrections automatically are issued over time, keeping the performance of the oscillator as close as possible to that of the reference source.

If the incoming reference signal is lost, HP SmartClock Technology automatically switches the timing system into an intelligent holdover mode. HP SmartClock Technology takes control of the oscillator so that it continues to distribute highly-stable synchronization outputs. Having learned the oscillator's behavior (aging rate and effects of temperature) when it was locked to the reference signal, HP SmartClock Technology adjusts the oscillator as needed. When the reference signal is restored, the unit automatically relocks.

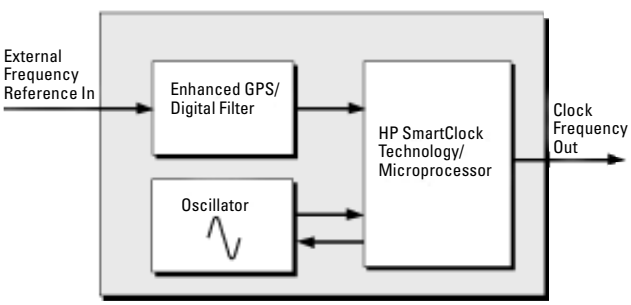
HP SmartClock Technology also evaluates the received GPS signal data. Bad data resulting from a satellite malfunction, temporary reception problems or an erroneous upload to a satellite is not used. As a result, the HP SmartClock Technology unit avoids errant timing that causes errors in the timing system.

HP Quartz Oscillator

HP's oven-controlled quartz oscillators provide best-in-the-industry performance. The HP 10811D/E quartz oscillator (see page 115.6), currently used in most HP timing products, has a proven record of reliability with mean time between failures (MTBF) of more than 500,000 hours.

HP Enhanced GPS/Digital Filter

The adverse effects of selective availability (SA), which occur because jitter is added to the GPS signal to maintain security for U.S. military applications, are minimized by a digital filter called HP Enhanced GPS. HP uses a similar filter technology to remove jitter from other external reference sources such as T1 or E1 lines from the wireline network.



HP SmartClock Technology Block Diagram

GPS Time and Frequency Reference Receiver

HP 58503A

- Reduce the cost for precise time and frequency
- Eliminate calibration through GPS technology
- Improve reliability through HP quartz oscillators

HP 58503A Option 001

HP 58503A GPS Time and Frequency Reference Receiver

GPS Makes Precise Time and Frequency Affordable

The HP 58503A is well-suited for a broad range of applications. Regardless of industry, it meets the needs of manufacturing, development, calibration labs and services. Through a unique combination of technology, the HP 58503A Time and Frequency Reference Receiver provides a highly-reliable, low-cost source of precision time and frequency.

The HP 58503A is based on Hewlett-Packard's proven quartz technology. This provides unsurpassed reliability and confidence, as well as excellent short-term stability. The core of the design is an oscillator with >500,000 hours of field-proven mean-time-between-failure (MTBF). This delivers superior performance and reliability while eliminating the need for periodic oscillator replacement as required in rubidium sources.

By locking the oscillator to the GPS signal, the HP 58503A provides frequency accuracy of better than 1×10^{-12}. This gives you the long-term performance of GPS with the superior short-term stability of a state-of-the-art quartz oscillator. Time accuracy compared to UTC (USNO MC) is better than 110 ns—even in the presence of Selective Availability (SA).

When the GPS signal is interrupted, the HP 58503A automatically enters an intelligent holdover mode using HP SmartClock. This minimizes frequency drift and compensates for environmental changes, maintaining accuracy to better than 1×10^{-10} per day.

This unique combination of technology provides you superior value—lower cost, smaller size, higher performance and superior reliability. For a more detailed description of the technologies, see "Key Technologies", page 499.

Using Technology to Solve Problems

By providing an affordable high-performance reference for frequency and time, many problems have been solved. This convenient reference is easy to integrate into any environment requiring precise time or frequency.

Development labs and manufacturing now have a convenient source for frequency and time—both 10 MHz and 1 pps outputs are standard. Often the HP 58503A proves to be a cost-effective alternative to distributing an in-house standard. By using the HP 58503A as an external frequency reference for test equipment, time-base aging is eliminated—improving the quality of test results while eliminating the need for periodic time-base calibration.

Metrology and calibration labs find the HP 58503A essential. For smaller labs where cost is a key concern, the HP 58503A provides a low-cost alternative for precise time and frequency. For more advanced labs, the HP 58503A offers an excellent time reference. Additionally, it gives you a view into the international time scale through UTC—allowing you to steer or monitor the performance of other oscillators in the lab.

The communications industry also benefits from the convenience of the HP 58503A. When telecom reference signals are unavailable or unreliable, a high-quality reference signal is required. Output options for the HP 58503A provide highly-accurate reference signals with signal formats consistent with all ITU-T specifications. This simplifies the evaluation of communications equipment during development and deployment.

Regardless of industry, the HP 58503A provides a cost-effective, highly-reliable source of precise time and frequency anywhere in the world.

Abbreviated Characteristics and Specifications

GPS Receiver
- 6-channel, parallel-tracking
- C/A code, L1 carrier
- HP SmartClock/HP Enhanced GPS
- DC power options available

10 MHz Output Characteristics

Frequency Accuracy (locked): $<1 \times 10^{-12}$ for a one-day average
Holdover Aging (unlocked): $<1 \times 10^{-10}$ per-day average frequency change in 24 hours of unlocked operation
Output Level: $>1 V_{p-p}$ sine wave into 50 Ω load

Phase Noise (locked):

Offset from signal (Hz)	SSB phase noise (dBc)
1	–85
10	–125
100	–135
1,000	–140
10,000	–145

Time Domain Stability (locked):

Averaging time (seconds)	Root Allan variance
0.01	1.5×10^{-10}
0.1	1.5×10^{-11}
1	5×10^{-12}
10	5×10^{-12}
100	5×10^{-11}
1,000	5×10^{-11}

1 pps Output Characteristics

Jitter on Leading Edge (locked): <750 ps rms
Time Accuracy (locked): <110 ns with respect to UTC (USNO MC)–95% probability when unit is properly installed and calibrated
Accumulated Time Error (unlocked): <8.6 μs/accumulated in 24 hours after three days of locked operation with a fixed antenna location
Output Level: >2.4 V pulse into 50 Ω load
Pulse Width: 26 μs

Front-Panel Indicators (LED): Power, GPS lock, holdover, alarm
Remote Interface: RS-232-C DTE configuration
RS-232 Connector: 25-pin female rectangular D subminiature on rear panel
Power Requirements

Standard (ac power): 90 to 132 Vac or 198 to 264 Vac, automatically selected; 50 to 60 Hz
Option AWM (48 Vdc power): –37 to –60 Vdc operating range. Less than –46 Vdc required at start.
Option AWR (24 Vdc power): +19 to +30 Vdc operating range. Greater than +23 Vdc required at start.
Input Power (all power options): < 35 watts nominal

Ordering Information

HP 58503A GPS Time and Frequency Reference Receiver
Opt 001 Front-Panel Display
Opt AWM 48 Vdc Power
Opt AWR 24 Vdc Power
Special Output Frequencies
Including telecom T1 and E1 telecom reference signals; contact HP for availability and price.
GPS Antenna System and Accessories
See page 505 for the complete line of GPS Accessories.

- Accuracy: ±1 x 10^{-12}
- Settability: ±1.0 x 10^{-9}
- "Flicker floor": ≤ 2.0 x 10^{-14} (≤5 days)
- Fast warmup
- No adjustments before or during operation
- Remote operation

HP 5071A

HP 5071A Primary Frequency Standard

The HP 5071A primary frequency standard delivers unsurpassed accuracy and stability for both laboratory and field applications. Its improved cesium-beam tube reduces the effects of Ramsey pulling. New beam optics use cesium more efficiently. The combined results—increased accuracy and stability, and increased tube life—ensure that your calibration lab services are available longer.

The HP 5071A is easy to use. Automatic startup is simple and requires no adjustments. A logical menu structure simplifies front-panel operations, selections, and status reporting.

The HP 5071A can be operated and maintained anywhere. All controls are programmable, status can be checked remotely, and no adjustments or alignments are necessary during operation. An internal battery provides 45 minutes of backup in case of ac power failure.

Unmatched Accuracy and Stability

The HP 5071A uses Cesium II technology to double the accuracy of its predecessor, the HP 5061B. Cesium II technology includes a new cesium tube and redesigned electronics. The improved accuracy ensures that any HP 5071A Option 001 can power up to within ±1 x 10^{-12} of the accepted standard for frequency. This is achieved under full environmental conditions in 30 minutes or less.

Cesium II technology brings a new level of stability to the cesium clock. The HP 5071A is the first cesium standard to specify its stability for averaging times longer than a day. It is the first standard to specify a "flicker floor"—the point at which the standard's stability does not change with longer averaging. Under laboratory conditions, the standard HP 5071A has a flicker floor better than 5 parts in 10^{14}.

Hewlett-Packard has been producing cesium frequency sources since 1964. The exceptional accuracy and stability of the HP 5071A are a result of this experience and are characterized by improved reliability. Backing up this reliability is a five-year warranty on the standard cesium tube and a three-year warranty for the optional high-performance tube.

Ease of Use

Startup and operation of the HP 5071A are extremely simple. Once connected to an ac or dc power source, the instrument automatically powers up to its full accuracy specifications. No adjustments or alignments are necessary during powerup or at any time during the lifetime of the cesium tube.

Intuitive menus logically report status and facilitate control of the instrument. These menus—Instrument State, Clock Control, Instrument Configuration, Event Log, Frequency Offset, and Utilities—are accessible via the front-panel LCD display and keypad.

High-Performance Tube: Option 001

For the most demanding operations, the HP 5071A Option 001 high-performance cesium-beam tube offers increased performance. Accuracy is two times better than the standard tube, and stability is superior as well. The high-performance tube allows a flicker floor of better than 2 x 10^{-14}.

Telecommunications Options

The HP 5071A primary frequency standard may be optionally equipped to provide output frequencies, impedances, and signal formats required of a Primary Reference Clock in modern telecommunication networks. Configurations are available for both DSI and CEPT standards. The HP 5071A can also be equipped to operate from a 48 Vdc central office battery.

Clock rates of 1.544 and 2.048 Mb/s are available. Impedance choices and signaling formats for all current ITU-T specifications are available. The HP 5071A with 2.048 Mb/s options are ITU-T G.811 compliant. All features found in a standard HP 5071A are retained when a 1.544 or 2.048 Mb/s option is installed. This includes both programmable 5/10 MHz outputs and the 1 MHz and 100 kHz outputs. The 1 pps output and sync are only available on the front panel of the instrument.

The HP 5071A Option 048 equips the frequency standard to operate from 48 Vdc power. Two independent 48-volt power sources may be supplied. The power sources must be of the same polarity but either polarity may be used.

The HP 5071A Option 048 is fully fuse-protected and each power source is isolated. The frequency standard draws power from the source with the higher voltage. Upon source failure the frequency standard will automatically switch to the good source—ensuring uninterrupted operation.

The HP 5071A Option 048 automatically uses a 48 Vdc source if one is present. The instrument will attempt to use ac power if no dc source is available. The internal battery normally supplied with the HP 5071A is not available when Option 048 is installed.

Specifications

Accuracy and Stability

Full Environmental Range

Conditions (any combination of):
Temperature: 0° to 50° C
Humidity: 0 to 80% (40° C maximum)
DC magnetic field: 0 to 2 gauss

Warmup Time (typical):
15 minutes to normal operating status
30 minutes to full specs

Settability
Resolution: 6.3×10^{-15}
Range: $\pm 1.0 \times 10^{-9}$

Frequency change due to environment: $\pm 1 \times 10^{-13}$ ($\pm 8 \times 10^{-14}$ Option 001)
Accuracy: $\pm 2 \times 10^{-12}$ ($\pm 1 \times 10^{-12}$, Option 001)

Time domain stability[1], 5/10-MHz outputs:

Averaging times	HP 5071A	HP 5071A Option 001
10^4 s	$\leq 5.6 \times 10^{-13}$	$\leq 8.5 \times 10^{-14}$
1 day	$\leq 2.0 \times 10^{-13}$	$\leq 3.0 \times 10^{-14}$
5 days	$\leq 1.0 \times 10^{-13}$	$\leq 2.0 \times 10^{-14}$
30 days	$\leq 5.0 \times 10^{-14}$	$\leq 2.0 \times 10^{-14}$

[1]Excluding environmental effects

Flicker floor (value):
$\leq 5.0 \times 10^{-14}$
$\leq 2.0 \times 10^{-14}$ (Option 001)

Reproducibility: $\leq 5.0 \times 10^{-13}$

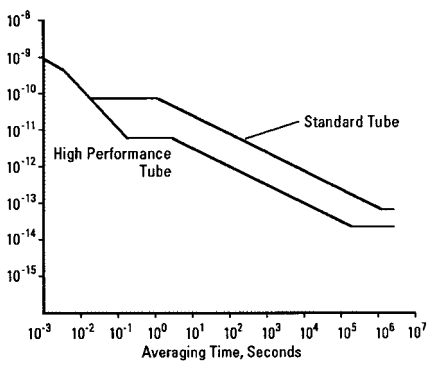
Sinusoidal Output Characteristics (all located on rear panel)

Parameter	Ports 1 and 2[2]	1 MHz, 100 kHz
Amplitude into 50 Ω load	>1 V rms	>1 V rms
Isolation between ports	>110 dB (typ.)	not specified
Harmonic and sub-harmonic signals (typical)	< –40 dBc	< –40 dBc
Non-harmonic distortion	< – 80 dBc	not specified
Connector type	N	BNC
Source impedance (nominal)	50 Ω	50 Ω

[2]Each output can be set to either 5 or 10 MHz from the front panel or by remote command.

Frequency Stability (5/10-MHz Outputs)

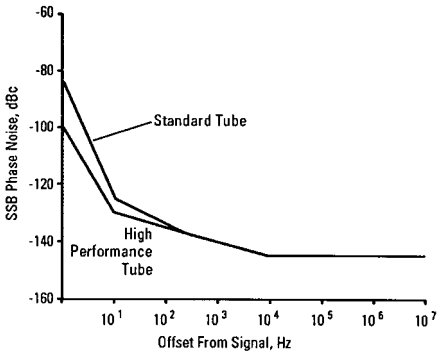
Time Domain Stability[1]



	$\sigma y(2, \tau)$	
Averaging time (seconds)	Standard cesium-beam tube	High-performance cesium-beam tube (Option 001)
10^{-2}	$\leq 1.5 \times 10^{-10}$	$\leq 1.5 \times 10^{-10}$
10^{-1}	$\leq 5.6 \times 10^{-11}$	$\leq 1.5 \times 10^{-11}$
10^{0}	$\leq 5.6 \times 10^{-11}$	$\leq 5.0 \times 10^{-12}$
10^{1}	$\leq 2.3 \times 10^{-11}$	$\leq 3.5 \times 10^{-12}$
10^{2}	$\leq 5.6 \times 10^{-12}$	$\leq 8.5 \times 10^{-13}$
10^{3}	$\leq 1.8 \times 10^{-12}$	$\leq 2.7 \times 10^{-13}$
10^{4}[(1)]	$\leq 5.6 \times 10^{-13}$	$\leq 8.5 \times 10^{-14}$
1 day[(1)]	$\leq 2.0 \times 10^{-13}$	$\leq 3.0 \times 10^{-14}$
5 days[(1)]	$\leq 1.0 \times 10^{-13}$	$\leq 2.0 \times 10^{-14}$

[(1)] Excluding environmental effects

Frequency Domain Stability



	SSB Phase Noise dBc	
Averaging time (seconds)	Standard cesium-beam tube	High-performance cesium-beam tube (Option 001)
10^0	≤ –85	≤ –100
10^1	≤ –125	≤ –130
10^2	≤ –135	≤ –135
10^3	≤ –140	≤ –140
10^4	≤ –145	≤ –145
10^5	≤ –145	≤ –145

Internal Standby Battery (nominal values)

Capacity: 45 minutes at 25° C from full charge
Charge Time: 16 hour maximum from fully discharged state
Charge Source: AC input power only

Remote System Interface and Control

RS-232-C (DTE configuration): Complete remote control and interrogation of all instrument functions and parameters
Interface Circuits: Optically isolated
Software Command Set: SCPI, version 1990.0
Connector: 9-pin male rectangular D subminiature type

Status Output: Logic output for externally monitoring normal and abnormal operation (user-defined)
Output: TTL open collector with internal pull-up resistor
Circuit Sink Capability: Up to 10 mA
Connector: BNC on rear panel

Environmental and Physical

Temperature
Operating: 0° to 55° C
Non-operating: –40° to +70° C

Size: 425.5 mm W x 133.4 mm H x 523.9 mm D (16.75 in x 5.25 in x 20.63 in)
Weight: 30 kg (65 lb)

Ordering Information

HP 5071A Primary Frequency Standard
Opt 001 High-Performance Cesium-Beam Tube
Opt 0B2 Extra Operating and Programming Manuals
Opt 0BW Assembly-Level Service Manual
Opt 908 Rack Flange Kit (for use without handles)
Opt 913 Rack Flange Kit (for use with handles included with HP 5071A)
Opt W30 Extended Repair Service (see page 584)
Opt W50 Extended Repair Service (not available with Option 001)

Telecommunications Options
Opt 048 48 Vdc Power
Opt 104 or 105 1.544 Mb/s, 100 Ω Balanced
Opt 220, 221 or 222 2.048 Mb/s, 120 Ω Balanced
Opt 270, 271 or 272 2.048 Mb/s, 75 Ω

- Unsurpassed accuracy and stability
- High reliability with redundancy
- Highly configurable and upgradeable

HP 55000 Series

HP 10811D/E

Ultra-Precise Time and Frequency Systems

The HP 55000 series Precision Time and Frequency Systems offer unsurpassed accuracy and stability in a reliable, redundant platform. These systems integrate the leading cesium technology, GPS receivers, distribution amplifiers, and backup power supplies from Hewlett-Packard with a sophisticated Time Measurement System from Timing Solutions Corporation. Metrology, communications, and electronic intelligence can all benefit from this cost-effective and fault-tolerant system.

The HP 55000 series solutions deliver state-of-the-art cesium in a complete rackmounted system. An intelligent controller manages the system, resulting in higher performance and increased reliability. The versatility of this system allows configuration and performance to be tuned to meet your needs. As needs change and the demands continue to increase, the HP 55000 series is easily updated to enhance performance.

Two or more HP 5071A primary frequency standards, or primary reference clocks, contribute to the system output. The Time Measurement System continuously monitors all clock outputs and can automatically adjust their phase and frequency. Over time, it learns each clock's characteristics and compensates for hardware deviations and reduces random noise.

Short-term stability is improved. Long-term stability is greatly enhanced and exceeds the results of any single clock contributor in the system. Distribution of the frequency output to various locations is easily accomplished by integrating HP's distribution amplifiers .

The Time Measurement System monitors the system and can automatically steer the individual frequency standards. System status is monitored and potential problems are flagged to the operator or automatically corrected.

The Right System Solution for Each Application

The HP 55000 series addresses a wide variety of needs. System configurations resulting in high accuracy, stability and availability will meet today's demanding frequency and time environments. Application areas include timekeeping and metrology, synchronizing communications networks, and research.

For high-level metrology and timekeeping, the HP 55000 series can be configured as a real-time primary clock ensemble. With the HP 58503A GPS receiver, the system is able to monitor UTC (USNO MC) and produce a highly accurate timescale.

For communications, the HP 55000 series includes a primary reference clock that exceeds the accuracy and stability required at the Stratum 1 or International Gateway level of the network. This performance level becomes increasingly more important with the deployment of SONET/SDH.

For communications research, the cesium frequency and time subsystem meet the demanding phase and timing requirements inherent in modern communications. The redundant, fault-tolerant configuration ensures high system availability.

HP 10811D/E Oscillators

The HP 10811D/E crystal oscillators are oven-controlled, high-performance component oscillators. Both offer unmatched quality, high performance, and low cost. The low aging rate and fast warmup time reduce maintenance costs and downtime. Low power consumption gives the HP 10811D/E oscillators longer battery-backup time. Low phase noise translates to lower system phase noise when using HP oscillators.

The HP 10811D has a PCB connector for all external connections; the HP 10811E uses filter feedthrough terminals for power connections and oven monitor. The HP 10811E also has SMB snap-on RF connectors for the 10 MHz output and EFC input, and provisions for shock mounting.

The HP 105B quartz frequency standard uses the HP 10811D and is available as a complete standalone instrument.

Ordering Information

HP 105B Quartz Frequency Standard
  Opt 908 Rack Flange Kit
  Opt 910 Extra Manual
HP 10811D 10 MHz Oscillator, PCB/Edge Connector
HP 10811E 10 MHz Oscillator, SMB Connectors
Options for HP 10811D or HP 10811E
  Opt 001 Low Aging Rate
  Opt 002 Low Phase Noise
  Opt 003 Integrated Option 001 and Option 002
  Opt 100 Reduced Specifications
Note: Options are mutually exclusive; no mixing.
HP 5089A Standby Power Supply (includes ac and dc input power cables, dc output cable, and extender board)
  Opt 001 Spare Board (HP 05089-60001)
  Opt 908 Rackmounting Adapter Kit
  Opt 910 Extra Operating and Service Manual
HP 55000 Series Precision Time and Frequency Systems

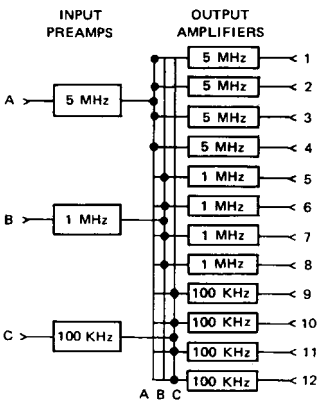
HP 5087A
HP E1750A
HP E1752A

HP 5087A

HP 5087A Distribution Amplifier

The HP 5087A distribution amplifier provides the flexibility needed for distribution of frequency standard outputs, where multiple-output frequencies are required. The modular construction allows you to configure the product for a variety of distribution needs.

Several configurations are available, and special combinations of input and output modules can be supplied. Amplifiers can be added or the configuration easily changed with the HP 10812A options.



HP 5087A with Option 031

HP 5087A Specifications

Inputs: Up to three rear-panel BNC
- **Frequencies:** 10 MHz, 5 MHz, 1 MHz, or 100 kHz
- **Level:** 0.3 to 3.0 V rms, 50 Ω

Outputs: Up to 12 rear-panel BNC
- **Frequencies:** 10 MHz, 5 MHz, 1 MHz, or 100 kHz
- **Level:** 0 to 3 V into 50 Ω (screwdriver adjustment)
- **Harmonic Distortion:** > 40 dB below rated output
- **Non-Harmonic Distortion:** > 80 dB below rated output

Isolation
- **Load** (open or short on any other channel)
  - **Amplitude Change:** 0.1%
  - **Phase Change:** < 0.1 ns at 5 or 10 MHz; < 0.5 ns at 1 MHz; < 5.0 ns at 100 kHz
- **Injected Signal:** 1 V signal up to 50 MHz applied to any output except 10 MHz, will be down >60 dB in all other outputs; 10 MHz output channel will be down >50 dB

SSB Phase Noise (5 MHz): >145 dB below signal in 1 Hz BW for frequencies >1 kHz from carrier

Short-Term Stability Degradation (5 MHz): <1 x 10^{-12} in 10 kHz bands (1-s average)

Environmental
- **Temperature:** MIL-E-16400, class 4
- **Operating:** 0° to 50° C
- **Storage:** –62° to +75° C

Stability
- **Amplitude:** ±0.5 dB, 0° to 50° C
- **Phase:** <0.1 ns/° C, 5 and 10 MHz
- **Humidity:** 95% at 40° C
- **Altitude:** Up to 30,000 ft.

General
- **Power:** 115 or 230 V ±10%, 48 to 440 Hz, 20 VA, maximum, or 22 to 30 Vdc, 600 mA, maximum
- **Size:** 425 mm W x 88 mm H x 286 mm D (16.7 in x 3.5 in x 11.3 in)
- **Weight:** Typical, Option 031; net, 7 kg (15 lb)

HP E1750A HP E1752A

HP E1750A VXI Distribution Amplifier

These VXI distribution amplifier modules buffer and distribute standard clock and other signals in laboratory, factory, and general ATE environments. They feature one input and six outputs per module, and are suited to distributing a wide variety of signals in a single ATE system or throughout a building. Principal features of the product include:
- Broadband sine wave or pulse buffering/distribution
- Built-in AGC for no level adjustments
- Preservation of input phase and frequency characteristics with changing environment (temperature, humidity, etc.)

General Specifications

Input Ranges

	HP E1750A	HP E1752A
Freq. min.	100 KHz	1 pps
Freq. max.	10 MHz	10 million pulses per second
Level, min.	+7 dBm	Logic LO: ≤0.8 V
Level, max.	+19 dBm	Logic HI: 2.0 V ≤ V_{in}
Damage	+27 dBm	+14 V, –9 V
Impedance	50 Ω	50 Ω

HP E1750A Outputs, 50 Ω load

Level	+13 dBm ±1 dBm
Phase noise	< –145 dBc
Port-to-port isolation (open/short loads)	
phase modulation	< –100 dBc
phase change, peak	< ±.0012°

HP E1752A Outputs, 50 Ω load

Rise-fall time	<5 ns
Pulse amplitude	>3.5 V
Propagation delay	22 ns, typical
Jitter	<1 ns rms

Ordering Information

HP 5087A Distribution Amplifier Mainframe
- **Opt 908** Rack Flange Kit

Normal Configurations (input and output amplifiers)
- **Opt 031** 5, 1, 0.1 MHz Inputs; 4 Outputs at each
- **Opt 032** Single 5 MHz Input and 12 Outputs
- **Opt 033** Single 10 MHz Input and 12 Outputs
- **Opt 034** Single 5 MHz Input, 4 each; Outputs at 5, 1, and 0.1 MHz

Special HP 5087A Configurations
- **Input Preamplifiers** (up to 3 total)
- **Opt 004** Input Preamplifier (0.1 to 10 MHz)
- **Opt 005** 5 to 1 MHz Input Divider
- **Opt 006** 1 to 0.1 MHz Input Divider
- **Opt 011** 5 to 10 MHz Input Doubler
- **Opt 013** 10 to 5 MHz Input Divider
- **Opt 014** 10 to 1 MHz Input Divider
- **Output Amplifiers** (up to 12 total)
- **Opt 001** 5 MHz Output Amplifier
- **Opt 002** 1 MHz Output Amplifier
- **Opt 003** 0.1 MHz Output Amplifer
- **Opt 012** 10 MHz Output Amplifier

HP E1750A Broadband Distribution Amplifier
- **Opt AV9** Delete Operation and Programming Manual

HP E1752A Pulse Distribution Amplifier
- **Opt AV9** Delete Operation and Programming Manual

- Complete solutions for GPS antenna systems
- High reliability GPS accessories
- Broad range of products to meet every need

HP 58504A
HP 58505B
HP 58509A
HP 58509F
HP 58510A
HP 58513A
HP 58514A
HP 58515A
HP 58516A
HP 58517A
HP 58518A
to 58521A
HP 58518AA
to 58521AA

HP GPS Accessories

Complete Your GPS-Based Solution with Confidence

High-quality Hewlett-Packard Global Positioning System (GPS) accessories let you configure a complete GPS antenna system with confidence and reliability. These products simplify installation while providing high signal integrity. By providing a range of GPS accessories, HP offers a complete solution—from the GPS antenna to precise time and frequency reference receivers.

HP GPS accessories include antennas, antenna assemblies, line amplifiers, lightning arresters, distribution amplifiers/splitters, bandpass filters, cables and cable kits—everything you need for your complete antenna system.

GPS Antennas and Antenna Assemblies

The HP 58504A GPS L1 antenna delivers highly-accurate signals to GPS receivers. Characterized by low noise and high gain, it ensures signal fidelity while simplifying the antenna system architecture and installation. An HP 58510A environmental cover and ground plane is available for additional environmental protection.

For maximum protection, HP offers the HP 58513A antenna assembly. It integrates a stainless steel mast and ground plane with the antenna, antenna cable and environmental cover.

Antenna Specifications
Frequency Range: 1575.42 ± 5 MHz (L1 carrier)
Total Gain: > 30 dBi
Operating Environment: –40˚ C to +80˚ C

Lightning Arrester

The bulkhead-mount HP 58505B lightning arrester provides multiple-strike protection for antenna systems and GPS receivers. This compact unit makes installation easy while protecting your investment.

Lightning Arrester Specifications
Frequency Range: 1.2 to 2.0 GHz
Surge: 20 kA IEC 801-5 8/20 microsecond waveform
Turn-on: +7, –1 Vdc
Turn-on Time: 4 ns for 2 kV/ns
Operating Environment: –40˚ C to +80˚ C

Line Amplifiers

The HP 58509A GPS line amplifier is a high-gain, broadband amplifier that allows extended cable runs from receiver to the antenna. The HP 58509F line amplifier integrates an L1 bandpass filter, providing the same benefits as the HP 58509A and additional immunity from noise or interference.

Line Amplifier Specifications
HP 58509A
Amplifier Gain: > 20 dB (25 dB typical)
Frequency Range: 750 MHz to 2.4 GHz
HP 58509F
Amplifier Gain: > 20 dB (24 dB typical) at L1
Filter Attenuation: > 7 dB at L1 ± 35 MHz, > 30 dB at L1 ± 140 MHz
HP 58509A and HP 58509F
Operating Environment: –40˚ C to +80˚ C

Bandpass Filter

The HP 58514A GPS L1 bandpass filter protects GPS receivers from the effects of noise and interference near the L1 carrier frequency. The filter ensures accurate satellite tracking even in the presence of disturbances.

Bandpass Filter Specifications
Frequency Range: 1575.42 ± 20 MHz (L1 carrier)
Filter Attenuation: > 7 dB at L1 ± 35 MHz, > 30 dB at L1 ± 140 MHz
Operating Environment: –40˚ C to +80˚ C

Distribution Amplifier/Splitters

The HP 58515A, 58516A and 58517A distribution amplifiers/splitters distribute the GPS signal to two, four or eight output ports, respectively. For ease of installation and configuration, these units feature built-in amplification to provide unity gain from input to each of the output ports. High isolation between output ports eliminates the risk of interaction between GPS receivers connected to the distribution amplifier.

Distribution Amplifier/Splitter Specifications
Frequency Range: 1575.42 ± 20 MHz (L1 carrier)
Gain (input to output)
HP 58515A: 3 dB ± 3 dB; **HP 58516A:** 0 dB ± 3 dB;
HP 58517A: 0 dB ± 4 dB
Isolation (typical)
HP 58515A and HP 58516A: – 40 dB; **HP 58517A:** – 35 dB
Operating Environment: 0˚ C to +55˚ C

Cables and Cable Kits

HP offers a complete line of antenna cables and interconnect cables for completing your antenna system. The HP 58518A and HP 58519A RG-213 cables provide increased flexibility for installation ease. The HP 58520A and HP 58521A LMR 400 cables feature low-loss and are ideal for installations requiring greater cable lengths. All cables are available in a variety of lengths ranging from 1 meter to 50 meters for RG-213 cables and 1 meter to 330 meters for LMR 400 cables.

For installations requiring greater flexibility or where cables must be pulled through conduit, cable kits are available. These kits provide the raw cable with connector kits. This allows the connectors to be installed once the cable is in place. The HP 58518AA and 58519AA are kit versions of the RG-213 cables and the HP 58520AA and 58521AA are the kit versions of the LMR 400 cables.

Cables and Cable Kits Specifications
Impedance: 50 Ω typical
Signal Loss at L1 Frequency
RG-213 Cables: 7.9 dB per 20 meters
LMR 400 Cables: 3.35 dB per 20 meters
Cable (Propagation) Delay
RG-213 Cables: 5.05 ns per meter
LMR 400 Cables: 3.93 ns per meter
Connectors or Connector Kits
HP 58518A/AA, 58520A/AA: One TNC(m) and One N(m)
HP 58519A/AA, 58521A/AA: Two N(m)

Key Literature

GPS Antenna System Configuration Guide, HP p/n 5964-9068E

Ordering Information

HP 58504A GPS Antenna
HP 58505B Lightning Arrester
HP 58509A Line Amplifier
HP 58509F Line Amplifier with L1 Bandpass Filter
HP 58510A Environmental Cover and Ground Plane
HP 58513A Antenna Assembly
HP 58514A L1 Bandpass Filter
HP 58515A 1:2 Distribution Amplifier/Splitter
HP 58516A 1:4 Distribution Amplifier/Splitter
Opt 05Ω External Power
HP 58517A 1:8 Distribution Amplifier/Splitter
Opt 05Ω External Power
HP 58518A/19A RG-213 Cables
HP 58518AA/19AA RG-213 Cable Kits
HP 58520A/21A LMR 400 Cables
HP 58520AA/21AA LMR 400 Cable Kits

11

HP 58000 Series

Drawing on decades of experience building the world's most accurate cesium and most reliable quartz clocks, HP designs and manufactures custom timing subsystems for network equipment manufacturers. Acting as an off-site R&D team, HP engineers are responsive to the needs of manufacturers. HP designs a custom module and then moves quickly to prototype and high-volume production. By outsourcing the timing subsystem, manufacturers can focus on other critical design issues to achieve faster time-to-market. HP's leadership in timing, decades of experience, and proven technologies remove manufacturer's risk for this increasingly-complex piece of base stations and network nodes.

90's Technologies

HP's areas of expertise include the technologies of the 90's: global positioning system's (GPS) precise time and frequency, advanced quartz oscillators and breakthrough intelligent oscillator technology (see "Key Technologies," page 499). Together, these technologies revolutionize wireless base station and wireline network timing by making low-cost, highly-reliable timing available. Manufacturers can now replace the rubidium technology of the 80's with this trio of technologies for near-cesium performance when locked to GPS and near-rubidium performance during holdover. Because quartz is more reliable than rubidium (see "Oscillator Continuum", page 498), time-consuming and costly base station and transit node service is dramatically reduced. GPS further stabilizes the quartz, making recalibration that is required for rubidium or standalone quartz unnecessary. Maintenance is dramatically reduced.

The HP 58000 Series custom timing modules are designed and built for any level of accuracy and stability needed by manufacturers. HP meets and exceeds the standards for CDMA, TDMA and GSM, analog, special/private mobile radio (SMR/PMR) and paging technologies. For stratum 2, 3 and 3E transit node and local area clocks, we meet or exceed ANSI, ETSI and Bellcore standards. We match your requirements for size and form factor with a box, card or board. And we match each manufacturer's specific requirements for space, power, configuration and price.

HP 58000 Series OEM Custom Timing Modules

Important decisions that affect performance and price are:

Intelligent Oscillator: HP SmartClock Technology, which adds intelligence to the base station or local office oscillator, vastly improves the clock's performance during normal conditions as well as during holdover when the GPS antenna is down or the reference source is not available.

Holdover Capability: Lower-performance base stations can be designed without holdover capability. But for a high-performance network, rubidium or high-performance quartz oscillators will provide holdover timing when the external frequency reference source is not available. Fluctuations in temperature at the base station site and length of desired holdover are the key factors that affect initial cost. Lifetime cost is lower with quartz because it is more reliable than rubidium and, unlike rubidium, does not need to be replaced after 8 or 10 years.

Special Features: HP responds to any request. We'll provide autoswitching, a scheme that automatically switches a base station from one timing module to another without any change in output. Or you might need a special frequency—19.6608 MHz for CDMA or 13 MHz for GSM.

Frequency Reference Source: Although GPS timing combined with HP SmartClock Technology gives the best price/performance, T1 or E1 can also be used as a frequency reference source. Other levels of performance can be achieved without an external frequency reference source. The local clock—a quartz or rubidium oscillator used with or without HP SmartClock Technology—can provide the frequency for less stringent performance requirements.

Ordering Information

Contact HP for more information and design consultation for a custom solution.

11

Example Configurations for Different Performance Requirements

	Performance Required						HP Custom Solution	
	Frequency Outputs	**Temperature**	**Holdover Requirement**	**Accuracy**	**Accuracy during holdover**	**Timing sync between cell sites**	**MTBF (hrs.)**	
High-performance timing module for CDMA base station	10 MHz; 19.6608 MHz; 1 pps	0° to 50° C	24 hrs. in loss of GPS	$1x10^{-11}$ for 1 day avg. when locked	$1x10^{-10}$ for 24 hrs.	±1 μsec. locked ±7 μsec. unlocked	>100,000	Frequency Reference: GPS HP SmartClock Technology HP 10811 double-oven quartz oscillator Enhanced GPS/digital filter
Medium-performance timing module for TDMA base station (GSM or IS-54 standard)	13 MHz	0° to 50° C	1 week	$1x10^{-10}$ for 1 day avg. when locked	$1x10^{-9}$/ week	N/A	>100,000	Card-based, multi-function Frequency Reference: E1 or GPS HP SmartClock Technology HP 10811 single-oven quartz oscillator Telecom digital filter
Medium-performance timing module for paging base station	10 MHz, 32 kHz, 100 kHz; 1 pps	0° to 50° C	6 μsec./ 6 hrs.	$1x10^{-11}$ for 1 day avg. when locked	$5x10^{-10}$/ 6 hr.	<600 nsec.	>100,000	Card-based Frequency Reference: GPS HP SmartClock Technology HP 10811 single-oven quartz oscillator
Timing for SMR/PMR analog base station	10 MHz	–30° to +60° C	None	5×10^{-10}	N/A	N/A	>100,000	HP 10811 single-oven quartz oscillator Frequency Reference: None 12-channel distribution system Compact box

HP 55400A

- Provides precise timing synchronization signals
- For E1, 2048 kbps, primary rate systems
- Complies to ITU and ETSI requirements
- Designed for SDH deployment.
- Supports Synchronization Status Messages (SSM)
- Designed to be managed, locally or remotely
- Local management software: HP SmartView PC
- TMN compliant remote management software: HP SmartView UX
- Industry standard platform allowing easy integration with other management systems
- Industry-leading timing quality under stressed conditions
- Minimizes SDH pointer movements
- No phase hits with input reference switching
- Unprecedented reliability for maximum network uptime
- Oscillator MTBF > 500,000 hours
- Redundant hot swappable modules
- 1:1 output protection
- Downloadable firmware for easy upgrades
- Modular and expandable
- Customized systems available

HP 55400A E1 Network Synchronization Unit

The HP 55400A Network Synchronization Unit, commonly known as a Synchronization Supply Unit (SSU), is a modular, fully redundant, timing distribution unit for 2048 kbps primary rate networks. It is ideally suited for telecommunications networks where SDH technology is being deployed or expanded. The SSU tracks up to nine incoming reference signals from higher or equal levels of the network, qualifies the signals, then filters and distributes up to 400 precise timing signals to the node's network equipment. Incoming reference signals may come from cesium standards at the top level of the network, GPS reference sources, or live traffic signals.

The HP 55400A SSU is compliant to ITU-T G.703, G.704, G.812, G.823, and ETSI prETS-300 462-4. It is compatible with current (PDH) and emerging (SDH/ATM) industry technologies and services for network synchronization.

Outstanding Holdover Performance

HP has developed breakthrough technology, called HP SmartClock, that delivers Stratum 2 holdover performance at less cost and higher reliability than rubidium (estimated 5x higher). HP SmartClock technology is a forward-looking correction process applied to the HP 10811 high-performance quartz oscillator; hence the lower cost and higher reliability. HP SmartClock evaluates the aging characteristics of the quartz oscillator via proprietary algorithms in conjunction with HP's high-precision counter technology. The result is outstanding holdover performance.

Various levels of holdover performance can be achieved through a selection of ITH cards with a choice of both quartz and rubidium oscillators: from 2 x 10^{-11}/day exceeding ANSI Stratum 2 requirements, to 1 x 10^{-8}/day exceeding the ITU-T G.812 Local Node requirements.

System Key Features

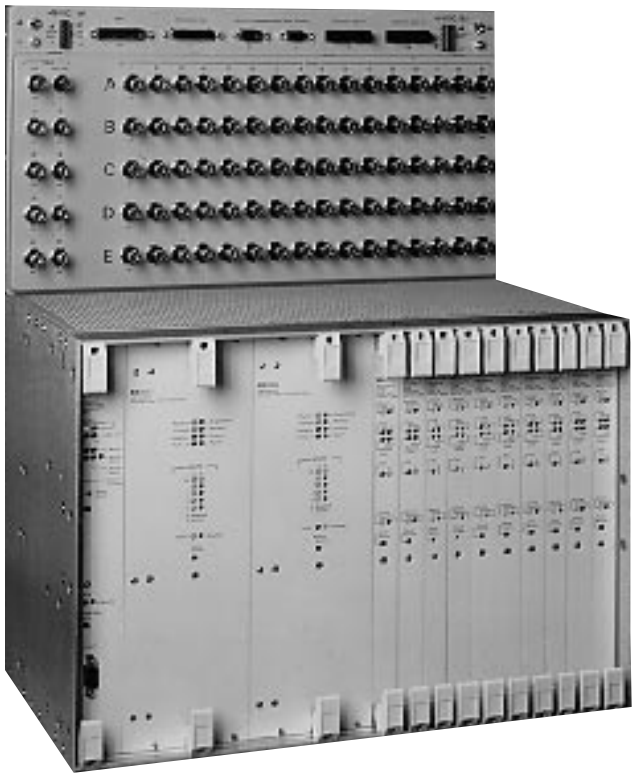
Compliant to:
- ITU-T G.703, G.704, G.812, G.823
- ETSI prETS-300 462-4
- Bellcore GR-1244

Up to 9 timing reference signals with 1:1 protection
- Built-in monitoring of MRTIE and TDEV
- Use all inputs as references or use some only for monitoring timing quality

Up to 400 outputs with 1:1 protection
- Up to 80 outputs with modular master subrack
- Up to 400 outputs total with modular expansion subracks

Designed to be managed
- Largest set of TL1 commands in the industry
- Local management with HP SmartView PC software for installation, configuration, commissioning and troubleshooting
- Remote management (TMN compliant) with HP SmartView UX software for complete synchronization network management

Modular, plug-in cards
- Input Track and Hold (ITH), various levels of holdover stability:
  - ANSI Stratum 2
  - ITU transit
  - ETSI compliant
  - Stratum 3E and local node



HP 55400A

- Management Cards (AIC, IMC, NIMC)
  - Alarm Management (critical, major, minor)
  - Information Management (alarm and local management)
  - Network Information Management Card (alarm, local and remote management through LAN or X.25)
- Output Cards
  - 2048 kbps with programmable traffic patterns
  - 2048 kHz
  - 1.544 Mbps
  - 64/8 kHz Composite Clock
  - 1, 5, 10 MHz

No phase hits on outputs during input reference switchover
Hot-swappable cards
Supports Sync Status Messaging (SSM)
Firmware upgrades are downloadable
–48 Vdc operation, fully redundant with dc-to-dc converters on each card
ETSI and NEBS rack mounting

Key Specifications

Internal Reverence: Quartz crystal oscillator or rubidium
Holdover Stability
- **Stratum 2 rubidium:** ± 2.0 x 10^{-11}/day
- **Stratum 2 quartz:** ± 3.0 x 10^{-11}/day for three days
- **Enhanced Transit Node quartz:** ± 1.0 x 10^{-10}/day
- **Transit Node quartz:** ± 5.0 x 10^{-10}/day
- **Stratum 3E and Local Node quartz:** ± 1 x 10^{-8}/day

Output Phase Variation
- **Reference switch-over:** < 1 ns
- **ITH card switch-over:** < 15 ns
- **Output card switch-over:** < 15 ns
- **ITH card failure:** < 15 ns
- **Output card failure:** < 1 μs

Ordering Information

HP 55400A System

For detailed pricing and specific system configuration, contact your local HP sales office.

HP 55450A
HP 55452A

Sync Network Management

Cost effective management of your synchronization network is critical for staying competitive and to guarantee quality of service levels. Unfortunately, not all synchronization equipment has been designed to be easily managed with computers. But HP has designed our equipment to be managed right from the start. Our products support a vast array of TL1 commands that allow them to be completely managed from a computer, locally or remotely. This means fewer people are needed for local management. And to make things even easier, you don't have to write the management programs. You'll never need to work with TL1 commands if you don't want to.

HP SmartView Family of Software

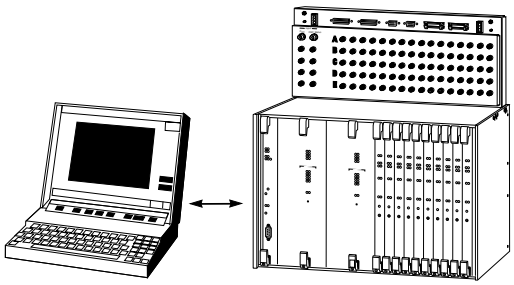
HP has developed software to make management of your synchronization equipment very easy. We have different packages depending on your needs. One version, HP SmartView-PC, makes installing, configuring, commissioning, monitoring and troubleshooting SSUs easy by providing a Graphical User Interface in place of typing tedious TL1 commands. The same package can be used to monitor and control several SSUs remotely by modem or LAN.

Another version, HP SmartView-UX, does everything that HP SmartView-PC does, and much, much more. HP SmartView-UX is designed to facilitate the management activities of Fault, Performance, Configuration and Security, complying with ITU-T TMN standards. By providing network-wide view and control from a single view point, operators can monitor the network effectively and can reconfigure equipment parameters, ensuring a high quality of service—a must in today's environment of intense competition where end-users want superior functionality, support and fast problem resolution. HP SmartView-UX is an open, state-of-the-art, network management product running on HP-UX and based on de-facto telecommunication industry standard platforms like HP OpenView DM and Oracle. It is targeted to effectively manage HP 55400A Network Synchronization Units, commonly known as Synchronization Supply Units (SSUs), which are at remote locations in the synchronization network. The SSUs are connected to HP SmartView-UX over TCP/IP, X.25 or TP4. HP SmartView-UX provides a programmerless, easy to use, graphical user interface to execute complex tasks of configuration, monitoring and setting thresholds on the performance parameters. It enables the detection, isolation and possible correction of abnormal operation of the network, thereby reducing downtime and leading to higher productivity and operational efficiency. It provides various security levels to control and protect access to the SSUs in the network, and to define management domains for the network management center operators. HP SmartView-UX provides correlation services to ensure that operators work on the actual "root-cause" alarms occurring in the SSU network rather than paying attention to "related" alarms. It also provides a Q3 interface to communicate with higher level Operation Support Systems (OSS), hence providing the possibility for a higher level manager to provision, monitor and maintain the SSU network. It notifies operators in case connectivity is lost to any SSU in the network, and also ensures that it is aligned with all the SSUs in the network at all times.

Capability of Both Versions

- Monitor alarms, timing quality (MTIE, TDEV)
- Configure and inventory SSUs
- Security management: different levels for technicians and system managers

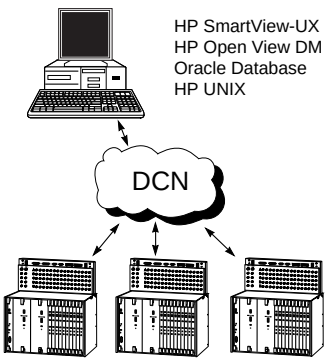
HP SmartView-PC



HP 55450A HP SmartView-PC used for local control of an HP 55400A SSU

- Local: installation, configuration, commissioning, troubleshooting
- Remote: small network monitoring; control and status of one SSU at a time
  - Network connectivity option (modem, LAN)
  - Sequential monitoring option
- Control and view SSU settings: inputs, outputs, alarms, any card
- View performance of any input: MTIE, TDEV, Frequency Deviation
- Prioritize alarms in response to SSU events
- View automatic messages generated by an SSU: alarms, events
- Download firmware
- TL1 command interface
- Platforms: Windows 95, NT

HP SmartView-UX



HP 55452A HP SmartView-UX used for management of a network of HP 55400A SSUs interconnected by LAN

- Full Sync Network Management for larger networks
- Makes your entire sync network visible
  - Single point of view
- Simultaneous monitoring of all SSUs
- Allows fast problem isolation and root cause analysis
  - Filtering and correlation options
- Integrate with other Network Management Systems
  - Q3 interface to external OSS
- Fully designed to TMN standards (M3400)
- Mapping of network, connectivity, sync trails, timing loops
- Full database of events, alarms, messages
- Redundancy and resiliency options
- Simulation and modeling options
- Multiple viewers
- Network connectivity: LAN, X.25
- Robust platform: OpenView DM, Oracle database, HP-UX

Ordering Information

HP 55450A HP SmartView-PC Software (per SSU)
HP 55452A HP SmartView-UX (per SSU)
Synchronization Network Management Software

For detailed pricing and specific system configuration, contact your local HP sales office.

HP 55300A
HP 55310A
HP 55320A

- Low-cost upgrade for office BITS clocks and SSUs
- Cesium-like timing performance
- Highly-reliable quartz oscillator with HP SmartClock technology
- Network Time Protocol to synchronize networked computers
- IRIG-B time of day fault location

HP 55300A module in the HP 553310A shelf

HP 55300A: Timing Synchronization for SONET/SDH

The HP 55300A GPS Telecom Primary Reference Source provides a highly-reliable low-cost source of precision timing for both wired and optical telecom digital networks.

The unit is ideally suited for telecom service providers that are installing or upgrading existing networks to comply with and integrate new standards such as SONET/SDH. These high-speed technologies require highly accurate and stable network synchronization and distribution. The HP 55300A exceeds the published specifications for primary reference sources. This affordable synchronization solution can flatten hierarchical networks, providing cesium-like performance at all points. Comparable in holdover performance to more expensive rubidium products, the HP source offers significantly better reliability and does not require the periodic service associated with rubidium alternatives.

Based on advanced GPS technology, the HP 55300A with enhanced GPS provides frequency accuracy of $<1 \times 10^{-12}$ using a 1-day average, even in the presence of Selective Availability. If the GPS signal is interrupted, the module enters an intelligent holdover mode ensuring that precise frequency is maintained for more than 24 hours.

The general-purpose HP GPS synchronization source can upgrade any office; the unit is not restricted to use with specific models of existing timing signal generators (TSGs), or synchronization source units (SSUs). Modules can be configured for 1.544 Mb/s, 2.048 MHz, 2.048 Mb/s, and 10 MHz.

U.S. and International Versions

The HP 55300A consists of a plug-in card, which can be combined with a lightweight, compact rackmount frame. Configured in this manner, the unit can be hardwired into an office rack. For customers in the U.S., the HP 55300A GPS Telecom Primary Reference Source should be ordered with HP 55310A GPS NEBS/EIA Rackmount Frame. International customers can purchase the HP 55300A with the HP 55320A or HP 55322A GPS ETSI Rackmount Frame.

Integrated Time-of-Day Function

Each HP synchronization module takes advantage of the accuracy of the GPS reference to provide a time-of-day signal. The accurate time-of-day facilitates fault isolation, sequence-of-events analysis, and other emerging troubleshooting techniques that benefit service providers by improving the quality and availability of services.

Specifications Summary

Key Characteristics
Locked Accuracy: $<1 \times 10^{-12}$ using a 1-day average (when locked to GPS)
Holdover Stability: $<1 \times 10^{-10}$ per day
Outputs Available: 1.544 Mb/s and 2.048 Mb/s
Framing: Industry-standard formats available
Oscillator MTBF: >500,000 hours
Cold Start-up: GPS lock in < 30 minutes (assumes "normal" view of sky)

Front Panel
LEDs: Power, GPS Lock, Holdover, Critical, Major, and Minor Alarms, ACO Active
Push-buttons: Alarm Cut-Off (ACO) and ACO Reset
DS1/E1 Monitor Output: Bantam connector
Local Command Interface (Craft Interface)**:** RS-232C, DE-9 connector, DTE configuration, TL1 command/status structure

Rear Panel (HP 55310A); Top Front (HP 55320A and HP 55322A)
GPS Antenna: "N" connector
Power: Redundant –48 V power inputs; latching plug-in connectors for 14 to 28 gauge wire (secured by screws)
DS1/E1: Wire-wrap (HP 55310A); BNC or (HP 55320A); DE-9S (HP 55322A)
Alarms: Wire-wrap (HP 55310A); DB-25P (HP 55320A and HP 55322A)
Remote Command I/F: RS-232C at 9.6 kbps, DB-25S connector, DTE configuration, TL1 command/status structure
Time-of-day Output: HP SCPI I/F for connection to Network Time Protocol (NTP) server
Other: 1 PPS at RS-232C level, 10 MHz sine wave, IRIG-B time-of-day

Alarm Operation
Configurable Causes: Power failure, output failure, oscillator failure, synthesizer failure, GPS signal loss (holdover)
Remote and Local: Two separate sets of connections. Local set responds to ACO pushbutton.
Multiple Alarm Priorities: Critical, major, or minor for each
Relay Connection Outputs: Common, NO, NC

Environment/Installation
Rack Configuration: 19-, 21-, and 23-inch, NEBS/EIA or ETSI-compatible
Temperature: 0 to +50°C (operating); –40 to +80° C (storage)

Antenna
Active Antenna: 30 dB (typical) active gain with dielectric filter
Temperature: –30 to +80°C (operating); –40 to +85°C (storage)

HP 55300A module in the HP 55320A shelf

Ordering Information

NEBS (US) Version
HP 55310A GPS NEBS/EIA Rackmount Shelf
HP 55300A GPS Telecom Primary Reference Source
Order Option 104 or 105
ETSI (International) Version (Unbalanced Outputs)
HP 55320A GPS ETSI Rackmount Shelf
HP 55300A GPS Telecom Primary Reference Source
Order Option 270, 271 or 272
ETSI (International) Version (Balanced Outputs)
HP 55322A GPS ETSI Rackmount Shelf
HP 55300A GPS Telecom Primary Reference Source
Order Option 220, 221 or 222
GPS Antenna Systems and Accessories
See page 505 for the complete line of GPS Accessories.

GPS Measurements Synchronization Module for Power Transmission

HP 59551A

- Tailored for power transmission networks
- Timing accuracy: 110 ns to UTC (USNO) @ 95% confidence level*
- HP SmartClock technology learns and adjusts frequency
- Time tagging (standard feature)

HP 59551A

HP 59551A GPS Measurements Synchronization Module

The HP 59551A GPS measurements synchronization module meets the precision-timing needs of wide-area electric power transmission systems. Based on advanced Global Positioning Systems (GPS) receiver technology, the module has superior long-term timing accuracy and permits exhaustive measurement and analysis of power system performance.

The HP 59551A combines low cost and unmatched functionality, making it the timing solution of choice for a variety of applications. For monitoring existing wide-area transmission networks, the HP 59551A provides the timing synchronization and time tagging required to efficiently locate faults, analyze network disturbances, and perform detailed sequence of events analysis. The newest, state-of-the-art transmission networks benefit from the highly-accurate synchronization foundation provided by the HP 59551A.

Time Tagging

Time tagging, a standard feature of the HP 59551A, allows event marking to a quantization of 100 ns. Up to 256 tagged events per channel are stored in buffer memory, which can be downloaded to a computer for in-depth failure or sequence-of-events analysis.

HP SmartClock Technology

The timebase for the HP 59551A is based on the HP 10811D quartz oscillator and HP SmartClock algorithm. The oscillator, proven to be a leader in reliability, offers exceptionally low sensitivity to temperature changes, low phase noise, and well-understood aging characteristics.

HP SmartClock compares the oscillator frequency with a GPS reference signal. By "learning" the aging behavior and the environmental effects on the oscillator over time and adjusting the oscillator output frequency accordingly, HP SmartClock can raise the performance of the HP 59551A to approach that of a rubidium-based solution—for a much lower cost. The superior performance is also achieved in holdover mode; the GPS signal can be lost for up to 24 hours with <8.6 μs loss in timing accuracy.

Versatile I/O

The HP 59551A incorporates many input/output features and enhancements. The range of inputs and outputs allow the HP 59551A module to be integrated with external processing solutions, or used with a variety of event and fault recorders. The versatile design also integrates with the newest designs for real-time applications (state estimation, demand-side management, and energy management systems).

*This specification has a 95% probability, and is based on availability of four or more GPS satellites during three days locked operation with a fixed antenna location. The temperature must remain within a 10° C range between 10° C and 40° C.

Highlights of the I/O capabilities include:

Separate Front/Rear RS-232 Ports: The HP 59551A can be controlled locally without interfering with output signals.

Standard IRIG-B

Alarm BITE: System fault or loss of satellite lock generates an alarm signal.

Time-Tag Inputs: Conditioned TTL signals can be time-tagged to a quantization of 100 ns.

Programmable Pulse Output: An output pulse or repetitive signal can be programmed at a specific time or repetition period.

Specifications

Performance

Timing Accuracy: <110 ns to UTC (USNO) @ 95% confidence level
Holdover: <8.6 μs accumulated in 24 hr. unlocked after 3 days of locked operation with antenna in fixed location, for any 10°C range, 10°C to 40°C.

Basic Module I/O

2 RS-232C Ports
- **Baud Rate:** 9600, other setting computer-selectable
- **Functions:** All required communication and control functions
- **Connectors:** 9-pin female rectangular D subminiature on front panel; 25-pin female rectangular D subminiature on rear panel

1 IRIG-B123 Output Port: BNC output interface
1 1-pps Output Signal: BNC output interface, risetime <5 ns
1 Alarm BITE Output
- **Basic Unit Output:** Solid state relay (NO) with closed contact indicating system fault or loss of satellite lock
- **Output Interface:** Twin BNC

3 Time-Tag Inputs
- **Received Signal:** Conditioned TTL
- **Time-Tag Accuracy:** The accuracy of the timing module
- **Input Interface:** BNC
- **Quantization:** 100 ns

3 Time-Tag Buffers: 256 events, retrievable via RS-232C port
- **Minimum Time Between Events:** 1 ms

Programmable Pulse Output
- **Output Pulse:** Single pulse at the time programmed via RS-232C port, or repetitive output pulse at a programmable repetition period from 1 sec to 1 year
- **Quantization:** 100 ns

Environmental

Antenna
- **Operating:** –30° to +80°C

Remainder of Timing Module
- **Operating:** 0° to +50°C
- **Power:** <35 watts @ 129 Vdc

Surge Withstand: Meets IEEE/ANSI C37.90, C37.90.1
RFI: No degradation when a 10 watt walkie-talkie is activated within 1 meter of the module (VHF/UHF)

More Information

There is no front-panel display or keypad. During installation and start-up, information is entered into and retrieved from the timing module with an HP-100LX or HP-200LX PalmTop computer or any DOS-compatible computer serial interface. A Windows® application is shipped with the instrument.

Ordering Information

HP 59551A GPS Measurements Synchronization Module (includes 129 Vdc power supply)
- **Opt 1CM** Rack Mount 19-inch
- **Opt AXQ** Rack Mount 23-inch
- **Opt AWM** RPower Supply (48 Vdc)
- **Opt 170** 90 to 132 Vac or 198 to 264 Vac, 50 to 60 Hz

HP 58504A GPS Antenna (required)
HP 58505B Lightning Arrester (optional)
HP 58509A Antenna Line Amplifier
HP 58509F Antenna Line Amplifier w/L1 Bandpass Filter
GPS Antenna Systems and Accessories
See page 505 for the complete line of GPS accessories.

HP 59552A and HP 59553A

High-integrity distribution of a common clock is the backbone for power utility substation synchronization. The HP 59552A Fiber-Optic Distribution Amplifier and HP 59553A Fiber-Optic Receiver provide a simple, modular approach to signal routing. Immunity to electrical noise makes fiber-optic cable a superior choice for the challenging environment of the power substation.

The HP 59552A Fiber-Optic Distribution Amplifier receives a digital (TTL) signal and an analog signal via two BNC connectors. The HP 59552A combines the signals, and transmits the result on each of eight fiber-optic outputs. Signal integrity is even maintained over customer-supplied, fiber-optic cable lengths of up to a kilometer.

An HP 59553A Fiber-Optic Receiver resides near each remote equip ment installation. The HP 59553A receives the signal on fiber-optic cable, separates analog and digital waveforms, and outputs each signal on a BNC connector.

HP fiber-optic products are designed to provide clean timing quality transmission signals to monitoring, analysis and control equipment. In a typical application calling for distribution on 1 pulse per second (1 pps) and IRIG-B time code, each substation instrument receives an identical, synchronous, high-quality clock signal and precise time of day.

Coupled with the HP 59551A, the HP 59552A and HP 59553A form a complete master clock and distribution system for power substations. This system could be used for applications like fault location, adaptive relaying, and disturbance analysis.

HP 59552A Fiber-Optic Distribution Amplifier

Specifications

Inputs
- One digital input typically used as 1PPS input
- One analog input typically used as IRIG-B123 input

Digital Input
- **Input Signal Requirements:** TTL
- **Input Impedance:** 50 Ω to GND (default) or 1 kΩ to +5 volts configurable with internal jumper

Analog Input
- **Input Signal Requirements:** 5 volts peak-to-peak (nominal)
- **Input Impedance:** 600 Ω (default) or 10 kΩ configurable with internal jumper

Outputs
- **Number of Optical Outputs:** 8
- **Optical Connector:** Metal ST

Front-Panel LEDs Indicating
- Power
- Digital input active
- Analog input active

Note that annunciator is activated at a minimum voltage of 1.6 volts pk-pk (nominal)

Power Requirements
- **dc Power (standard):** 129 Vdc, 115 to 140 Vdc operating range
- **ac Power (Option 170):** 90 to 132 Vac or 198 to 264 Vac, automatically selected; 50 to 60 Hz

Dimensions
- **Height:** 88.5 mm (3.5 in)
- **Width:** 212.6 mm (8.53 in)
- **Depth:** 348.3 mm (13.7 in)
- **Weight:** 3 kg (6.6 lbs)
- Half-Rack module

HP 59553A Fiber-Optic Receiver

Specifications

Inputs
- **Number of Optical Inputs:** 1
- **Optical Connector:** Metal ST

Outputs
- One digital output typically used as 1PPS output
- One analog output typically used as IRIG-B123 output

Digital Output
- **Output Signal:** TTL
- **Output Impedance:** Drives 50 Ω to GND

Analog Output
- **Output Signal:** 5 volts peak-to-peak (nominal)
- **Output Impedance:** Drives 600 Ω to GND

Front-Panel LEDs Indicating
- Power
- Digital input active
- Analog input active

Note that annunciator is activated at a minimum voltage of 1.6 volts pk-pk (nominal)

Power Requirements
- **dc Power (standard):** 129 Vdc, 115 to 140 Vdc operating range
- **ac Power (Option 170):** 90 to 132 Vac or 198 to 264 Vac, automatically selected; 50 to 60 Hz

Dimensions
- **Height:** 87.1 mm (3.4 in)
- **Width:** 133.2 mm (5.2 in)
- **Depth:** 185.3 mm (7.3 in)
- **Weight:** 0.91 kg (2.0 lbs)

Fiber-Optic Cable Core Size Recommendations: 62.5/125 μm

Ordering Information

HP 59552A Fiber-Optic Distribution Amplifier
HP 59553A Fiber-Optic Receiver
- ***Opt 170** 110 Vac operation

*HP 59552A/59553A come standard with 129 Vdc. For use with ac power, order Option 170.

GPS & SmartClock Technology

AN 1272: GPS and Precision Timing Applications
5965-2791E
AN 1279: HP SmartClock Technology– Improving Oscillator Long-Term Stability for Synchronization Applications
5964-6725E

General Purpose

HP **58503A** Precise Time and Frequency Anywhere in the World
5963-3696E
5963-3698E
5964-2460E
HP **5071A** Sync Family Brochure
5964-9932E
HP **5071A** Unsurpassed Stability in the Lab or Field
5091-6013E
HP **55000** Series Unsurpassed Performance and Reliability in Time and Frequency Systems
5962-6227E

Telecom Network Synchronization

HP **55300A** GPS Telecom Frequency Reference Source
5965-5155E
5965-1682E
HP **5071A** Sync Family Brochure
5964-9932E
HP **5071A** Unsurpassed Stability in the Lab or Field
5091-6013E
HP **55000** Series Unsurpassed Performance and Reliability in Time and Frequency Systems
5962-6227E
AN 1264-1: Synchronizing Telecommunications Networks, Basic Concepts
5963-6867E
AN 1264-2: Synchronizing Telecommunications Networks, SONET/SDH
5963-9798E
AN 1264-3: Synchronizing Telecommunications Networks, Fundamentals of Sync Planning
5963-6978E

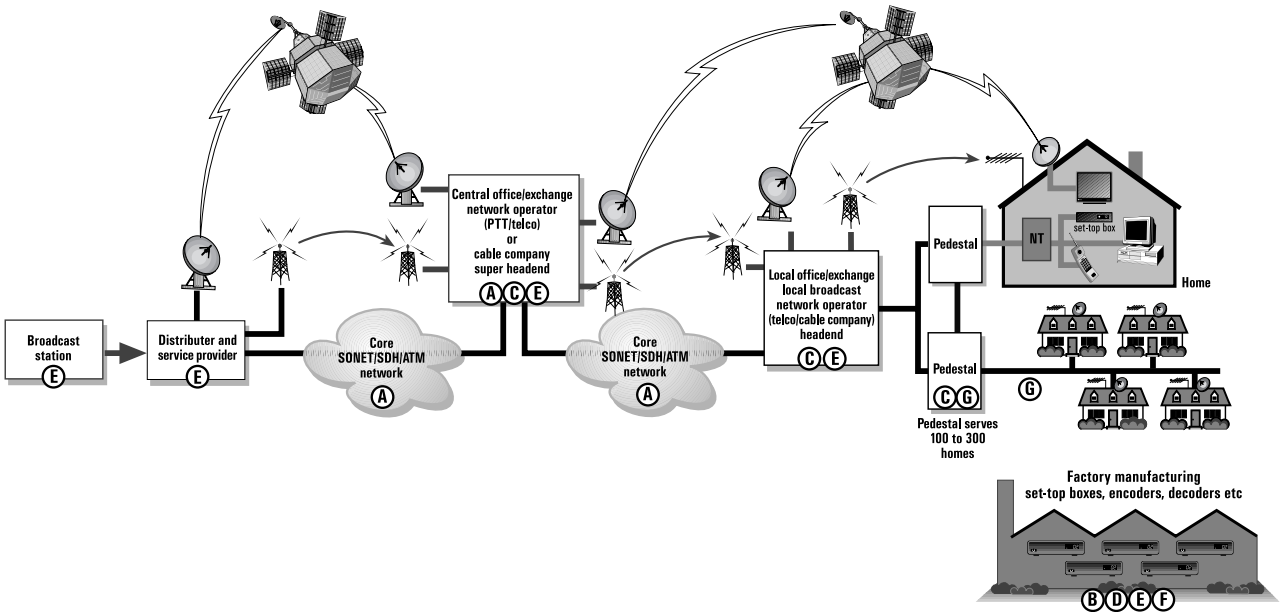
Wireless OEM Timing Modules

HP **58000** Series Time and Frequency Reference Distribution Systems
5963-3504E
QUALCOMM Taps HP for CDMA Timing System
5964-9063E
HP **58503A** Precise Time and Frequency Anywhere in the World
5963-3696E
5963-3698E
5964-2460E

Power Measurement Synchronization

HP **59551A** GPS Measurements Synchronization Module
5965-2998E
Synchronize and Analyze Power System Performance
5964-0262E
GPS Synchronization for Power Transmission Systems
5964-2459E
HP **59552A** Fiber Optic Distribution Amplifier and HP **59553A** Fiber Optic Receiver
5964-8927E
AN 1271: Increasing Power Transmission Uptime
5964-0398E

Many of these literature pieces are available at:
http://www.hp.com/go/tmc98



Test Equipment for Digital Video Broadcast/Cable TV

Digital transmission is the key enabling technology that will allow cable systems to deliver a multitude of emerging services. Ensuring a high quality of service requires testing various aspects of the signal—data integrity, modulation, and RF signal quality. HP offers a wide range of instruments for testing all these aspects of digital video service development, deployment, and device manufacuring.

A
HP E6271A MPEGscope ATM
Real-time MPEG-2 tests over AAL-5, MPEG-2 transport quality of service measurements, real-time PSI table decodes. Runs on HP E4200 Broadband Series Test System. See page 519.

B
HP 89400 Digital Video Signal Analyzer
State-of-the-art modulation quality measurements for R&D and commissioning. See page 518.

C
HP 8594Q DVB-C QAM Analyzer
Comprehensive RF, modulation, and data quality measurements for cable system operators. See page 515.

D
HP ESG-D4000A Digital Signal Generator
Used with HP E4441A DVB QAM coder to produce highly accurate IF or RF signals. See page 202.

HP E2507B Multi-Format Communications Signal Simulator
Simulate varying return link traffic levels with multiple-modulated signals. See page 217.

E
HP E6277A MPEGscope
Capture, analyze, and transmit transport streams, real-time transport stream analysis, bit error rate test, TS and PES protocol, DVB, and ATSC table decodes; optional ES compression analysis software. See page 519.

F
HP E4441A DVB QAM Coder
Fully DVB-C compliant modulation source with calibrated impairments for R&D and set-top test. See page 516.

G
HP CaLan 3010 R/H Sweep/Ingress Analyzer
Digital channel power, sweep and ingress measurements for network technicians. See page 523.

- Field testing solution for DVB-C[1] cable TV systems
- Test from the headend to the subscriber drop
- Comprehensive suite of RF, modulation, and data quality measurements
- Verify your quality of service

HP 8594Q QAM Analyzer

HP 8594Q QAM Analyzer

The HP 8594Q QAM Analyzer is a comprehensive solution for RF installation and maintenance testing of DVB-C (Digital Video Broadcast via Cable) signals on cable TV systems. It gives engineers the measurement capability required to accurately verify the quality of service delivered to the subscriber. All measurements are easy to access and the results are presented in a clear graphical displays.

Applications

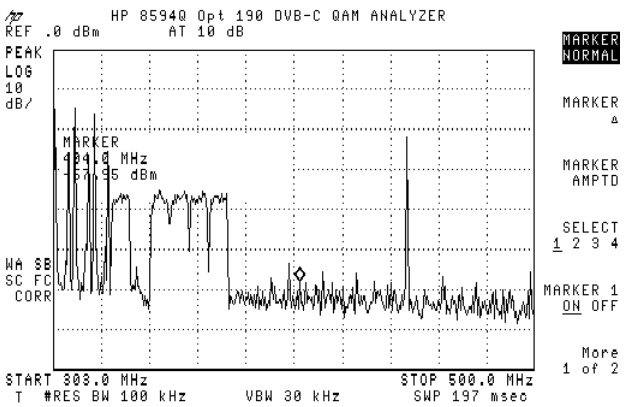
The HP 8594Q QAM Analyzer can help you during:
- Headend equipment installation and maintenance
- System verification
- Field installation and maintenance
- Modulator manufacturing or incoming inspection test

Measurement Capability

The HP 8594Q QAM Analyzer demodulates and accurately measures the 64 QAM signals carried through the DVB-C system. It provides new measurement metrics necessary to characterize these signals and troubleshoot problems. The graphical displays, clear user interface, and one-button measurement capability will help make the transition easy for analog cable TV engineers.

To accurately verify your quality of service, the HP 8594Q QAM Analyzer provides the following measurement capability:
- Average channel power—To verify the signals levels from the headend through the system to the subscriber drop
- Adjacent channel power—To make sure that transmissions are not leaking into and causing interference in adjacent channels
- Constellation display—Display the constellation points and quickly identify any modulation problems
- Error vector magnitude and modulation error ratio—To quantify the modulation quality of the signal transmitted through the system
- Equalizer response—Frequency, impulse, group delay and phase response plots can be displayed on screen to show distortions caused by the transmission channel
- Data measurements—Add Option 195 to the 8594Q QAM Analyzer to verify that the MPEG data has been correctly decoded, and check transport stream content. The option also proves a real-time output (both ASI and parallel), to allow access to the data stream for further analysis. The HP 8594Q option 195 includes a real-time FEC decoder. By monitoring the activity of the FEC decoder, analysis of byte and packet errors is provided.

The HP 8594Q QAM Analyzer makes all of these measurements quickly and accurately. In addition the HP 8594Q QAM Analyzer provides a fully featured 2.9 GHz spectrum analyzer.



Ordering Information

HP 8594Q QAM Analyzer
- **Opt 190**[2] DVB-C Measurement Capability
- **Opt 195** Data Measurements
- **Opt 016** Soft Yellow Operating/Carrying Case
- **Opt 040** Front Panel Protective Cover with Storage
- **Opt 043** RS232/Parallel Interface
- **Opt 908** Rackmount Kit without Handles
- **Opt 909** Rackmount with Handles
- **Opt 910** Additional Manual Set

[1] DVB-C is a standard defined by the European Telecommunications Standards Institute.
[2] Required option.

HP E4441A

HP E4441A DVB QAM Coder

DVB-C Compliance

The HP E4441A DVB QAM coder is a fully compliant test source for testing DVB-C set-top boxes, devices, or networks. In conjunction with an ESG-D series digital signal generator, it produces DVB-C compliant test signals with programmable impairments for true bit error rate measurements.

Real-Time Encoding

The system can channel code and modulate either internally generated MPEG-2 null packets or an external MPEG-2 transport stream onto IF/RF to the DVB-C standard. This allows both test and real world signals to be generated. The internal MPEG-2 null packet source allows receivers to be fully characterized through bit error rate measurements or simply through FEC results. Via the external MPEG-2 input, real-life pictures or MPEG-2 stress patterns can be coded and modulated in real time.

Calibrated Impairments

The DVB QAM coder and digital signal generator combination provides a precision reference signal suitable for both laboratory and manufacturing test. To simulate poor signal conditions the DVB QAM coder includes an accurate Gaussian noise source. Noise can be added to the reference in a controlled and calibrated manner. The instrument combination can also produce a range of other signal impairments such as carrier leakage and I/Q imbalance to test the limits of receiver design or network performance.

Complete Flexibility

The DVB QAM coder is user configurable making it ideal for R&D, early manufacture, and system installation testing. Use of internal settings for 8, 6, 4 and 2 MHz channels and an external clock source, such as an HP 33120A function generator, allows the symbol rate (and hence the channel occupancy/bandwidth) to be varied continuously from 5.2 to 7 Mbaud. The DVB QAM coder generates a 64 QAM signal which is coded, mapped, and filtered according to the DVB-C standard. An intuitive Windows®-based graphical user interface allows coding, constellation size, symbol mapping, and filter characteristics to be changed easily and quickly.

For R&D and Manufacturing

The Windows-based graphical user interface controls both the DVB QAM coder and the digital signal generator for local operation. Both units are completely HP-IB compatible and easily racked, making them suitable for integration into manufacturing test systems.

Specifications

Modulation
- **Modulation Types:** 16, 32, 64, 128 and 256 QAM
- **Symbol Mapping:** DVB compliant, user defined
- **Error Vector Magnitude:** < 1% typical

Channel Characteristic
- **Channel Filter Type:** Root raised cosine, raised cosine, user defined
- **Channel Filter Alpha:** 0.15, 0.13

Symbol Rate (selectable):

Nominal channel bandwidth	Internal (Mbaud)	External (Mbaud)
8 MHz	6.890 6.872 6.875 6.900	5.2 to 7.0*
6 MHz	5.274	
4 MHz	3.445	2.6 to 3.5*
2 MHz	1.7225	1.3 to 1.75*

* Fully variable

Data Source
Data Source Type:
- Internal $2_{23} - 1$ PRBS
- Internal packetized $2_{23} - 1$ PRBS
- Internal MPEG-2 null packets
- Internal arbitrary fixed symbol
- External 188 byte MPEG-2 packet input
- External 204 byte MPEG-2 packet input

Channel Coding
Channel Coding: As per ETS 300 429
Channel Coding Control:
- Randomization on/off
- Sync inversion on/off
- Reed-Solomon encoding on/off
- Byte interleaving on/off
- Differential encoding on/off

Impairments
Gaussian noise, spurious tone carrier leakage, I/Q magnitude imbalance, I/Q quadrature imbalance, and inverted spectrum

I & Q Outputs
- **Level:** 0.28 V rms (nom.) into 50 ohms
- **Residual dc Offset:** < 300 μV
- **Connectors:** BNC

Symbol Clock Output
- **Type:** TTL compatible
- **Connector:** BNC

MPEG-2 Input
- **Type:** DVB-PI as per DVB document A010. Oct. 1995
- **Connector:** 25-pin sub-miniature D-connector

Ordering Information

HP E4441A DVB QAM Coder
- **Opt 001** Internal 6.872 Mbaud fixed symbol rate
- **Opt 002** Internal 6.875 Mbaud fixed symbol rate
- **Opt 003** Internal 6.900 Mbaud fixed symbol rate
- **Opt 004** Internal 5.274 Mbaud fixed symbol rate
- **Opt 1CP** Rackmount Kit

HP 11759D
HP 8992A

- Simulates realistic propagation models for analog and digital television
- Static and time varying ghosts
- 12-bit processing for minimum distortion
- RF input/output for full IF/VHF/UHF coverage

HP 11759D

- Complete pulse characterization of digital video/audio signals
- –33 to +20 dBm measurement range
- Prints to an HP-IB graphics printer

HP 8992A

HP 11759D Dynamic Ghost Simulator

The HP 11759D dynamic ghost simulator easily simulates the ghosting and airplane flutter that commonly degrade terrestrial TV broadcasts. With the HP 11759D, ghost canceller or digital HDTV designs can be tested under the real-world conditions of multiple reflections and motion. The simulation of motion is required to account for the effects of tower sway, airplane flutter, and the movement of people, vehicles, and trees. The HP 11759D is ideally suited to simulate these phenomena.

The HP 11759D consists of the applications software and the RF processing hardware and requires two user-supplied components to complete the dynamic ghost simulation system—a PC acting as a user interface and a synthesized local oscillator with a 10 MHz timebase output.

Easy to Use Manually or Remotely

Simple-to-use on-screen menus guide the user through the task of creating complex RF multipath ghost signals for testing ghost cancelling systems or digital HDTV receivers. These same menus are accessed remotely by installing an optional HP-IB interface card in the PC.

HP 11759D Partial Specifications

(See Technical Data Sheet for complete specifications)
RF Channels: 1 of 6 paths
RF Frequency Range: 40 to 1,000 MHz (useable to 2700 MHz)
RF Bandwidth (1 dB)**:** > 6 MHz typical
RF Input Level: –10 dBm (+ 97 dBµV) nominal
Path Insertion Loss: 24 dB ± 3 dB typical
Path Delay Range: 0 to ± 186 µs, maximum delay spread, 186 µs
Path Attenuation Range: 0 to 50 dB in 0.1 dB steps
Relative Phase Between Paths: Adjustable 0 to ± 360°, 0.1° steps
Simulated Doppler Range: 0 to 425 Hz, in 0.01 Hz steps
For NTSC Modulated Signals
- **Chrominance-to-Luminance Delay Inequality:** < 10 ns typical
- **Chrominance-to-Luminance Gain Inequality:** < 4% typical
- **Differential Phase Distortion:** < 1 degree typical
- **Differential Gain Distortion:** < 1% typical

General
- **Power:** 90 to 132/190 to 264 V; 48 to 66 Hz; 325 VA maximum
- **Size:** 425 mm W x 146 mm H x 620 mm D (16.8 in x 5.7 in x 24.4 in)
- **Weight:** Net, 13.6 kg (30 lb); shipping, 19 kg (42 lb)

HP 8992A Digital Video Power Analyzer

Digital video transmission and digital audio broadcast are placing new demands on RF broadcasting transmitters as well as the lasers and amplifiers used in cable TV networks. Random peak power events can overload transmitters, amplifiers, and lasers that are operating near maximum power and cause bit errors that result in subscriber dissatisfaction. Measuring total average power as well as peak power when aligning these system components can help to avoid this interruption of service to your customers.

The HP 8992A digital video analyzer provides complete and accurate characterization of today's complex pulsed signals. It is capable of performing seven automatic timing measurements (rise time, fall time, pulse width, PRI, PRF, duty cycle, and delay) and five automatic power measurements (peak power, average power, pulse top/base amplitude, and overshoot) with push-button ease. Front panel operation is intuitive and straightforward.

For detailed specifications on the 8992A digital video analyzer and compatible peak power sensors, see page 290.

Ordering Information

HP 8992A Digital Video Power Analyzer
- **Opt 001** Deletes Channel
- **Opt 002** Rear Panel Sensors Inputs Only
- **Opt 003** Add 1 GHz Sensor Check Source
- **Opt 004** Adds Precision 50 MHz Reference
- **Opt 915** Service Manual
- **Opt 916** Extra User, Getting Started Calibration, and Programming Guides
- **Opt W30** Two Additional Years of Return-to-HP Warranty

HP 84815A 50 MHz to 18 GHz Peak Power Sensor
HP 84812A 500 MHz to 18 GHz Peak Power Sensor
HP 84813A 500 MHz to 26.5 GHz Peak Power Sensor
HP 84814A 500 MHz to 40 GHz Peak Power Sensor

HP 89400
Option AYH

- Adaptive equalization now included in Option AYH
- Peak-to-average power measurements
- Constellation, eye, and error magnitude analysis for QAM, VSB, and other modulation formats (Option AYH)
- Dynamic power measurements, including: peak, average, band-integrated, and adjacent channel
- Waveform capture and analysis
- Carrier phase noise measurements to –124 dBc/Hz (typical at 10 kHz offset)

HP 89400 Option AYH Digital Video Signal Analyzer

Meeting the needs of both broadcast and cable system designers, HP 89400 vector signal analyzers precisely characterize RF signals in the emerging modulation formats of the digital video industry, including QAM and VSB. Off-the-shelf, lab-quality spectrum and waveform measurements allow designers of ATV/HDTV components, equipment and systems to deliver higher-quality video signals faster and for less cost than with custom-built test tools.

Signal Quality Measurements

HP 89400 vector signal analyzers measure signal power and waveforms in the time, frequency, and modulation domains, making them extremely versatile design and troubleshooting tools. Their advanced DSP architecture provides measurements that are not only fast, but exceptionally accurate and informative—even for complex, broadband ATV signals. For more information about HP 89400 signal analysis capabilities, see page 250.

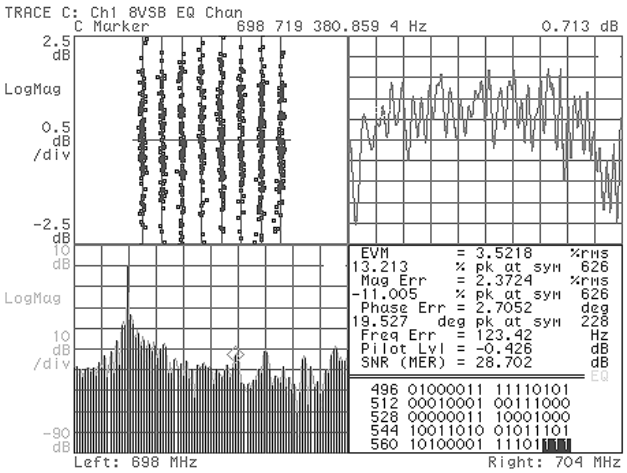
Digital-Modulation Analysis

Digital video analysis Option AYH equips HP 89400 analyzers to demodulate and characterize a wide variety of video-related signal formats. Results are shown via traditional eye and constellation displays, or as error vector magnitude and MER (Modulation Error Ratio) measurements. EVM quantifies the instantaneous difference between the actual input signal and an ideal, internally-generated reference signal containing the same data stream. It is a measurement technique now widely accepted among digital RF communications designers and international standards organizations. Expressed as a time waveform, an rms average or an error spectrum, EVM is sensitive enough to reveal the slightest degradations in signal quality, such as those which occur between the input and output of even a single amplifier stage. Use it to troubleshoot BER or other signal problems back to their root causes.

In digital demodulation mode, carrier lock, and symbol clock synchronization are automatic. This means external carrier reference or clock inputs are never required, making the HP 89400 analyzers useful even in remote or field test applications.

Adaptive Equalization

A new adaptive equalization capability is included with digital video analysis Option AYH and works with digital demodulation to remove linear errors, such as frequency response and reflections, from transmitted signals. Measurements more closely approximate the performance of real-world receivers and can be used to isolate linear vs. non-linear error mechanisms. New measurements in this option include displays of channel frequency response and impulse response of the equalization filter. This equalization does not require prior knowledge of the signal such as a training sequence.



New measurement displays include channel frequency response and impulse response of the equalization filter.

Specifications

Frequency Range and Bandwidth

Model number	Frequency range	Sensitivity	Maximum bandwidth
HP 89410A	dc to 10 MHz	–144 dBm/Hz	10 MHz
HP 89441A	dc to 2650 MHz	–160 dBm/Hz	8 MHz

Symbol Rates (Symbols/Sec)
VSB Formats: 10.77 M nominal (adjustable)
QAM Formats: Rate < (Analyzer BW)/(1 + α)
Examples:

Model number	QAM α = 0.2	DVB α = 0.15
HP 89410A	< 8.33 M	< 8.70 M
HP 89441A	< 6.09 M	< 6.96 M

Maximum Measurement Size
1 sample/symbol: 4096 symbols
5 samples/symbol: 819 symbols

Modulation Formats
8, 16VSB
16, 32, 64, 256QAM
16, 32, 64QAM (DVB)
(QPSK, Offset QPSK, FSK, MSK, BPSK and other formats are supported by Option AYA)

Residual Error (instrument contributed)
QAM Formats: Symbol rate 5 to 7 MHz, 0.15 < α < 0.2, full-scale signal ≥ –25 dBm: ≤ 1.0% EVM typ. (≤ 40 dB SNR)
VSB Formats: Symbol rate 10.762 MHz, α = 0.1152, full-scale signal ≥ –25 dBm: ≤ 1.5% EVM typ. (≤ 36 dB SNR)

Required Options
AYA (vector modulation analysis)
UFG (4 MB extended RAM)

For complete product, literature, and ordering information, see page 250.

HP E6277A
HP E6277A Option 010
HP E6285A
HP E6271A
HP E6277A Option 014
HP E4219A
HP E4266B

- Analyze and troubleshoot DVB, ATSC, and MPEG-2 implementations
- Verify digital encoder performance and interoperability
- Stress-test NTSC decoders

HP E6277A MPEGscope Plus

Real-Time Digital Video Test Platform

The new HP E6277A MPEGscope Plus is a PC-based test platform that offers a complete array of capture, generation, and analysis tools for Digital Video Broadcast (DVB), Advanced Television Standards Committee (ATSC), and other MPEG-2 transport-stream-based implementations. With the HP MPEGscope Plus and optional software test applications, it's easy to verify and debug the entire range of digital video network transmission and distribution components, including encoders and decoders, video servers, multiplexers and demultiplexers, and set-top boxes.

Key features of the HP E6277A MPEGscope Plus include:

- MPEG-2 transport stream capture, with analysis and storage of up to 9 Gb of traffic at up to 60 Mb/s
- Trigger captures based on specific events
- Real-time measurement and error-checking, with instantaneous views of statistics for PID utilization and bandwidth, PCR jitter and interval, PSI table decodes, and BER measurements, as well as a complete set of ETR-290 health checks
- Onscreen TS, PES, and table decodes for all MPEG-2, DVB, and ATSC-specific tables
- Generation of transport streams
- Cost-effective, easily upgraded modular architecture that supports multiple line interfaces and application-specific software packages (described below)

Many new applications for digital video testing with the HP MPEGscope Plus are coming. For the latest, visit our web site (www.hp.com/go/videotest).

Encoder Test Applications

With the HP E6277A Option 010 Video Elementary Stream Compression Analyzer software, you can test all aspects of video encoding. The software extracts individual video-program elementary streams from the transport stream and provides detailed post-capture testing, including syntax and semantic checking, header decodes, and bit-rate and macroblock analysis. Analysis of elementary stream content can be used in verifying bitstreams, developing or optimizing encoder algorithms, and troubleshooting interoperability, particularly encoder/decoder conflicts.

The HP E6285A Encoder Stress Test Patterns provides on tape a series of synthetically produced test patterns that can be used to evaluate or optimize digital encoders. Each pattern stresses a single potential source of digital encoding artifacts within a short sequence, eliminating the need to use extended natural scenes or common video test streams, which may introduce their own artifacts into the encoded output.

Decoder Stress Testing

The HP E6277A Option 014 NTSC Decoder Stress Test Patterns is the first of many HP products that allow you to verify the functionality of a set-top box, decoder chip set, or professional decoder.

Key Literature

HP E6277A MPEGscope Plus, p/n 5965-8194E
HP E6277A Option 010 Video Elementary Stream Compression Analyzer, p/n 5965-6491E
HP E6285A Encoder Stress Test Patterns, p/n 5965-6492E

Ordering Information

HP E6277A MPEGscope Plus
  Opt 010 Video Elementary Stream Compression Analyzer
HP E6288A MPEG NTSC Decoder Test Bit Streams
HP E6285A Encoder Stress Test Patterns
  Opt 001 D1 Tape Format
  Opt 002 Digital Betacam Tape Format

HP MPEGscope ATM Test Application for the BSTS

The HP E6271A MPEGscope ATM Test Application for the HP E4200B/E4210B Broadband Series Test System (BSTS) adds powerful, real-time MPEG-2 testing to the industry's most comprehensive ATM test system.

The HP MPEGscope ATM Test Application performs MPEG-2 transport stream testing over numerous standard ATM interfaces ranging from 1.5 Mb/s to 155 Mb/s. It can be used in conjunction with other BSTS features—for example, with the HP E4219A ATM Network Impairment Emulator Module, to visualize the effects of ATM impairments on the MPEG-2 transport stream, or with the HP E4226B MPEG-2 Protocol Viewer Test Software, to enable protocol testing of MPEG-2 transport streams over interleaved and non interleaved AAL-1 (as defined in I.363) and over AAL-5.

Features of the HP E6271A MPEGscope ATM include:

- PCR jitter and interval analysis
- PID bandwidth and utilization measurements
- PSI table analysis and decoding
- Transport stream error indication
- Triggering on measurement thresholds, errors, or pattern matches
- Full MPEG-2 protocol analysis
- Off-line video decoding and analysis

Key Literature

HP E6271A MPEGscope ATM Test Application Product Overview, 5965-0990E

For more information on the HP Broadband Series Test System, please see page 454.

HP 8591C
HP 85721A
HP 85905A
HP 85921B

- Dedicated cable TV analyzer
- Portable and easy to use
- Non-interfering RF and video measurements
- New—Digital carrier power measurements
- New—Cable TV data management software

HP 8591C

HP 8591C Cable TV Analyzer

Industry's Only Cable TV Analyzer that Keeps Pace with Changing Regulations

The HP 8591C cable TV analyzer (1 MHz to 1.8 GHz) is the first economical, portable, one-box solution for making automatic, non-interfering cable TV RF and video measurements. The analyzer features a flexible hardware and software architecture that can be upgraded easily to protect your investment as new test requirements are introduced.

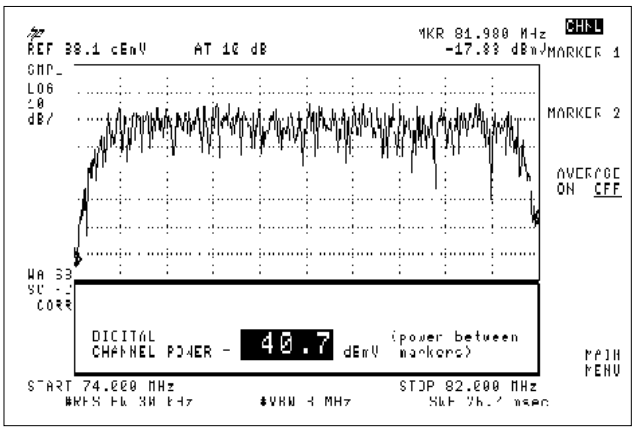
Included in the cable TV analyzer are the features you need for cable TV testing compatible with worldwide formats and standards, including all FCC proof-of-performance tests:

- HP 85721A cable TV RF/video measurements personality to simplify channel and system cable TV measurements
- 75 Ω input matches analyzer to cable TV impedance
- Built-in, internally switched preamplifier for improved carrier-to-noise measurements
- Precision frequency reference to accurately measure carrier frequency
- Fast time-domain sweeps for displaying individual TV lines
- TV trigger for selecting TV lines by number
- RS-232 and parallel interfaces for PC and printer operation, respectively
- HP 85702A 128K RAM card for storing test data
- Rugged, yellow, soft carrying case

Options add even greater measurement capability to the analyzer. These include a 75 Ω tracking generator, narrow resolution bandwidths, and non-interfering RF and video measurements.

Non-Interfering Measurements

Option 107 for the HP 8591C and the HP 8590 E-series spectrum analyzers adds the hardware needed to make non-interfering RF and video measurements. Non-interfering measurements let you perform required tests on multiple channels at multiple locations with no impact on customer programming. The video measurement capability allows you to perform required FCC color tests. Option 107 also enables simultaneous viewing of TV pictures and listening to program sound. The hardware demodulates NTSC-format television signals as well as versions of PAL and SECAM.



Digital Carrier Power Measurement on HP 8591C

NEW

Measurements for RF and Video Testing

The HP 85721A measurement personality card (included with the HP 8591C) customizes the analyzer for easy, non-interfering proof-of-performance measurements on NTSC-, PAL-, or SECAM-format signals. This software adds dedicated cable TV test functions and measurements that you can perform with the push of single keys. Measurements include the following functions and tests:

- Automatic tuning of cable TV and TV broadcast carriers
- Visual and aural carrier levels and frequencies
- Digital carrier power
- System channel survey
- Depth of modulation
- TV aural and FM broadcast carrier deviation
- Carrier-to-noise ratio (C/N)
- In-channel frequency response
- Hum/low frequency disturbances
- System frequency response
- Baseband TV line and field viewing
- TV aural and FM broadcast carrier demodulation
- Distortion (CSO/CTB)
- Crossmodulation
- Ingress and co-channel viewing

System monitor capability automates measurements, allowing the analyzer to test without assistance from the operator. It also allows you to design test plans and to turn test data into reports instantly. With Option 107 added to the cable TV analyzer, non-interfering measurements of carrier-to-noise, in-channel frequency response, and distortions can be made, as well as video measurements:

- Differential gain
- Differential phase
- Chromiance-luminance delay inequality

Painless Reports and Data Archiving

Take the pain out of cable TV reports with the HP 85921B cable TV data management software. Running on IBM compatible PCs, it downloads test data from your HP 8591C, and HP CaLan 2010B, 3010, 3010B, and 3010R into a PC database for making reports and archiving data. The software compares measurement results to your specifications and displays pass/fail messages for each test. Test data can also be exported to a word processor or spreadsheet for other analysis.

You can print the results of every test run at each specified location in the cable system. The printout will list all the channels tested, as well as additional required information such as the date of the testing, the name and qualifications of the person who ran the test, and the serial number of the equipment used. Add Option 032 to automatically generate reports in a format compliant with the FCC regulations. All RF and video tests (except leakage) currently required by the FCC are included.

HP 8591C
HP 85721A
HP 85905A
HP 85921B

Specification Summary

Specifications apply to the HP 8591C cable TV analyzer with preloaded HP 85721A measurements personality, and to the HP 8591E spectrum analyzer with Options 001, 004, and 301, and the HP 85721A personality.

General

Channel Selection: Analyzer tunes to specified channels
Input: 75Ω, BNC
Frequency Range: 5 to 1002 MHz for channel model;
54 to 896 MHz for system mode;
1 MHz to 1.8 GHz for spectrum analyzer mode
Amplitude Range: –15 to +70 dBm V for S/N > 30 dB
Displayed Average Noise Level (1 kHz RBW, 0 dB atten.)
- **Without Preamplifier:** ≤ –63 dBmV (1 to 1500 MHz)
- **With Internal Preamplifier:** ≤ –83 dBmV (1 to 1000 MHz)
- **With External Preamplifier:** ≤ –83 dBmV (1 to 1000 MHz)

Cable TV Measurements

Visual Carrier Frequency (visual carrier frequency is counted)
Precision Frequency Reference
- **Resolution:** 100 Hz
- **Accuracy:** ±(1.2 x 10^{-7} x carrier freq. +110 Hz)
- **At 55.25 MHz** (ch. 2): ±117 Hz
- **At 325.25 MHz** (ch. 41): ±149 Hz
- **At 643.25 MHz** (ch. 94): ±187 Hz

Visual-to-Aural Carrier Frequency Difference [counted frequency difference between visual (vision) and aural (sound) carriers]
- **Difference Range:** 4.1 to 4.9 MHz
- **Resolution:** 100 Hz
- **Accuracy:** ±221 Hz for precision frequency reference

Visual Carrier Peak Level (measured to an absolute standard)
- **Amplitude:** –15 to +70 dBm V
- **Resolution:** 0.1 dB
- **Absolute Accuracy:** ±2.0 dB for S/N > 30 dB
- **Relative Accuracy:** ±1.0 dB relative to adjacent channels in frequency; ±1.5 dB relative to all other channels

Visual-to-Aural Carrier Level Difference [measured difference between peak amplitudes of visual (vision) and aural (sound) carriers]
- **Difference Range:** 0 to 25 dB
- **Resolution:** 0.1 dB
- **Accuracy:** ±0.75 dB for S/N > 30 dB

Digital Carrier Power
- **Accuracy (characteristic) :** ±0.75 dB
- **Readout Resolution:** 0.1 dB

Depth of Modulation, Characteristic (percent difference from horizontal sync tip to max. video level)
- **AM Range:** 50 to 93%
- **Resolution:** 0.1%
- **Accuracy:** ±2.0% for C/N > 40 dB

FM Deviation, Characteristic (peak reading of FM deviation)
- **Range:** ±100 kHz
- **Resolution:** 100 Hz
- **Accuracy:** ±1.5 kHz

Hum/Low Frequency Disturbance (measured for power-line frequency and low-frequency disturbance)
- **AM range:** 0.5 to 10%
- **Resolution:** 0.1%
- **Accuracy:** ±0.7% for hum ≤ 5%

Visual Carrier-to-Noise Ratio, C/N (calculated from visual-carrier peak level; min. noise level normalized to 4 MHz for NTSC format)
- **Range** (input level dependent): 63 dB max. for +25 dBmV input

C/N Resolution: 0.1 dB
C/N Accuracy (input level and measured C/N dependent): < ±1 dB for 50 dB C/N and +25 dBmV input with external preselector filter
Composite Second Order and Composite Triple Beat Distortion (CSO and CTB measured relative to visual-carrier peak)
- **Range** (input level dependent): 77 dB max. for 25 dBm V input
- **Resolution:** 0.1 dB
- **Accuracy** (input-level, measured-CSO/CTB dependent): <± 1.5 dB for 60 dB CSO/CTB and +25 dBm V input

Crossmodulation Characteristic (15.7 kHz horizontal-line related AM measured on unmodulated visual carrier)
- **Range:** 60 dB, usable to 65 dB
- **Resolution:** 0.1 dB
- **Accuracy:** ±2.6 dB for xmod < 50 dB, C/N > 40 dB

System Frequency Response (system amplitude variations measured relative to a reference trace stored during the setup)
- **Frequency Response Setup:** Reference-trace storage for 50 traces including analyzer states
- **Frequency Response Test:** Trace-flatness accuracy is ± 0.1 dB per dB deviation from a flat line and ±0.75 dB maximum cumulative error

Option 107 Operation (for video and non-interfering measurements)
TV Receiver Input
- **Frequency Range:** 50 to 850 MHz
- **Amplitude Range:** 0 to 40 dBm V

Non-interfering Color Test (requires FCC composite or NTC-7 test signal for NTSC format)
- **Differential Gain Accuracy:** ≤ ±4%[1]
- **Differential Phase Accuracy:** ≤ ±3°[1]
- **Chrominance-luminance Delay Inequality Accuracy:** ≤ ±45 ns, ±32 ns typical

Non-interfering Tests with Gate ON[2]
- **C/N and CSO:** Quiet line must be selected
- **In-channel Frequency Response Accuracy:** < ±0.5 dB within channel (requires sin x/x, Philips ghost canceling reference, or FCC/NTC-7 multiburst test signal for NTSC format)

Preamplifiers

HP 85905A 75 Ω Preamplifier (external)
- **Frequency Range:** 45 to 1000 MHz
- **Gain:** 20 dB ±1.0 dB
- **Noise Figure:** 7 dB maximum at midband

HP 8591C 75 Ω Preamplifier (internal)
- **Frequency Range:** 1 to 1000 MHz
- **Gain:** ≥ 24 dB
- **Noise Figure:** ≤10 dB

Ordering Information

HP 8591C Cable TV Analyzer (includes HP 85721A)[3]
- **Opt 107**[4] TV Receiver/Video Tester (includes 75 Ω coupler and cables)
- **Opt 011** 75 Ω Tracking Generator
- **Opt 015** Change Yellow to Tan Soft Carrying Case
- **Opt 030** Cable TV Data Management Software with FCC Reports
- **Opt 040** Front-Panel Cover (used without soft carrying case)
- **Opt 041**[5] HP-IB and Parallel[6] Interfaces
- **Opt 119** Noise Figure Card
- **Opt 130** Narrow Resolution Bandwidths
- **Opt 180**[7] TV Picture Display
- **Opt 701** Delete TV Trigger, AM/FM Demodulator, Fast Time-Domain Sweeps
- **Opt 704** Delete Precision Frequency Reference
- **Opt 908** Rackmount without Handles
- **Opt 909** Rackmount with Handles
- **Opt 915** Component Level Info. and Service Guide
- **Opt W30** Two Additional Years Return-to-HP Service
- **Opt W32** Two Additional Years Return-to-HP Calib.
- **Opt R07** Retrofit Kit for Option 107

Recommended Accessories
HP 85702A 128K RAM Card
HP 85721A[3] Cable TV Measurements and System Monitor Personality (for HP 8590 E-series)
HP 85901A Portable AC Power Source
HP 85905A 75 Ω Preamplifier
HP 85921B Cable TV Data Management Software
- **Opt 030** with FCC Reports

HP 24542U RS-232 Nine-Pin Cable (analyzer to PC)
HP 24542G RS-232 Nine-Pin to 25-Pin Cable (analyzer to PC)
HP C2950A Parallel Cable (analyzer to printer)
HP 10833A HP-IB (GPIB) Cable

[1] 20° to 30° C, ≥ 20 dBm V input
[2] Gate ON synchronizes the measurement to the TV line selected
[3] NTSC format only; worldwide options available
[4] Not compatible with Option 180
[5] Replaces standard RS-232 and parallel interfaces
[6] Print and plot control only
[7] Not compatible with Option 107

12

HP CaLan 2010B
HP CaLan 3010B

- Fast, accurate carrier analysis
- Noninterfering system sweep
- Digital Carrier Power Measurement
- TDMA and Bursted Power

HP CaLan 3010B

HP CaLan 2010B and 3010B

Fast, Accurate Carrier Level Analysis

The HP CaLan 2010B is a field-rugged, easy-to-use signal measurement device that maintains accuracy in all environmental conditions. The 2010B comes with a standard frequency range of 5 MHz to 1 GHz and four modes of operation: single channel, four channel, spectrum scan, and a time-saving channel scan (60 channels in less than two seconds).

Programmed unattended measurements store results to 90 internal memories. Each memory will store picture and sound information for up to 158 channels. This data can also be analyzed by the built-in FCC Pass/Fail compliance reporter. The Pass/Fail report criteria is also user definable. Comparisons of levels over time can be done with the "normalize" and "motion on screen" functions.

The HP CaLan 3010B combines the power of the 2010B with forward sweep receiver features. This solution offers a system maintenance tool coupled with powerful measurement and signal analysis in one easy-to-use lightweight package.

Ingress Detection

By placing a 3010H at your headend, every 2010B (with Option 010) and 3010B becomes a powerful tool to aid you in troubleshooting and eliminating ingress problems.

Fiber Power Meter

An optional, built-in fiber power meter adds maintenance and troubleshooting for hybrid fiber-coax networks. Accurate power measurements can be made over a large dynamic range on a large, easy-to-read display in auto ranging dB, dBm, and watts.

Specification Summary

Frequency
- **Range:** 5 MHz to 1 GHz
- **Accuracy:** ±25 kHz
- **Resolution:** 10 kHz
- **Tuning Configuration:** Standard, off air VHF/UHF, HRC, IRC, SECAM, PAL and user-defined
- **IF Bandwidth:** 230 kHz
- **Video Bandwidth:** 300 kHz, automatic 10 Hz in C/N

Level
- **Range:** –45 to +70 dBmV
- **Accuracy**
  - **Calibrator:** ±0.25 dB @ 113.36 MHz, ±0.2 MHz
  - **Frequency Flatness:** ±0.5 dB
  - **Attenuator:** ±0.5 dB
  - **Log Linearity:** ±0.5 dB
  - **Typical Overall Accuracy:** ±1.0 dB
- **Resolution:** 0.1 dB
- **Difference Range:** 0 to 25 dB
  - **Relative Accuracy:** ±0.75 dB
- **Input Impedance:** 75 Ω
- **Input Match:** >14 dB, 0 dB attenuation; >20 dB, attenuation >0 dB

Sweep
- **Receiver:** HP CaLan 3010B compatible with HP CaLan 1777/1777P forward sweep transmitters
- **Sweep Width:** Continuously variable
- **Frequency Resolution:** 223 to 401 data points
- **Minimum Sweep Time:** 800 ms
- **Sweep Tables:** 4 user-definable tables for 350 carriers

Digital Signal Power Levels
- **Formats:** QAM, QPR (DMX), QPSK, and VSB ±1.5 dB (typical)
- **Amplitude Accuracy:** ±1.5 dB (typical)

Hum
- **Range:** 0.5 to 5%
- **Resolution:** 0.1%
- **Accuracy:** ±(0.2%, +30% of reading)

Carrier-to-Noise (with extended preselector)
- **Range:** 50 dB typical; 55 dB typical, measured in-band with carrier off
- **Accuracy:** ±2 dB
- **Repeatability:** ±1 dB

General
- **Size:** 95 mm W x 318 mm H x 267 mm D (3.75 in W x 12.5 in H x 10.5 in D)
- **Weight:** 10.7 lb.(4.9 kg) with battery
- **Power:** +10 to +15 Vdc @ 550 mA maximum
- **Battery:** 12 V (1.9 AH) rechargeable lead acid
- **Usage Time:** 4 hrs. continuous; 12 hrs. typical; battery-saving sleep mode for 3010B
- **Display Area:** 127 mm x 33.8 mm (5.00 in x 1.33 in)
  - **Resolution:** 240 x 64 pixels
  - **Type:** LCD with EL backlight

Temperature
- **Operating:** –20° to +50° C
- **Storage:** –20° to +70° C

Fiber Power Meter Option
- **Wavelength:** 1310 and 1550 nm
- **Measurement Range:** +20 to –38 dBm, 1310 nm; +18 to –38 dBm, 1550 nm
- **Resolution:** 0.1 dB
- **Accuracy:** ±5%
- **Display:** dB, dBm, mW, μW, nW
- **Connector Styles:** ST, FC, biconic, D4, SMA or bare fiber, rotary splice, RM

Ordering Information

HP 85960B HP CaLan 2010B SLM *Plus*
- **Opt 010** Ingress Measurement
- **Opt 020** Fiber Power Meter
- **Opt 030** Cable TV Data Management Software with FCC Reports
- **Opt 031** Cable TV Data Management Software

HP 85961B HP CaLan 3010B Sweep/SLM *Plus*
- **Opt 020** Fiber Power Meter
- **Opt 030** Cable TV Data Management Software with FCC Reports
- **Opt 031** Cable TV Data Management Software

For additional price and ordering information (including options), call your local HP sales office.

- Ingress detection
- Exclusive DigiSweep technology
- Built-in digital carrier power measurement
- TDMA and Bursted Power
- Built-in reverse sweep transmitter covers 5 to 1000 MHz
- Headend unit supports up to ten field units
- Rugged and easy to use

HP CaLan 3010R
HP CaLan 3010H

The HP CaLan 3010R and 3010H Sweep/Ingress Analyzer

HP CaLan Sweep/Ingress Analyzer

The HP CaLan sweep/ingress analyzer gives you confidence that your cable system is operating reliably by helping you to eliminate ingress. Designed with ingress in mind, this new solution consists of a portable field unit (HP CaLan 3010R) and a rackmount headend unit (HP CaLan 3010H).

When ingress corrupts return-path communication, the 3010H instantly detects the problem and transmits a "picture" of the ingress through the forward data pilot. This image will be displayed on the 3010R so your technician can begin troubleshooting immediately. The 3010H can support up to ten 3010Rs simultaneously. The display will advise you which 3010Rs are currently active in the field.

With the addition of Option 052 forward dual path option, you'll be armed with a complete forward, reverse sweep and ingress analysis tool. The forward sweep is still compatable with the 1777 transmitter.

DigiSweep Technology

The HP CaLan sweep/ingress analyzer offers our exclusive DigiSweep technology. DigiSweep is the industry's fastest high-resolution, non-interfering, digital services-compatible sweep. Its fast on/off speed and accurately-placed sweep pulses quickly sweep your forward and return paths without interference. The 401 points of sweep resolution give you the ability to see reflection, diplexer, and other response problems not visible with four carrier generators or other lower-resolution approaches. DigiSweep's five microsecond duration pulses allow placement close to digital signals without interference. This combination of features gives you the highest-available amplitude accuracy and frequency resolution of any sweep technology.

Specifications Summary

Digital Signal Power Levels
- **Formats:** QAM, QPR (DMX), QPSK, and VSB
- **Amplitude Accuracy:** ± 1.5 dB (typical)

Frequency
- **Range:** 5 MHz to 1 GHz
- **Accuracy:** ± 25 kHz
- **Resolution:** 10 kHz
- **Tuning Configuration:** Standard, Off Air VHF/UHF, HRC, IRC, SECAM, PAL, and user-defined
- **IF Bandwidth:** 230 kHz
- **Video Bandwidth:** 300 kHz, automatic 10 Hz in C/N

Level
- **Range:** –45 to + 70 dBmV
- **Accuracy**
  - **Calibrator:** ± 0.25 dB @ 113.36 MHz, ± 0.2 MHz
  - **Frequency Flatness:** ±0.5 dB
  - **Attenuator:** ± 0.5 dB
  - **Log Linearity:** ± 0.5 dB
  - **Typical Overall Accuracy:** ± 1.0 dB
- **Resolution:** 0.1 dB
- **Difference Range:** 0–25 dB
  - **Relative Accuracy:** ± 0.75 dB
- **Input Impedance:** 75 ohms
- **Input Match:** > 14 dB, 0 dB attenuation; > 20 dB, attenuation > 0 dB

Sweep
- **Receiver:** HP CaLan 3010R compatible with HP CaLan 1777/1777P forward sweep transmitter
- **Sweep Width:** Continuously variable
- **Frequency Resolution:** 223 to 401 data points
- **Minimum Sweep Time:** 800 ms
- **Sweep Tables:** 4 user-definable tables for 350 carriers

Hum
- **Range:** 0.5 to 5%
- **Resolution:** 0.1%
- **Accuracy:** ± (0.2% + 30% of reading)

Carrier-to-Noise (with external preselector)
- **Range:** 50 dB typical; 55 dB typical, measured in-band with carrier off
- **Accuracy:** ± 2 dB
- **Repeatability:** ± 1 dB

General
- **Size: HP 3010H:** 483 mm W x 133 mm H x 292 mm D (19 in W x 5.25 in H x 11.5 in D)
- **HP 3010R:** 95 mm W x 317 mm H x 267 mm D (10.5 in W x 12.5 in H x 3.75 in D)
- **Weight: HP 3010H:** 4.31 kg (9.5 lb.);
- **HP 3010R:** 4.8 kg (10.7 lb.) with battery
- **Power: HP 3010H:** 90 to 264 Vac, 47 to 63 Hz, 20 VA max.;
- **HP 3010R:** + 10 to +15 Vdc @ 550 mA max.
- **Battery:** 12 V (1.9 AH) rechargable lead acid
- **Usage Time:** 4 hrs. continuous; 12 hrs. typical; battery-saving sleep mode for 3010B
- **Display Area:** 127 mm x 33.8 mm (5.00 in x 1.33 in)
  - **Resolution:** 240 x 64 pixels
  - **Type:** LCD with EL backlight
- **Temperature**
  - **Operating: HP 3010H:** 0° to + 55°C; 3010R: –20° to + 55°C
  - **Storage: HP 3010H and HP 3010R:** –20° to + 70° C

Fiber Power Meter Option
- **Wavelength:** 1310 and 1550 nm
- **Measurement Range:** –38 to + 20 dBm @ 1310 nm; –38 to + 18 dBm @ 1550 nm
- **Resolution:** 0.1 dB
- **Accuracy:** ± 5%
- **Display:** dB, dBm, mW, microW, nanoW
- **Connector Styles:** ST, FC, biconic, D4, SMA, or bare fiber, rotary splice, RM

Ordering Information

HP 85962B HP CaLan 3010R Sweep/Ingress Analyzer
- **Opt 030** Cable TV Data Management Software with FCC Reports
- **Opt 031** Cable TV Data Management Software
- **Opt 052** Dual Path Sweep

HP 85963B HP CaLan 3010H Sweep/Ingress Analyzer
- **Opt 030** Cable TV Data Management Software with FCC Reports
- **Opt 031** Cable TV Data Management Software

Opt 050 Forward Sweep Transmitter
- **Opt 052** Dual Path Sweep

Broadcast TV Analyzers

Spectrum Analyzer Testing

HP 85724A
HP 8590
E-Series

- RF and video tests for broadcast transmitters
- One-button, noninterfering measurements
- Wide selection of frequency coverage, options
- Easily upgraded with circuit cards and DLPs

HP 85724A and HP 8591E

Broadcast Transmitter Testing with the HP 8590 E-Series Spectrum Analyzers

The HP 85724A broadcast television measurement personality provides an HP 8590 E-series spectrum analyzer with one-button measurements that simplify the installation, maintenance, and troubleshooting of TV broadcast transmitters. You can perform nearly all RF and three key video measurements without interrupting your system, offering you convenience while keeping your customers happy.

A simple process configures the spectrum analyzer to work with your particular TV system. User-definable parameters include TV standard, default ITS lines, and noise-power bandwidths. You can tune to channels by entering the channel number and band; nonstandard TV channels or FM radio channels can be measured using the frequency tuning mode. The broadcast TV measurement personality supports PAL-I/B/G, NTSC-M, and SECAM-D/K formats.

RF and Video Measurements at the Push of a Button

The HP 85724A broadcast TV measurement personality provides the following tests:

RF Measurements

- Automatic tuning of vision, sound, and FM broadcast carriers
- Vision and sound carrier levels and frequencies (including NICAM for PAL-B/G/I)
- Vision to chrominance level
- Vision in sound (AM on FM)
- NICAM intermodulation (PAL-B/G/I)
- Intermodulation products
- Three-tone intermodulation test
- Spurious signals
- Depth of modulation (frame by frame)
- Depth of modulation (ITS line)
- Low-frequency error (hum)
- Field sync distortion
- FM deviation
- Carrier-to-noise ratio
- Simultaneous TV picture and sound[1]

Video Measurements[1,2]

- Differential gain
- Differential phase
- Chrominance-to-luminance delay inequality

Advanced Analyzer Features

The spectrum analyzer's built-in features include trace math, limit-line testing, Fast Fourier transforms, and storage for up to 50 traces and states. Adjustable markers display the amplitude and frequency of any signal; zero span markers display amplitude and time or inverse-time information. A built-in memory card reader allows you to store and load application-specific programs. Other features include local oscillator output option for compatibility with sideband adapters, optional HP-IB or RS-232 programming with a parallel printer port for direct printer or plotter output.

Flexible Operation

A built-in card cage allows you to add circuit-card options at any time for increased measurement capability. There are two important circuit-card options for broadcast TV measurements. Option 301 Fast Time Domain Sweeps adds Analog+, TV line triggering, and AM/FM demodulation to the analyzer. Option 107 TV Receiver/Video Tester adds capability to display TV pictures and to perform video measurements, and it provides time gating for non-interfering carrier-to-noise testing.

Bundled Options

You can order the spectrum analyzer and options individually (see Ordering Information), or you can order one of four system bundle options for a cost savings.

System Bundle Options	HP 8591E 9 kHz to 1.8 GHz E80	E81	HP 8593/4/5/6E See Note E85	E86
Preloaded HP 85724A Broadcast Measurement Personality	•	•	•	•
AM/FM demod. plus TV line trigger	•	•	•	•
Fast time domain sweeps	•	•	•	•
Analog+ display mode	•	•	•	•
Precision frequency reference	•	•	•	•
RS-232 and parallel interfaces	•	•	•	•
Rugged carrying case	•	•	•	•
Built-in 20 dB preamplifier	•	•	—	—
TV receiver/video tester	—	•	—	•
(does not include cost of analyzer)				

Note:
HP 8594E, 9 kHz to 2.9 GHz
HP 8595E, 9 kHz to 6.5 GHz
HP 8596E, 9 kHz to 12.9 GHz
HP 8593E, 9 kHz to 22/26.5 GHz

Ordering Information

HP 85724A Broadcast TV Measurement Personality
(for use with HP 8590 E-series spectrum analyzers)
Spectrum Analyzer (choose one)
HP 8591E, 8593E, 8594E, or 8596E Portable Spectrum Analyzer (See page 234 for prices and additional options.)
Options
Opt 041 HP-IB and Parallel Printer Interfaces
Opt 043 RS-232 and Parallel Printer Interfaces
Opt 301 Fast Time Domain Sweeps, TV Trigger and AM/FM Demod, ANALOG+ Display
Opt 107 TV Receiver/Video Tester
Opt 180[3] PAL/SECAM/NTSC Picture Display
Opt H02 LO Output (HP 8591E without Option 010)
Opt H38 LO Output (HP 8591E with Option 010)
Opt 009 LO Output (HP 8593/4/5/6E)
Recommended Accessories
HP 85702A Additional 128K RAM Card
HP C2655A DeskJet 340 Printer
HP 85901A Portable AC Power Source

[1] Requires Options E81, E86, or 107
[2] Requires Options E81, E86, or 107 and 301
[3] Incompatible with Option 107

HP 85990A

- Complete computer control
- Synchronous or non-synchronous modulation
- Amplitude stability within ±0.2 dB, frequency stability better than ±5 ppm
- Frequency range 5 to 1100 MHz
- Provides both IEEE-488 and RS-232 control

HP 85990A Multicarrier Signal Generator

The HP 85990A multicarrier signal generator provides up to 180 clean, stable, noise-free carriers from 5 to 1100 MHz for convenient testing of distortion performance of broadband components and communication systems. The HP 85990A is particularly well-suited to making CTB, CSO, and cross modulation measurements for CATV component manufacturers and CATV headend installers and operators.

Product Description

The HP 85990A consists of up to 180 individual frequency sources installed in system cabinets. The frequencies of these modules are customer-specified, as is the rack capacity. System expansion is easily accommodated by specifying racks with larger capacity than currently required.

Each module contains a 15 dB attenuator and a pulsed-amplitude modulator. The modulator operates at the standard frequency specified by NTSC, PAL, or SECAM. All channels are summed at a single-output port, where a system attenuator provides additional amplitude control.

A Remote Control Program, running under Windows 3.1 or Windows 95, is supplied with the generator. This program provides control of all generator functions by addressing one, several, or all modules simultaneously. Access to the generator is provided via both RS-232 and IEEE-488 (HP-IB) interfaces.

Specifications

Output Frequency: 5 to 1100 MHz, customer specified to meet NTSC, SECAM, or PAL video carrier requirements
Maximum Output Level: 40 to 50 dBmV (typical). Dependent on frequency and number of channels.
Level Stability: ±0.2 dB (after 4 hour warm-up)
Spurious: < –100 dBc (16 KHz from carrier) with carrier-under-test OFF; < –80 dBc (16 KHz from carrier) with carrier-under-test ON
SSB Phase Noise: –103 dBc @ fc ± fmod
Residual FM: ±200 Hz (typical)
Frequency Accuracy: ±5 ppm, with common PLL reference
Attenuation:
Module Attenuator: 0 to 15 dB in 0.1 dB steps
Main Attenuator: 0 to 63 dB in 1.0 dB steps
Output Impedance: 75 Ω (Option 004: 50 Ω)
Output SWR: < 2:1

Key Literature

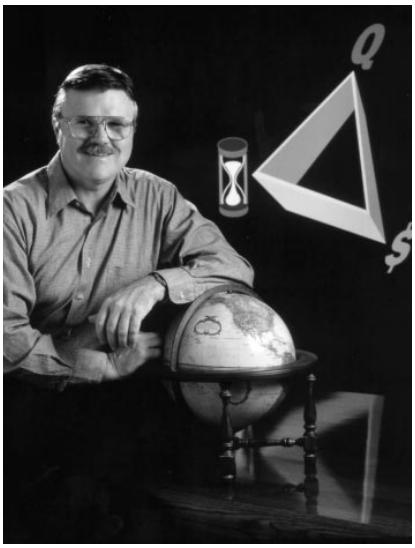
HP 85990A Multicarrier Signal Generator Product Overview, p/n 5964-6226E
HP 85990A Multicarrier Signal Generator Technical Data, p/n 5964-3682E

Ordering Information

HP 85990A Multicarrier Signal Generator
Opt 001 Individual HP 85990A carrier module (number of carrier modules)
Opt 002 Modulation format (NTSC standard, PAL with option)
Opt 004 Output Impedance (75 ohm standard, 50 ohm with option)
Opt 005 Secondary Modulation Duty Cycle (19% standard, may specify with option)
Opt 006 Spare/Retrofit Carrier Module (number of spare modules)
Opt 059 59-Channel Master Mainframe
Opt 060 60-Channel Slave Mainframe
Opt 089 89-Channel Master Mainframe
Opt 090 90-Channel Slave Mainframe
Opt 129 129-Channel Master Mainframe
Opt 130 130-Channel Slave Mainframe
Opt UK6 Commercial Calibration Certificate with Test Data

This page has been
intentionally left blank

Electronic Manufacturing Test 13



HP's Scott Elliott leads a team of manufacturing consultants who help customers worldwide review and improve their manufacturing and test processes while finding the right balance of time, cost and quality.

Manufacturing Success Factors

Manufacturers in every industry, and especially in electronics manufacturing, face increasingly complex and competitive markets, with shrinking product life cycles and razor-thin profit margins. Several disparate issues and challenges must constantly be juggled: labor, cost of sales, distribution channels, R&D, new technologies, global demographics. Not one ball can be dropped.

The Infernal Triangle

Electronics manufacturing revolves around managing three basic issues: minimizing time-to-volume in order to maximize shipments, reducing production cost in order to maximize profit, and ensuring high product quality to guarantee high customer satisfaction.

- You can produce a high-quality product in a short time, but it will cost a lot of money.
- You can produce a low-cost product quickly, but the quality will suffer.
- You can produce a low-cost product with high quality, but it will take a long time.

When this "Infernal Triangle" is mismanaged or overlooked, your business success is impacted and your profits can disappear very quickly. With regard to the three points of this triangle—time, cost, and quality—manufacturers used to say, "Pick two." Today, your customers and your managers demand all three.

Addressing any two aspects of the infernal triangle is easy. Meeting all three is a challenge, but it's central to the success of your electronics manufacturing enterprise.

Scott Elliott, former manufacturing manager of HP's Gallium Arsenide foundry in Sonoma County, California, now manages HP's Manufacturing Process Consulting team:

"If you understand your manufacturing process, if you have characterized it so you know what its capabilities are, then you can put new products on the manufacturing line really fast. One of biggest problems when introducing a new product to manufacturing is that most products are just not designed to work well within the limits of the manufacturing machinery or manufacturing processes. A big project may even reset the whole manufacturing process, which causes problems with other products coming through the line.

"For example, if a line is making ten different products, and making them with very high yields of 90 to 95 percent, and then this new product comes along with low yields, maybe 20 percent, it's a problem with far-reaching effects. Because people react to the hottest problem of the day or week and forget about the other processes that work, a new product that requires lots of attention can send a whole line into decline.

"While many manufacturing people dread new products coming in for this reason, those who have been working with the design team to understand the manufacturing issues can avoid these issues."

When "Build-Your-Own" is Right, Build the Right System Fast with Test System Components

Test system components are the backbone of HP's test and measurement solutions. We provide the instrumentation, mainframes, controllers, I/O, software languages and tools that you need if you want to build your test systems from the ground up. We not only adhere to industry standards—IEEE-488, VXIbus, etc.—we are leading members of the consortiums, committees, and groups that bring those standards from wishful thinking to implementation.

When Schedules are Tight, Jump-Start Your System Integration Effort With Pre-Assembled Platforms

Shrinking time-to-market and reducing the cost of test are together increasing the demand for platform-level test solutions. Platform-level test solutions provide the hardware sub-systems and software required for specific applications.

HP is providing a growing number of these platforms, for example in the automotive and telecom industries. Examples include the TS-2000 SONET/SDH for communications functional test series, the TS-5400 automotive electronics test series, and the 3279CT communications test system.

Platform-level test solutions provide an opportunity for electronic manufacturers to lower their overall cost of test while increasing test development efficiency. Because they are tuned for specific applications, platform-level solutions typically provide higher performance than systems built "from scratch." They are transportable worldwide, providing repeatability as well as consistent strategies for self-test and calibration, for example. Designed for reconfigurability and reuseability, HP platforms are a sound investment for manufacturers in key application areas.

When Engineering Resources are Scarce, Supplement Your Capabilities with HP Solution Engineering Services

If you are faced with a shortage of test engineering capability or simply lack the needed capacity because you and your technicians are too busy with other projects, contracting for complete, turnkey test systems may be the best answer.

HP can relieve the burden of test system development by providing consulting, engineering, integration and support services to augment your staff. Our team of test and measurement experts can work with you to perform a needs analysis, develop test system requirement specifications, and then design, develop, integrate, deploy and support tailored test solutions on your site. And HP's professional project managers can work with you to ensure delivery of test solutions on time and on budget as well as manage third-party subcontractors.

With HP acting as a collaborative extension of your own internal team, you can focus on your higher level manufacturing and product engineering challenges. Let us do the worrying about test system integration.

"Test" and its Role in Electronics Manufacturing

Critical success factors for world-class manufacturing include supplier management, activity-based cost analysis, process control, design for manufacturability, and test strategies. When you consider that an electronics product starts out as set of components, parts and ICs, and ends up as a highly sophisticated, complex system such as a computer, printer, telephone, satellite, or airbag control module, it becomes imperative that your production line give you a high level of confidence that three things are going to work right. One is that the design is correct, that the design is going to work and have some flexibility to small variations in the components and small variations in the manufacturing parameters. Second, you want to know that the components themselves are working the way they should and within their specifications. Third, that the assembly process—the mechanical part of the manufacturing process—is working. The result—field warranty issues that may be reaching your customers.

The only way to get this confidence is with some kind of inspection or testing process. At any given point, it is practically impossible to have 100 percent confidence because it would be prohibitively expensive to test a product in every possible configuration. Still, with the right kind of test that is matched precisely to your products and manufacturing processes, you can achieve a high level of coverage—and confidence.

World-class manufacturers are using structural and in-circuit process test to lower costs, increase quality and accelerate time-to-volume. Process test helps determine that the process is defined and in control, and that key parameters are within acceptable limits. Process test looks at things like solder structure and infers changes that might improve the paste and solder process. Some manufacturers use visual inspection or X-ray machines to inspect solder joints, not just for opens but also process drifts and variations. When process test does its job, problems can be eliminated before they occur.

While improved manufacturing processes and in-circuit process test have increased production yields, manufacturers are finding that their functional test requirements are still growing. Increasingly complex boards and sub-assemblies with mixed-signal content and decreasing nodal access shift more of the fault-detection burden to functional test stations. At the same time, products must meet rising customer expectations for quality. And companies must deal with increasingly stringent regulatory and documentation requirements.

The Road Ahead

For electronic manufacturers fighting to stay on top of their game and juggling their time, cost and quality constraints, being competitive today means:

- Effective supplier management with reduced parts on-hand, and more just-in-time delivery.
- Use of activity-based cost analysis, moving from accounting by extrapolation to monitoring actual costs based on actual cost drivers.

- Test strategies that yield management information and allow process refinement, as well as indicate process and product performance.
- Process control that comes from fully understanding and characterizing the design and manufacturing process.
- Design for manufacturability and design for testability by linking the R&D, manufacturing engineering and test engineering departments from initial product investigations to prototype development and manufacturing pilot through mature shipments.
- Quick time-to-prototype, time-to-volume, cycle time, and overall time-to-market through complete process control.
- Low cost through improved, streamlined, and simplified manufacturing processes, and outsourcing anything that is not deemed a core competency.
- Product quality that is designed in

We've learned these lessons at HP in over 50 years of electronics design and manufacturing for many thousands of products. Over the company's history, HP has evolved to keep pace with an ever-changing and expanding global community of customers.

At one time, being an innovator and a quality leader was enough. Today, it's merely the baseline for staying in business. Manufacturers can succeed today only by embracing and effecting change and managing all three aspects of the infernal triangle. They must take control of their manufacturing processes, and sometimes recalibrate, revitalize and reengineer themselves from top to bottom.

Testing Electronic Circuit Boards

In today's electronics manufacturing, surface-mount technology is widespread. More manufacturers are building highly complex boards, with higher device densities, dual-sided component placement, new soldering techniques and new device packaging technologies. These changes and complexities introduce process defects and stretch the printed circuit board assembly process. As a result, manufacturers need test systems to inspect the assembly quality of the boards being produced—not so much to sort good boards from bad, but to monitor the stability of the assembly process and provide rapid information about the quality of the process.

HP offers two types of process test equipment for the electronics manufacturer. One type uses x-ray and image analysis techniques to ensure the board is physically built correctly and the other uses electrical techniques to ensure electrical integrity. Both produce process control measurements for analysis of the stability of the assembly process. Both are designed for automated environments and yet are flexible enough to be operated in manual environments.

Structural Process Test Systems

The HP 5DX Series II X-ray systems provide a powerful solution to today's PCBA test challenges. The HP 5DX quickly tests for a wide range of defects including shorts, opens, insufficient solder, missing components and misalignment. The system is particularly effective when test access is not available or the cost of fixturing is prohibitive.

Limited Access: Densely-populated, double-sided circuit boards are often lacking probe points. And small, advanced componentry such as ultra-fine pitch TAB and BGA components are impossible to inspect with the human eye, even aided by a microscope. Joints hidden from visual access by devices like RF shields or double-sided boards also present test challenges. The HP 5DX is a perfect solution in these cases, because it does not require physical access and can see through visual obstructions, producing images of a high enough resolution to predict future failures.

High Mix Board Types: Because the HP 5DX does not require fixturing, it is a good choice for prototype testing and in environments with many different boards, especially if they are produced in small quantities which make the price of fixturing prohibitive.

The HP 5DX Series II is capable of keeping pace with high beat rate manufacturing lines, inspecting densely populated, double-sided boards at a rate of one every 60 seconds. Therefore, the systems can be effectively used in line or as a diagnostic tool for failed boards.

Electrical Process Test Systems

The HP 3070 family of loaded circuit board test systems uses electrical measurement technologies and a computer-designed short wire bed-of-nails fixture to find defects inserted by the manufacturing process. A wide range of capabilities are available, to fit any manufacturer's needs. And since the members of the family are modular and upgradeable, you can purchase what you need now and add more capability later without having to re-learn a new programming environment and, in most cases, without having to build new fixtures or test programs.

Three sizes of test system permit the greatest flexibility for the manufacturer, from the HP 3270 which permits a maximum of 1296 test points in a one square meter footprint package, to the HP 3170 at 2592 test points, and up to the HP 3070 at a maximum of 5184 test points. Within each of the package sizes, HP offers unpowered testing (passive analog component testing and HP TestJet technology for testing of digital components), digital MDA testing (MDA-style analog testing with vectorless digital capabilities), standard in-circuit testing (analog component testing, digital pattern testing with backdriving and vectorless HP TestJet technology), combinational testing (in-circuit testing with advanced digital, analog and mixed-signal functional testing of components and clusters*), and communications functional test.

With advanced user interfaces and test program generators, the HP 3070 family of board test systems makes your test programmers effective and efficient and ensures stable tests that can be counted on to monitor your assembly process. HP systems are well-known for their reliability, measurement stability and affordability.

Ordering Information

Prices depend on system configuration
HP 3070 Entry-level unpowered test systems start at
HP 5DX Series II prices start at

*Seamless integration of functional test instrumentation without sacrificing in-circuit resources.

HP 83000
HP 94000
RF 9490
HP 84000
HP V3300
HP 4071

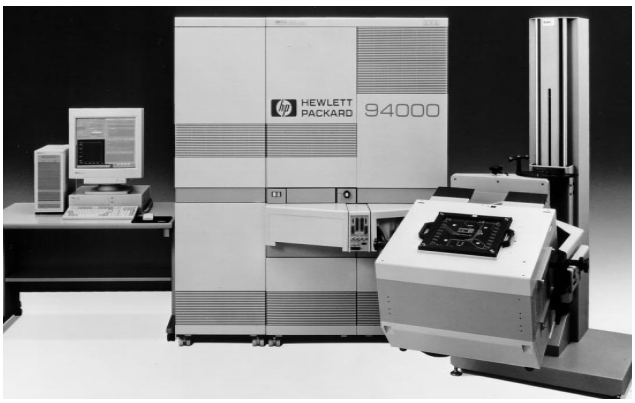
- HP's Semiconductor Test Systems offer low cost production test solutions for a broad range of markets
- Digital Test Systems cover clock rates from 50 MHz to 660 MHz and data rates up to 1.3 GBps with up to 1024 pins. With additional Smart DSP and waveform capability, HP's digital test systems can address Multimedia, Memory, VLSI, PLL, and other state-of-the-art building blocks
- Mixed-Signal Test Systems offer DC to real-time DSP to RF capability along with up to 512 pin digital capability
- HP's Memory and Logic Test Systems lead the market in Wafer Level testing of Flash Memory, Non-Volatile Memory and field programmable devices
- RFIC Test Systems and precision contactors provide the ability to test wireless ICs at the test site at frequencies up to 18 GHz
- HP's Semiconductor Parametric Test Systems offer high throughput, with links to SPECS modeling software, and maximize the instrumentation close to the wafer for maximum precision

HP 83000 Series Digital IC Production Test Systems

- Production test of microprocessors/VLSI /ASIC /Rambus ICs/ Microcontrollers/Telecom ICs/Multimedia ICs/FSRAM
- Highest throughput test processor-per-pin architecture
- Up to 660 MHz for "at speed test" with up to 1024 pins
- Timing flexibility with "Change Waveform On the Fly"
- Up to ± 50 p.s. measurement accuracy
- Smart DSP and waveform capture on some models
- High-speed memory interface testing
- Algorithmic pattern generator per pin for memory testing
- High-speed DRAM and SRAM testing
- Efficient docking to handlers/probers
- Multisite testing capability up to 16 sites

For more information, contact your HP sales engineer or see our website (http://www.hp.com/go/semiconductor).

HP 94000 Series Mixed-Signal IC Test Systems



- Production test IC test solutions for wireless and wired communications, graphics controllers, high speed PRMRL HDD, integrated PC audio, digital subscriber line (xDSL), ATM, A/D and DAC
- Up to 256 pins at 532 Mbps digital capability
- Excellent analog performance with low noise floor
- Full analog/digital synchronization
- Multisite testing capability
- Graphical software environment for rapid test development

For more information, contact your HP sales engineer or see our website (http://www.hp.com/go/semiconductor).

RF 9490 Integrated RF/Mixed-Signal IC Production Test Systems

- Production test of devices with integrated RF and mixed-signal functions
- Sourcing up to 3 GHz and measuring up to 6 Ghz
- Technology to make spectral, vector, modulation/de-modulation and noise figure measurements
- Simple menu-driven test setup for rapid test development and optimized test programs
- Simplified RF calibration

For more information, contact your HP sales engineer or see our website (http://www.hp.com/go/semiconductor).

HP 83000
HP 94000
RF9490
HP 84000
HP V3300
HP 4071

HP V3300 Mixed Memory /Logic IC Production Test System

- Tester-per-site architecture for high-throughput testing at eight independently-operating parallel test sites with up to 64 I/O per site
- Combined site resource mode for up to 128 I/O per site ensures test floor flexibility for high pin count devices.
- Ability to test both memory and logic offers flexibility for a wide range of product test needs.
- Windows® NT system software offers the power of UNIX® at the price of a PC.
- 20 MHz data rates support non-volatile memory needs with 40 MHz available through pin-pair multiplixing.
- Channel assignment module (CAM) provides software flexibility to assign any APL address or data channel to any I/O channel.

For more information, contact your HP sales engineer or see our web-site (http://www.hp.com/go/semiconductor).

HP 84000 RFIC Test System

- Production test of wireless and RF ICs
- Up to 3 GHz or 18 GHz at the device contact for at speed test
- Error corrected S-parameter, noise figure and power measurements
- Per-pin architecture for up to eight RF ports
- Simplified graphical environment for rapid test plan development
- Simplified RF calibration
- Complete DUT fixturing is available, including the HP YieldPro Contactor

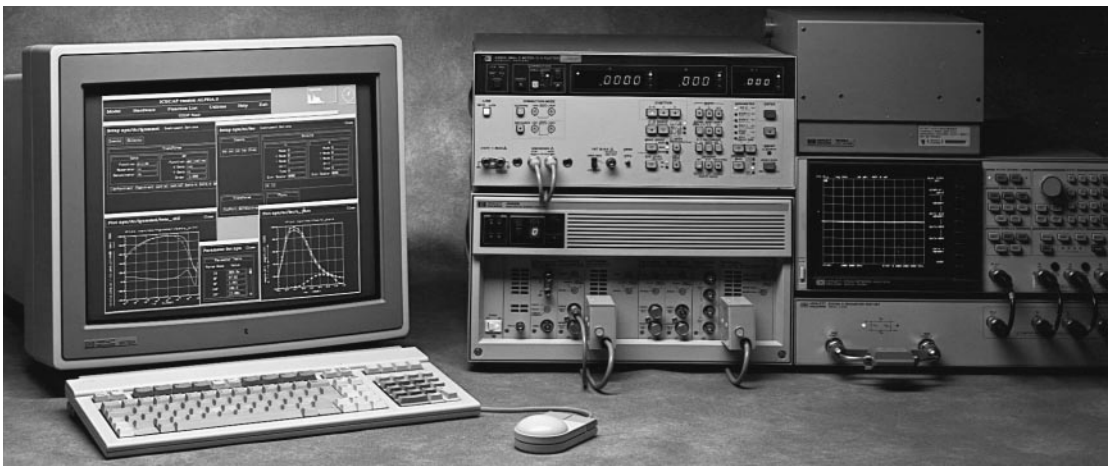
For more information, contact your HP sales engineer or see our web-site (http://www.hp.com/go/semiconductor).

HP 4071 High-Speed Semiconductor Parametric Test System

- Integrated tester-in-head design
- High throughput for all measurements
- Higher accuracy, resolution, repeatability
- Built-in diagnostics for fewer operator assists
- Direct docking to probe card for optimum performance
- Maintains laminar air flow for clean room operation
- HP SPECS new test shell for HP 4062UX and HP 4071A

For more information, contact your HP sales engineer or see our web-site (http://www.hp.com/go/semiconductor).

- Minimize design iteration cycle
- Optimize the IC performance
- Create new device models and circuit macromodels with ease



IC-CAP

IC-CAP Circuit/Device Modeling Software

New Approach to Modeling

Over the last decade, semiconductor technology has gone through rapid advancements resulting in dramatic improvement in the performance of ICs. State-of-the-art IC technologies use devices that require careful attention to modeling the parasitics and second-order effects. Parasitics must be included as subnetworks formed around the transistors.

Subnetwork Characterization and Modeling

The success of an IC technology is rooted in its ability to achieve the desired performance while maintaining high product yield. Accurate prediction of the performance of an IC relies on the simulation models used and the capability to accurately extract device parameters as well as subnetwork component values for these models.

Simulating a Device or Subnetwork

IC-CAP provides a direct link to SPICE and other circuit simulators through an open interface and uses them for analysis and optimization of device or subnetwork performance. Direct use of the built-in SPICE simulators or your own simulator also eliminates any discrepancy between modeling and simulation tools.

Extracting Parameters/Statistical Analysis

IC-CAP's powerful extraction, optimization, and advanced utilities, coupled with a built-in or your own simulator, will help you generate the most accurate device model parameters or circuit element values for your designs. An improved user interface and a statistics package are now part of IC-CAP.

Macromodeling

Macromodels are simplified versions of complex circuits that are used for efficient simulation of circuits or systems. You describe the topology of the macromodel in the form of a subnetwork for IC-CAP. IC-CAP performs the analysis and measurements based on the inputs, and finds the optimum component or device parameter values for best performance.

IC-CAP Software Now From the HP EEsof Division

IC-CAP software is supplied by the HP EEsof division to better serve the needs of our customers. Please see pages 318 and 319 for more about HP EEsof's circuit and system simulators, as well as complete modeling systems.

Ordering Information

HP 85190A IC-CAP Modeling Suite
Includes:
- **HP 85199A** IC-CAP Software Environment
- **HP 85199B** IC-CAP Analysis Module
- **HP 85199C** LCRZ Measurement Drivers
- **HP 85199D** DC Measurement Drivers
- **HP 85199E** AC Measurement Drivers

Other modules available:
HP 85199J IC-CAP Statistics Package

Measurement Drivers
HP 85199F Time Domain Measurement Drivers
HP 85199G Noise Measurement Drivers
HP 85199H Pulsed Measurement Drivers

MESFET/HEMT Device Models
HP 85191A HP Root FET Model Generator
HP 85192A High-Frequency FET Models
HP 85192B EEFET3 FET/EEHEMT1 Model

BJT Device Models
HP 85193A Gummel-Poon BJT Models
HP 85193B EEBJT2 BJT Model
HP 85193C Philips MEXTRAM BJT Model
HP 85193D VBIC95 BJT Model

MOSFET Device Models
HP 85194A High-Frequency MOS Level 3 Model
HP 85194B Root MOS Model Generator
HP 85194C EEMOS1 MOS Model
HP 85194D UCB BSIM 1, 2 Model Extraction Module
HP 85194E UCB BSIM 3 Model Extraction Module
HP 85194H UCB MOS Level 2, 3 Model Extraction Module
HP 85194J Philips MOS Model 9

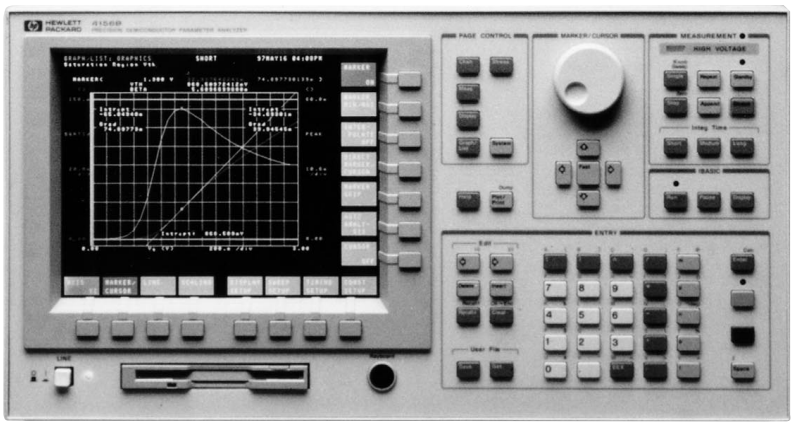
Thin-Film Transistor Models
HP 85194F HP a-SI TFT Model Extraction Module
HP 85194G UCB p-SI TFT Model Extraction Module

Diode Device Models
HP 85195A Root Diode Model Generator

Please contact your local HP sales office (listed on page 591) for complete information on IC-CAP software, including data sheets, prices, and application assistance.

HP 4155B
HP 4156B

- High-resolution/accuracy and wide range. I: 1 fA to 1 A (20 fA offset accuracy), V: 1 μV to 200 V
- Fully-automated I-V sweep measurements with dc or pulse mode, expandable up to 6 SMUs
- Synchronized stress/measure function, two high-voltage pulse generator units (±40 V)
- Time-domain measurement: 60 μs–variable intervals, up to 10,001 points
- Easy to use: knob-sweep similar to curve tracer, automatic analysis functions
- Automation: built-in HP Instrument BASIC, trigger I/O capability



HP 4155B

Whether you are looking for a low-cost bench-top instrument or an automated test system, HP can meet your semiconductor test needs with its Just-Enough-Test line of semiconductor measurement instruments. This instrument family provides versatile coverage of application needs in process development, device characterization, process monitoring, reliability testing, failure analysis, and incoming inspection. The low leakage switching matrix, various useful accessories, and Windows-based interactive characterization software allow the instruments to be configured flexibly from a one-box solution to an integrated, automated system.

HP 4155B Semiconductor Parameter Analyzer
HP 4156B Precision Semiconductor Parameter Analyzer

HP-IB NEW

The HP 4155B and HP 4156B are the next generation in precision semiconductor parameter analyzers. You get the best digital sweep parameter analyzer plus a reliability tester, powerful failure-analysis tool, and automated incoming inspection station, all rolled into a single instrument.

This new family was explicitly designed to provide unprecedented accuracy and functionality for evaluating your sub-micron geometry devices. With one flexible instrument, you can improve your semiconductor quality starting from material evaluation and device characterization all the way through final packaged part inspection and field failure analysis.

Choose the Right Solution

The HP 4155B/56B offer four built-in source/monitor units (SMUs), two voltage source units (VSUs), and two voltage monitor units (VMUs). The HP 4155B is best suited for basic semiconductor applications with its non-kelvin connections, 10 fA/1 μV resolution, and 100 mA/100 V measurement range. For critical low-level characterization, the HP 4156B extends current resolution to 1 fA and accuracy to 20 fA. The HP 4156B utilizes full-kelvin remote sensing on each SMU.

At any time, you can add the HP 41501B SMU and Pulse Generator Expander, which is supplied with a 0 V/1.6 A Ground Unit. The expander accepts two 100 mA/100 V SMUs or one 1 A/200 V SMU, and two specially-synchronized 40 V/200 mA/1 μs pulse generators.

Setup and Measurement

HP 4155B/56B can perform staircase and pulse sweep measurement, and sampling (time-domain) measurement using many measurement units, including units in the HP 41501B, without changing connections. Moreover you can easily perform stress-measure cycling test for reliability evaluation such as hot carrier injection and flash EEPROM test.

Setup and measurement are made by setting up pages and filling in the blanks from front-panel keys, keyboard, or HP-IB (SCPI commands). You can also instantly measure and find setup conditions by using knob sweep capability, which is similar to curve tracer operation.

Display and Analysis

The measurement and analysis results are displayed on the color LCD, and you can superimpose stored graphics from four graphic memories for comparison. A number of powerful graphical analysis tools make it easy to analyze and extract many parameters such as hFE and Vth.

Once you find the parameter extraction conditions, you can automatically get the parameter by using the automatic analysis function.

Output and Storage

Setup, measurement, and analysis data can be output via HP-IB, parallel or network interface 10 Base-T LAN to a color plotter and printer. You can also save the data onto a disk via network or 3.5-inch disk in MS-DOS or LIF format. Graphic (HP-GL, PCL or TIF) output file allows you to transfer graphics to desktop publishing software.

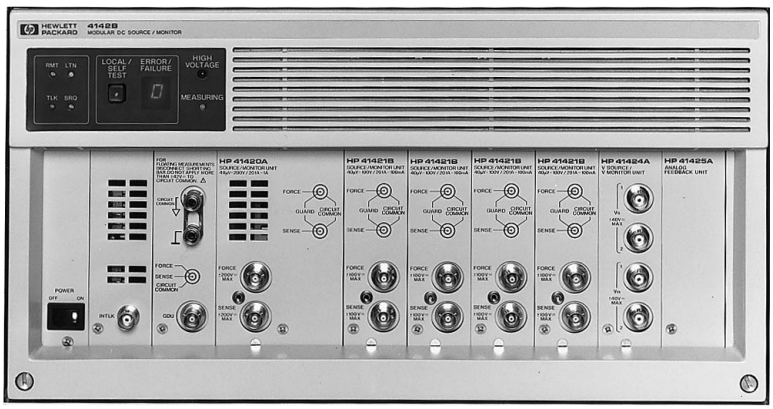
Repeating and Automating Tests

The HP Instrument BASIC controller built into the HP 4155B/56B can construct an automatic measurement system using external instruments without a controller. HP 4155B/56B can be synchronized with external instruments by the versatile trigger I/O functions.

Product	Applications								
	Basic I-V	Low Current	Ultra Low Current	High Voltage & Current	Pulsed Meas.	Time Domain Meas.	C-V & C-t	Multi-freq. Meas/	Quasi-Static C-V
HP 4155B	V	V			V	V			
HP 4156B	V	V	V		V	V			
HP 4142B	V	V		V	V				
HP 4140B	V	V							V
HP 4280A							V		
HP 4284A								V	

HP Semiconductor Measurement Instruments for Applications

- Flexible, modular architecture
- Wide measurement range with high resolution
  V: ±4 μV to ±1000 V, 0.05%
  I: ±20 fA to ±10 A, 0.2%
- Pulse measurement capabilities
  Pulse width 1 ms to 50 ms, 100 μs resolution
- High-speed measurement (typical)
  Sourcing or monitoring: 4 ms
  Vth, hFE extracting: 12 ms
- Internal memory
  Program memory: >2000 commands (typical)
  Data memory: 4004 measurement points



HP 4142B

HP 4142B Modular DC Source/Monitor

HP-IB

Offering a wide measurement range and excellent sensitivity, the HP 4142B modular dc source/monitor is a system-use dc measurement instrument especially designed for high-throughput dc semiconductor testers. A completely user-definable system component, the HP 4142B features modular architecture that allows you to build a custom configuration to suit your measurement needs.

Eight plug-in module slots can accommodate any combination of the five presently-available modules; as new modules become available, you can upgrade your measurement capabilities with ease. Choose from two types of source/monitor units (SMUs) to force or measure up to ±200 V and ±1 A: a high-current source/monitor unit (HCU) up to ±10 A, a high voltage source/monitor unit (HVU) up to ±1000 V, a voltage source/voltage monitor unit (VS/VMU), and an analog feedback unit (AFU).The HP 4142B's instrument command and measurement data-storage capabilities, coupled with the high-speed HP-IB interface, minimize computer loading, enhance throughput, and simplify systemization.

Versatile SMUs and Reliable Measurement

For general-purpose dc or pulsed measurement, use the HP 41421B source monitor unit. The equivalent of four instruments, this precision module forces voltage up to ±100 V and simultaneously measures currents down to 20 fA. It can also force currents up to ±100 mA while measuring voltage down to 40 μV.

If you test high-power components or desire a wider measurement range, use the HP 41420A source monitor unit. This versatile SMU can source ±200 V or ±1 (14 W, dc or pulsed) and still maintain a measurement resolution of 40 μV and 20 fA. Both SMUs include a compliance feature that limits output voltage, current, or power to prevent damage to your device. Each SMU (HP 41420A or HP 41421B) acts as either a voltage source/current monitor or current source/voltage monitor. These complementary operating modes let you change the stimulus on a device without modifying the physical connections. This versatility reduces test time and eliminates instabilities caused by changing connections at the DUT.

Test Power Devices to 10 A and 1000 V

The HP 41422A HCU and the HP 41423A HVU expand the measurement range of the HP 4142B to 10 A and 1000 V. They dramatically expand the HP 4142B's ability to test power devices, such as power transistors, power MOSFETs, GaAs FETs, and smart ICs. Using a combination of the two units, measurements of up to 20 A and 2000 V are possible.

Using the HCU, fast pulse testing (100 μs minimum pulse width) at high current increases test reliability by minimizing the effects of thermal drift. Quasi-pulsed measurements by the HVU are effective for measuring breakdown voltage by minimizing the duration of the breakdown condition.

The HP 16087A module selector is a scanner that lets you remotely control the connection of the HP 41420A/41421B SMUs, the HP 41422A HCU, or the HP 41423A HVU to a test pin. It contributes to automatic testing for high-power devices with high-breakdown voltage. The built-in module selector can be specified as an option of the HP 16088B test fixture.

High-Speed Parameter Extraction by Analog Feedback Technique

To find important parameters that are specified at a given voltage or current, such as Vth or hFE, connect the HP 41425A AFU to two SMUs. The AFU modulates the output voltage of one SMU while monitoring the current or voltage of the other. Target currents and voltage are found with great speed (12 ms). This unique analog feedback network rapidly measures Vth, hFE, ΔL, or ΔW—parameters that would require excessive test time on other parametric testers.

You can also use the AFU to bias and test microwave devices. It can be integrated into the network analyzer system.

By using the AFU, you can eliminate the effect of device thermal drift and can hold the initial setting bias for ac measurement time.

Interactive Characterization Software (ICS)

The Windows-based HP E5230B Interactive Characterization Software together with the HP E5231B I-V Parametric Driver Library provides a uniquely-powerful instrumentation control and data analysis software package, and provides true point-and-click measurements, intuitive matrix control window, built-in database, and graphical analysis for total system solution. ICS delivers more than programming-free instrumentation control. Its spreadsheet windows and scientific plotting capability allow you to view and analyze data easily. ICS also includes valuable scientific and engineering data reduction tools necessary for interpreting test results, such as cursor assignments and curve fitting routines. ICS's resources include a robust file management system that allows you to create multiple databases without relying on external database software.

The I-V Parametric Driver Library controls the HP 4155A/B, 4156 A/B, 4142B and 4145A/B. The HP E5232B C-V Driver Library and HP E5233B Switch Driver Library control the HP 4284A and HP E5250A, respectively.

HP E5250A
HP 4140B
HP 4280A

HP E5250A Features:
- Unique analog bus architecture to allow configuration as a 10 x 48 cross-point matrix or as a 384-channel multiplexer
- 100 fA offset current with 10 tera-Ω channel isolation for accurate current measurement
- 100 μV offset voltage and low contact resistance for accurate voltage measurements
- Plug-in module architecture

HP 4140B Features:
- Three basic semiconductor measurements: I, I-V, and quasi-static C-V
- Two programmable voltage sources: ±100 V programmable source/function generator ±100 V programmable dc voltage source
- Basic accuracy: 0.5%
- High resolution: 1 fA
- Quasi-static C-V: 0.1 pF to 1999 pF, dc voltage ramp rate 1 mV/s to 1 V/s in 1 mV/s increments

HP 4280A Features:
- Built-in sweepable dc source and timer for C-V and C-t (capacitance-time) measurements
- High-speed C-t measurements with minimum measurement interval of 10 ms (10 μs if an external pulse generator is used)
- Basic C measurement accuracy: 0.1%

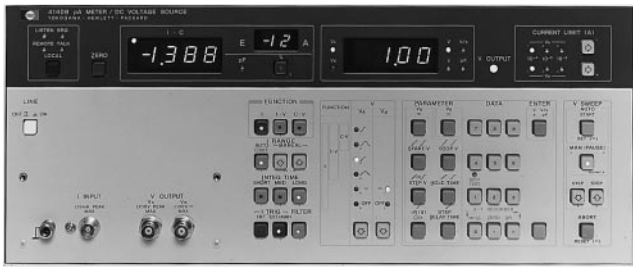
HP E5250A with HP 4155B

HP E5250A Low Leakage Switch

The HP E5250A switch mainframe has four slots for one to four 10 x 12 cross-point matrix modules or one to four 24-channel multiplexer modules. The cross-point matrix provides an automated solution for general parametric measurements while the multiplexer is ideal for long-term reliability measurements. The unique analog bus architecture ensures low noise internal interconnection of the plug-in modules without external cables. The four backside slots provide a maximum of 48 matrix outputs (one mainframe with four matrix modules installed) or 384 multiplexer outputs (four mainframes with four multiplexers installed in each mainframe).

When configured as a 10-input cross-point matrix, this configuration is ideal for general parametric measurements with six I-V triaxial inputs, low leakage (100 fA) performance, and four C-V coaxials, but can also be used for dc source/measure, and pulses up to 10 MHz.

When configured as a multiplexer, each module has 24 channels with an isolated external dc stress bias input for each set of eight channels. To safeguard other devices under stress from any surges when a device breaks down, each channel has a user-selected protection resistor to dampen the surge.



HP 4140B

HP 4140B pA Meter/DC Voltage Source

HP-IB

The HP 4140B pA meter/dc voltage source is part of component-measurement instrumentation. It consists of an extremely stable picoampere meter and two programmable dc voltage sources, one of which operates as a ramp and staircase generator as well as a dc source. These features make the HP 4140B ideal for making dc-characteristic measurements such as leakage current, current-voltage characteristics, and quasi-static C-V measurements, required by the semiconductor industry for new-product development and for improving production yields. It is equally useful in measuring electronic components and materials to determine leakage currents or insulation resistances.

The HP 4140B can contribute to the development, production, and quality control of semiconductor devices and to improvements in the reliability of electronic components and equipment.

HP 4280A

HP 4280A 1 MHz C Meter/C-V Plotter

HP-IB

The HP 4280A 1 MHz C meter/C-V plotter measures the capacitance and conductance of semiconductor devices and materials as functions of applied voltage (C-V) or time (C-t). The HP 4280A consists of a precision 1 MHz C-G meter, a programmable dc bias source that can be swept in staircase fashion, and accurate timing control.

The HP 4280's internal dc bias source has a range of 0 V to ±100 V with 1 mV resolution on the most sensitive range. Various measurement parameters for C-V and C-t measurements can be manually set from the front panel, or these parameters can be set under program control via the HP-IB. Settable range for C-t measurement interval is 10 ms to 32 s with a best-case resolution of 10 μs. If an external pulse generator is used, however, measurement intervals as short as 10 μs can be set. Up to 9,999 readings can be set for a C-t measurement. These capabilities make it possible for the HP 4280A to measure the C-t characteristics of virtually any device.

The HP 4280A can measure either floating or grounded devices. Thus, it can be connected to a wafer prober and still provide stable, accurate C and G measurements.

HP's TestSpan Series of Products & Services

The HP Test Span Series of Products & Services
5964-1576E

(PN E6230A/TS-5430) Air Bag Systems ECU Test Platform
5965-6505E
(PN E6230A/TS-5430) Antilock Brake/ Traction Control ECU Test Platform
5965-6507E
(PN TS-5400) Family of Test Systems
5965-5226E
(PN TS-5430) HP TS-5430 Automotive Electronics Test Platform
5965-5289E

Board Test & Inspection

HP 3070 Quick Verify Platform for ICT Plus Functional Product Verification
5965-8060E
Lowering the Total Cost of Test
5963-2015E
HP 3279CT Communications Board Test System
5965-4879E
HP Automated Process Test Solutions
5964-9443E
HP 5DX Series II automated X-ray inspection system improves product and process-in-line, off-line, real-time
5965-8566E

(PN 3070) HP Performance Port Fixturing Product
5965-8567E
(PN 3070) RPM Invitation, Color Piece
5965-6622E

Semiconductor Test Systems

Testing Digital Series to Their Limits Data Sheet
5962-7010E
HP 83000 Model F3504 Digital U Test System Technical Specifications Sheet
5962-7008E
HP V1100/V2100 Test Systems
5963-6941E
HP 82000 IC Evaluation System Data Sheet
5091-0623E
HP 83000 U Test System Brochure
5091-2357E
HP 82000 Series Fast and Precise IC Characterization and Test
5953-6335
HP 83000 Pay-Per-Use
5964-0094E
HP 83000 The Key to More Quality Parts at Lower Cost
5965-5033E
HP 83000 Model F660 Can You Test Your Most Advanced Devices to Their Limits?
5962-7011E
HP 84000 Series High Throughput RFIC Test Systems
5965-5272E
HP 4062 Series HP 4062UX Semiconductor Process Control System
5091-1070E
HP 9490 Series Real Mixed-Signal Test Solutions for Production
5963-7048E
HP V1100/2100 Test Systems
5963-6941E
HP V1200 Test Systems
5965-3343E
HP 4070 Series of Semiconductor Parametric Testers – HP SPECS Semiconductor Process Evaluation Core Software
5965-2723E
HP Modeling Systems Brochure
5964-9022E
IC-CAP Modeling Suite Release 4.4 Data Sheet
5964-0207E

(PN 4062-1) Sub-Pico Amp Measurement Using the Guarded Technique on an Automatic Wafer Prober
5090-0290
(PN 4062-2) Precision Evaluation of Flash Memory Cells
5091-6806E
(PN 4062PC-1) Effective Data Analysis Using Lotus 1-2-3– HP 4062PC Semiconductor Parametric Test System
5091-4993E
(PN 82000) Test Cost Analysis
5091-0512E
(PN 82000M) Specifying the Application-Focused Noise of Mixed Signal Test Systems
5091-4499E
(PN) Wafer Probing with the HP 83000 Model F330t
5962-0117E
(PN) Characterizing Communications ICs with the HP 83000 Model F660
5962-9273EUS
(PN) Memory Test Software Provides Cost-Effective Solutions to Testing Advanced SRAMs (83000 F660)
5963-5078E

Semiconductor Measurement Instruments

(PN) HP 4155A/4156A Semiconductor Parameter Analyzer—Edition 1 Programming Guide for HP 4145A/B
5963-3201E
(PN 4142B-1) DC Characterization of Semiconductor Power Devices
5091-2744E
(PN 4145B) HP 4145B Preventing SMU Oscillation
5950-2909
(PN 4140A/B) HP 4140A 4140B Measurement Hints
5950-2921

Many of these literature pieces are available at:
http://www.hp.com/go/tmc98

This page has been
intentionally left blank

FFT Dynamic Signal Analyzers

Overview

Realtime Update is our free newsletter for noise, vibration and data acquisition professionals. In the USA, call 1-800-452-4844 for a free subscription.

Hewlett-Packard dynamic signal analyzers use digital sampling and fast fourier transform (FFT) techniques to provide:

- Fast spectrum measurements
- Network analysis
- Transient event analysis

Some of these analyzers additionally provide real-time fractional octave measurements for acoustic analysis of rapidly changing signals, or to satisfy compliance tests.

Solve the Whole Problem

Because solving measurement problems often requires more than just an analyzer, HP offers an expanding selection of transducers suitable for general vibration, rotating machinery, and structural dynamics testing. Complete descriptions of these accessories are in the DSA Accessory Catalog, p/n 5964-8939E.

To help you arrive at solutions faster, we offer a variety of application and product notes and have application specialists available to deliver seminars and training. For advanced analysis of test results, several independent software vendors offer packages that are compatible with HP instruments and systems.

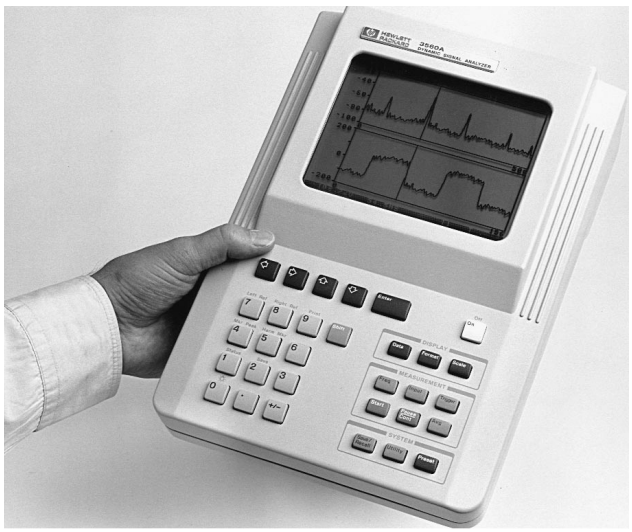
All HP dynamic signal analyzers support a standard data format (SDF). You can gather measurements in the field with a portable analyzer, then read the files into a benchtop or system-type DSA for advanced analysis at your desk. Cut and paste data and displays to your favorite PC software with HP 35639A data viewer.

Choosing the Right Analyzer

	Vibration and acoustics	Control system development	Signal analysis	Device testing
HP 3560A (page 541)	Portable for vibration, impact testing, and acoustics in the field (battery powered)	—	Good portable analyzer for general-purpose measurement (battery-powered)	Good portable analyzer for general-purpose measurement (battery-powered)
HP 3569A (page 541)	Portable 2-channel real-time octave analyzer with optional sound intensity, narrowband FFT, and reverberation measurements (battery powered)	—	Good portable analyzer for general-purpose measurement (battery powered) and lab quality acoustic measurements	Good portable analyzer for general-purpose measurement (battery powered) and lab quality acoustic measurements
HP 35665A (pages 542, 543)	Extensive acoustic and rotating machinery measurements	Similar to HP 35670A capabilities as a lower-cost, benchtop model	Deep capture memory, waterfall display and fast spectrum measurements	Similar to HP 35670A capabilities as a lower-cost, benchtop model
HP 35670A (pages 544, 545)	Portable superset of HP 35665A, ruggedized for field work. Nonvolatile memory option. 2- or 4-channel options.	Fast swept-sine and s-domain modeling options for analog systems, system controller option for automated testing	Portable superset of HP 35665A, ruggedized for field work. Nonvolatile memory option. 2- or 4-channel options.	Automate measurements and external device control via HP Instrument BASIC programming option
HP 3565S (page 547) **or VXIbus** (page 547)	Modular PC or workstation-based systems for advanced structural testing and rotating machinery analysis	—	Create high speed multiple-input custom systems using HP 35635T software tools	Cost-effective solutions for automated testing of multiple devices simultaneously
HP 3566A HP 3567A (page 546)	A compact PC-based system with up to 48 channels and a choice of input modules and frequency ranges. HP 3567A offers higher frequency range.	Cost-effective solutions for automated test of multiple systems in parallel with optional swept sine. HP 3567A offers higher-frequency range.	Flexible data display and Microsoft Windows interface for analysis of waveforms and spectra. HP 3567A offers higher frequency range.	Cost-effective solutions for automated testing of multiple devices simultaneously. HP 3567A offers higher frequency range.
HP 89410A (pages 232-235)	Flexible frequency, time and modulation analysis for frequencies and spans to 10 MHz, 1 and 2 channel	Flexible frequency, time and modulation analysis for frequencies and spans to 10 MHz, 1 and 2 channel	Flexible frequency, time and modulation analysis for frequencies and spans to 10 MHz, 1 and 2 channel	Flexible frequency, time and modulation analysis for frequencies and spans to 10 MHz, 1 and 2 channel

For the latest information on HP's Data Acquisition products, see HP's website at: (http://www.hp.com/go/data_acq).

- Frequency response, spectrum, transient analysis
- 6 hour (typical) operation on rechargeable battery pack
- Lightweight (3.2 kg/7lbs) and portable
- Multispectrum display (HP 3569A)
- Spectral map displays (HP 3560A)
- 1/1 and 1/3 octave analysis
- Online zoom for greater resolution



HP 3560A

Ultra-Portable Dual-Channel Measurements

The internal, rechargeable battery pack permits the HP 3560A and HP 3569A to make spectrum and frequency response and acoustic measurements in the field. The HP 3560A and HP 3569A are built to withstand the harsh environmental conditions normally encountered in portable applications. With a 3.2 kg (7 lb) total weight, the HP 3560A and HP 3569A can be taken virtually anywhere.

HP 3560A Portable Dynamic Signal Analyzer

The HP 3560A portable dynamic signal analyzer is an FFT-based instrument capable of measuring time domain and frequency signals from both steady state and quickly changing signal sources. With two input channels, the HP 3560A provides a variety of frequency response measurements with a frequency range from 31.25 mHz to 40 kHz. The HP 3560A provides more than raw measurements. The ICP input mode directly powers accelerometers and hammer kits, so external signal-conditioning hardware is not required. Synthesized octave measurements, spectral map displays and marker functions make the HP 3560A a powerful, portable measurement and analysis tool.

HP 3569A Real-Time Frequency Analyzer

The HP 3569A is a portable, battery-powered real-time frequency analyzer designed for on-site product-noise characterization. Octave and 1/3-octave resolution measurements are made in real time. Built-in microphone and BNC ICP inputs eliminate the need for external signal conditioning. A built-in noise source provides convenient stimulus for reverberation and frequency response measurements.

The optional Real-Time Sound Intensity mode can be used to identify noise sources. I.E.C. 1043 Class 1 compliant sound power measurements can be calculated easily and automatically in the analyzer.

The optional FFT mode allows high-resolution measurements of tones, vibration or single frequencies. FFT frequency resolution of up to 1600 lines, including cross channel measurements, can help you identify vibration and acoustic problems.

The optional Reverberation Time mode provides direct display of octave and 1/3-octave decay times. RT 60 computations are done automatically.

Documentation and Analysis

The HP 3560A and the HP 3569A measurements can be printed on HP DeskJet or HP LaserJet printers, or HP-GL plotters via RS-232. Stored data can also be transferred to a computer via RS-232 and is compatible with Hewlett-Packard's SDF (Standard Data Format) which allows data transportability to other Hewlett-Packard dynamic signal analyzers and third-party analysis packages. An optional utilities package for the HP 3569A (Option 550) allows easy data transfers to DOS PCs and special display utilities with the HP 95LX palmtop PC.

Specifications Summary

Octave Mode (HP 3569A)
Frequency: Maximum span of 36 bands plus two overall bands
1/3-Octave Bands, Single Channel: 1.6 Hz to 20 kHz (real time)
Octave Bands, Single Channel: 2.0 Hz to 16 kHz (real time)
Maximum Octave Bands, Dual Channel: 10 kHz (1/3) and 8 kHz (1/1)
Amplitude Accuracy: ±0.3 dB
Dynamic Range: 72 dBfs
Input Ranges: 70 to 130 dB SPL in 10-dB steps (5 mV to 5 V)
Weighting Filters: A-weight, C-weight, linear, flat (all pass)
Measurement Results: Leq, SPL (maximum), SPL (minimum), Ln, PSD
Averaging: Integration and exponential ; from 3.9μs to 24,500 s
Trigger Source: SPL level, SPL event, external TTL
Intensity Mode (HP 3569A Option AY1) (other specs same as octave mode)
Frequency: Maximum span of 33 bands plus two overall bands
1/3 octave: 1.6 Hz to 10 kHz **Octave:** 2.0 Hz to 8 kHz
Indicator Accuracy: ±0.2 dB
Measurement Results: Active intensity; average sound-pressure level, P-I index, field indicator function (per ISO 9614-2)
Trigger Source: External TTL for start or gating
Narrowband Mode (HP 3560A and HP 3569A Option AY2)
Frequency: 100 to 1600 lines of resolution.
Baseband Spans: 50 Hz to 25.6 kHz (40 kHz for HP 3560A)
Digital Zoom Spans: 20 Hz to 10 kHz
Windows: Uniform, Hann, flat top, force/exponential
Measurement Results: Spectrum/SPL, power spectral density, time, differentiated time, frequency response, coherence, cross-correlation, cross-spectrum, intensity (HP 3569A)
Averaging: RMS, RMS exponential, peak hold, time
Reverberation Time Mode (Option AY3)
Computes reverberation time in octave or 1/3 octave bands by using Schroeder's reverse integration method to compute the decay times. Single channel; maximum bandwidth is 11.4 kHz; minimum integration time is 3.9μs.
Data Storage: Non-volatile RAM disk memory can store: (HP 3560A) up to 500 state/trace combinations of 200 line spectra. (HP 3569A) up to 3000 octave or 1000 1/3 octave spectra.
General
Power: Internal battery power; rechargeable during operation
Recharger: 100/120 or 220/240 Vac + 5%, –10%, 48 to 66 Hz
Size: 210 mm W x 300 mm H x 95 mm D (8.25 in x 11.75 in x 3.75 in)
Weight: Approximately: 3.2 kg (7 lbs)
Accessories Included: Battery, ac adapter, carrying case, SDF utilities

For more information, visit our website (http://www.tmo.hp.com/tmo/datasheets/English/HP3560A.html). (http://www.tmo.hp.com/tmo/datasheets/English/HP3569A.html).

Key Literature

HP 3560A Technical Data Sheet, p/n 5952-2990
HP 3569A Technical Data Sheet, p/n 5091-4805E
HP 3569A Configuration Guide, p/n 5962-7919E
HP 35639A Data Viewer Product Overview, p/n 5962-9499E
HP 35639A Data Viewer Demo Disk, p/n 5963-1834E
HP 35639A Data Viewer Demo Setup Inst., p/n 5963-1833E
Standard Data Format Utilities, p/n 5091-2945E
DSA Accessory Catalog, p/n 5964-8939E

Ordering Information

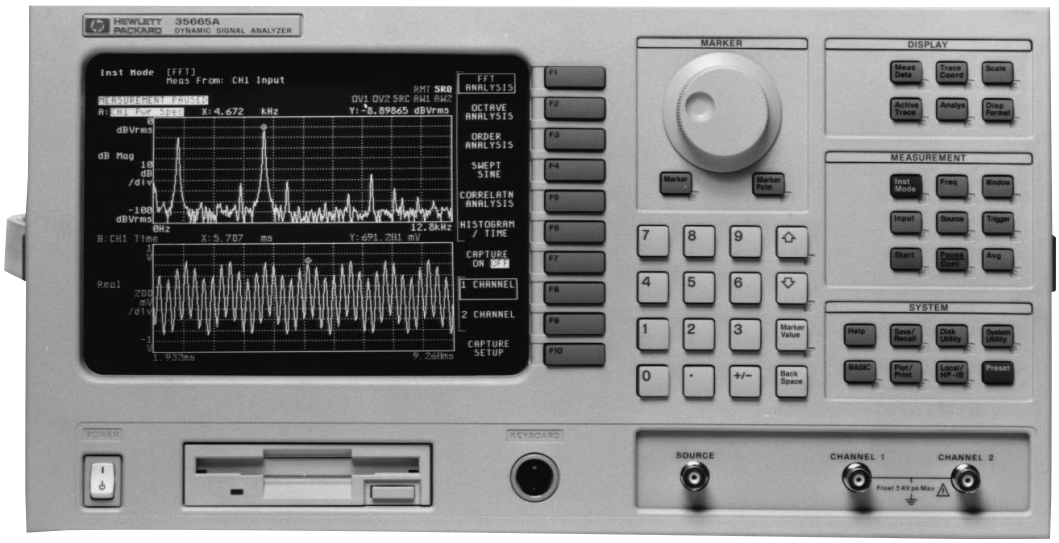
HP 3560A Portable Dynamic Signal Analyzer
HP 3569A Real-Time Frequency Analyzer
Opt AY1 Real-Time Intensity
Opt AY2 Narrowband FFT
Opt AY3 Reverberation Time
Opt 550 Data Transfer Utilities for PC

FFT Dynamic Signal Analyzers

Dual-Channel Dynamic Signal Analyzer

HP 35665A

- Network, spectrum, waveform, transient analysis
- Flexible option structure—buy only what you need
- Up to 6.4 MB deep transient capture (optional)
- HP Instrument BASIC (optional)
- 1.44 MB internal LIF/MS-DOS® disk drive
- Fast update rate for interactive measurements
- High-speed processing: 8 traces/s, 12.8 kHz real-time fast average
- Computed order tracking for more stable measurements (optional)
- 31.5 kHz real-time octave measurements (optional)
- Fast swept-sine measurements (optional)



HP 35665A

HP 35665A Dynamic Signal Analyzer

The HP 35665A is a flexible FFT-based analyzer that provides time, spectrum, network and amplitude domain measurements with a broad range of measurement options applicable in electronics, servo-mechanical and electronic control systems, machinery vibration, and general noise and vibration troubleshooting applications. The measurement options include:

- Computed order tracking measurements
- Real-time octave measurements (complies with ANSI S1.11-1986)
- Swept-sine measurements
- Curve fit/synthesis
- Arbitrary waveform source

Measurement options expand the electronic test capability of the standard HP 35665A into other application areas. With the addition of HP Instrument BASIC programs, even the most complex applications can be reduced to a single keystroke. The multi-faceted measurement modes of the HP 35665A have the measurement functionality of a spectrum analyzer, network analyzer, acoustic sound-level meter, acoustic intensity analyzer, vibration analyzer, audio oscilloscope and amplitude domain analyzer in a single package.

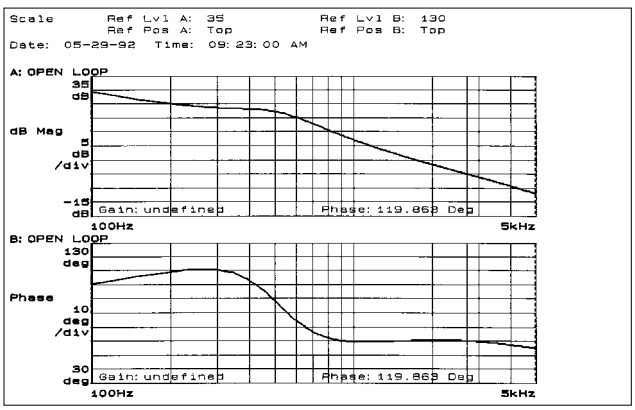
Add More Options as Your Needs Evolve

Your analysis requirements can change as test needs expand and change. The HP 35665A allows you to configure your own solution to meet both your test requirements and your budget. As your needs evolve, expanding the capability of your analyzer is as easy as ordering the firmware upgrade kit that you can install yourself. Any combination of measurement options is available, with no sacrifice in measurement speed.

Fast Swept-Sine and Broadband Control Systems Measurements

Swept-sine measurements typically offer higher signal-to-noise ratios, noise rejection and measurement accuracies than broadband techniques. The optional swept-sine measurements (Option 1D2) add this traditional measurement technique to the HP 35665A, but in an implementation that offers faster measurement results than before. Fast input auto-ranging during the measurement process increases dynamic range to greater than 130 dB.

Fast test time in production settings is even more critical with swept-sine tests since the instrument measurement time is usually the limiting factor in device throughput.



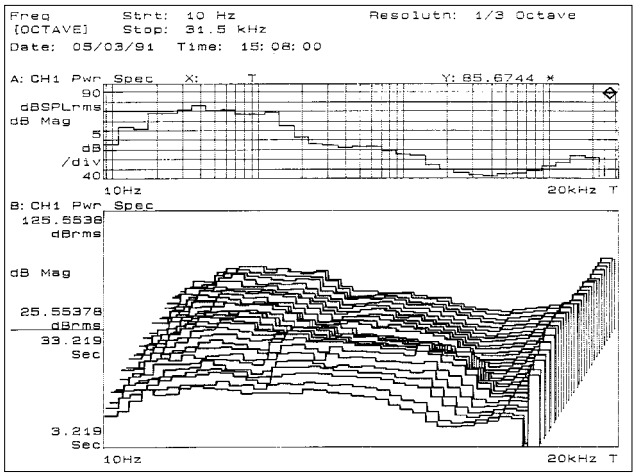
Advanced Modeling and Analysis Cut Design Time

The addition of curve fit and synthesis (Option 1D3) allows design engineers to measure real-life devices, compare the actual response to the design goals, model compensation circuits, and predict the end effect of the compensation circuits on the newly modified model. Curve fit and synthesis capability enhances design productivity by reducing the need to build prototypes and by simplifying the design optimization task.

Real-Time Octave for Compliance Testing

Real-time octave measurements (Option 1D1) provide continuous 1/1, 1/3 and 1/12 octave measurements per ANSI S1.11 (1986, order 3, type 1-D, extended and optional range), ANSI S1.4 and IEC 651-1979 type 0 impulse specifications. These high-performance measurements used to require separate real-time analyzers. Now these same high-performance measurements are available at a fraction of the cost of previous solutions.

MS-DOS® is a U.S. registered trademark of Microsoft Corp.



Computed Order Tracking Eases Machinery Analysis

The HP 35665A computed order tracking option (Option 1D0) adds Hewlett-Packard's order tracking capability to the HP 35665A. This algorithm digitally resamples the incoming signal resulting in extremely stable and repeatable order measurements that were not possible using analog ratio synthesis and filtering. In situations involving quickly varying and fast run-up tests, this option provides unprecedented stability. It is only available on HP measurement hardware.

The internal tachometer input provides a powerful and flexible triggering facility that virtually eliminates the need for external signal-shaping circuitry.

HP Instrument BASIC for Powerful Automation

HP Instrument BASIC (Option 1C2), a subset of HP BASIC, provides the test automation power of an external computer inside the HP 35665A. In production applications, HP Instrument BASIC, along with other production-oriented features, such as limit lines, enables the HP 35665A to control external HP-IB test equipment, like voltmeters and counters, address external peripherals, like disk drives, printers and plotters, and fully automate a production test procedure with custom graphics and interactive operator prompts.

HP Instrument BASIC is also useful in research and development and field applications. Complex test sequences can be recorded and simplified to a single key press. Tests can be repeated easily by operators not familiar with the measurement problem.

Measurements like electronic filter characterization (Q, 3 dB bandwidth, shape factor), acoustic intensity, Cepstrum displays, Hilbert Transforms and multi-plane balancing can also be derived using HP Instrument BASIC.

Specifications Summary

Frequency
- **Measurement Range:** 244 μHz to 102.4 kHz (1-channel mode); 122 μHz to 51.2 kHz (2-channel mode)
- **Spans:** 195.3 mHz to 102.4 kHz (1-channel mode); 97.6 mHz to 51.2 kHz (2-channel mode)
- **Measurement Resolution:** 100, 200, 400, and 800 lines
- **Frequency Resolution:** Frequency span/measurement resolution (minimum 244 μHz 1-channel mode; 122 μHz 2-channel mode)
- **Windows:** Hann, flat top, uniform, force, exponential

Amplitude
- **Range:** 3.99 mVpk to 31.7 Vpk, manual or auto
- **Accuracy:** ±2.92% (0.25dB) of reading ±0.025% of full scale
- **Dynamic Range:** 72 dB (FFT mode); 130 dB (swept-sine measurement mode); 80 dB (octave mode per ANSI S1.11-1986);
- **Noise:** <–130 dBV/$\sqrt{\text{Hz}}$ 160 Hz to 1.28 kHz <–140 dBV/$\sqrt{\text{Hz}}$ 1.28 kHz to 102.4 kHz
- **Single Channel Phase:** ±4.0 degrees relative to external trigger

Frequency Response Channel Match
- **Amplitude:** ±0.04 dB at full scale
- **Phase:** ±0.5 degree at full scale

Input Impedance: 1M Ω ±10% shunted by <100 pF
Coupling: ac, dc, ICP current source, engineering units, A-weight filter, integration and differentiation via math functions
Source Types: Fixed sine, random, chirp, burst random, pink noise, burst chirp, swept sine (Option 1D2), arbitrary waveform (Option 1D4)
Display Results: Frequency response, power spectrum, linear spectrum, coherence, cross spectrum, power spectral density, time, autocorrelation, cross-correlation, orbit (lissajous), histogram, PDF, CDF
Trace Types: Log magnitude, linear magnitude, dB magnitude, phase, real, imaginary, Nyquist, Bode, unwrapped phase
Trace Formats: Single, upper/lower, front/back, setup, waterfall, waterfall skew, grid on/off, display blanking
Update Rate: >8 traces per second
Transient Capture: Continuous (real-time) data recording to RAM
- **Maximum Rate:** 262,144 samples/s for 1-channel mode
- **Maximum Capture Length:** 1.2 Msamples (standard), 3.2 Msamples (Option ANA)

Saved Data and Measurement Memory: 2.4 MB (standard), 6.4 MB (Option ANA)

Option 1D0 Computed Order Tracking
Computed ratio synthesis, computed tracking filters
- **Displays:** Spectral map, order map, order track (mag + phase) or orbit
- **Trigger:** Time or RPM, external or free run
- **Tachometer Input:** 0.5 to 2048 pulses per revolution
- **Trigger Level:** ±20 V maximum, user-selectable level
- **Slope:** Positive or negative; User-selectable trigger holdoff

Option 1D1 Real-Time Octave Measurements (All frequencies in nominal band center frequencies)
- **Measurements:** 1/1 octave (full), 1/3 octave, 1/12 octave
- **Real-time Frequency Range:**
  1/1 octave measurements: 0.063 Hz to 16 kHz bands;
  1/3 octave measurements: 0.08 Hz to 31.5 kHz bands;
  1/12 octave measurements: 0.997 Hz to 12.34 kHz live measurements, 0.997 Hz to 49.35 kHz for post-processed time capture
- **Span:** 1 to 12 octaves—all modes

Option 1D2 Swept-Sine Measurements
- **Sweep Types:** Up, down, linear, log, manual
- **Input Ranging:** Fixed range, or auto-range during measurement
- **Resolution:** Selectable frequency resolution during measurement
- **Source Level Control:** Auto-level feature adjusts source level to maintain constant signal level at selected input channel

Option 1D3 Curve Fit/Synthesis
20 pole, 20 zero multiple degree of freedom curve fit, auto-order selection, user-selected pole/zero location with fit; table format: polynomial, pole/zero, partial fraction expansion

For more information, visit our website (http://www.tmo.hp.com/tmo/datasheets/English/HP35665A.html).

Key Literature

HP 35665A Technical Data Sheet, p/n 5091-2492E
HP 35665A Technical Data Sheet for Acoustics, p/n 5091-2296E
Standard Data Format Utilities, p/n 5091-2945E
DSA Accessory Catalog, p/n 5964-8939E

Ordering Information

HP 35665A Dual Channel Dynamic Signal Analyzer
- **Opt 1D0** Computed Order Tracking Measurements
- **Opt 1D1** Real-Time Octave Measurements
- **Opt 1D2** Swept-Sine Measurement
- **Opt 1D3** Curve Fit/Synthesis
- **Opt 1D4** Arbitrary Waveform Source
- **Opt 1C2** HP Instrument BASIC
- **Opt ANA** Increase RAM to 8 MB total
- **Opt 1F0** U.S. PC-Style Keyboard (other selected local keyboards are available)

Two- or Four-Channel Dynamic Signal Analyzer

HP 35670A

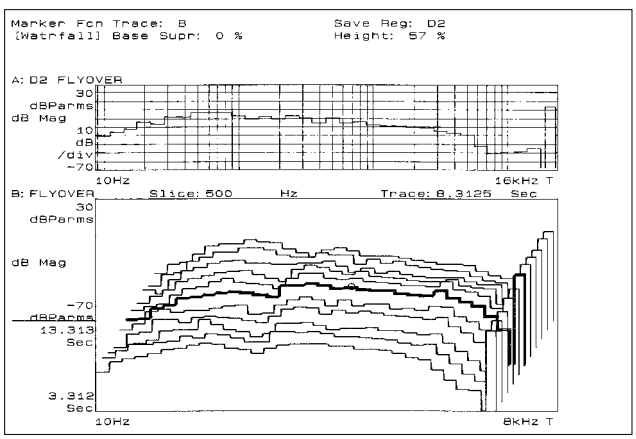
- Two or four channels (optional)
- Portable–fits under an airplane seat
- 1600 line frequency resolution
- Real-time octave analysis (optional)
- Computed order tracking (optional)
- 16-bit ADC/90 dB dynamic range (typical)
- 10 MB deep transient capture (optional)

HP 35670A Dynamic Signal Analyzer

The HP 35670A lets you make laboratory-quality measurements in the field—on an automobile test track, flying above a city, or in the narrow confines of a submarine. Small enough to fit under an airplane seat, the HP 35670A is a two- or four-channel (Option AY6), FFT-based spectrum/network analyzer. The standard instrument provides spectrum, network, time-domain, and amplitude-domain measurements from virtually dc to slightly over 100 kHz. Your ability to solve problems in the field is enhanced with the optional four-channel HP 35670A—measure noise at multiple locations inside vehicles, make triaxial vibration measurements, or gather data from several locations along a noise transmission path.

With the HP 35670A, you carry all your measurement and analysis tools in one package. Octave analysis (Option 1D1) adds real-time measurements of 1/1, 1/3, or 1/12 octave spectra at frequencies up to 40 kHz. Computed order tracking (Option 1D0) allows you to view spectra as a function of orders, or to view the amplitude of multiple orders as a function of RPM. Up to 8 MB of additional memory (Option AN2) provides deep transient time capture or extra space for up to four waterfalls of time- or frequency-domain data. An arbitrary source (Option 1D4) lets you test devices with real-life test signals. With HP Instrument BASIC (Option 1C2), you can automate measurements or customize your instrument interface. Everything you need to troubleshoot vibration and noise problems in the field is in one instrument. (You can retrofit all options—buy only the functionality you need today and add more as your needs change.)

A deep transient time capture memory can record up to four channels of data plus a tachometer signal for playback in the narrowband FFT, octave, order, correlation, or histogram instrument modes. Pre- and post-trigger delay functions let you capture the leading edge of one-time events or eliminate transmission delay in signals.



Real-Time Octave Analysis to 40 kHz (ANSI S1.11-1986)

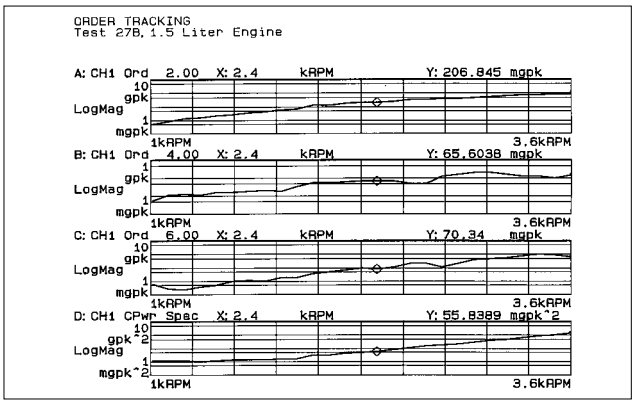
Octave analysis (Option 1D1) adds a real-time octave analyzer to your HP 35670A for analysis in 1/1-, 1/3-, or 1/12-octave bands. Four LEMO connectors with power for microphones are provided by the microphone adapter and power supply (Option UK4). The 1/1- and 1/3-octave band filters in the HP 35670A comply fully with ANSI S1.11-1986 (Order 3 Type 1-D), DIN 45651, and IEC 225-1966. An overall total power band and an A-weighted overall power band can be activated as needed. All three octave band modes and the overall power band can be A-weighted with an analog filter in full compliance with IEC 651-1979 Type 0. The overall power band can be redefined as a broadband impulse detector that complies with IEC 651-1979 Type 0. A fan-off mode eliminates instrument noise from measurements. A pink noise source allows you to evaluate electroacoustic devices.

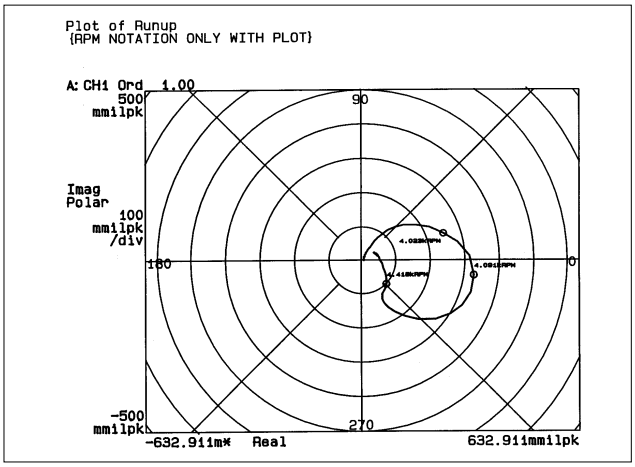
HP 35670A

View Spectra in the Order Domain (Option 1D0)

View spectra as a function of orders or track up to five orders on four channels simultaneously with computed order tracking (Option 1D0). Orders as high as 200 can be tracked. An order map can be displayed as a function of RPM or time, using the waterfall function. Waterfall markers let you view the track of any order.

Computed order tracking is ideal for troubleshooting rotating machinery. Run-up or run-down measurements can be displayed in bode or polar formats. Oscilloscope-quality orbit diagrams are another benefit. Because the data is resampled with changes in RPM, a single-loop orbit display is maintained as the shaft RPM is varied. With four channels (Option AY6), two orbits can be measured simultaneously—at both ends of a shaft, for instance. An RPM measurement readout, available in any instrument mode, aids in the interpretation of measurement data from rotating machinery.





Note: RPM annotation on plot only

Computed order tracking provides alias-protected measurements without expensive and cumbersome external ratio synthesizers and tracking filters. This new technique uses a digital tracking algorithm that follows rapid changes in shaft RPM without time delay and eliminates the phase noise normally associated with ratio synthesizer techniques. Accuracy is enhanced over traditional methods.

Swept-Sine for Broad Measurement Range (Option 1D2)

The swept-sine instrument mode expands the network analysis range of the HP 35670A to 130 dB. Higher noise rejection and accuracy are obtained by auto-ranging the instrument during the sweep. Automatic sweep resolution reduces measurement time without sacrificing accuracy. Alternatively, sweep resolution can be set by the user.

Advanced Modeling and Analysis Cut Design Time

Prototype revisions are reduced by modeling design modifications using curve fit and synthesis functions (Option 1D3). In a typical application, a model of the test device is created by curve fitting a frequency response measurement. Up to 20 poles and 20 zeros are used to describe the device; results can be output in pole/zero, pole/residue, or polynomial formats. The designer then transfers the circuit model to the synthesis function. Using synthesis, the model is modified by adding or deleting poles and zeros. The frequency response function of the modified model is then synthesized to test the design modification.

Automation Improves Productivity

HP Instrument BASIC (Option 1C2) replaces the external computer in small test systems. Like the computer, it can be used to automate measurements, create a custom user interface, synthesize new information from raw data, or control other instruments and peripherals. An optional external keyboard plugs into the rear panel. The HP 35670A provides direct control of external disks, plotters, and printers via HP-IB, RS-232, or parallel interfaces, and is fully programmable via the HP-IB.

Specifications Summary

Frequency Range

Channel mode	One	Two	Four
2 channel	102.4 kHz	51.2 kHz	—
4 channel	51.2 kHz*	51.2 kHz	25.6 kHz

Note: * A four-channel HP 35670A can be set to 102.4 kHz in a single channel mode by turning the anti-alias filter off.

Windows: Hann, flat top, uniform, force, and exponential
Amplitude
- **Range:** 3.99 mVpk to 31.7 Vpk, manual or auto
- **Accuracy:** ±2.92% (0.25dB) of reading ±0.025% of full scale
- **Dynamic Range:** 90 dB typical, 80 dB guaranteed (FFT mode) 130 dB (optional swept sine mode), 80 dB from 10 Hz to 20 KHz on 1 V range (optional octave mode per ANSI S1.11)
- **Noise:** <–130 dBV/√Hz 160 Hz to 1.28 kHz; <–140 dBV/√Hz 1.28 kHz to 102.4 kHz

Frequency Response Channel Match
- **Amplitude:** ±0.04 dB at full scale
- **Phase:** ±0.5 degree at full scale

Channels: 2 or 4 (Option AY6)
Channel Reference: 1 or 1 and 3 (Option AY6)
Input Impedance: 1 MΩ ±10% shunted by <90 pfd nominal
Coupling: DC, AC, and AC with ICP current source
Source Types: Fixed sine, random, chirp, burst, random, pink noise, burst chirp, swept-sine (Option 1D2), and arbitrary source (Option 1D4)
Source DC Offset: ±10 V, 1mV resolution from 0 to ±2 V, 5 mV resolution from ±2 V to ±10 V
Measurement Modes: Frequency response, power spectrum, linear spectrum, coherence, cross spectrum, power spectral density, time, windowed time, auto-correlation, cross-correlation, orbit (lissajous), histogram, PDF, CDF
Trace Types: Log magnitude, linear magnitude, dB magnitude, phase, real, imaginary, polar, Nyquist, Bode, unwrapped phase and group delay
Trace Formats: Single, upper/lower, quad, front/back, setup, waterfall, waterfall skew, grid on/off, display blanking
Update Rate: >9 traces/s maximum
Transient Capture: Continuous (real-time) data recording to RAM
- **Maximum Rate:** 262,144 samples/s for single channel mode
- **Maximum Capture Length:** 500 Ksamples (standard), 2.6 Msamples (Option AN2, add 4 MB), 4.7 Msamples (Option UFC, add 8 MB)

Saved Data and Measurement Memory: 1.2 MB (standard), 5.4 MB (Option AN2), or 9.6 MB (Option UFC)
Trigger: Free run, internal, or external
Option 1D0 Computed Order Tracking (computed ratio synthesis, computed tracking filters)
- **Displays:** Spectral map, order map, order track (mag and phase), and orbit
- **Trigger Arm:** Automatic, manual, RPM, time
- **Trigger:** Free run, source, HP-IB, channel, external
- **Tachometer Input:** 0.5 to 2048 pulses per revolution
- **Tachometer Level** ±20 V maximum, user-selectable level

Option 1D1 Real-Time Octave Measurements (all frequencies in nominal band center frequencies)
- **Measurements:** 1/1 octave, 1/3 octave, 1/12 octave

Real-Time Frequency Range

Channel mode	One	Two	Four
2 channel			
1/1 octave	16 kHz	8 kHz	—
1/3 octave	40 kHz	20 kHz	—
1/12 octave	12.3 kHz	6.2 kHz	—
4 channel			
1/1 octave	16 kHz	8 kHz	4 kHz
1/3 octave	40 kHz	20 kHz	10kHz
1/12 octave	12.3 kHz	6.2 kHz	3 kHz

- **Span:** 1 to 12 octaves–all modes

Option 1D2 Swept-Sine Measurements
- **Sweep Types:** Up, down, linear, log, manual
- **Input Ranging:** Fixed range, or auto-range during measurement
- **Resolution:** Selectable frequency resolution or auto-resolution during measurement
- **Source Level Control:** Auto-level feature adjusts source level to maintain constant signal level at selected input channel
- **Dynamic Range:** 130 dB

Option 1D3 Curve Fit/Synthesis
20 pole, 20 zero multiple degree of freedom curve fit, auto-order selection, user-selected pole/zero location with fit

For more information, visit our website (http://www.tmo.hp.com/tmo/datasheets/English/HP35670A.html).

Key Literature

HP 35670A Technical Data Sheet, p/n 5963-2341E
HP 35670A Product Overview, p/n 5963-2344E
DSA Accessory Catalog, p/n 5964-8939E
Standard Data Format p/n 5091-2945E

Ordering Information

HP 35670A Dynamic Signal Analyzer
- **Opt AY6** Add 2 Input Channels
- **Opt 1D0** Computed Order Tracking Measurements
- **Opt 1D1** Real-Time Octave Measurements
- **Opt UK4** Microphone Adaptor and Power Supply
- **Opt 1D2** Swept-Sine Measurements
- **Opt 1D3** Curve Fit/Synthesis
- **Opt 1D4** Arbitrary Waveform Source
- **Opt 1C2** HP Instrument BASIC
- **Opt AN2** Add 4 MB Memory
- **Opt UFC** Add 8 MB RAM
- **Opt UFF** Add 1 MB nonvolatile RAM
- **Opt 1F0** PC-Style Keyboard–USA
- **Opt 1F1** PC-Style Keyboard–German
- **Opt 1F3** PC-Style Keyboard–French
- **Opt 1F4** PC-Style Keyboard–U.K.

Accessories
HP 35250A DC Power Cable (3 meter)
HP 35251A DC Power Cable w/Cigaretter Lighter Adapter

HP 3566A

HP 3566A, 3567A Signal Analyzers

Up to 48 Channels of Time and Frequency Measurements

A rich measurement set makes the HP 3566A and 3567A excellent for mechanical test, signal characterization, control systems, rotating machinery analysis and production test where signals are below 102.4 kHz. These PC-based dynamic signal analyzers are configurable from 2 to 48 channels and use modular HP 3565S hardware to achieve high system performance. Since the HP 3566A and 3567A are Microsoft Windows applications, measurement results are easily shared with other Windows applications, such as spreadsheets and word processors.

The HP 3566A and 3567A have the same measurement feature set but differ in maximum frequency span and hardware configuration. Each analyzer includes a source for stimulating circuits or systems. An optional programmable DAC module adds arbitrary waveform and chirp capability. For fast measurement processing, a powerful hardware signal processor module converts time data to frequency domain data using FFT (Fast Fourier Transform) technology. If portability is important, the 4-slot HP 35650B mainframe and a portable PC make a very cost-effective multichannel system.

HP 3566A and 3567A Measurement Capability

Standard	Optional
Transient capture	Order tracking
Time display	Order ratio map
Synthesized 1/1 and 1/3 octave display	Order ratio spectrum
RPM spectral map	Swept-sine
Linear, power and cross spectrum	Filtered orbit diagram
Auto- and cross-correlation	Playback time capture
Coherence	Transient capture to SCSI disk
Frequency response gain/phase	Real-time 1/1, 1/3, 1/12 octave
Histogram (PDF, CDF)	

Hardware Setup Display Simplifies Multichannel Testing

The hardware setup mode shows information about the input channels, source, and DAC, in one place. Up to 16 channels of high update-rate monitors show time or frequency domain data and simplify transducer troubleshooting; waterfall and spectrogram displays show how signals change with time.

HP 35636A Order Tracking Software (Optional)

Distinguish order-related from other rotating machinery signals as you display accurate order-spectra independent of changing RPM. Patented HP technology shows digitally computed order ratio maps and order tracks, avoiding the problems of other methods. Optional HP 35658A tachometer/trigger module is recommended with this optional software, but is not required.

HP 35637A Swept-Sine Software (Optional)

Swept-sine techniques provide transfer functions with 132dB dynamic range by changing the source levels and input ranges for each frequency point measured. Auto-range, auto-level, and auto-resolution can dramatically reduce measurement setup times. Gain and phase margins are calculated just by pushing a button, simplifying control system analysis.

HP 35638A Real-Time Octave Software (Optional)

The optional 1/1, 1/3, and 1/12 octave software provides real-time 1/3 octave measurements on 2 channels at 20 kHz and 4 channels at 10 kHz. When used with data throughput to the optional SCSI disk, up to 20 channels at 20 kHz or 48 channels at 5 kHz are available.

DAC Provides Arbitrary Waveforms (Optional)

A programmable, 16-bit DAC, DAC editor, and waveform calculator allow custom waveforms to be created and used as stimulus. Captured transients can be played back through the DAC module while new measurements are run, recreating real-world stimulus.

High-Speed, Multichannel Transient Capture

A special transient capture mode allows very high-speed transient captures to signal processor RAM or to the optional SCSI disk. Simultaneously monitoring up to 16 channels while the throughput occurs helps prevent costly mistakes. Entire captures or portions can be selected for analysis using all HP 3566A and 3567A measurements except swept-sine.

Documentation of Results

A special Hardcopy Mode lets you document measurement results with up to 6 displays with annotation per page.

Prints and plots can be made to any Microsoft® Windows-supported graphics printer or HP-GL plotter (Centronics or RS-232 interface only). In addition, you can write reports using word processors and include HP 3566A and 3567A displays either by using Microsoft Windows "cut and paste" or by importing HP-GL plot files.

Create Custom Measurements Easily

A full-function waveform calculator lets you create custom measurements and integrate them into the standard user interface. Mathematical functions can be performed on any measurement result, and the result of the operations can be displayed using the full display functionality or output through the programmable DAC.

For more information, visit our website (http://www.tmo.hp.com/tmo/datasheets/English/HP3566A.html). (http://www.tmo.hp.com/tmo/datasheets/English/HP3567A.html).

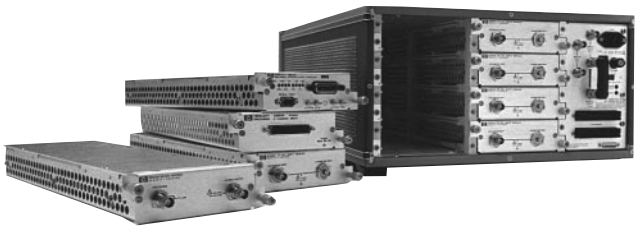
Key Literature

HP 3566A, 3567A Product Overview, p/n 5963-2340E
HP 3566A, 3567A Technical Specifications, p/n 5963-2343E
HP 3566A, 3567A Configuration Guide, p/n 5962-7080E
HP 3565S Technical Specifications, p/n 5963-2342E
HP 35639A Data Viewer Product Overview, p/n 5962-9499E

Ordering Information

HP 3566A/3567A Spectrum/Network Analyzers
Includes HP 35650A Mainframe, HP 35653C Source Module, HP 35651C Signal Processor, HP-IB cable, 1 year onsite hardware warranty, and HP 35634A time/frequency measurement software
HP3566A Spectrum/Network Analyzer
Includes 1 HP 35655A 8-channel, 12.6 kHz input
HP3567A Spectrum/Network Analyzer
Includes 2 HP 35652B 1-channel, 102.4 kHz inputs
- **Opt 005** Add 1 HP 35650A Mainframe
- **Opt 010** (HP 3566A only) Add 1 HP 35655A 8-Channel Input Module (maximum of 6 HP 35655A modules)
- **Opt 010** (HP 3567A only) Add 1 HP 35652B 1-Channel Input Module (maximum of 48 HP 35652B modules)
- **Opt 116** Convert HP 35651C RAM to 16 MB
- **Opt 054** Replace HP 35651C with 35654B DSP Module
- **Opt 056** Add HP 35656B Programmable DAC Module (required for chirp, arb, and record/playback)
- **Opt 050** Replace HP 35650A Mainframe with portable, 4-slot, non-expandable 35650B
- **Opt 058** Add 1 HP 35658A Tachometer/Trigger Module
- **Opt 059** Add HP 35659A SCSI Interface for External SCSI Disk (maximum is 1 HP 35659A)
- **Opt 060** Add HP 35659A SCSI Interface with Internal 2 GB Disk (maximum is 1 HP 35659A)

HP 35636A Order Tracking (optional software)
HP 35637A Swept Sine (optional software)
HP 35638A Real-Time Octave (optional software)
HP 35634A Software only for HP 3566A and 3567 (order only if you already have the hardware)



HP 3565S

HP 3565S Multichannel Measurement System

The modular HP 3565S system is optimized for fast signal acquisition and analysis, acting as a measurement co-processor to your UNIX workstation or DOS-based PC. Each system may have up to 496 input channels.

Applications Software

System software for the HP 3565S is available from HP (HP 3566A and 3567A), and many independent software vendors, such as: Leuven Measurement Systems, Structural Measurement Systems, m & p international, Structural Dynamics Research Corp., and Creare Inc.

Please refer to the HP VXI Channel Partner Solution Catalog for more information: (http://www.hp.com/go/vxichanpart).

System Mainframes

System mainframes provide power and interconnection for a system. Up to eight HP 35650A 8-slot mainframes may be connected in a system. The HP 35650B 4-slot mainframe is for use in single mainframe or portable systems.

Signal Processing and SCSI-Interface Modules

Each system needs one signal processing module to perform computation and control tasks. The HP 35651C signal processor comes with 4 MB of RAM and one MC 56002 DSP; the HP 35654B signal processor uses two MC56002 DSP, and has 4 MB of RAM. RAM may be optionally increased to 16 MB. The HP 35659A SCSI interface module provides high-speed digital recording of input data. There is an optional internal 2 GB SCSI hard drive available.

Signal and Tachometer/Trigger Input Modules

All analysis input channels are equipped with an anti-alias filter, ADC, digital filter, FIFO, and ICP supply. They are sampled simultaneously to maintain cross-channel phase match. Both the HP 35652A/B 1-channel input modules are equipped with BNC and charge-amp input connectors.

The HP 35655A is a 12.8 kHz, 8-channel input module. The HP 35658A tachometer/trigger module produces input for rotating machinery analysis and system trigger needs.

Source Modules

The HP 35653C 102.4 kHz source supplies a variety of signals for measurement stimulus and system calibration. Arbitrary stimulus with 16-bit resolution is available from the HP 35656B Programmable DAC.

For more information, visit our website (http://www.tmo.hp.com/tmo/datasheets/English/HP3565S.html).

Key Literature

HP 3565S Technical Specifications, p/n 5963-2342E

Ordering Information

HP 35650A 8-Slot Expandable Mainframe
HP 35650B 4-Slot Portable Mainframe
HP 35651C Signal Processing Module
HP 35652A 51.2 kHz 1-Channel 80-dB Input Module
HP 35652B 102.4 kHz 1-Channel 80-dB Input Module
HP 35653C 102.4 kHz Source Calibration Module
HP 35654B Advanced Signal Processing Module
HP 35655A 12.8-kHz, 8-Channel 72-dB Input Module
HP 35656B Programmable DAC Module
HP 35658A Tachometer/Trigger Input Module
HP 35659A SCSI Interface Module

VXI Measurement Platform for Mechanical and Acoustic Test

The HP E1433A 8-channel digitizer, E1432A 16-channel digitizer, and E1434A 4-channel arbitrary source provide both system excitation and digitization for the mechanical and acoustical tests common in the automotive and aerospace industries. The HP E1433A's 196-kSa/sec sample rate and onboard digital signal processing (DSP) boost total system performance while cutting system development time. The HP E1432A 16-channel 51.2 kSa/sec digitizer provides many of the same measurements and features as the E1433A, but at a lower sample rate and decreased cost. For system excitation, the HP E1434A arbitrary source provides multi-channel stimulus.

When combined with the existing HP E1562D/E/F SCSI data disk they form a comprehensive measurement platform for mechanical, acoustical, and electrical test. Now all functions necessary for these demanding applications: digitization, excitation, and highspeed data recording are available on an industry standard VXI hardware platform.

Minimize Complexity, Maximize Performance

The HP E1432A and E1433A simplify system integration by providing signal conditioning, filtering, digitization, and measurement computation, all in a single module. Built-in measurement computations such as FFTs and averaged power spectra off load work from the host computer, keeping it from becoming a computational bottleneck. The HP E1434A arbitrary source can playback continuous arbitrary wave forms, but also provides common test signals such as sine, random and burst random noise.

Software Support

Customers can develop their own custom software solutions using VXI *plug&play* drivers and common programming languages, or they can use Mathwork's Matlab or HP's VEE graphical programming environment. For turnkey software solutions, expect wide application support from the industry's leading third-party solution providers. Applications include rotating machinery analysis, modal analysis, acoustics, vibration control, and road simulation, as well as general-purpose multi-channel data acquisition and analysis.

Key Literature

HP E1432A, HP E1433A and HP E1434A Product Overview, p/n 5965-9834E
HP E1434A Technical Specifications, p/n 5963-9654E
HP E3243A Product Overview, p/n 5965-5224E
HP E1433A Technical Specifications, p/n 5963-9652E
HP E1432A Technical Specifications, p/n 5965-7193E
HP E1562D/E/F Product Overview, p/n 5965-6938E

Ordering Information

HP E1432A 16-Channel, 51.2 kSa/sec Digitizer + DSP
HP E1433A 8-Channel, 196 kSa/sec Digitizer + DSP
HP E1434A 4-Channel, 65 kSa/sec Arbitrary Source
HP E1562D VXI Data Disk, DAT and SCSI-2 Interface

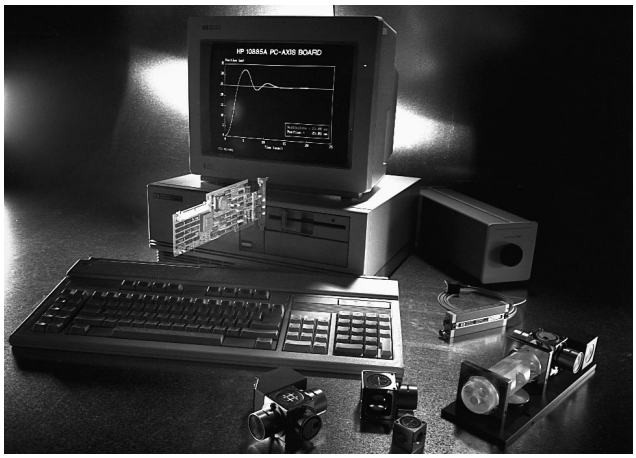
See VXI catalog for more details and additional modules.

For the latest information on HP's Data Acquisition products, see HP's website at: (http://www.hp.com/go/data_acq).

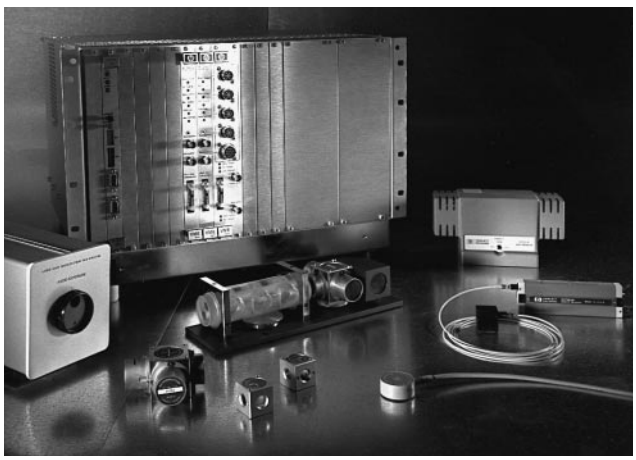
Laser Interferometer Positioning Systems

HP 5527B

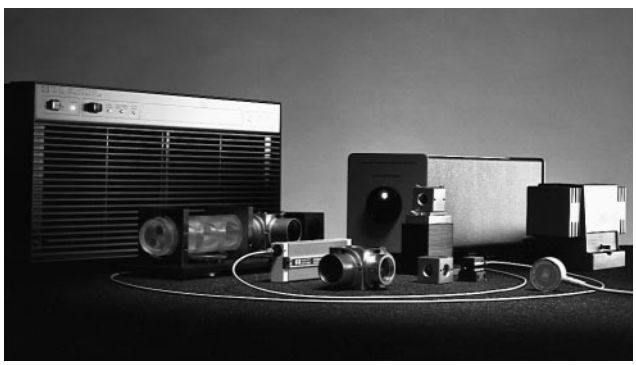
- PC-compatible and VMEbus electronics
- Resolutions to 0.3 nm, data rates to 10 MHz
- PC servo-axis board for closed-loop positioning
- Multiaxis measurements for greater control
- Wavelength-of-light compensation
- Remote sensing with fiber-optic receivers



PC-compatible laser interferometer electronics provide open- or closed-loop positioning and speed integration into the lowest-cost industry-standard backplane.



The HP 10897B High Resolution Laser Axis Board for VMEbus provides the highest position resolution commercially available and allows easy, cost-effective integration into this popular, 32-bit industry-standard backplane.



The HP 5527B Laser Interferometer Positioning System offers the greatest variety of output formats, including 32-bit position, servo-motor drive, and A-quad-B.

Precision Positioning Systems

Laser interferometer precision positioning systems—composed of electronic and optical components—provide very precise position or distance information for dimensional measurements and motion control. When built into manufacturing and inspection equipment, a laser interferometer system reports the position of a probe or controls the motion of a product platform with more accuracy than any other method.

Precision laser positioning systems improve product quality and reliability, increase manufacturing consistency for increased production yields, and allow the production of precision products that would otherwise be impossible to manufacture. Laser interferometer positioning systems are vital in many applications:

- Integrated-circuit fabrication, inspection, and repair
- Manufacture of high-capacity disk drives
- Precision machine tools
- Manufacture or calibration of other measurement scales
- Mechanical parts inspection/measurement
- Custom test and measurement
- Precise plotting
- Mechanical vibration analyis
- Antenna testing

Many of HP's innovations have resulted in products, such as digital programmable servo-control electronics for closed-loop positioning, that are unavailable from any other vendor.

System Components

Hewlett-Packard precision positioning systems combine Michelson interferometry with a two-frequency HeNe laser. HP's patented two-frequency design provides greater stability and reduced noise sensitivity, and extends the measurement range—up to 40 m (130 ft), or 80 m (260 ft) in certain circumstances. Three subsystems make up a laser interferometer system:

Laser: Supplies a monochromatic light source (or beam)
Optics: Directs the beam and generates the interference pattern
Electronics: Detects and counts the light and dark interference fringes, processes the data, and outputs distance information

HP offers the components needed to configure laser interferometer positioning systems for a broad range of applications and other requirements. All systems support the same laser sources, optics, and receivers and are primarily differentiated by the electronics.

Interferometer Electronics

HP interferometer electronics offer a choice of: backplane (interfacing characteristics), output formats, and environmental compensation options. Table 2 on page 550 summarizes the HP products based on these differentiators.

The HP product line offers interferometer electronics tailored for a variety of customer needs. For interfacing to industry-standard backplanes, the VMEbus provides a high-performance alternative and PC products provide the lowest-cost solution. Both are popular industry standards and offer system configuration flexibility. The proprietary HP 5527B offers a broader choice of output formats compared with the VMEbus and PC electronics.

Each of the electronics alternatives supports the complete range of lasers and optics. In addition, the HP 10780C receiver and HP 10780F remote receiver work with all electronics.

The new HP 10737L and 10737R Compact Three-Axis Interferometers improve positioning accuracy of lower-cost equipment too compact to use the HP 10735A or 10736A.

Optics

The optics tailor each interferometer system for the physical layout and measurement requirements of each application.
HP 10702A Linear Interferometer: The basic optic for linear measurements
HP 10706A/B Plane-Mirror Interferometers: Commonly used with multiaxis stages
HP 10716A High-Resolution Interferometer: A plane-mirror interferometer with twice the resolution of the HP 10706A/B
HP 10715A Differential Interferometer: A plane-mirror interferometer for differential measurements
HP 10705A Single-Beam Interferometer: Physically smaller for confined spaces or low-mass, non-contact measurements
HP 10719A, HP 10721A One- and Two-Axis Differential Interferometers: For optimized accuracy and repeatability with IC fabrication equipment; the position of the wafer stage is directly referenced to the optics column
HP 10735A, HP 10736A Three-Axis Interferometers: Can be used in pairs to make 5 precise measurements (x, y, pitch, roll, and yaw) simultaneously for IC fabrication
HP 10737L/R Compact Three-Axis Interferometers: Multiaxis measurements for precise control of smaller, lower-cost equipment

See Table 1 for a summary of HP reflector products and the configurations supported with HP optics.

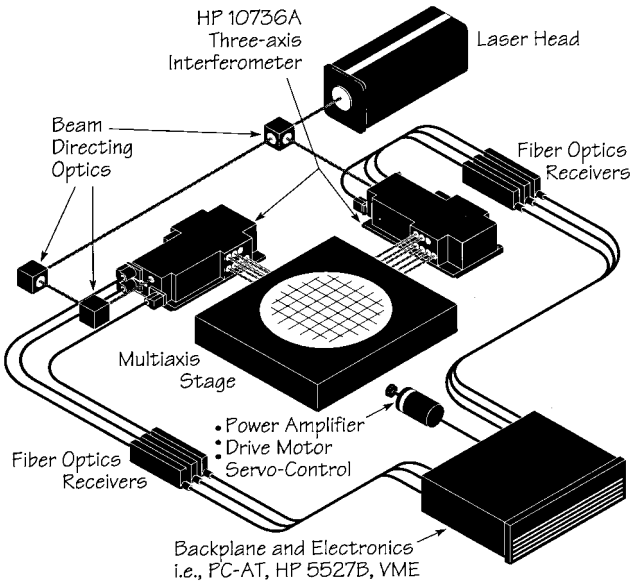
Laser Heads

Four laser heads are available for HP interferometer systems: the HP 5517A, 5517B (500-mm/second axis velocity for linear optics), 5517C (700 mm/second for linear optics), and 5517D (1000 mm/second for linear optics).

The total accuracy of an interferometer system is the sum of the errors from the laser head, the optics, and the effects of the environment. All HP laser heads have a vacuum wavelength accuracy of ±0.1 ppm. Option UK6, an NIST-traceable wavelength calibration service, is available. With this calibration, a laser's wavelength accuracy becomes ±0.02 ppm. HP laser heads have a demonstrated mean time between failure of greater than 50,000 hours.

Improving Accuracy and Repeatability

Maximum accuracy and repeatability require compensation for environmental conditions. The wavelength of light in air varies with the air's refractive index, which is a function of air temperature, pressure, and composition. In addition to the wavelength-of-light effects, errors can result from thermal expansion of the workpiece. To take full advantage of Hewlett-Packard's high-wavelength stability, the HP 10717A Wavelength Tracker compensates for changes in the air's refractive index. The HP 10780F Remote Receiver eliminates thermal effects due to the receiver electronics by using a remote, fiber-optic pickup. The HP 10896B, with wavelength-of-light compensation and material temperature measurement, increases accuracy and repeatability for VMEbus systems, and the HP 10886A provides these functions for PC-compatible systems. Product Note 5527A/B-2 (p/n 5952-7973) describes in detail how to achieve maximum accuracy and repeatability.



The HP 10735A and HP 10736A Three-Axis Interferometers offer greater accuracy for microlithography and other applications that require up to five degrees of freedom.

Table 1.

HP Reflectors and Interferometers: Supported Combinations

	Reflectors/Mirrors			
Interferometers	**HP 10703A, 10713B**	**HP 10704A, 10713C, D**	**HP 10724A**	**Custom Mirrors**
HP 10702A	•			
HP 10705A		•		
HP 10706A/B			•	•
HP 10716A			•	•
HP 10715A			•	•
HP 10719A, HP 10721A				•
HP 10735A, HP 10736A				•
HP 10737L/R			•	•

Key Literature

To configure and order an HP laser interferometer positioning system, please request the appropriate data sheets and ordering information from your local Hewlett-Packard sales office:

Introduction to Laser Systems Brochure, p/n 5091-2507E
Laser Head and Optics Technical Data Sheet, p/n 5091-0728E
PC Compatible Technical Data Sheet, p/n 5091-8435E
VMEbus Technical Data Sheet, p/n 5091-7575E
HP 5527B Technical Data Sheet, p/n 5091-2508E
Systems Ordering Information, p/n 5091-7651E

See the next page for information on laser system electronics.

Table 2.

Key Characteristics of HP Laser Interferometer Electronics

System	Backplane	Electronics	Output formats	Other differentiators
PC Compatible	ISA (PC/AT)	HP 10885A	32-bit digital (hardware output and backplane output)	Lowest-cost, most-popular, industry-standard backplane
		HP 10889B	Motor drive (in ±10 Vdc)	Servo-axis board Fast system development
		HP 10887B	32-bit digital	Part of HP 5529A calibration system
		HP 10887P	32-bit digital	Programmable version of HP 10887B
		HP 10886A	PC compensation board	Complete environmental compensation
VMEbus	VMEbus	HP 10895A	32-bit digital (hardware output and backplane output)	High-performance, robust, industry-standard 32-bit backplane
		HP 10897B	36-bit digital (hardware output and backplane output)	Highest resolution and data rate Fast system development
		HP 10896B	VME compensation board	Complete environmental compensation
HP 5527B	Proprietary	HP 5507B	32-bit digital, GPIO, HP-IB, motor drive (in ±10 Vdc, 16-bit digital, and pulse-width modulated), A-Quad-B, up/down pulse	High-performance, complete package Servo-axis board Fully compensated A-Quad-B for high-precision machine tools Complete environmental compensation

PC-Based Laser Interferometer Positioning System

The new HP 10889B PC servo-axis board is a programmable, digital servo with built-in motion control algorithms for closed-loop positioning that is compatible with the most popular PC backplane. Output is a ±10 V analog motor drive signal updated at 20 kHz. A trace function speeds and simplifies servo-loop characterization and tuning. The HP 10885A PC axis board provides a 32-bit digital, real-time position output via hardware, and position can also be read over the backplane. The HP 10886A PC compensation board increases accuracy and repeatability of systems using either the HP 10889B or HP 10885A by compensating for environmental conditions using HP environmental sensors. Combining the high performance of HP laser interferometers with the most popular, lowest-priced, industry-standard backplane speeds system development and reduces system costs.

VMEbus Laser Interferometer Positioning System

The HP 10897B high-resolution laser axis board provides the highest position resolution commercially available (up to 0.3 nm) at a 10 MHz rate for the most demanding applications. Position data is output in 36-bit format for very high performance closed-loop positioning systems. The HP 10895A laser axis board provides output in 32-bit format for typical applications. Both boards provide a hardware position output and also output position over the VMEbus backplane. The HP 10896B compensation board increases the accuracy and repeatability of systems using either the HP 10897B or 10895A by compensating for environmental conditions using HP or custom environmental sensors. All HP laser electronics for VMEbus are compatible with VME Rev. C.1 providing easy, cost-effective integration into VMEbus.

HP 5527B Laser Interferometer System

The HP 5527B can be configured for closed- or open-loop control, automatic compensation for environmental effects, and special prototyping abilities for custom electronics.

The HP 5507B system electronics for the HP 5527B combine superior perfomance with ease of use and full EMC compliance. The system is controlled with HP-IB, GPIO, or serial (RS-232). Five outputs are available depending on the boards used:

HP 10932B Axis Board: Open-loop measurements or position data for custom closed-loop positioning. Outputs are in 32-bit digital format, and are available directly and over HP-IB.

HP 10934A A-Quad-B Board: Provides high-resolution, A-Quad-B and Up/Down pulse outputs with full environmental compensation.

HP 10936B Servo-Axis Board: Closed-loop motor drive outputs for a range of motor amplifiers. Motor-drive outputs are ±10 V analog, 16-bit digital, or pulse-width modulated for precision positioning. The HP 10936B is a programmable digital servo with built-in motion control algorithms; custom algorithms can be downloaded. A trace function speeds and simplifies servo-loop characterization and position control.

HP 10941A Prototyping Board: Capabilities for custom electronic designs.

HP 10946C Automatic Compensation Board: With HP 10717A wavelength tracker and/or HP 10751A air sensor and HP 10757A material temperature sensor, automatically compensates for wavelength-of-light and material temperature effects.

System Specifications

	PC Compatible	VMEbus	HP 5527B
Accuracy			
Vacuum	0.1 ppm	0.1 ppm	0.1 ppm
Vacuum with MIL-STD-45662A	0.02 ppm	0.02 ppm	0.02 ppm
Maximum resolution			
Linear optics	5 nm	1.2 nm	10 nm
Plane mirror optics	2.5 nm	0.6 nm	5 nm
High-res. optics	1.2 nm	0.3 nm	2.5 nm
Maximum axis velocity			
Linear optics	1000 mm/s	1000 mm/s	700 mm/s
Plane mirror optics	500 mm/s	500 mm/s	350 mm/s
High-res. optics	250 mm/s	250 mm/s	175 mm/s
Maximum optical range	40 m	40 m	40 m
Maximum hardware data output rates			
Position/position error	3.0 MHz	10.0 MHz	3.0 MHz
A-Quad-B (transition rate)	N/A	N/A	5.2 MHz
Up-down pulse	N/A	N/A	5.2 MHz
Motor-drive	20 kHz	N/A	8 kHz
Environmental compensation	Yes	Yes	Yes

- Calibration of machine tools, CMMs, pick and place machines, robots, and machines with precision movement
- Comprehensive calibration
- Flexible triggering and parameter setting
- Minimum machine downtime with easy control through MS-Windows
- Graphical output provides conformance to seven international standards
- Complete localization in eight languages
- Customized compensation table enables improved performance

HP 5529A Dynamic Calibrator for Flexible, Comprehensive Calibration

The HP 5529A dynamic calibrator is a high-performance calibration tool for most equipment with precision movement. This calibrator minimizes downtime and enables conformance to international standards with its powerful measurement capability. The HP 5529A is a laser-based machine tool calibration system consisting of a laser head, optics, PC-based electronics, and Microsoft Windows®-based software that operates in an IBM-PC-style (ISA bus) computer.

Comprehensive Measurements

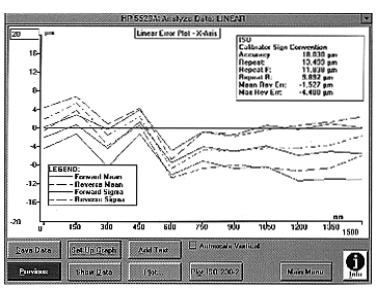
- Linear
- Angular
- Straightness
- Squareness
- Way straightness
- Parallelism
- Flatness
- Timebase
- Ballbar
- Diagonal
- Thermal drift
- 2-axis
- Rotary table

Flexible Triggering

- Manual
- Automatic
- A-Quad-B

Flexible Parameters

- Environmental compensation
- English/metric units
- 0 to 10 seconds averaging
- Measurement target lists
- CNC compensation table



Linear Plot Using ISO 230-2

Conform to Seven International Standards

Today's world market requires many manufacturers to conform with a specific international standard. The HP 5529A provides graphical output that shows your machines' conformance with seven international standards:

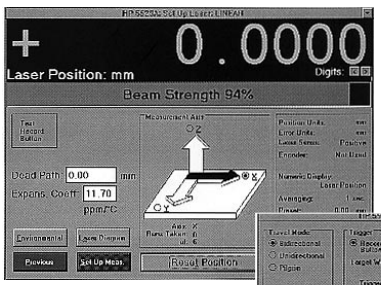
- ISO 230-2
- NMTBA
- ANSI B5.54
- BSI
- VDI
- JIS
- GB 10931-89

Internet URL **www.hp.com/go/tmc98**

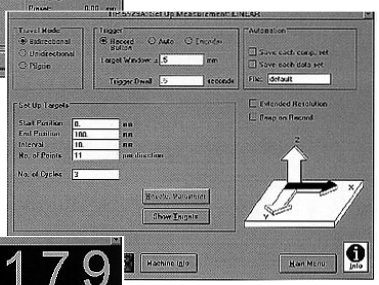
Minimize Machine Downtime

The HP 5529A is easy to control because of its simple-to-use Windows interface. Measurements are made in three steps: set up laser, set up measurement, then collect data. The standard user interface based on Windows provides in-depth help every step of the calibration, including detailed drawings showing the setup for each measurement.

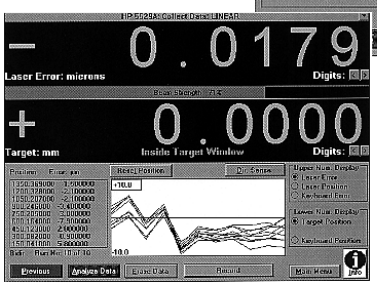
Training on the system is available at the HP factory, and HP consulting is available at your site.



Set Up Laser



Set Up Measurement



Collect Data

Available in Eight Languages

Complete documentation, control, and on-line help is available in eight languages:

- English
- French
- Spanish
- German
- Italian
- Japanese
- Chinese (PRC)
- Chinese (ROC)

Brief Specifications

Data Rate: Up to 33 kHz
Linear
Accuracy (range): ±0.02 ppm to ±3.0 ppm
Resolution: Down to 1 nm
Range: Up to 80 meters
Angular
Resolution: Down to 0.005 arc seconds
Range: ±20°

Key Literature

HP 5529A Brochure, p/n 5964-3568E
HP 5529A Price List, p/n 5964-6412E/EUS
HP 5529A Spec Sheet, p/n 5964-9307E

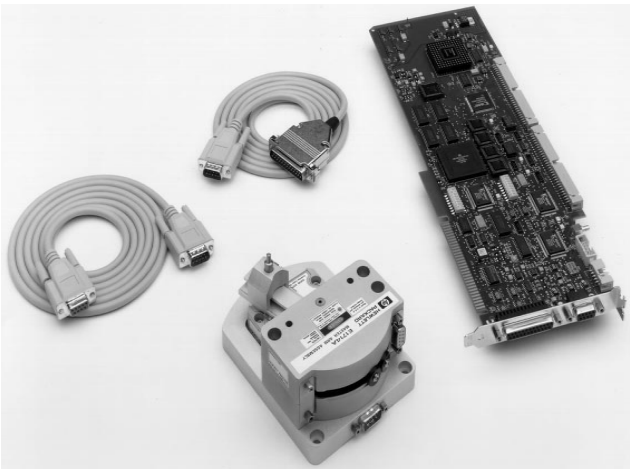
Ordering Information

HP 5529A Dynamic Calibrator

Product & Order Info **See inside back cover**

HP E1710A
HP E1720A

- Data Storage: Servo Writing, Spinstands, HGA Testers
- Dimensional metrology



Angular Encoder System (E1710A) with master arm assembly and mechanical pushpin

HP E1710A/E1720A Encoder Systems

The HP E1710A Angular and HP E1720A Linear Encoder Systems are PC-compatible sets of opto-mechanical and electronic components. They provide ultra-high resolution (16 nanoradians angular or 0.6 nm linear) measurements and servo-controlled positioning for use in dimensional metrology and motion control. They are compact, integrated solutions for precisely-controlled angular or linear positioning used in writing servotracks in the data storage industry. Individual components of the HP E1710A and HP E1720A systems are available if you wish to integrate specific HP E1710A or HP E1720A functions into systems of your own design. The HP E1710A is available with the HP E1710A Option 001 Master Arm Assembly. This combines a power amplifier, motor, arm and mechanical pushpin (HP E1710A Option 002) in an easy-to-use, integrated package.

Increase Storage Densities through Greater Track-to-Track Accuracy (10 nm)

The HP Encoder Systems are immune to turbulence created by spinning disks as well as from other changing conditions of the servotrack writing environment. This translates into superior track-to-track accuracy in measuring and controlling the drive arm.

Simplify Servo Designing Tasks with HP Electronics

14

Why spend valuable resources designing a custom servo capability when you can buy a cost-effective, easy-to-use electronics board from a leader in electronics for servotrack writing applications?

Leverage from Your HP 10889B Software Investment

For companies already familiar with HP 10889B Servo-Axis Board, the HP Encoder Systems make for an easy transition since most of the C functions used for the new HP Encoder Systems are the same as those used with the industry's popular HP 10889B.

Lower Your System Cost

HP Encoder Systems are designed for cost efficiency. They have few components, and there is no need for alignment if you purchase an HP factory-assembled and fully-tested system, including the master arm assembly. Their rugged construction provides long-term reliable performance.

Take Advantage of Hewlett-Packard's Worldwide Service and Support

Wherever your company's operations are in the world, such as Southeast Asia, Japan, Korea, China, Taiwan, North America or Europe, HP has offices staffed with local engineers and highly trained technicians. HP will meet your service and support needs quickly and efficiently as only local contacts can. You won't be left to fend for yourself if a problem or technical challenge should arise.

System Components

The HP E1710A and HP E1720A Encoder Systems consist of the components described below:

HP E1711A Sensor Head

The sensor head uses an infrared laser diode and interferometric technique to read the displacement of the scale relative to the sensor head. The lines on the scale are imaged onto a detector which at all times views and averages more than 10 radial markings. This results in highly linear measurements with relatively high immunity to dirt on the scale. The base of the sensor head has precisely machined holes for locating pins to facilitate accurate mounting in user-supplied hardware.

HP E1712A Scale (specify by option code)

The standard linear scale (Option 011) is on a glass plate 1.5 mm (0.059 in) thick. The standard angular scale (Option 038) is designed to be mounted so that the encoder markings are centered at a radius of 38.2 mm (1.504 in) measured from the axis of rotation. Registration marks are provided on the angular encoder to assist in accurately positioning it at the design radius.

HP E1713A Scale Servo Axis Board

This new 8-bit PC/AT-compatible board processes the signals from the sensor head to provide a 32-bit position word at a dedicated connector and on the ISA bus. The position word can be used to control either the onboard servo or a user-provided servo. The onboard servo runs a proportional-integral-differential (PID) or infinite-impulse-response (IIR) equation for a single measurement axis, and generates a ±10-volt output signal to either the servo amplifier and Voice Coil Motor (VCM) of the HP E1714A Master Arm Assembly, or a user-provided servo-amplifier motor. The servo axis board also has a provision for adding a 16-bit value to the control loop for systems using multiple inputs. The board comes with the following software: Tune Program, Demo Program, and a library of functions (ANSI C source code). The user's manual (HP E1710A Option 101) includes the procedure for setting the PID coefficients. (The firmware and software used for servo functions are based on those used with the HP 10889B Servo Axis Board.)

HP E1714A (HP E1710A Option 001) Master Arm Assembly (applies to angular system only)

This assembly is specifically designed for servotrack writing applications. It is provided with the HP E1712A Scale attached at the proper radius on the master arm. It contains a Voice Coil Motor and servo amplifier which drive the master arm over a range of ± 20 degrees. The master arm is provided with a high-quality bearing selected for very low runout and incorporates a dovetail for mounting the mechanical pushpin (HP E1710A Option 002) at any radius in the range of 15 mm to 55 mm. The base of the assembly has a provision for locating pins that mate with the locating holes on the HP E1711A Sensor Head, which reads the angular position of the master arm via the attached scale. The master arm housing is provided with a tapped hole and countersink which can be used with an auxiliary pin to align the axes of rotation of the master arm and the moveable arm of the hard disk assembly (HDA).

HP E1710A and HP E1720A Encoder Systems (Sensor Head, Scale and Servo Board)

	HP E1710A Angular Encoder	HP E1720A Linear Encoder
Repeatability	0.05 μrad	± 2 nm
System resolution (LSB)	16 nanoradians (8 nanoradians LSB)	0.6 nm (0.3 nm LSB)
Track-to-track accuracy	≤0.25 μrad (250 μrad span)	≤10 nm (9 μm span)
Long range accuracy	≤0.19%[3] (40 degree sweep)	±200 n[1]
Range	±20 degree[4]	150 mm range[4]
Sensor head dimensions	61 mm x 33 mm x 17 mm (2.40 in. x 1.30 in x 0.68 in.)	61 mm x 33 mm x 17 mm (2.40 in. x 1.30 in. x 0.68 in.)
Scale dimensions	30 mm x 7 mm x 1.5 mm (1.18 in. x 0.275 in. x 0.059 in.)	155 mm x 6 mm x 3.8 mm[4] (6.1 in. x 0.24 in. x 0.15 in.)
Operating temperature range	15° C to 40° C (59° F to 104° F)	15° C to 40° C (59° F to 104° F)
Velocity	22.2 radians/s	850 mm/s
Power requirements (via HP E1713A)	+5 Vdc @ 2 amps +12 Vdc @ 1.2 amps –12 Vdc @ 0.09 amp (with HP E1714A)	+5 Vdc @ 2 amps +12 Vdc @ 1.2 amps –12 Vdc @ 0.09 amp

[1] For angular system, scale radius –38.2 mm
[2] Power for HP E1711A Sensor Head and HP E1713A Servo Axis Card
[3] 0.19%=0.0004% (scale tolerance) + mounting eccentricity
[4] Contact factory for specific requirements

HP E1713A Scale Servo Axis Board

Motor Drive Output: ±10 volts with 0.3 mV resolution, updated at the sample rate. Programmable limit centered on zero volts.
Sample Rate: Up to 20 kHz (depends on equation used)
Hardware Position Output: 32-bit, updated at 400 kHz
Servo Equations: PID with feedforward or up to third order IIR
Data Age: 6.56 μsec (top connector)
Interface: Full size PC-compatible card. 8-bit ISA bus interface.

HP E1714A Master Arm Assembly

Track-to-Track Step and Settle Time:
5 msec typical for a 65 μrad step (2.5 μm step at R = 38.2 mm)
Servo Bandwidth: 200 Hz
Angular Range: ±20°
Mechanical Pushpin Radial Location Range: 15–55 mm
Operating Temperature: 0° C to 40° C (32° F to 104° F)
Torque: 0 –6V 0.0093 N–m/V; 6 –10V 0.056 N–m
Power Requirements: +12V @ 1 amp

Note: When ordered with the HP E1710A system, the master arm is ordered as HP E1710A Option 001.

Ordering Information

HP E1710A Angular Encoder Sytem
(38.2 mm radius scale is standard)
- **Opt 001** Add Master Arm Assembly
- **Opt 002** Add Mechanical Pushpin
- **Opt 030** Delete 38.2 mm Radius Scale
- **Opt 040** Delete Sensor Head Cable
- **Opt 050** Delete Servo Motor Cable
- **Opt 101** Add (English) User Manual and System Software

HP E1711A Sensor Head (Sensor Head Cable included)
- **Opt 040** Delete Sensor Head Cable
- **Opt 101** Add (English) User Manual (Software disk not included)

HP E1712A Scale (order with an option code)
- **Opt 011** Linear Scale
- **Opt 038** Angular Scale 38.2 mm Radius

HP E1713A Scale Servo Axis Board
- **Opt 101** Add (English) User Manual and System Software

HP E1714A Master Arm Assembly (with standard 38.2 mm scale included on arm)
- **Opt 002** Add Mechanical Pushpin (not installed)
- **Opt 050** Delete Servo Motor Cable
- **Opt 101** Add User (English) Manual (Software disk not included)

HP E1720A Linear Encoder System
- **Opt 040** Delete Sensor Head Cable
- **Opt 060** Delete Linear Scale
- **Opt 101** Add (English) User Manual and System Software

HP DAC1000 System

History and Applications

Hewlett-Packard has provided data acquisition solutions for over 25 years with early systems consisting of rackmounted multiplexing scanners and digital multimeters. Since the early 1970s these solutions have evolved into powerful modular data acquisition and control systems capable of providing not only a variety of analog and digital measurement capabilities, but also analog and digital control signal output for a wide variety of applications. Today, R&D test engineers use data acquisition and control systems to evaluate electromechanical product and process designs for industries supplying consumer, industrial, medical, and transportation products.

Measurements

One class of data acquisition systems is designed to measure static or slowly changing signals using multi-channel scanning analog-to-digital converter technologies. Other systems—usually, with only a few channels—measure dynamic (repetitive signals) or fast transients using high-speed digitizers with digital signal processing. Scanning measurements include the basic electrical quantities like voltage, resistance, and current. In some cases, sample-and-hold capability is available for modestly changing signals. Many of the measurements are sensor-based: temperature, strain, pressure, acceleration, acoustics and noise. Other measurements include frequency, event counts, and digital state. Some applications require a stimulus (or control) to the device being tested or the process being monitored. Typically, analog and digital output signals are available to control switches, valves, stepper motors, shaker table or ram for vibration and shock tests.

About this Section

Although products featured in this section are static data acquisition systems, it is not uncommon for applications requiring both static and dynamic measurement capabilities to be integrated together in a single system. HP's offering of dynamic measurement systems are featured in the FFT Dynamic Signal Analyzers section of this catalog.

HP's Data Acquisition and Control Products

HP's data acquisition and control offering includes:

Portable, small channel count:

- HP 34970A Data Acquisition/Switch Unit: For low cost data logging and system switching with precision 6.5-digit multimeter, temperature measurements with units conversion; up to 120 channels. Data logging software included.
- HP 75000 Series B (E1300A/01A mainframe-based) Portable/Remote Data Acquisition and Control System: VXIbus, high-speed 5.5-digit multimeter, temperature/strain measurements, dac, counter/timer, digital input/output; up to 112 channels.

High-performance, medium channel count:

- HP DAC1000 Multifunction Data Acquisition and Control System: VXIbus, sensors-based measurements with high-speed scanning a/d, analog signal conditioning, temperature/strain measurements with units conversion, counter/timer, dac, digital input/output, pulse with PWM, stepper motor control, up to 320 channels. HP VEE graphical programming language software.
- HP 75000 Series B (E1302A mainframe-based) Portable/Remote Data Acquisition and Control System: VXIbus, high-speed 5.5-digit multimeter with separate 16-channel multiplexers or precision 16-bit 32-channel scanning A/Ds, temperature/strain measurements, dac, counter/totalizer, digital input/output; up to 320 channels.

High-performance, large channel count:

- HP 75000 Series C Data Acquisition and Control System: VXIbus, high-speed scanning a/d, specialized high-speed measurement module with up to 32 PID control loops, analog signal conditioning, temperature/strain measurements with units conversion, counter/totalizer, dac, digital input/output, pulse with PWM, stepper motor control; up to 768 channels.
- HP 3852A Data Acquisition and Control System: Non-VXIbus (proprietary architecture), 40 measurement and control modules including digital multimeters, high-speed a/d, scanning switches, digital input/output, dac, counter/totalizer, stepper motor control; up to 216 channels.

More Information

For more information on the full line of HP VXIbus products, see the VXIbus Products section in this catalog. Also, request the HP System Builder's Source Book and CD, HP p/n 5965-8791E.

New: HP Data Acquisition Information On-line

For more information about HP data acquisition products, applications, and measurement technology, visit our website (http://www.hp.com/go/data_acq).

HP 34970A

- 3-slot data acquisition and switching mainframe
- 6½ digit (22 bit) internal DMM
- 8 switch and control plug-in modules
- HP BenchLink data logger software included

The HP 34970A shown with HP BenchLink Data Logger software

HP 34970A Data Acquisition/Switch Unit

The HP 34970A is a precision, low-cost data acquisition and switching mainframe ideal for data logging, data acquisition, and general-purpose switching and control applications. It consists of a half-rack mainframe with an internal 6½ digit (22 bit) digital multimeter. Three module slots are built into the rear of the unit to accept a combination of switch and control modules. Whether you need a few channels of simple data logging or a hundred channels of ATE performance, the HP 34970A meets your data acquisition needs at a price that meets your budget.

Measurements You Can Trust

The HP 34970A incorporates the measurement engine from our best-selling benchtop digital multimeter (DMM). You get the benefit of proven HP performance, universal inputs with built-in signal conditioning, and modular flexibility, all in a low-cost, compact data acquisition package. The HP 34970A features 6½ digits (22 bits) of resolution, 0.004% basic dcV accuracy, and ultra-low reading noise. Combine that with scan rates of up to 250 channels/sec, and you've got the speed and accuracy you need to get the job done.

Powerful Flexibility

The HP 34970A's unique design allows per-channel configurability for maximum flexibility and quick, easy setup. The internal autoranging DMM measures 11 different functions directly, eliminating the need for expensive external signal conditioning. Temperature conversion routines are built-in to display raw thermocouple, RTD, or thermistor inputs in degrees C, F, or Kelvin. Use Mx+B scaling to convert linear transducer outputs directly into engineering units. You can even set high/low alarm limits to warn you of out-of-tolerance conditions.

Custom Configurations That Grow with You

Three module slots and eight switch and control modules allow you to customize the HP 34970A to meet your unique requirements. Buy only what you need, and add more modules later as your application grows. Measure up to 120 inputs with a single half-rack unit.

Free HP BenchLink Software Simplifies Your Data Gathering

If you want PC-based data logging capabilities, but don't want to spend hours programming, HP BenchLink Data Logger is the answer. Use it to set up your test, acquire and archive measurement data, and perform real-time display and analysis of the incoming measurements.

A familiar spreadsheet environment makes it easy to configure and control your tests. A rich set of colorful graphics provides many options for displaying your data—all with point-and-click ease. Set up multiple graphics using strip charts, histograms, X-Y scatter charts, alarm lights and more. Also use HP BenchLink Data Logger to easily move data to other applications for further analysis, or for inclusion in your presentations and reports.

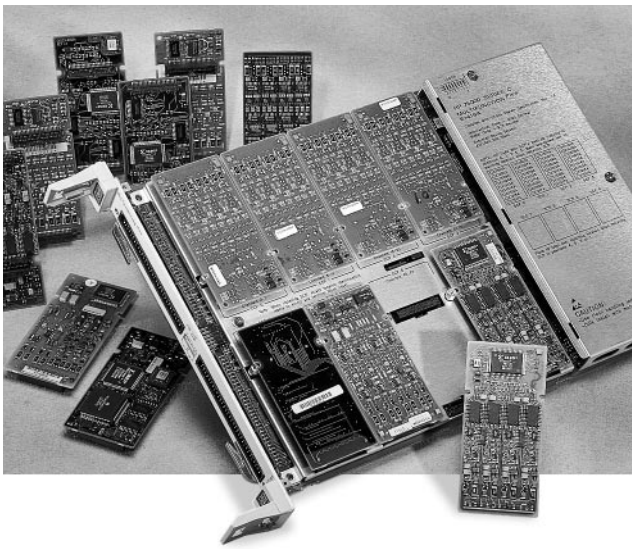
Ordering Information

HP 34970A Data Acquisition/Switch Unit
Includes internal 6½ digit DMM, operating and service manuals, test report, power cord, and quick start package (includes HP Benchlink Data Logger software, RS-232 cable, thermocouple, and screwdriver).
Opt 001 Delete Internal DMM
Same as above but deletes DMM and quick start package; order 34970-80010 to retrofit DMM at a later time
HP 34901A 20-Channel Armature Multiplexer
HP 34902A 16-Channel Reed Multiplexer
HP 34903A 20-Channel Actuator/General Purpose Switch
HP 34904A 4 x 8 Two-Wire Matrix Switch
HP 34905A 2 GHz Dual 4-Channel RF Multiplexer, 50 Ohms
HP 34906A 2 GHz Dual 4-Channel RF Multiplexer, 75 Ohms
HP 34907A Multifunction Module
HP 34908A 40-Channel Single-Ended Multiplexer
34970-80010 DMM Field Installation Kit

For more information on the HP 34970A Data Acquisition/Switch Unit, see page 554 of this catalog or refer to the HP 34970A Overview, HP p/n 5965-5290E.

For more information on-line, visit HP's data acquisition website (http://www.hp.com/go/data_acq).

HP DAC1000 System



HP E1419A and Family of SCPs

Data Acquisition and Control System with the New HP E1419A

NEW

The HP DAC1000 data acquisition and control system is a cost-effective solution for characterizing the designs of electromechanical products and monitoring and controlling critical manufacturing processes. This precision 16-bit scanning A/D and control unit—ideal for a variety of sensor-based and mixed-signal acquisition and control applications—is used to verify design of electromechanical assemblies and physical processes. The DAC1000 system measures temperature using thermocouples, RTDs, or thermistors and other physical parameters such as displacement and strain. It also measures dc volts, currents, resistances, pulse counts, frequencies, digital state, and more. With several output possibilities—analog voltage and current DACs, pulse generators with PWM, and digital output—the system can control switches, valves, stepper motors, and other electromechanical devices.

The HP DAC1000 combines the HP E1419A multifunction real-time measurement and control module, HP VEE 4.0 Visual Programming Language for Windows 95/NT, and the HP E1421B 6-slot VXI mainframe with HP-IB command module/PC interface. The HP E1419A offers breakthroughs in flexibility of configuring I/O functions, ease of programming, performance and accuracy, at a surprisingly low price in VXI. It provides nearly all the functionality of separate modular cards and multiple benchtop meters including multimeters, function generators, and counters, PLUS on-board intelligent measurement analysis and control—all on a single module. The HP E1419A employs small palm-sized signal conditioning plug-ons (SCPs). These SCPs provide not only a choice of signal conditioned inputs (gain, attenuation, filtering), but a variety of input/output functions such as counter, totalizer, DAC, pulse generator, and digital input/output.

HP's premier visual programming language, HP VEE for Windows 95/NT, is the recommended software development environment for HP DAC1000. It allows the test engineer to connect graphical "objects" in an easy-to-understand block diagram approach without writing lines of code. With HP VEE, users enjoy dramatic reductions in test development time over traditional programming methods. HP VEE handles the day-to-day tasks in instrument control, measurement processing and test reporting. Many HP VEE program utilities are provided to speed test development. Some of these include calibration, custom function generation, hot-swap running algorithms, variables and arrays updates during program runtime, and others.

More Information

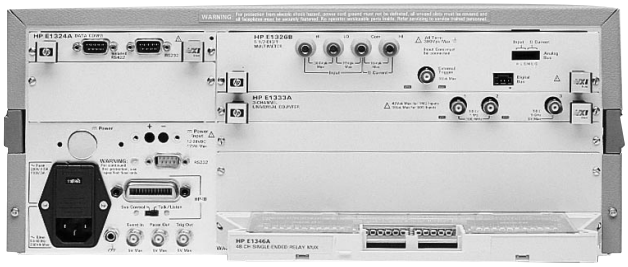
For more information, request HP DAC1000 Photo Card, HP p/n 5965-8641E, HP DAC1000 Product Note, HP p/n 5965-8642E, HP E1419A Technical Specifications, HP p/n 5965-8828E, and HP VEE Visual Programming Language Brochure, HP p/n 5965-6806EN. Additional information about HP VEE and VXI components of the HP DAC1000 may be found in the Test Software and Development Tools and the VXIbus Products sections in this catalog. For more information on-line, visit HP's data acquisition website at (http://www.hp.com/go/data_acq).

HP DAC1000 Base System Configuration

- HP E1419A with 32 input channels with X1 gain (HP E1501A SCP)**, 8 channels of analog voltage output (HP E1531A SCP), and 16 channels of digital I/O (HP E1533A)
- HP VEE 4.0 for Windows 95/NT
- HP E1421B 6-slot VXI Mainframe
- HP E1406A HP-IB Command Module and HP-IB Cable
- HP-IB PC Interface Card

**Note: The first four 8-channel SCP positions may only be configured with non-programmable voltage measurement SCPs. The second four 8-channel SCP positions allow both input and output.

HP 75000 Series B VXI–HP E1302A Mainframe



HP 75000 Series B VXI–HP E1300A Mainframe

HP 75000 Series B VXI Data Acquisition System: Portable/Remote

The HP 75000 Series B DACQ is a family of portable data acquisition systems. These VXI-based solutions are suited for low to medium point-count applications where temperature, strain, pressure, flow, digital I/O, voltage, resistance, and frequency measurements are required. These systems may be used in a number of electro-mechanical applications where physical data must be collected. These include material evaluation, energy research, process characterization, facility monitoring, environmental control, or remote station monitoring and control.

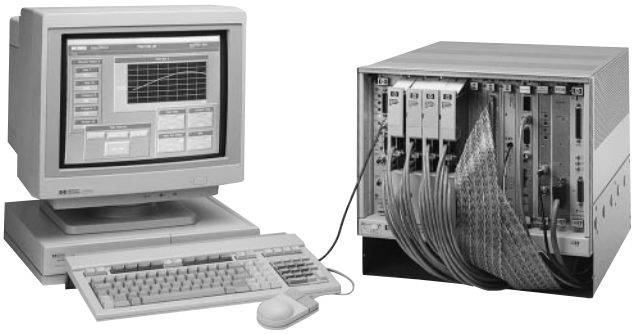
The HP E1300A/E1301A mainframes with built-in controller, optional interfaces, and battery backup, can perform remote, unattended measurements and download data via long distance phone lines to your host computer.

The HP E1302A 20-slot mainframe with HP E1306A command module may be configured as a standalone PC-based data acquisition system or integrated into a general-purpose HP-IB test system for switching applications. When combined with the HP E1313A scanning A/D, up to 64 channels per module may be scanned at a rate of 100 k-channels/s.

Ordering Information

VXI Mainframes
HP E1300A Mainframe with Blank Front Panel
HP E1301A Mainframe with Front Panel Keyboard
  Opt 009 Internal Multimeter
HP E1302A 20-Slot Mainframe
HP E1306A HP-IB Command Module

VXI Modules
HP E1313A 32/64-Channel Scanning A/D
HP E1328A 4-Channel D/A Converter
HP E1330B Quad 8-Bit Digital Input/Output
HP E1332A 4-Channel Counter/Totalizer
HP E1333A 3-Channel Universal Counter
HP E1345A 16-Channel Low-Offset Relay Mux
HP E1346A 48-Channel Single-Ended Relay Mux
HP E1347A 16-Channel T/C Low-Offset Relay Mux
HP E1351A 16-Channel Fet Multiplexer
HP E1352A 32-Channel Single-Ended Fet Mux
HP E1353A 16-Channel T/C Fet Mux
HP E1355A 8-Channel 120 Ohm Strain Relay Mux
HP E1356A 8-Channel 350 Ohm Strain Relay Mux
HP E1358A 8-Channel 350 Ohm Strain Fet Mux
HP E1364A 16-Channel Form C Switch



HP 75000 Series C VXI

HP 75000 Series C VXI Data Acquisition System: High-Performance

The HP 75000 Series C VXI data acquisition system products provide high-performance measurement, control, and computing capabilities that are well suited for solving major equipment, vehicle, and power system and many others—design problems. This data acquisition system is based on the HP E1413C high-performance scanning A/D, HP E1415A algorithmic closed-loop controller, new HP E1419A multifunction and control module, and the new HP E6237A real-time VXI computer or HP-UX controller.

All of HP's VXI scanning A/D and multifunction and control modules incorporate signal conditioning plug-ons (SCPs) for configuring the module for various measurement inputs and control outputs.

More Information

Refer to the VXIbus Products section of this catalog for prices, or request the HP System Builder's Source Book and CD, HP p/n 5965-5343E for more information on VXI Products.

For more information on-line, visit HP's data acquisition website at (http://www.hp.com/go/data_acq).

Measurement and Control VXI Modules

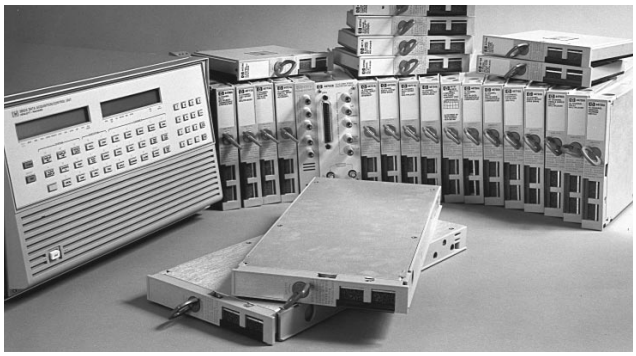
- **HP E1413C 64-Channel Scanning A/D:** This high-performance, 16-bit, 100 k-channels/s scanning A/D provides a variety of electrical and sensor-based measurements with signal conditioning (gain or attenuation and filtering). It is designed only for measurement tasks (i.e., no control outputs are available).
- **HP E1419A Multifunction Measurement and Control Module:** Similar in design to the HP E1413C, the HP E1419A is a 64-channel module with 32 channels dedicated only to non-programmable, fixed gain analog inputs. Its second 32 channels are configurable with programmable analog and digital inputs and outputs including counter, totalizer, analog output, and digital I/O for control of the device- or process-under-test. NEW
- **HP E1415A Algorithmic Closed Loop Controller:** This 64-channel module combines the technology of the HP E1413C scanning A/D with unrestricted SCP choices (configurations for analog or digital inputs/outputs). Specialized control of 1 to 32 PID or custom control loops is available with multiple input/output connections. Algorithms with math are programmable in C.

High-Speed Transient Measurement Products

- HP E1428A Digitizing Oscilloscope
- HP E1428A/B 20 MSa/s Digitizer
- HP E1430A 10 MSa/s 23 bit, A/D with Filter/Memory
- HP E1437A 20 MSa/s Digitizer with DSP

VXI Embedded Controllers (C-size)

- HP E6232A 133 MHz Intel Pentium
- HP E6233A 166 MHz Intel Pentium
- HP E6237A Pentium Real-Time NEW
- HP E1497A PA-RISC, HP-UX, 64 MHz
- HP E1498A PA-RISC, HP-UX, 100 MHz



HP 3852A Data Acquisition and Control System

You can easily configure an HP 3852A data acquisition and control system to measure physical parameters. The HP 3852A is set up to handle many different transducer inputs, including thermocouples, thermistors, RTDs, and strain gages, as well as measuring dc volts, currents, resistances, pulse counts, frequencies, and more. The HP 3852A mainframe has eight (8) slots for plug-in function modules, and has provisions for extending the mainframe (the HP3853A) for large systems requiring more plug-in cards.

High Speed and Accurate Analog in One System

Choose from three digital voltmeters to meet your measurement needs. The voltmeters can be used in the mainframe or extenders, with multiple voltmeters allowed in each mainframe.

Versatility and Expandability

With the HP 3852A you can choose from a complete set of input and output plug-in modules providing a variety of measurement and output-controlling capabilities.

Front End, Computer, and Software-System

The HP 3852A has built-in, 68000-based processing to increase the speed and effectiveness of the system and to collect, analyze, and respond to data. Control decisions are handled quickly using subroutines running within the mainframe (not having to communicate via HP-IB to an external computer in every case). This intelligence can be used to return only the most significant data to the computer, increasing its efficiency with other tasks. The power of this front-end intelligence, in combination with an HP 9000 computer and data acquisition software, adapts easily to testing your product or characterizing your processes. Or, if you prefer, you may configure your system to run with a PC as the host computer, incorporating the HP-VEE graphical programming language.

Ordering Information

To order, specify an HP 3852A system with the appropriate software, controller, mainframe, extenders, function modules, racks, and extra terminal modules. The HP 3852A itself has no cost—each component of the system is priced individually. ROM revision is in brackets. Please contact your local sales office for ROM upgrades, pricing, and information.

Mainframe
HP 3852A Data Acquisition and Control Unit
HP 44703B Mainframe Extended Memory Card–1MB, 2 MB, and 4 MB from Infotek Systems, 1045 S. East Street, Anaheim, CA 92805

Extender Chassis
HP 3853A Extender Chassis with 10 additional slots

Voltmeters
HP 44701A 5½- to 3½-Digit Integrating Voltmeter
HP 44703C High-Speed Extended Memory Card for expanding HP 44702A buffer to over 64,000 readings
HP 44704A 16-Bit High-Speed Voltmeter

Relay Multiplexers
HP 44705A 20-Channel Relay Multiplexer
HP 44705H 20-Channel High-Voltage Relay Multiplexer
HP 44706A 60-Channel Single-Ended Relay Multiplexer
HP 44708A 20-Channel Relay Multiplexer with Thermocouple Compensation
HP 44708H 20-Channel High-Voltage Relay Multiplexer with Thermocouple Compensation
HP 44717A 10-Bridge 120 Ω Static Strain Gage Relay Multiplexer [2.0]
HP 44718A 10-Bridge 350 Ω Static Strain Gage Relay Multiplexer [2.0]

FET Multiplexers
HP 44709A 20-Channel FET Multiplexer
HP 44710A 20-Channel FET Multiplexer with Thermocouple Compensation
HP 44711A 24-Channel High-Speed FET Multiplexer
HP 44711B 24-Channel High-Speed FET Multiplexer (use with HP 44704A)
HP 44712A 48-Channel High-Speed Single-Ended FET Multiplexer
HP 44713A 24-Channel High-Speed FET Multiplexer with Thermocouple Compensation
HP 44713B 24-Channel FET Multiplexer with Thermocouple Compensation
HP 44713A/B Opt 003 Anti-Noise Filter Option
HP 44719A 10-Bridge 120 Ω Static Strain Gage FET Multiplexer
HP 44720A 10-Bridge 350 Ω Static Strain Gage FET Multiplexer
HP 44730A 4-Channel Track/Hold Multiplexer with Signal Conditioning [3.5]
HP 44732A 4-Channel 120 Ω Dynamic Strain Gage Multiplexer
HP 44733A 4-Channel 350 Ω Dynamic Strain Gage Multiplexer

Solid State Relay Multiplexers
HP 44705F 20-Channel Solid State Multiplexer
HP 44708F 20-Channel Solid State Multiplexer T/C

Analog Outputs
HP 44726A 2-Channel Arbitrary Waveform DAC [3.5]
HP 44727A 4-Channel Voltage DAC
HP 44727B 4-Channel Current DAC
HP 44727C 2-Channel Voltage; 2-Channel Current DAC

Stepper Motor Controller
HP 44714A 3-Channel Stepper Motor Controller/ Pulse Output

Counter
HP 44715A 5-Channel Counter/Totalizer (200 kHz)

Digital Inputs/Outputs – Switching
HP 44721A 16-Channel Digital Input with Totalize and Interrupt
HP 44722A 8-Channel AC Digital Input with Totalize and Interrupt
HP 44723A 32-Channel High-Speed Digital Sense/Control [3.0]
HP 44724A 16-Channel Digital Output
HP 44725A 16-Channel General-Purpose Switch
HP 44728A 8-Channel Relay Actuator
HP 44729A 8-Channel Power Controller

Interfaces
HP 44788A HP-IB Controller
HP 44789A Serial Interface

Breadboard
HP 44736A Breadboard

Service and Support Products
HP 44743F Service Kit

*Only one extended memory option may be added per mainframe.

FFT Dynamic Signal Analyzers

DSA Accessory Catalog
5964-8939E
DSA Family Brochure
5091-5887E
Standard Data Format Utilities
5091-2945E
HP 3560A Technical Data Sheet
5952-2990E
HP 35639A Demo Disk Set-Up Instructions
5963-1833E
HP 35639A Data Viewer Demo Disk
5963-1834E
HP 35639A Data Viewer Product Overview
5962-9499E
HP 3566/67A Configuration Guide
5962-7080E
HP 3566/67A Technical Specifications
5963-2343E
HP 3566/67A Product Overview
5963-2340E
HP 3569A Configuration Guide
5962-7919E
HP 3569A Technical Data Sheet
5091-4805E
HP 35665A Technical Data Sheet
5091-2492E
HP 35665A Technical Data Sheet for Acoustics
5091-2296E
HP 35670A Dynamic Signal Analyzer Technical Specification Sheet
5963-2341E
HP 35670A Dynamic Signal Analyzer Product Overview
5963-2344E
HP 3565S Technical Data Sheet
5963-2342E
HP E1432A Technical Specification
5965-7193E
HP E1562D/E/F Technical Specifications
5965-6938E
HP E1862D/E/F Technical Specifications
5965-6938E

Dimensional Measurements

Introduction to Laser Systems Brochure
5091-2507E
PC Compatible Technical Data Sheet
5091-8435E
HP 5527B Technical Data Sheet
5091-2508E
HP 5529A Ordering Information
5091-4370EUS

(PN 5527A/B-1) Rapid Data Collection with the HP 5527A/B Laser Position Transducer System
5952-7947
(PN 5527A/B-2) Achieving Maximum Accuracy and Repeatability with the HP 5527A/B Laser Position Transducer System
5952-7973
(PN 5527A/B-3) Advanced Measurement Techniques Using the HP 5527A/B Laser Position Transducer System
5952-8020

Data Acquisition Systems

HP DAC1000 Data Acquisition and Control System
5965-8642E
HP 34790A Data Acquisition/Switch Unit, Product Overview
5965-5290EN

(PN E1415A) HP E1415A Algorithmic Closed Loop Controller
5965-3311E
(PN) HP E1413A/B/C, E1313A, and E1415A Recommended Wiring and Reduction Techniques
5965-1635E

Many of these literature pieces are available at:
http://www.hp.com/go/tmc98

This page has been
intentionally left blank

HP E3660A
HP E3905A
HP E3661A
HP E3662A

The Rack Solution for HP Systems

Hewlett-Packard offers 19-inch EIA (Electronics Industries Association) rack cabinets tailored to meet the needs of HP test and measurement instrumentation customers. Rackmounting is fast and easy with unique column and rail design features. A selection of options and accessories provides flexibility to meet the vast majority of racking applications.

Enhance Your Instrument Investment

HP racks are specifically designed for HP's test and measurement equipment, virtually ensuring a perfect fit. Designed for today's competitive environment, four heights are offered to accommodate any system: 1.1 m, 1.3 m, 1.6 m, and 2.0 m. All racks are deep enough to hold HP instruments of varying sizes.

The attractive exterior color and contemporary design coordinate with HP instrumentation. Standard with all racks are the top, side panels, solid base, anti-tip foot, 3-inch heavy-duty casters, one pair of System II rails, and lockable rear door. Delivery is based on customer requirements.

Load a Rack in Less Time

The design of HP columns and support rails can cut in half the time required to install equipment in a rack. The rails hang on discrete slots on the vertical mounting columns, corresponding to each EIA unit in the rack. Vertical adjustment between instruments is minimized by selecting the proper rail. The system was specifically designed to minimize the time required to install HP instrumentation and computers, and can be used with other equipment as well.

Rack Systems Fast and Easy

Racks are shipped already assembled, ready for immediate configuration. No time is lost assembling racks or tracking down missing parts.

More than just a way of storing instruments, the racks reflect HP's reputation for quality and design. A sturdy frame provides structural integrity, which allows lightweight, easy-to-lift off side panels for installation and easy access to equipment and cables. Rails are placed into keyed slots in the vertical columns, resulting in quick and accurate positioning.

Use Vertical Space Efficiently

Vertical space within a rack is measured in industry-standard EIA units, where 1 EIA unit = 1.75 inches (44.5 mm). Equipment height is often specified in EIA units.

Triangle cutouts on the front of the vertical columns show the top and bottom of each EIA unit and help assure proper placement of each instrument. Counting EIA units from the base of the rack is also easy since every fifth rail cutout is notched for easy counting. Other racks offer support rails that can be continuously adjusted vertically within a rack, which offers infinite adjustability, but can increase installation time.

Manage Power Requirements

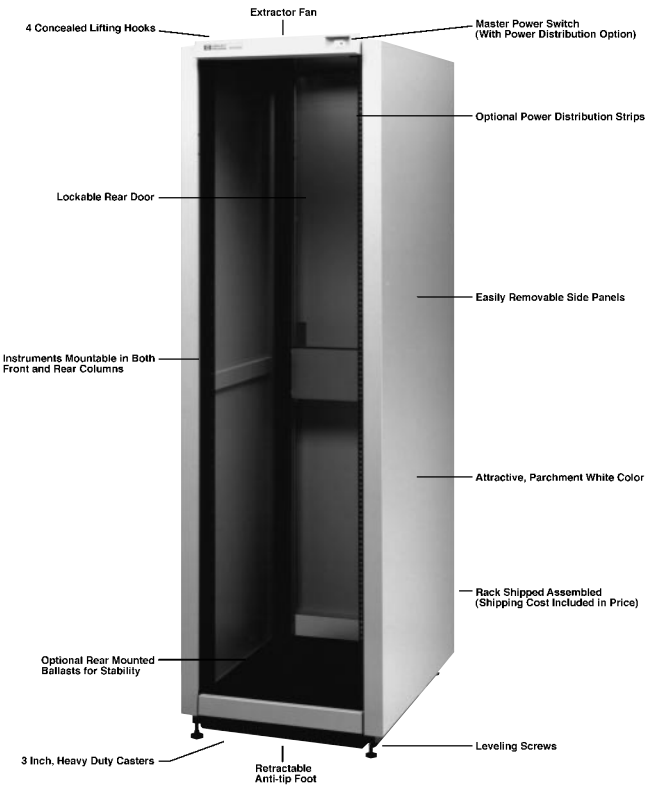
A power management system is available by selecting an optional power distribution unit (PDU) that is vertically mounted behind the rack rear column and supplies power to the cabinet. It is controlled by a single, illuminated master switch located on the front of the rack. This switch is included when power option is selected.[1]

Protect from Heat Buildup

System-generated heat is removed by natural convection through a ventilation path incorporated in the roof of the racks. For greater heat dissipation, an optional top-mounted extractor fan is available.

Secure Instruments During Test

Both the rear door and the optional Plexiglas front door can be locked to secure against disruption of tests or unauthorized removal of system components. The symmetrical door design allows it to be mounted for opening to either left or right, useful for multi-bay applications.



Move Racks Easily

Each rack is provided with four 3-inch diameter, smooth-rolling, heavy-duty casters to facilitate moving racks over short distances. Four lifting hooks conveniently concealed in the top of the rack allow for transport, even when fully loaded. Each hook can support 227 kg (500 lbs) to easily handle the maximum recommended gross weight for a loaded rack of 816 kg (1800 lbs).

Enhance Stability

A retractable anti-tip stabilizer that can be extended into place with ease is standard on all racks. It provides temporary anti-tip capability for slide-mounted products when they are in their extended position. Use the optional anti-tip ballast accessory when permanent anti-tip capability is desired.

Improve Cable Management

An additional 100 mm of internal space is available at the rear of the rack for installation of PDUs and as a convenient location for cables, which are routed out the bottom of the rack. The added rear space also enhances air flow.

HP Rack Options and Accessories

HP rack options and accessories provide configuration flexibility. To ensure the correct combination of options for each particular need, many options are designed to work together, such as a fan and a PDU.

[1] If a customer chooses to order a rack without the power option, the customer will receive the rack without the PDU and with a blank forehead bezel. A basic rack without the power options can be shipped to customers who want to develop their own power configuration. Racks ordered without the power option will be delivered to customers with a blank forehead bezel, which does not include a cut-out for the power switch. If a customer should decide to order a PDU in the future, that customer will have to order it with PDU Installation Kit (E4472A) and PDU as an accessory product number.

HP E3660A/E3905A/E3661A/E3662A Rack Specifications

	Height	Width	Depth	EIA units
E3660A				
Exterior	1120 mm (44.1 in.)	600 mm (23.6 in.)	905 mm (35.6 in.)	21
*Interior	933.45 mm (36.8 in.)	450.8 mm (17.8 in.)	851 mm (33.5 in.)	
E3905A				
Exterior	1320 mm (51.9 in.)	600 mm (23.6 in.)	905 mm (35.6 in.)	25
*Interior	1111.25 mm (43.8 in.)	450.8 mm (17.8 in.)	851 mm (33.5 in.)	
E3661A				
Exterior	1620 mm (63.8 in.)	600 mm (23.6 in.)	905 mm (35.6 in.)	32
*Interior	1422.5 mm (56.0 in.)	450.8 mm (17.8 in.)	851 mm (33.5 in.)	
E3662A				
Exterior	2020 mm (79.5 in.)	600 mm (23.6 in.)	905 mm (35.6 in.)	41
*Interior	1822.5 mm (71.8 in.)	450.8 mm (17.8 in.)	851 mm (33.5 in.)	

Front to rear column hole spacing: 610 mm (24 in.)
*Interior = EIA units = Rackmountable space

Weight

Rack:
E3660A 81 kg (179 lb) empty
E3905A 89 kg (196 lbs) empty
E3661A 100 kg (221 lbs) empty
E3662A 116 kg (255 lbs) empty

Casters Rating:
318 kg (700 lbs) each, 816 kg (1800 lbs) total

Lift Hook Rating:
227 kg (500 lbs) each

Total system and cabinet weight is a maximum 816 kg (1800 lbs) static. Lift cabinet using all four (4) hooks.
Ventilation: Vented top for HP E3660A, E3661A, E3662A, and E3905A

HP Rack System Design Guide
Full details and specifications are included in the *Rack Solutions Catalog* (HP p/n 5965-9759EN/5965-9759EUS)

Ordering Information

Racks
HP E3660A Rack, 1100 mm (1.1 m)
HP E3905A Rack, 1300 mm (1.3 m)
HP E3661A Rack, 1600 mm (1.6 m)
HP E3662A Rack, 2000 mm (2.0 m)
Opt AW3 100/120 V North America PDU
For 1.1 m and 1.3 m rack
For 1.6 m and 2.0 m rack
Opt AW5 200/240 V International PDU
For 1.1 m and 1.3 m rack
For 1.6 m and 2.0 m rack
Bare Rack: Each bare rack model includes 3-inch heavy duty casters, solid base with retractable anti-tip foot, vented top, lifting hooks under vented top, System II rail kit. (Please order rear door and side panel as accessories.)
HP E3661A Option AXH Bare Rack Cabinet, 1.6 meter (63.8 inches) high, 32 EIA units
HP E3662A Option AXH Bare Rack Cabinet, 2.0 meter (79.5 inches) high, 41 EIA units

Rear Doors
HP E4476A 1.6 meter Solid Rear Door Kit
HP E4477A 1.6 meter Vented Rear Door Kit
HP E4478A 2.0 meter Solid Rear Door Kit
HP E4479A 2.0 meter Vented Rear Door Kit

Side Panels
HP E4458A 1.6 meter Side Panel Kit
HP E4459A 2.0 meter Side Panel Kit

Extractor Fans
HP E4470A 100/120 V Top-Mounted Extractor Fan
HP E4471A 200/240 V Top-Mounted Extractor Fan

Additional PDUs
HP E4451A 100/120 V North America PDU for E3660A, E3905A
HP E4452A 200/240 V North America PDU for E3660A, E3905A
HP E4453A 200/240 V International PDU for E3660A, E3905A
HP E4455A 100/120 V North America PDU for E3661A, E3662A
HP E4456B 200/240 V North America PDU for E3661A, E3662A
HP E4457B 200/240 V International PDU for E3661A, E3662A
HP E4472A PDU Installation Kit
Order one for first PDU in cabinet (1.1 m, 1.3 m, 1.6 m or 2 m) but not along with options AW3 or AW5. Includes PDU mounting bracket and replacement forehead bezel for mounting power switch.

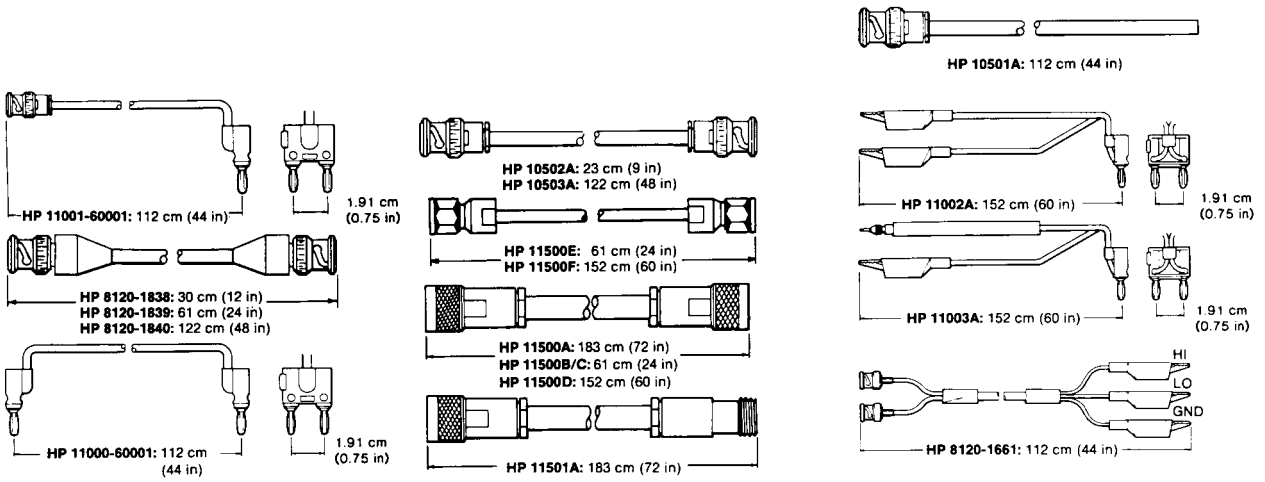
Lockable, Plexiglas Front Doors
HP E4460A 1.1 m Front Door for E3660A
HP E4461A 1.3 m Front Door for E3905A
HP E4462A 1.6 m Front Door for E3661A
HP E4463A 2.0 m Front Door for E3662A

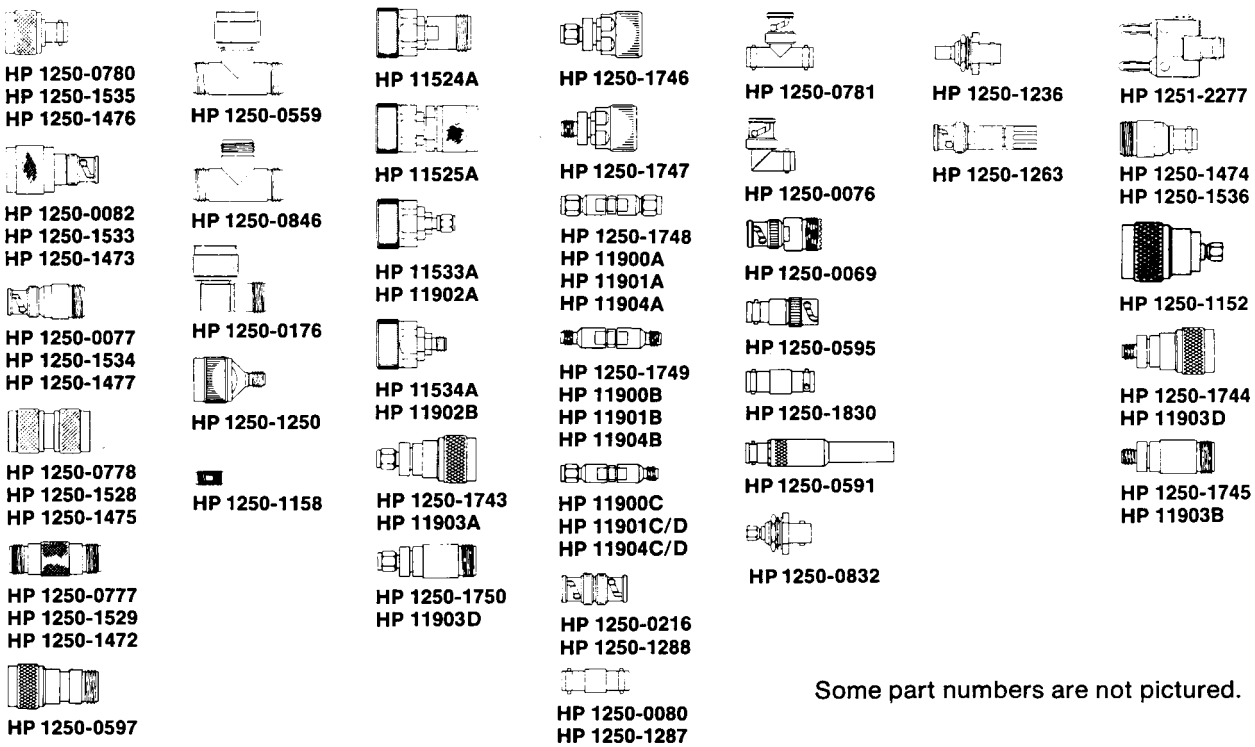
Tie-Together Kits
HP E4466A 1.1 m Tie Kit for E3660A
HP E4467A 1.3 m Tie Kit for E3905A
HP E4468A 1.6 m Tie Kit for E3661A
HP E4469A 2.0 m Tie Kit for E3662A

Accessories
HP E3663A Support Rail (HP System II)
HP E3664A Support Rail (Third-party products)
HP E3665A Support Rail (HP VXI)
HP E3666A Plain Shelf
HP E3900A Keyboard Rack Kit (fixed)
HP E4079A Retractable Keyboard Rack Kit
HP 35181C Drawer Unit (89 mm)
HP 35181G Drawer Unit (133 mm)
HP 46298R Mounting Hardware
HP 40101A 1-EIA Unit Filler Panel
HP 40102A 2-EIA Unit Filler Panel
HP 40103A 3-EIA Unit Filler Panel
HP 40104A 4-EIA Unit Filler Panel
HP 40105A 5-EIA Unit Filler Panel
HP 40106A 6-EIA Unit Filler Panel
HP 40107A 7-EIA Unit Filler Panel
HP E3668A Feedthrough Panel (plain)
HP E3669A Feedthrough Panel (BNC)
HP C2790A Ballast 14 kg (30 lb)
HP 35199A Vectra SPU Rackmount Kit (HP 12679B Rail Kit required) (QS20)
HP E3904A HP Vectra SPU Rackmount Kit (386S, 486S, 486U, 486XU)
HP E3906A Vectra 386N/486N SPU Rackmount Kit
HP E3909A HP Vectra Series VL, M, VE, VL3 Rackmount Kit
HP E5922A HP Universal Monitor Rackmount Kit
HP 5181-8707 IEC-320 Male Power Cable Replacement Plug
HP 8120-1575 IEC-320 Female-male Power Cables/ 720 mm (30 in) long
HP 8120-1860 IEC-320 Female-male Power Cables/ 1524 mm (60 in) long

For additional information, see the Rack Solutions Catalog, p/n 5965-9759EN/5965-9759EUS, or visit the Enclosures website (http://www.hp.com/go/enclosures).

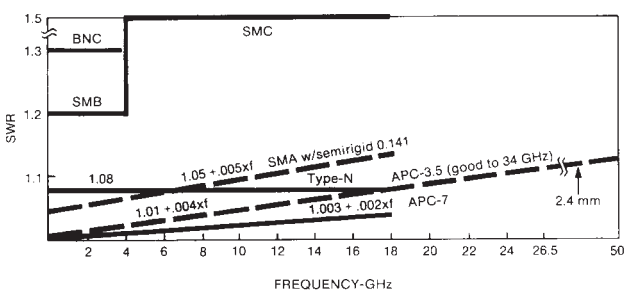
Cables, Adapters, and Typical SWR Performance





Some part numbers are not pictured.

Coaxial Connector and Adapter Performance



Typical SWR for connector pairs

The performance curves in the graph will help you in choosing and applying HP cables, connectors, and adapters. SWR curves show design specifications for mated pairs of connectors of the type indicated. You can expect typical performance in that range.

For cross-series adapters, use the curve with the highest SWR in each case. For applications of Tee-adapters such as HP 1250-0559, 1250-0846, and 1250-0781, be sure to consider the extra shunt capacitance of the Tee.

Of course, when HP mounts various connectors onto RF and microwave products, the product specification predominates and SWR is often far superior to that shown in these utility curves. For example, the HP "precision" type-N adapters shown on these pages are for high accuracy use dc to 1.3 GHz where SWR <1.03.

For more information on history and performance of various coax connectors, see HP's *Microwave Test Accessories Catalog* (p/n 5952-2843 (D)).

Ordering Information

Cable Assemblies

HP 10501A 112 cm 50 Ω Coax with One UG-88C/U BNC (m) Connector
HP 10502A 23 cm 50 Ω Coax with UG-88C/U BNC (m) Connector
HP 10503A Like HP 10502A, but 122 cm
HP 8120-1838 30 cm 50 Ω Coax with Two BNC (m) Connectors
HP 8120-1839 Like HP 8120-1838, but 61 cm
HP 8120-1840 Like HP 8120-1838, but 122 cm
HP 11000-60001 112 cm 50 Ω Coax with Dual Banana Plugs
HP 11001-60001 112 cm 50 Ω Coax, UG-88C/U BNC (m) to Dual Banana Plug
HP 11002A –OBSOLETE
HP 11003A Test Leads: 152 cm, Probe and Alligator Clip to Dual Banana Plug
HP 18182A 152 cm WECO 310 to 2 Alligator Clips
HP 92219Z Centronics Cable 1 M
HP 92224F Female Gender Converter
HP 92224M Male Gender Converter

HP model no.	Frequency range (GHz)	Length cm (in)	Connectors	SWR	Ins. loss (dB)
11500A	dc to 12.4	183 (72)	N(m) (2)	—	—
11500B	dc to 12.4	61 (24)	N(m) (2)	—	—
11501A	dc to 18	183 (72)	N(m)-N(f)	—	—
11500C	dc to 18	61 (24)	Precision N(m) (2)	1.4	1.5
11500D	dc to 18	152 (60)	Precision N(m) (2)	1.4	3.0
11500E	dc to 26.5	61 (24)	APC-3.5 (m) (2)	1.4	2.0
11500F	dc to 26.5	152 (60)	APC-3.5 (m) (2)	1.4	4.0

Adapters, 2.4 mm

(See page 564 for technical description and performance)
HP 11900A 2.4 mm (m) to 2.4 (m)
HP 11900B 2.4 mm (f) to 2.4 (f)
HP 11900C 2.4 mm (m) to 2.4 (f)
HP 11901A 2.4 mm (m) to APC-3.5 (m)
HP 11901B 2.4 mm (f) to APC-3.5 (f)
HP 11901C 2.4 mm (m) to APC-3.5 (f)
HP 11901D 2.4 mm (f) to APC-3.5 (m)
HP 11902A 2.4 mm (m) to APC-7
HP 11902B 2.4 mm (f) to APC-7
HP 11903A 2.4 mm (m) to Type N (m)
HP 11903B 2.4 mm (f) to Type N (f)
HP 11903C 2.4 mm (m) to Type N (f)
HP 11903D 2.4 mm (f) to Type N (m)
HP 11904A 2.4 mm (m) to K (m) [5]
HP 11904B 2.4 mm (f) to K (f) [5]
HP 11904C 2.4 mm (m) to K (f)
HP 11904D 2.4 mm (f) to K (m)

Adapters Type N, Standard 50 Ω

HP 1250-0077 N (f) to BNC (m)
HP 1250-0082 N (m) to BNC (m)
HP 1250-0176 N (m) to N (f) Right Angle (use < 12 GHz)
HP 1250-0559 N tee, (m)(f)(f)
HP 1250-0777 N (f) to N (f)
HP 1250-0778 N (m) to N (m)
HP 1250-0780 N (m) to BNC (f)
HP 1250-0846 N tee (f)(f)(f)
HP 1250-1250 N (m) to SMA (f)
HP 1250-1636 N (m) to SMA (m)

Adapters Type N, Precision 50 Ω [1]

HP 1250-1472 N (f) to N (f)
HP 1250-1473 N (m) to BNC (m)
HP 1250-1474 N (f) to BNC (f)
HP 1250-1475 N (m) to N (m)
HP 1250-1476 N (m) to BNC (f)
HP 1250-1477 N (f) to BNC (m)

Adapters Type N, Standard 75 Ω [2]

HP 1250-0597 N (m) (50 Ω) to N (f)(75 Ω)
HP 1250-1528 N (m) to N (m)
HP 1250-1529 N (f) to N (f)
HP 1250-1533 N (m) to BNC (m)
HP 1250-1534 N (f) to BNC (m)
HP 1250-1535 N (m) to BNC (f)
HP 1250-1536 N (f) to BNC (f)

Adapters APC-3.5

HP 1250-1743 APC-3.5 (m) to N (m)
HP 1250-1744 APC-3.5 (f) to N (m)
HP 1250-1745 APC-3.5 (f) to N (f)
HP 1250-1746 APC-3.5 (m) to APC-7
HP 1250-1747 APC-3.5 (f) to APC-7
HP 1250-1748 APC-3.5 (m) to APC-3.5 (m)
HP 1250-1749 APC-3.5 (f) to APC-3.5 (f)
HP 1250-1750 APC-3.5 (m) to N (f)

Adapters Subminiature, SMA

HP 1250-1158 SMA (f) to SMA (f)
HP 1250-1249 SMA Right Angle (m) (f)
HP 1250-1397 SMA Right Angle (m) (m)
HP 1250-1462 SMA (m) to SMA (f)
HP 1250-1698 SMA tee (m) (f) (f)
HP 1250-1787 SMA (m) to BNC (m)
HP 1250-2015 SMA (f) to BNC (m)

Adapters APC-7®

HP 11524A APC-7 to N (f)
HP 11525A APC-7 to N (m)
HP 11533A APC-7 to SMA (m)
HP 11534A APC-7 to SMA (f)

Adapters BNC, Standard 50 Ω

HP 1250-0069 BNC (m) to UHF (f)
HP 1250-0076 Right Angle BNC (UG-306/D)
HP 1250-0080 BNC (f) to BNC (f) (UG-914/U)
HP 1250-0216 BNC (m) to BNC (m)
HP 1250-0591 BNC (f) to WECO Video (m)
HP 1250-0595 BNC (f) to BNC Triaxial (m)
HP 1250-0781 BNC tee (m) (f) (f)
HP 1250-1263 BNC (m) to Single Banana Plug
HP 10110B BNC (m) to Dual Banana Plug
HP 1250-1830 BNC (f) to BNC Triaxial (f)
HP 1251-2277 BNC (f) to Dual Banana Plug
HP 1250-1236 BNC (f) to SMB (f)

Adapters BNC, Standard 75 Ω [3]

HP 1250-1287 BNC (f) to BNC (f)
HP 1250-1288 BNC (m) to BNC (m)

Adapters Subminiature, SMB, SMC [4]

HP 1250-0674 SMB (m) to SMA (f)
HP 1250-0832 SMC (f) to BNC (f)
HP 1250-1391 SMB tee (f) (m) (m)
HP 1250-1857 SMB (f) to BNC (m)
HP 1250-1152 SMC (f) to N (m)

[1] "Precision": typically ≥36 dB return loss to 1.3 GHz
[2] Type N outer conductor; center pin sized for 75 Ω characteristic
[3] BNC outer conductor; center pin sized for 75 Ω characteristic
[4] SMB and SMC are used often inside HP instruments for intermodule RF connections. SMB is snap-on configuration; SMC is screw-on configuration.
[5] The K-connector is developed and manufactured by the Wiltron Co., Morgan Hill, California.

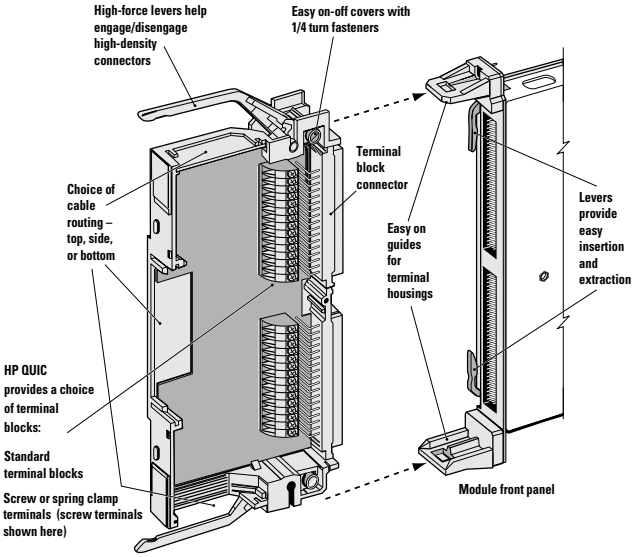
APC-7® is a registered trademark of the Bunker Ramo Corporation.

15

Flexible Wiring via Terminal Blocks

HP provides terminal blocks standard with all low-frequency multiplexer, matrix, general-purpose switch modules and scanning voltmeters. Several of the C-size modules have terminal blocks which incorporate HP's new HP QUIC (Quality Insertion and Connection). The HP QUIC terminal block provides you a convenient method of wiring to your application as shown in the accompanying illustration. A terminal block with screw or push-in spring-clamp terminals is provided as standard with HP QUIC-equipped VXI modules. HP QUIC also provides easy-in/easy-out levers and guides on the front panel to assure terminal block alignment when attaching the terminal block to the front panel of an instrument/switch module.

Note: Terminal block housings on HP QUIC-equipped C-size modules do not fit on older (pre-QUIC) modules and vice versa. Older versions of the terminal blocks (connector housings) will continue to be available for existing systems.



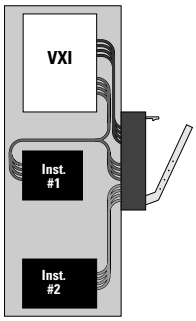
Rackmount Terminal Panel

- 96 terminals (32 3-wire channels)
- Built-in strain relief
- Includes pinouts and access to probe points
- System connections through 50-pin SCSI connectors
- Internal reference junction for 32 thermocouple channels

The HP E1586A Terminal Panel gives you maximum flexibility in configuring system wiring and interface solutions. In addition to the convenience of easy access for troubleshooting, the rackmount terminal panel gives you the flexibility you need to take advantage of money-saving wiring alternatives when system components are located at a distance from your mainframe. Within the Terminal Panel, the isothermal reference junction provides an internal reference junction for up to 32-wire thermocouple channels. The rackmount design provides easy access to the thermocouples for control and monitoring of distributed environmental temperatures, temperature control applications, and temperature control in material processing.

There are two different interconnect cables available from HP for connecting the HP E1586A Rackmount Terminal Panel to VXIbus modules with Option A3F. In both cases, two cables are required if all 32 channels are required. The standard cable is a 16-channel Twisted Pair Cable with an outer shield. This cable is suitable for relatively short cable runs. The second option is a 16-channel Twisted Pair Cable with each twisted pair individually shielded to provide better quality shielding for longer cable runs.

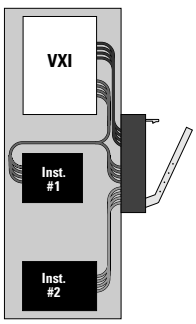
Optional RF filters on the terminal panel input channels filter out AC common-mode signals present in the cable connecting the terminal panel and the device under test. These filters are useful for filtering out small common mode signals below 5 Vp-p.



Rackmount ICA, High Density (21 slots)

HP 9420A Interface Connector Assembly (ICA)

Use this version of the HP 75000 System Resource Interface when:
- A significant portion of ICA connections are not wired directly to a single VXI mainframe
- Density and power requirements do not exceed 4,032 general-purpose pins and 250 Vac, 30 A per pin
- Visibility of VXI plug-in modules is required
- Significant cable area is required behind interface

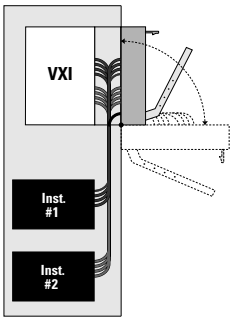


Rackmount ICA, Low Density (10 slots)

HP 34592A HP Quick Interconnect System

Use this version of the HP 75000 System Resource Interface when:
- A significant portion of ICA connections are not wired directly to a single VXI mainframe
- Density and power requirements do not exceed 960 general-purpose pins and 250 Vac, 3 A per pin
- Visibility of VXI plug-in modules is required

Please refer to the HP System Builder's Source Book and CD, p/n 5965-8791E, for additional configuration and product ordering information. Also, see the VXIbus Products, HP 75000 VXIbus Family section of this catalog.



Hinged ICA, High Density (21 slots)

HP E3722A Hinged Interface Connector Assembly (H/ICA)

Use this version of the HP 75000 System Resource Interface when:
- The majority of ICA connections are wired directly to VXI plug-in modules in a single VXI mainframe
- Up to 4,032 general-purpose pins and 250 Vac and 30 A per pin are required
- Wiring is flexible enough to bend when the fixture is closed
- Reduced access and visibility to VXI plug-in

Testmobile Carts

Testmobile Carts for Transportable Testing

HP 1180B
HP 1181A
HP 1182A

Shown left to right: the HP 1182A, HP 1181A, and HP 1180B testmobiles—the HP cart family

Specifications for HP Testmobile Carts

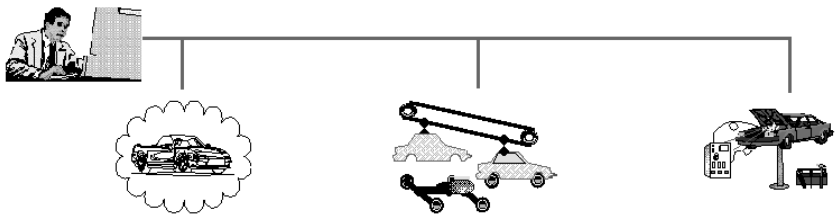
	HP 1180B	HP 1182A	HP 1181A
Testmobile Description	Scope cart	Instrument cart	System cart
Capabilities			
Tilt tray load	29.5 kg (65 lb)	68.0 kg (150 lb)	90.7 kg (200 lb)
Total load	59.0 kg (130 lb)	158.8 kg (350 lb)	226.8 kg (500 lb)
Cart net weight	18.1 kg (40 lb)	25.9 kg (57 lb)	39.0 kg (86 lb)
Size			
Tilt tray	457 mm x 457 mm (18 in x 18 in)	508 mm x 610 mm (20 in x 24 in)	559 mm x 660 mm (22 in x 26 in)
Height	721 mm (28.4 in)	721 mm (28.4 in)	721 mm (28.4 in)
Width	475 mm (18.7 in)	516 mm (20.3 in)	566 mm (22.3 in)
Depth	508 mm (20.0 in)	686 mm (27 in)	737 mm (29 in)
Vertical rack space*	N/A	N/A	533 mm (21 in)
Cart Selection Criteria			
Max. instrument depth	432 mm (17 in)	508 mm (20 in)	635 mm (25 in)
Host Products (examples)			
HP 1660, HP 1650, HP 1630	Yes	N/A	N/A
HP 54200, HP 54500	Yes	N/A	N/A
HP 8560, HP 8590 Series	N/A	Yes	N/A
HP 8720, HP 8750 Series	N/A	Yes	N/A
HP 16500B, HP 16501A, HP 8566B	N/A	N/A	Yes
HP 8703A, HP 8703B, HP 35600	N/A	N/A	Yes
HP Workstations, VXI, 70,000, 71,000	N/A	N/A	Yes
Accessories			
HP 35183A Work Surface	Yes	N/A	N/A
HP 35181A Printer/Plotter Stand	N/A	Yes	Yes
HP 35181B Keyboard Shelf	N/A	N/A	Yes
HP 35181C 89 mm (3½ in)-high Storage Drawer	N/A	N/A	Yes
HP 35181D Work Surface (533 x 305 mm)	N/A	Yes	Yes
HP 35181E Antistatic Mat for 35181D	N/A	Yes	Yes
HP 35181G 133 mm (5¼ in) Storage Drawer	N/A	N/A	Yes
HP 35182A 89 mm (3½ in)-high Storage Drawer, Support Shelf	N/A	Yes	N/A
HP 35182B 133 mm (5¼ in)-high Storage Drawer, Support Shelf	N/A	Yes	N/A
HP 5181-8723 Support Shelf, Drawer Cover	N/A	N/A	Yes
HP 5957-8476 Support Rails for Rackmounting	N/A	N/A	Yes
HP 92199B Power Strip (U.S.) (5 receptacles)	Yes	Yes	Yes
HP 92199E Power Strip (IEC 320) (4 receptacles)	Yes	Yes	Yes
International use of 92199E requires one or more of the cable assemblies below:			
HP 8120-1575 Cable, 762 mm (30 in)			
HP 8120-1860 Cable, 1.5 m (60 in)			
HP 8120-2191 Cable, 1.5 m (60 in) with Right-angle Plug			
HP 5181-8707 IEC-320 Male Power Cable Replacement Plug			

*Note: Vertical rack space is reduced the more the tilt tray is angled.

For additional information see the Rack Solutions Catalog, p/n 5965-9759EN/5965-9759EUS, or visit the Enclosures website (http:www.hp.com/go/enclosures).

HP can help vehicle makers and suppliers by:
- helping you make vehicles more reliable and affordable.
- helping you create more consumer conveniences in cars.
- helping you make cars that meet government regulations for emissions and safety.

HP's Automotive Solutions



Design/Development
- Data Acquisition
- Engine Emulation
- Powertrain Development
- Collision Avoidance/ Radar Test
- NVH Analysis
- ECU Development Tools

Manufacturing
- PCB X-ray inspection
- In-Circuit Board Test
- ECM Functional Test
- Vehicle assembly test
- Test integration
- Test management outsourcing

Service
- Diagnostic solutions
- Electronic Parts Catalogs
- Technical Info Systems
- Customer service solutions

With HP's 50 years of experience in electronics, we have helped many industries apply measurement, computation and communication technologies to their business. Today, HP is helping the automotive industry to work faster, cheaper and with more agility to meet the competitive and regulatory challenges of the industry. HP provides important tools for use in each phase of a vehicle's lifecycle — from design to manufacturing to service.

Design and Development

HP can help reduce time-to-market and increase engineering productivity with proven solutions for design and development teams. Information from the measurement data gathered by various systems is fed back to the design team to improve your designs.

Noise, Vibration, Harshness (NVH) and Acoustics Measurements

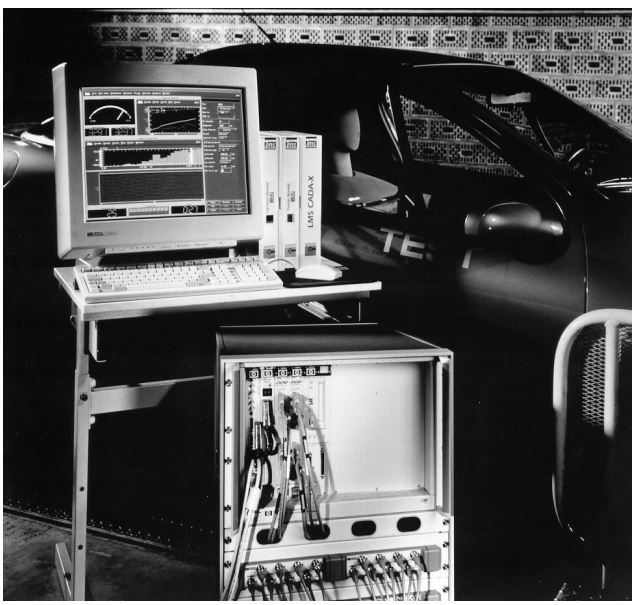
To create specific driving sensations requires mechanical systems engineering that involves thousands of design decisions from information on a variety of physical parameters, such as stress, vibration, temperature and noise. This better information lets you improve product and process quality to advance your competitive position in the world markets.

HP has industry-standard products and test-consulting resources to provide the solution. For example, HP's E1432A and E1433A are VXI-based digitizers used in electrical, mechanical and acoustical tests.The new HP E1434A 4-channel Arbitrary Source Module adds programmable outputs to your measurement system. If you have the skills and the time to integrate your own custom solutions, HP will provide the tools and platforms. Or, HP has a worldwide network of specialists, including Channel Partners, that are innovative software developers known for their application expertise.

Vehicle Data Acquisition

HP's B-size or C-size VXI Data Acquisitions Systems measure precise physical parameters, including vehicle speed and acceleration, wheel speed, brake system pressures, brake pedal force, and vehicle temperatures. Therefore, you can improve designs of vehicle bodies, subsystems and components. Applications include: bumpers, axles, engine mounts, ABS, traction control, semi-active suspension, climate control, cooling system characterization, heater valve testing, and many more.

The HP E1313A is a B-size 1 slot, VXI module and a key component to a VXI-based data acquisition system. It can easily be configured to gather data during the design and development of vehicles. The HP E1313A includes 64 channels of high speed data acquisition.



Powertrain Development

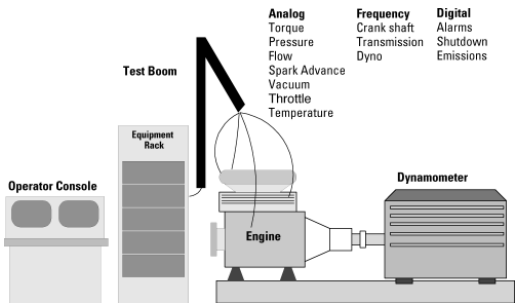
The design verification tools (hardware and software) are used by auto manufacturers and powertrain electronic control unit (ECU) suppliers to develop the software that runs in the vehicle's on-board computer system and operates the engine and transmission systems. The tools perform rapid prototyping, simulation and calibration of vehicle control modules to streamline development and ensure high quality while improving cost efficiency.

When combined with HP's engine emulation, logic analyzer, and distributed processor emulation products, the new tool suite provides a complete, independent development workbench, optimized for both efficiency and standardization in powertrain controller design verification.

As an independent supplier of design verification tools, HP allows automakers and powertrain ECU suppliers to concentrate design resources on the end product instead of on tool development.

Powertrain Development Test

HP has developed a high-performance measurement, control, and computing platform that is well-suited to powertrain test problems. Since designing and building a dynamometer cell for testing new powertrain design involves more than test equipment, HP collaborates with experts in this business. Using high-performance equipment, these HP Channel Partners work with the automotive test engineers to design and implement an optimum test solution.



Collision Avoidance and Radar Testing

Many changes in vehicles, including collision avoidance and telemetry systems are being driven by customer demands. Government and regulatory agencies require testing of these devices and HP's unique experience in rf and microwave applications is available to transportation companies. HP can design and build test systems for collision avoidance radar, keyless entry and other rf communication systems using standard measurement technology and customization.

For designing vehicles, HP offers advanced engineering workstations that can be integrated with electrical and mechanical CAE/CAD tools from HP and its network of value-added businesses.

HP's Components Group supplies a wide range of electronic components to improve visual communication including high-performance, visible light-emitting diodes (LEDs); radio frequency (RF) semiconductors and assemblies, and infrared, fiber-optic, motion-control and optically-isolated components.

Manufacturing and Production

Reducing costs and improving quality have always been key goals for manufacturers. Cost reductions can be achieved through higher throughput, lower warranty costs, reducing waste and increasing productivity. HP has a wide array of tools, solutions, and services to help you achieve these goals.

HP VXI open modular instrument standard is a foundation for faster, simpler system design. HP VXI mainframes, instruments, PC controllers and software work together to simplify functional test.

TS 5450

HP TS 5450 is a functional test system tuned specifically for automotive electronics such as engine control modules. The HP TS 5450 ships as a complete measurement-ready platform, so you can be in production faster. It features HP TestExec SL software, a complete standards-based functional test environment designed for high throughput and rapid test development in electronics test. Based on Microsoft Windows and VXI, the HP TS 5450 allows easy integration of additional measurement cards and software. Two configurations are available, one for fully-automated, high-volume production test, another for operator-based high-mix production test.

HP TS 5430 is a smaller, lower cost, functional test platform for testing ABS electronics, airbag, body electronics, and lighting systems. This automotive-production-tuned system lets you lower your development and test times.

Service and Aftermarket

HP has helped automotive companies with their business goals of customer satisfaction, loyalty, and retention by developing service-bay diagnostic tools and information-management systems. These tools and systems help you fix it right the first time, lower warranty costs and improve efficiency.

The newest hand-held diagnostic tool—HP Tech 2—uses superior computer technology to give service technicians a user-friendly and powerful device to fix it right the first time—all the time.

Automotive

HP in Automotive Folder
5964-9416E
HP and Cimtek Automation Case Study
5964-9643E
HP TS-5400 Family of Automotive Test Platforms
5965-4887E
HP TS-5450 Automotive Case Study
5965-1281E
Powertrain Development Test Platform
5965-0998E

(PN E6230A/TS-5430) Body Electronics Control ECU Test Platform
5965-6506E
(PN E6230A/TS-5430) Air Bag Systems ECU Test Platform
5965-6505E
(PN E6230A/TS-5430) Antilock Brake/ Traction Control ECU Test Platform
5965-6507E
(PN TS-5400) Family of Test Systems
5965-5226E
(PN TS-5430) HP TS-5430 Automotive Electronics Test Platform
5965-5289E

Resources for Engineering Educators

If you have ever taught a class of any kind, you know how difficult it can be. And if you have taught that class with the added stress of a demanding administration, inadequate lab equipment, unprepared students, long hours and a tight budget, then you are probably a professional educator. We salute you.

HP can't take away all the stresses of your job, but we can try to make it just a little easier, and that's what we're doing with the Higher Education Program from the HP Test & Measurement Organization. We have assembled a collection of tools to help you, the professional educator. Our goal? To save you time. All the educational materials can be viewed at our new Educator's Corner Website:
(http://www.hp.com/info/college_lab98).

Educator's Corner CD-ROM

Our website on a CD will provide the fast access to the information you need, such as our Pre-Written experiments. Just ask HP Direct or your local HP office for a copy.

Experiments

Log on to the HP Educator's Corner Website, and you will see a list of lab experiments. The "Pre-Written" experiments were created by your peers. We have put them into a standard format and made them available in several file formats for you to use in your curriculum. If you have some lab procedures or experiments written with HP equipment, be sure to submit them to our website and we will try to include them in the offering.

In addition to the written experiments, HP has created a number of interactive experiments on fundamental topics that you can give to students. Download them free from the website.

Teaching Tools

Videos

Tired of having that Teaching Assistant ask you basic questions about instrumentation? Just order, at educator prices, the three videos on how to use Oscilloscopes, Arb/Function Generators and Multimeters. These videos feature the HP 54600-Series of scopes, the HP 33120A Arb/Function Generator and the HP 34401A DMM. If that's not enough, download the Instrument Emulator from the website, and have the students and TAs practice with the products before they come to class.

Computer Based Training Courses

These courses cover AM Fundamentals, FM Fundamentals, Transmission-Line Fundamentals, and Lightwave Fundamentals. These are the same courses we use internally at HP.

Posters

Some of those lab walls can get pretty drab. Here are two very nice photos for you to hang on the wall, and by the way, these photos come with some very instructional material along the edges. Students who look at the photos might accidentally learn something about how measurements are made.

Tutorials

The website has literally hundreds of pages of tutorials on all kinds of measurement subjects. Add the HP Application Note section and Interactive Application Notes, and you get a library of measurement expertise at your fingertips.

Discounts and Grants

Log onto the HP Educator's Corner Website to see the discounts that we give to qualifying educational institutions. You may be surprised.

About Us

HP believes in lifelong learning. Engineers today must keep learning in order to stay marketable. We have programs for K–12 students, university students and continuing education for our employees. You can see some of these programs by visiting the "About Us" section of the Educator's Corner.

Products

Educators are often surprised when they find how affordable our instruments are. Then they are doubly surprised when they find out all the versatility our basic instruments exhibit, to remove the mysteries from engineering problems. Let's look at a few:

HP 54600B 100 MHz Digitizing Oscilloscope

The HP 54600-Series of scopes is as easy to use as an analog scope, but they have all the advantages of a digitizing scope. Students can trigger on an event and see what happened before the event occurred. You can add an HP 54657A Measurement/Storage module to teach students about Integration, Differentiation and FFTs. For example, drop a business card onto a speaker cone and use the FFT module to determine the resonant frequency of the speaker.

HP 54645A/D 100 Mhz MegaZoom Digitizing Oscilloscope

Almost identical in operation to the HP 54600B, the HP 54645A has higher sample rate and a megabyte of memory. Students capture the data only once, and then review it, pan across it, even zoom in on it or do an FFT on it... all on pre-stored data. It makes data analysis a dream instead of a chore. The HP 54645D's 16 logic channels and powerful triggering provide added capability to solve digital and mixed-signal problems.

HP 33120A/D Function/Arb Generator with HP BenchLink/Arb Software

This combination makes a great teaching tool. For example, with HP BenchLink software, create an arbitrary waveform that consists of a series of sine waves followed by series of square waves of equal amplitude. Then feed that sine-square-sine-square signal into a light bulb. The light bulb will blink, because the square wave and sine wave have RMS power values that differ by a factor of 2. This is a simple, yet valuable lesson in waveform theory that is easily demonstrated with the HP 33120A.

HP 34401A 6 ½ Digit Digital Multimeter

Your students will enjoy using the fully programmable, industry standard HP 34401A. The easy to use interface will allow the students to focus on their experiment and not struggle with which buttons to push.

E3631A Triple Output DC Power Supply

3 dc outputs and 80 W of total power provides the flexibility for all your labs. Connect to a PC via the built-in HP-IB or RS-232 port for automated measurements.

HP 34970A Data Acquisition System

It's hard to believe that you can buy a complete HP-IB data acquisition system for about the same price as a PC plug-in card. But it's true. The new HP 34970A is a very simple, easy-to-understand product that can show your students all kinds of physical measurements. It even comes with a free set of software that makes data acquisition foolproof.

RF Labs

Use the new HP ESA L1500A low-cost spectrum analyzer and a companion source like the HP 8648A for teaching RF communications. Now your students can learn RF principles on the same equipment that professionals use, and the educator's price will surprise you in a very pleasant way.

Three Year Warranty

Our Education Program provides a three year warranty on many products so you won't have to worry about repair charges.

Special Discounts* for Engineering Educators

Product

HP 54603B 60 MHz Digitizing Oscilloscope
HP 54600B 100 MHz Digitizing Oscilloscope
HP 54645A 100 MHz MegaZoom Oscilloscope
HP 54645D 100 MHz MegaZoom Scope with 16 digital channels
HP 33120A 15 MHz Function/Arb Generator with HP-IB/RS-232
HP 34401A 6 ½-digit DMM with HP-IB/RS-232
HP 34970A Data Acquisition Unit with HP-IB/RS-232 (20 channel with DMM)
HP ESA L1500 9 kHz–1.5 GHz Spectrum Analyzer
HP 8648A 100 kHz–1GHz Synthesized Signal Generator
HP E2310A Advanced Logic Probe

All the above products carry a discount* for qualifying educational institutions of:

Quantity	Discount
1	20%
5	25%
10	30%

Videos and Computer-Based Training Packages
HP H1300A Use and Abuse of Digitizing Oscilloscopes
HP H1301A Use and Abuse of Digital Multimeters
HP H1302A Use and Abuse of Function Generators
HP H5264A AM Fundamentals
HP H5265A Lightwave Fundamentals
HP H5266A Transmission Line Fundamentals
HP H5267A FM Fundamentals
HP VEE 4.0 Graphical Programming Software
HP BenchLink/Suite Software
Educator's discount for above software and teaching aids is 50% plus a generous right-to-copy.*

Call HP Direct or your local HP office to find out other discounts for educators.

*Restrictions apply. Accredited non-profit educational institutions only. Not available in all parts of the world. Prices subject to change.

This page has been
intentionally left blank

Consulting & Support 18

See also
Complete Test Solutions 31

Service Selection Guide

Supporting Your Success

You chose Hewlett-Packard equipment because it best meets your test, measurement, and computing needs. HP wants you to be successful and we're committed to helping you achieve the best results from your system for years to come. We don't stop serving you after the sale is completed. Our flexible support solutions—in hardware, software, customer education, and in application and engineering consulting services—bring you many benefits. Our support services will:

- Shorten the period between purchase and effective use of an HP product.
- Make available unique worldwide resources for maintenance and troubleshooting.
- Ensure continued measurement accuracy.

You can measure the results in greater overall productivity and lower cost of ownership.

Maximizing the return from your equipment investment can be seen as a three-phase process of planning and design, implementation, and operation. Hewlett-Packard offers support services to ensure that you obtain maximum performance from your measurement system during each of these phases.

Test & Measurement System Support Life Cycle

Planning and Design	Implementation	Operation
Engineering Services Consulting	Application consulting Installation services Engineering services Education services Integration	Hardware support Software support Education services

Smooth Implementation through Knowledge

A thorough understanding of your equipment's capabilities is essential to achieving maximum performance from your investment. That's why we back our products with education courses and materials to ensure that you learn the best way to apply our equipment to your environment.

We also offer site planning, site environmental surveys, and installation services to ensure that your system is installed correctly and quickly.

Peak Operation through Maintenance

To help maximize your equipment uptime and measurement accuracy, HP has a worldwide customer service organization staffed with trained engineers who are backed by factory designers. We focus the necessary resources to keep your equipment operating at peak performance.

Because computers are playing a key role in today's measurement systems, software support can be essential to optimizing your system's performance. HP keeps you up to date on the latest software improvements to ensure that your system continues performing to its maximum potential.

Support Life

To help you maximize your product's life, Hewlett-Packard will continue to offer support services for as long as feasible. To continue offering these services means managing our trained staff and repair parts inventories to match your needs.

In any event, HP offers support services on all of our products for at least five years beyond end of production.

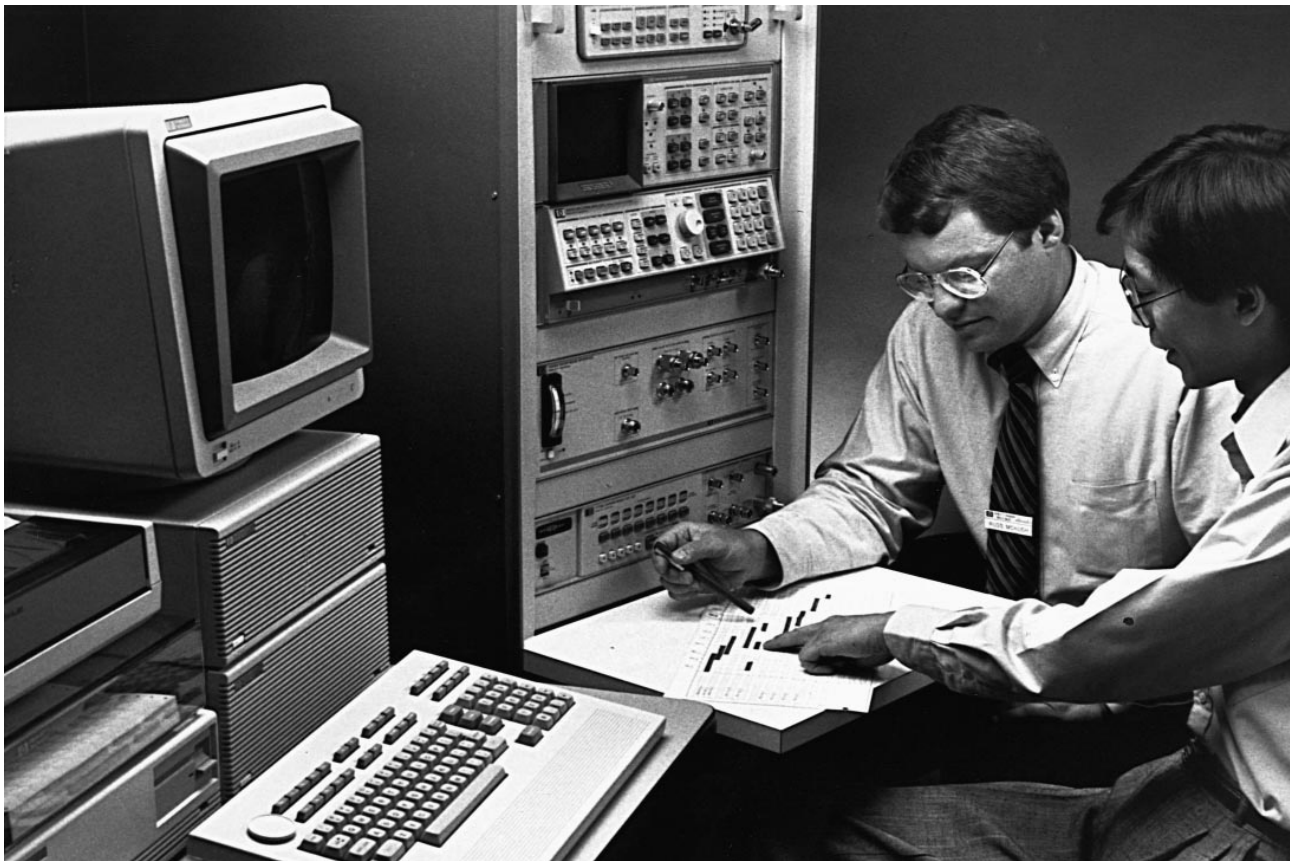
In addition, we will make our best effort to repair or calibrate any Hewlett-Packard product, whatever its age, even if the product has passed through its support life.

Support for Your Needs

The following pages provide more details on Hewlett-Packard's wide range of support services. Ask your local HP representative to help you select the services that best meet your needs in maximizing your measurement systems' performance.

Service Selection Guide

	Services	Major benefits	Best fit
Consulting and Engineering Services (pages 579-581)	Installation services Engineering and integration services Productivity assistance	Expert implementation assistance Quick startup of instrument systems Increased productivity	Fast, efficient implementation of instrument system required
Education Services (pages 582-583)	Wide variety of courses covering latest HP products and technology Variety of audiences and skill levels Flexible delivery options	Fast learning Time and cost savings over learning independently	Whenever new products or technology are introduced in your environment New people
Hardware Support (pages 584-585)	HP instrument repair and calibration HP and major brands on-site instrument calibration System repairs and calibrations	Fast turnaround time Cost savings Dependable measurement accuracy Flexible scheduling	Standalone transportable instruments A variety of instruments in accuracy-critical applications Complex systems, production systems, or other mission critical application
Software Support (page 586)	HP Response Center services Software and documentation update services Notification service	Software usage and problem resolution assistance New software releases Up-to-date software information Fast, accurate support	Test systems Instruments with software Instrument controllers



Productivity Assistance

Let Hewlett-Packard help you maximize the return on your measurement investment. A wide range of productivity-enhancing services helps you realize the full potential of your planned or newly acquired instrument or measurement system. HP can help you to get started and produce measurable results quickly. Whether you need a few hours of advice from an experienced systems or applications engineer, help with your overall test and measurement processes, or a complex custom system solution involving a major project, HP is ready to help—your success is our business.

Startup Assistance

Are you considering the purchase or lease of a complex piece of test equipment? You probably are concerned about getting results from your new equipment immediately. Or, you may have questions regarding the best way to apply a new instrument to your specific situation. HP's startup assistance is the answer. A few hours with an HP expert can often help you overcome measurement system roadblocks, or help you fine-tune your system for optimum speed and accuracy. Our engineers are experienced in the latest technology, measurement applications, and instrument operation. They can show you tips and techniques for maximizing your HP measurement system's performance, as well as assist you in customizing and integrating measurement systems into your environment.

For example, HP's startup assistance service can be used to help you in the following areas:

- System setup, installation, and initialization
- Operator or user training
- Controller, instrument, and system interfacing
- Calibration and measurement techniques
- Help with data management and presentation

HP's startup assistance provides you with quick answers to your questions, letting you harness the full power of your measurement system right away. HP's experienced system engineers can come to your site at your convenience, to consult with you on your specific questions or problems.

Startup assistance is available on a half-day and daily basis, to give you the flexibility you need. For more specific information on productivity and startup assistance services offered in your area, please consult your local HP field engineer.

Test and Measurement Services

Do you require a special measurement performed on a one-time basis, but cannot justify the purchase or lease of a complete system? Or, do you have a special measurement need that you cannot perform due to lack of equipment or expertise? HP can provide test and measurement services on specific instruments and in many applications.

Here are just some of the many examples of HP test and measurement services:

- Phase noise measurements
- High-frequency network measurements
- Local Area Network (LAN) audit/health check service
- HP 64000 system installation and application assistance
- Process data monitoring (data acquisition systems)
- RF/microwave component design consulting
- Transceiver test application services
- Three-dimensional X-ray board testing services
- Cable test applications consulting
- High-frequency materials testing services

Hewlett-Packard test and measurement services vary by region. For more specific information on test and measurement and applications consulting services offered in your area, please consult your local HP field engineer.

Applications Consulting

Would you like some help with improving your overall component or device test strategy to optimize throughput, accuracy, or quality? This consulting service leverages HP's knowledge and experience with current industry practices and HP instrument capabilities. Measurement performance consulting is an extension of basic applications assistance and instrument startup support. This service involves a more in-depth understanding and analysis of your measurement process or measurement protocol and provides you with possible suggestions for improvement.

How to Order

Your HP field engineer can help you select a combination of consulting, project, and support services to meet your needs. Ask your local HP field engineer for more information.

Hewlett-Packard—Your Complete System Integration Resource

In many cases, the instrument, system, and software products listed in this catalog are only part of the overall solution that you need. You may have a special requirement, or face resource restrictions that prevent you from developing the exact measurement system that you require in the time available. Why not employ Hewlett-Packard's engineering talent to help you meet the technical and time-critical challenges typical of today's fast-paced business environment? HP offers professional consulting, project engineering, system integration, support, and project management services to help you implement a complete test and measurement solution, customized for your specific needs.

Hewlett-Packard is as committed to quality and to your satisfaction with our wide range of professional services as we are with the hardware and software products that you use today. We are continuously striving to meet international quality standards such as ISO 9000. Our consulting services range from brief consulting assignments to comprehensive strategic planning that helps you determine your measurement and test needs in R&D, manufacturing, or servicing. HP can assist you with requirements definition consulting to help you develop detailed measurement system specifications. We offer system engineering and system integration services to develop and implement the actual test or measurement system solution. And finally, standard or customized support services are provided once your system has been implemented, installed, and accepted.

You have relied on Hewlett-Packard as a test and measurement equipment supplier for years. Why not consider HP your complete test and measurement solution supplier as well? We can be your most knowledgeable outside resource by providing you access to our broad base of measurement instrumentation, computer, and communication system knowledge and experience.

A Comprehensive Range of Professional Services for Test System Design and Integration

Needs Analysis

Are you concerned about the role and contribution of electronic measurement and test in your organization? You may be unsure of your exact measurement problem or requirement. Are you concerned about getting the maximum return on your existing or planned testing investment? Do you need assistance in determining what to test? Then HP's worldwide network of experienced consultants is the answer. As a global manufacturer of high-technology products, many of the challenges faced and surmounted by Hewlett-Packard are similar to yours. Put HP's knowledge of electronic test and measurement processes to work for you.

You can access this knowledge and expertise by enlisting one of our consultants to help you. Services range from simple and brief consulting sessions to assistance with developing your overall test process, test plan, or measurement protocol. Each of our consultants brings the benefit of years of experience in test and measurement to your problem, and can be a tremendous resource to you in gaining a clear understanding of your measurement and test needs.

Examples of services in the area of needs analysis available for you:

- Industry consulting—Assistance with new measurement and testing technologies and techniques specific to industries such as telecommunications, aerospace, and automotive electronics
- Technology consulting—Guidance on how your organization can benefit from using new electronic measurement technologies and techniques
- R&D and manufacturing process consulting—Information and recommendations on electronics product development and manufacturing processes and best practices
- Test process consulting—Focuses on test processes in use at your site, and their current versus desired contribution to your R&D and production processes

Requirements Definition

Do you have a basic idea about what your measurement problem is, but uncertain of the optimum solution? For example, you may have a well-optimized manufacturing process, but you may not know how to specify the test capability required. Or, you may want assistance to help qualify the latest available measurement and software technologies in advance of settling on an optimum solution. If this is the situation you are facing, then HP can be of help. With your basic measurement needs defined, requirements definition services will help you to determine the exact specifications for a measurement or test system. HP's consultants and factory experts stand ready to assist you. The solution may take the form of a single instrument or complex custom system involving multiple instruments, software, and customized support.

Examples of specific services in the area of requirements definition are:

- Feasibility studies
- Engineering evaluation studies
- Requirements analysis consulting
- System requirements specification
- Project management

Solution Design

Once your measurement needs and requirements are well-understood and documented, the design and development of the actual solution can begin. Proceeding from a *Statement of Work or System Requirements Specification*, HP system engineers can engage in the actual engineering of a solution. This involves extensive interaction between you, your engineering team, and support staff with HP's project staff of engineers, technicians, and the HP project manager.

Examples of activities and services in the area of solution design are:

- System engineering
- Software design
- Custom hardware engineering
- System functional design specification
- Design reviews
- Acceptance test specification
- Bench marking
- Data network design
- Support planning
- Project management

VXI-based manufacturing test system—racking and cabling to high-density, quick disconnect DUT fixture interface

Solution Implementation

In addition to working with you on the design specifications of your measurement solution, HP engineers and technicians can build the solution. This involves selecting or developing the actual system software and custom hardware, and managing integration of third-party subcontracted engineering. The final solution may incorporate HP as well as non-HP hardware and software products. These, HP's, and your engineering contributions are executed and managed. Assembly activities involve consolidating and racking the system hardware and associated cabling, designing and building the device-under-test (DUT) interface and related transducers, and writing and organizing the system documentation. Finally, required site surveys, site engineering, and preparation and training of your personnel must be accomplished prior to system shipment.

Examples of specific services in the area of solution implementation are:

- Software and hardware development
- Signal routing and cabling
- System assembly, racking, and integration
- Site preparation
- Generation of documentation and training materials
- HP and on-site acceptance testing
- System installation
- Final support planning
- Integration of the system into your site data network
- System operator and system administrator training
- Project management

Solution Support

During and after system installation and final on-site acceptance, Hewlett-Packard stands ready to support your measurement system with training, education, and support services tailored to your needs.

Examples of activities and services related to system support:

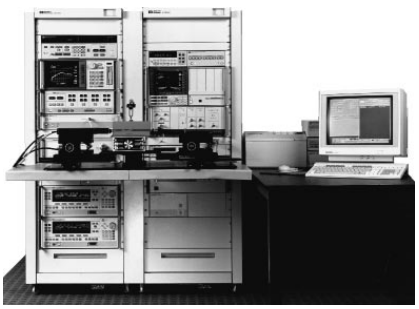
- On-site calibration and repair (where feasible)
- Spare replacement
- Diagnostic and functional system test
- System self-testing
- Custom support delivery
- System upgrades and maintenance
- Programming support

Your Trusted Resource

As a worldwide successful manufacturer of state-of-the-art measurement, computation, and communications tools, HP can help you address the time pressures and business challenges of this decade. Put Hewlett-Packard on your team.

Our international pool of field and factory-based consultants and experts includes:

- RF, microwave, and lightwave design engineers
- Data acquisition system designers
- Communications and data network engineers
- Computer software designers and programmers
- Project and program managers
- Manufacturing process experts



Customized system for cellular base station amplifier testing

The HP Advantage

When you hire Hewlett-Packard to be a part of your engineering team you will:

- Gain access to leading-edge process and system design capabilities
- Benefit from the latest advancements in measurement and test technologies
- Reduce your own risks through increased visibility of true cost and schedule control
- Accelerate your overall project schedule and improve your resulting time to market
- Enjoy a long-term support and maintenance strategy backed by a strong, reliable company
- Free your engineering resources to focus on your company's core capabilities and strengths

In working with HP's consultants, engineers, and project managers, you are assured of retaining a comfortable level of control—you are our customer and we want to be in position to be able to continue to address more of your measurement and test challenges in the future.

How to Order

For more information on how HP's consulting engineering, integration, and support services can help you achieve your technical and business goals, please contact your local HP field engineer.

HP Channel Partners

There are many specialized test and measurement applications where HP resources and products are only a part of the total solution. Often, these applications require the additional capabilities offered by third parties that have great expertise in a given area. HP recognizes this and as a result has formed alliances with many other world-class companies to provide you with complete and highly-reliable solutions necessary to meet your needs. The HP Channel Partners program combines each Channel Partners' strengths in application-specific products, systems, and services with HP's high-quality test and measurement products and worldwide sales support. Together, HP and its Channel Partners can provide you with the turnkey measurement systems that you need.

HP Channel Partners offer solutions in the following general application areas:

- Antenna and RCS testing
- Electrical system components
- Electronic components
- EMC
- Piston engine test
- Turbine engine test
- Structural and vibration analysis
- Frequency spectrum monitoring
- Rotating machinery
- Mechanical functional test
- RF and microwave semiconductor test
- Power generation
- Process monitoring and control
- Signal simulation

How to Order

The availability of HP Channel Partners and their areas of applications expertise vary by region. To obtain the name and telephone number of a Channel Partner for a specific application, or in other application areas not listed above, please contact your local HP field engineer or call:

In the US: 1-800-452-4844
In Europe: 31-20-547-9999

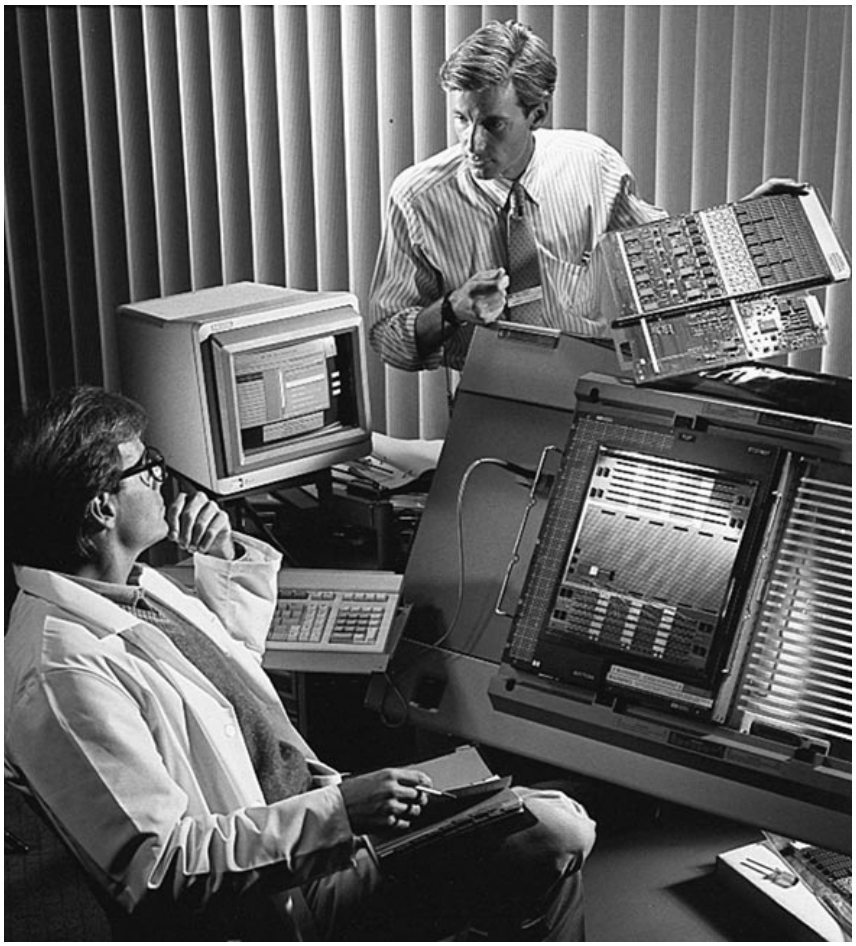
Educational Services

Overview

HP Educational Services

We are committed to offering training that will permit you to get the best possible use of your Hewlett-Packard equipment. HP recognizes that both initial instruction and ongoing education contribute to your success; that is why we offer courses covering applications, software and hardware maintenance, and operations for a wide range of HP instrument and computer solutions.

Our courses can help you build basic technical skills and learn new measurement techniques. Moreover, HP courses can enable you to minimize startup times on complex instruments, improve the quality of your measurements, and increase the accuracy of your data.



Quality Training

- Our instructors understand your industry—They speak the language. We make sure our instructors have a deep understanding of the subject and can effectively explain—in clear, concise terms—everything you need to know, from specialized test techniques to the physics behind the measurements. Working as a team, product specialists, industry experts, curriculum engineers, course writers, and instructors develop training materials and design courses with the goal of maximizing your learning experience.
- Limited class sizes—Classes are limited to six to ten students. We believe small classes encourage closer interaction with the teacher and other students, thus permitting students to share learning experiences and applications expertise.
- It's not all books—Hands-on training is important to your success. That is why we provide lab equipment in our classes. Each course has lab time as a key training benefit.
- The payback—Our experience shows that you will learn faster with HP education courses. The benefits are twofold: the equipment can be used sooner and the time you would have spent on independent learning can be used for other opportunities.
- Worldwide training—HP has training centers throughout the world, with classes in continuous progress. Training schedules are published regularly.
- On-site training—All HP courses can be scheduled and taught at your site. This option might prove more attractive to you, bringing the advantages of training in a familiar environment with your own equipment.
- Off-schedule training—In order to accommodate your emerging training needs, additional HP courses can be arranged beyond those published in the local training schedule. Contact your local HP sales representative for more details.
- Customized classes—We can meet special training needs by developing custom training classes. These changes may include modification of class materials, development of modular training, development of special labs, integration of new sections in the course, and even the development of entirely new classes.
- Specialized training materials—HP education is typically based on classroom training, led by professional instructors with solid engineering experience. Other HP training formats include computer-based training, videotape sessions, satellite-broadcast instructions, and self-paced training modules.

HP Education . . . Engineered for Your Success

Test and Measurement Curriculum

We offer education courses for a wide range of HP instrument and computer solutions:

- Computer-Aided Test and General-Purpose Instruments
- Electromagnetic Compatibility Products
- Signal Analysis and Monitoring Products
- RF and Microwave Products
- High-Frequency Design Systems
- Datacom, Telecom, and Mobil Communications Test Products
- Board Test Systems
- Digital Design and Characterization/ Embedded Control Systems
- Semiconductor Test Systems
- Open Systems, UNIX, HP-UX, and Networking Products
- Component and Material Test Products

Schedules and Literature

Your sales office can also provide the following training literature:

- Course data sheets—Every HP class has a data sheet that describes the course in detail. Included are key topics, target audience, course outline, prerequisites, and ordering information.
- Education course schedule—HP training schedules are published throughout the world and list class schedules for each area.
- Education catalog—The catalog presents information on the entire HP course range, including curriculum flow diagrams, course objectives, outlines, and course content. It is your tool for planning the best possible education for yourself and other members of your organization.

How to Order

To register for any HP class in the United States or order a *Test & Measurement Education Catalog*, call (800) HP CLASS (800-472-5277).

Outside the United States, contact your local HP sales office.

Fast, Convenient Support Services

Whether your company has one oscilloscope, or an entire factory floor full of integrated circuit production test systems, Hewlett-Packard can meet your test and measurement repair and calibration needs.

- HP's 42 Customer Service Centers worldwide deliver repair and calibration services when and where it is most convenient for you.
- The purchase plans for HP's hardware support are flexible, with the choice of purchasing repair and calibration services either on a contractual or per-incident basis.
- HP's services are the highest quality available and comply with national defense and international standards; HP's major Customer Service Centers are ISO 9000-registered.

Whatever your test and measurement hardware support needs, HP can provide a dependable, cost-effective support selection that you can trust to reduce downtime and get you back to business quickly.

Time-of-Purchase Support Services

At the time of equipment purchase, you can also purchase extended repair and calibration service plans—called the HP Support Options. These plans extend the HP support beyond the original product warranty for a total term of three to five years. You lock in maintenance cost savings and HP's high-quality repair or calibration services. Ask your HP sales representative for more information.

HP also offers a variety of services for instrument and systems that you can purchase anytime after product purchase.

After-Purchase Instrument Services

No matter what your repair or calibration needs, HP offers a variety of flexible choices to maximize instrument uptime, while letting you purchase only the coverage you need.

Instrument Repairs

Standalone, non-mission-critical instruments can be repaired most cost-effectively at an HP Customer Service Center. Repair services include all the necessary parts, labor and materials. HP instruments covered by the factory warranty or any other HP support programs are typically repaired within five working days of receipt. Whenever an instrument is sent to an HP Customer Service Center for repair, HP covers the return freight. Repairs sent to HP can be purchased either on a contractual or per-incident basis.

- Standard Repair (STREP) is HP's single-event, fixed-price repair service. This alternative is a good choice for low-usage applications.
- Mini-STREP charges a lower price for a simple repair if it requires less than one hour of labor and falls below a set price for parts.
- The most cost-effective alternative, especially for frequently-used products used in critical applications, is a one-year Repair Agreement. Repair agreements typically offer significant savings over equivalent per-incident service. In addition, HP provides accelerated turnaround time.

In cases where maximum uptime, greater flexibility or faster turnaround time are critical factors, HP offers On-Site Repair for selected standalone instruments. Ask your HP sales representative for more information.

Instrument Calibrations

All measurements made in HP's calibration processes are traceable to national and international standards. In the United States, measurements are traceable to the National Institute of Standards and Technology (NIST). Each product's performance is compared to standards of known accuracy to ensure conformance with published specifications.

HP's calibration services may be purchased on a contractual or per-incident basis. Standard Calibration, HP's per-incident calibration service, is best suited for low-usage applications where there has been a change in instrument use or operating conditions. Standard Calibration includes calibration at HP's recommended intervals, complete data reports for all measured product performance, a calibration certificate and a sticker that notifies you when your next calibration is due.

For accuracy-critical applications where regular calibrations and traceability are required, covering instruments under a Calibration Agreement is a beneficial, cost-effective alternative. Calibration agreements typically offer significant cost savings over equivalent per-incident service and provide the highest priority service. Agreements also provide the additional benefits of free recalibration after any repair performed by HP, free HP ExpressCal service, customized calibration intervals, and calibration-due notification.

Products covered under a calibration agreement or under HP Support Options are calibrated at no charge after a repair performed by HP.

For cases when instrument uptime and accuracy are critical, HP offers the HP ExpressCal service. HP ExpressCal offers the convenience of scheduling calibrations in advance, simply by calling the nearest HP Customer Service Center. Most scheduled calibrations are completed within 24 hours. HP ExpressCal service is included with all calibration contracts and calibration-related HP Support Options. There is a service fee for HP ExpressCal service for calibrations done on a per-incident basis.

HP also offers calibration services specifically designed to meet national defense and international standards, including AQAP-6 and MIL-STD-45662A. In addition to the features of HP's standard calibration service, an enhanced data report is provided that includes appropriate "before" and "after" data and a certificate stating compliance with the appropriate standard. HP will also notify you if one of HP's measurement standards is found to be out of tolerance such that your calibration may be compromised. HP will then recalibrate your instrument free of charge.

Instrument Calibration for HP and Major Brands

If your company has numerous instruments from a variety of vendors that require maximum instrument uptime, and if you need the most flexible scheduling available, Volume On-Site Calibration is the best calibration service for you. HP engineers will come to your site when and where it is most convenient to calibrate a broad range of sophisticated products, including more than 6,000 various test and measurement products from other vendors. In addition to the normal test and measurement equipment, HP will calibrate physical, dimensional, and mechanical devices such as particle counters, gauge blocks, humidity and temperature controls, ring gauges, and many others. This service can be tailored to meet your needs, including calibration of all functions to specification, military-compliant calibration, custom calibration, and operation verification. Turnaround time is reduced from days to hours with HP's Volume On-Site Calibration, providing maximum uptime for production or accuracy-critical applications.

Test System Services

Whether your company has a complex system such as a manufacturing test or semiconductor test system or a customized test system with special applications software or custom test fixtures, Hewlett-Packard can meet your support needs. You can purchase service at the time of your product purchase or at a later time.

On-Site System Repair

To maximize test system uptime, HP offers high-quality on-site support with flexible response times and coverage periods that enable you to tailor the support program to your needs. When you order one of HP's on-site service selections, a customer engineer (CE) is assigned to your company. The CE becomes familiar with your environment and takes personal responsibility for managing your measurement systems maintenance program. Your CE will also perform preventive maintenance on a regular basis.

On-Site System Support*

For mission-critical applications where you need HP to work around your schedule and provide very rapid service, the best alternative is Priority Plus Support*. This service level provides on-site repair service 24 hours a day, seven days a week, including HP holidays. Customers within 100 miles of an HP support facility receive an on-site visit within four hours.

Priority Support* is the best choice for critical operations where alternative equipment or process cannot be substituted. This service provides coverage for on-site repairs from 8:00 a.m. to 9:00 p.m. Monday through Friday, excluding HP holidays. This coverage allows all scheduled maintenance to be performed after normal working hours. Customers within 100 miles of an HP support facility receive an on-site visit within four hours.

Next Day Support* is the best choice for less-critical applications where equipment or process can be substituted. This repair service level provides next-day, on-site service coverage from 8:00 a.m. to 5:00 p.m. Monday through Friday, excluding HP holidays for customers within 100 miles of an HP support facility.

Cooperative Support service is for customers who maintain their own systems, and rely on HP for training, replacement parts, diagnostic support tools, repair documentation, and remote backup support. This service is available for customers with specific systems, spares, and personnel. Ask your HP representative for information on these prerequisites.

There are volume discounts for all of these support alternatives. In addition, if you have purchased Priority Support or Next Day Support and have a critical-support need, you can order a faster response time for an additional fixed charge when you have an open purchase order on file with HP.

*Service levels are subject to local availability.

On-Site System Calibration

For rapid, traceable, mission-critical test and measurement systems calibrations, on-site systems calibration is your best choice. With an on-site calibration agreement, your HP CE calibrates measurement systems at your site, when and where it is most convenient. HP also offers on-site calibrations on a per-incident basis. HP performs the same high-quality level of calibration service on-site as it does for instruments returned to HP. (Please see the "Instrument Calibrations" section for more information on the services provided.)

How to Order

Your HP sales representative can help you select the best support services to meet your needs. Ask your local HP sales representative for more information.

For all instrument calibration and repair services in the U.S., just call 1-800-403-0801.

HP Hardware Support Choices

Instrument Repairs

Situation	Repair location	Repair time	Purchase plans
Transportable, standalone instruments in non-mission-critical applications, and Instruments can easily be temporarily substituted	HP Customer Service Center	Five working days	One-year contract Per incident Customized

Instrument Calibrations

Situation	Calibration location	Calibration time	Purchase plans
Transportable, standalone instruments in non-mission-critical applications, and Instruments can easily be temporarily substituted	HP Customer Service Center	Five working days Most within 24 hours with HP ExpressCal	One-year contract Per incident Customized

Volume On-Site Instrument Calibrations (HP and Major Brands)

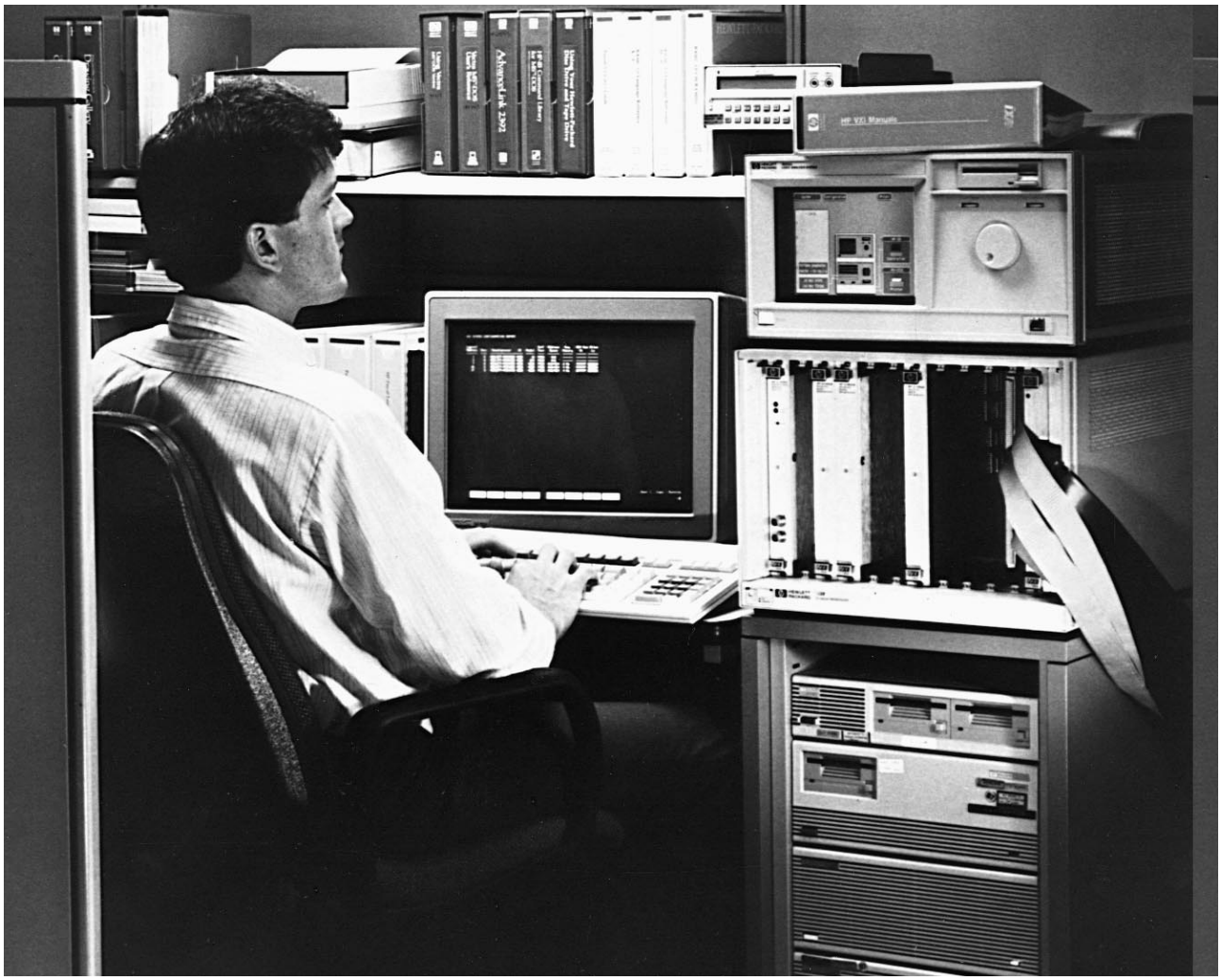
Situation	Calibration location	Calibration time	Purchase plans
Many HP and non-HP instruments in mission-critical applications that are not easily transported, and Need maximum flexibility and fastest turnaround	On-site	Varies per your plan	One-year contract Per incident Customized

System Repairs and Calibrations

Situation	Support location	Response time	Purchase plans
A complex test and measurement system, and/or A production or other mission-critical application, and/or Need maximum flexibilityand fastest turnaround	On-site	Priority Plus within 4 hours every day Priority within 4 hours on work days Next Day (workday) Customized per plan	One-year, three-year, five-year and cooperative support contracts Per incident Customized

Software Support

Overview



HP Software Support Services

Ongoing success with instrumentation products requires up-to-date information and software. Hewlett-Packard offers three software support services for instrumentation products: Response Center support, software updates, and notification services.

HP Response Center Support

With test systems becoming larger and more complex, even the most experienced system users have questions. And the faster they receive answers, the more productive they become.

With HP Test and Measurement Response Center support service, you place one telephone call: HP handles the rest. Specialists at the HP Response Center have access to sophisticated knowledge databases of known solutions to problems, product data, and system history. As a result, they can isolate the problem quickly and minimize downtime. Some of our systems even have remote diagnostic capabilities that enable our specialists to gain valuable information for identifying and resolving problems quickly.

Additional authorized caller services may be purchased separately. This will allow more callers beyond the designated caller or specified alternate.

HP Response Centers offer telephone assistance for normal software usage, clarification of documentation, and resolution of software problems.

Software Update Subscriptions

HP continually updates test system software to incorporate improvements that enhance the productivity of your staff and repair known defects.

A specialized HP Test and Measurement Application Software Update Subscription service for each of your applications ensures that you receive the latest software and documentation as it becomes available. That way, you'll maximize productivity and the return on your investment. Materials and right-to-use licenses may be purchased separately, so you minimize costs by purchasing only the services you need.

Notification Service

For mature products and hardware products with minimal software, HP offers a notification service. The HP T&M notification will provide some of the following services: notification of available product revisions (updates, upgrades, enhancements) to software, firmware, and hardware, notification of important product service issues, notification of product obsolescence, and new product information and availability.

Specific Support Services

Select the high-quality services that best meet your ongoing needs. HP provides software support services for our full range of test and measurement systems and products.

- Board test systems
- Semiconductor test systems
- Telecommunications test products
- Data communications test products
- High-frequency design systems
- Logic development systems
- HP VXI test systems
- Dynamic signal analyzers
- General-purpose test and measurement software
- Radio frequency and microwave products
- Electromagnetic compatibility products

Financing & Ordering 19

Leasing, Trade Ins, Refurbished Units & Sales Offices 587

Why Hewlett-Packard?

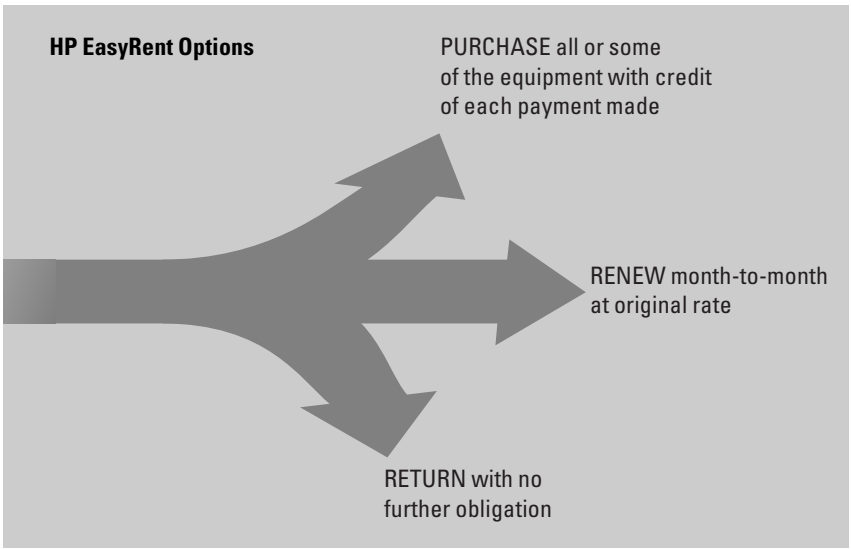
HP offers the ease of one-stop shopping. With HP Financing, your equipment is backed 100 percent by the company that knows it best. And HP's low cost of funds allow us to pass on to you very competitive rates. With competitive rates and flexibility, why not HP?

Why Financing?

Renting, leasing, or financing your instrumentation offers several important benefits: (1) you acquire the latest technology without a large cash outlay; (2) short-term projects can be managed economically; (3) upgrading and adding on is easy; and (4) you can match payments to your revenue stream.

To Learn More

Contact your HP sales representative to learn how an HP financing plan can be tailored to meet your needs.



HP EasyRent

HP EasyRent offers you a low-cost 12-month rental.

This unique plan is advantageous when you need an exceptionally low rate for shorter-term projects, built-in asset management, and off balance sheet financing.

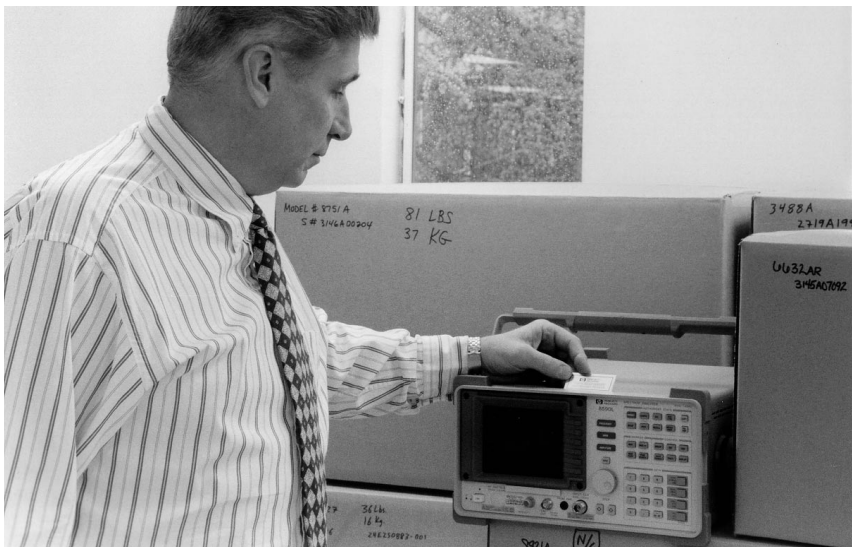
A Full Range of Choices

This chart indicates the broad range of plans available in the United States. Similar plans are available worldwide.

Hewlett-Packard Financing Plans

	Key Benefits	Term (months)	Purchase Option
HP EasyRent	Maximum flexibility with low monthly payments	12	Fixed or fair market value
HP EasyLease (HP Lease/Rental)	Provides flexibility and low monthly payments	12 to 60	Fixed or fair market value
HP EasyOwn (HP Installment)	Buy without a large cash outlay	12 to 60	None (full payout)
HP State and Local Government	Special financing for state and local government customers	12 to 60	None (full payout)

Extend Your Budget with Refurbished Equipment and Trade-In



An HP manufacturing manager places the official "Hewlett-Packard Test & Measurement Refurbished Product" seal on a refurbished unit. The seal guarantees that these high-value, HP products have been refurbished to HP's quality standard before they are shipped.

Hewlett-Packard's full-scale remarketing operation gives you two opportunities to stretch your test and measurement equipment budget. Trade-in allowances are available whenever you want to trade in a single instrument or a full pallet of used equipment. And high-quality, used equipment—refurbished to HP standards and warranted by HP—is available for you to purchase.

Trade Up To the Latest Technology

By taking advantage of HP's trade-in options, you can improve your ability to stay competitive by upgrading your test and measurement equipment to the latest technology and performance. Our trade-in programs are continuously available throughout the year. It's easy to trade in a pallet of equipment that is gathering dust in your warehouse for credit toward new or refurbished HP equipment for your network or factory. Or trade up a single network analyzer or scope to get the best available accuracy and performance for your R&D lab or manufacturing application.

HP sales engineers and finance experts can also work with you to develop a technology refresh program that is customized for your specific industry and needs. When technology breakthroughs occur, you are able to quickly return your equipment to HP in exchange for the advanced technology.

High-Quality, Refurbished Equipment

If your budget won't stretch far enough to purchase all of the new test and measurement equipment you need, you may want to consider adding some used instruments to your equipment pool. Many companies purchase new equipment in areas where technology is changing rapidly, but acquire used equipment in areas where technology remains steady.

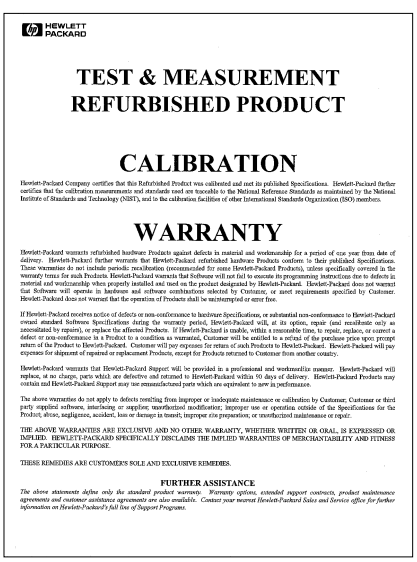
When you purchase new equipment from Hewlett-Packard, you know that you're getting the highest quality instrument available. HP is committed to that same rigorous quality standard for our refurbished test and measurement equipment. Refurbished to HP standards and warranted by HP, these high-quality instruments give you a safe, high-value choice.

You face little risk when you purchase an HP refurbished unit because we replace firmware as needed and make all necessary safety upgrades before we list the product for sale. We sell only products that are fully supported and for which parts are still available. Before and after you buy, you receive the same technical support available when you buy new from HP.

Depending on the instrument purchased, HP refurbished products offer:

- HP warranty of one year or more;
- Fully supported for a minimum of two years; supported five years beyond obsolescence;
- Refurbished to HP standards;
- Unmatched technical support;
- Return policies the same as for new HP equipment.

Contact your local sales office for availability and price for any refurbished instrument.



HEWLETT PACKARD

TEST & MEASUREMENT REFURBISHED PRODUCT

CALIBRATION

Hewlett-Packard Company certifies that this Refurbished Product was calibrated and met its published Specifications. Hewlett-Packard further certifies that the calibration measurements and standards used are traceable to the National Reference Standards as maintained by the National Institute of Standards and Technology (NIST), and to the calibration facilities of other International Standards Organization (ISO) members.

WARRANTY

Hewlett-Packard warrants refurbished hardware Products against defects in material and workmanship for a period of one year from date of delivery. Hewlett-Packard further warrants that Hewlett-Packard refurbished hardware Products conform to their published Specifications. These warranties do not include periodic recalibration (recommended for some Hewlett-Packard Products), unless specifically covered in the warranty terms for such Products. Hewlett-Packard warrants that Software will not fail to execute its programming instructions due to defects in material and workmanship when properly installed and used on the product designated by Hewlett-Packard. Hewlett-Packard does not warrant that Software will operate in hardware and software combinations selected by Customer, or meet requirements specified by Customer. Hewlett-Packard does not warrant that the operation of Products shall be uninterrupted or error free.

If Hewlett-Packard receives notice of defects or non-conformance to hardware Specifications, or substantial non-conformance to Hewlett-Packard owned standard Software Specifications during the warranty period, Hewlett-Packard will, at its option, repair (and recalibrate only as necessitated by repairs), or replace the affected Products. If Hewlett-Packard is unable, within a reasonable time, to repair, replace, or correct a defect or non-conformance in a Product to a condition as warranted, Customer will be entitled to a refund of the purchase price upon prompt return of the Product to Hewlett-Packard. Customer will pay expenses for return of such Products to Hewlett-Packard. Hewlett-Packard will pay expenses for shipment of repaired or replacement Products, except for Products returned to Customer from another country.

Hewlett-Packard warrants that Hewlett-Packard Support will be provided in a professional and workmanlike manner. Hewlett-Packard will replace, at no charge, parts which are defective and returned to Hewlett-Packard within 90 days of delivery. Hewlett-Packard Products may contain and Hewlett-Packard Support may use remanufactured parts which are equivalent to new in performance.

The above warranties do not apply to defects resulting from improper or inadequate maintenance or calibration by Customer, Customer or third party supplied software, interfacing or supplies, unauthorized modification; improper use or operation outside of the Specifications for the Product, abuse, negligence, accident, loss or damage in transit, improper site preparation, or unauthorized maintenance or repair.

THE ABOVE WARRANTIES ARE EXCLUSIVE AND NO OTHER WARRANTY, WHETHER WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED. HEWLETT-PACKARD SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

THESE REMEDIES ARE CUSTOMER'S SOLE AND EXCLUSIVE REMEDIES.

FURTHER ASSISTANCE

The above statements define only the standard product warranty. Warranty options, extended support contracts, product maintenance agreements and customer assistance agreements are also available. Contact your nearest Hewlett-Packard Sales and Service office for further information on Hewlett-Packard's full line of Support Programs.

All HP refurbished equipment carries a minimum one-year warranty. Three- and five-year extended warranties are also available on most refurbished products.

Communicating with HP

Product information

Your entry point to the resources of HP is through the HP sales office near you. Our sales representatives and order support specialists are well-equipped to provide you with pre-sale assistance in product selection, as well as related business information such as current product availability and price delivered to your location.

Most HP sales offices are tied into a sophisticated intra-company communications system. This not only means prompt transmission of orders to any HP product responsible division, it also speeds the flow of regular messages among HP sales offices and factories.

You can also call our Customer Call Centers for the same information, or for the location of your nearest Hewlett-Packard office. Locations of these centers are included in the listing of offices that starts on page 591.

Electronic data interchange

HP has established Electronic Data Interchange (EDI) links with many customers to allow more timely information regarding products and orders as well as provide a more efficient flow of purchase orders and invoices.

HP Worldwide Website

Be sure to visit the HP web pages for comprehensive technical, application, support, training and sales contact information. See page 2.

Pricing and Quotations

Prices in this catalog are U.S. list prices at the time of approval for printing. HP reserves the right to change prices. The prices for an order are determined by the prices prevailing at the time the order is received. Therefore, the prices in this catalog are intended only as budgetary information. To obtain destination prices, formal quotations, pro forma invoices, or other information you need before ordering, contact your local Hewlett-Packard office, distributorship, or Customer Call Center serving your area.

Inside the USA:

Call the Test & Measurement Customer Business Center, 1-800-829-4444, or write, P.O. Box 4026, Englewood, CO 80155-4026. See page 591.

Placing Your Order

Because many products or configurations are changed or improved during the year, we suggest that you always contact your nearby HP sales office for current product and pricing information prior to placing your order.

HP wants to be sure the product delivered to you is exactly the one you want. Therefore, when placing your order, please specify the product model, accessory, or part number, as well as the product name. Be as complete as possible in specifying exactly what you want, including standard options.

If you want special features or capabilities, such as different color or a non-standard voltage, ask your HP sales representative about availability and cost first. Then include special instructions and specification details with your order.

Outside the USA:

Orders for end use outside the USA should be placed with an HP sales office or distributorship in the country of end use. More information on placing such orders is available from the HP regional offices listed on page 591.

Terms of Sale

Inside the USA:

Hewlett-Packard's standard terms for established customers in the USA are net 30 days from invoice date. Other terms are contained in the customer's purchase agreement.

Leasing, rental and extended financing are available. However, the financing costs are not included in any product prices in this catalog. Your nearby HP office will be pleased to discuss your requirements and work with you in setting up an appropriate program.See also page 588.

Outside the USA:

Please contact your nearest Hewlett-Packard sales office or an authorized HP subsidiary or distributor regarding terms for orders placed with them.

U.S. Government Sales

For U.S. government sales, contact the HP U.S. Government Business Center at 1-800-468-8347. Many products in this catalog are covered on GSA federal supply schedule multi-award contracts. GSA is the General Services Administration; the HP office can supply GSA contract numbers for government purchasing officers.

Product Changes

Although product information and illustrations in this catalog were current at the time it was approved for printing, HP, in a continuing effort to offer excellent products at a fair value, reserves the right to change specifications, designs, and models without notice.

Shipping

Inside the USA:

All prices include HP standard transportation and routing to any U.S. destination. If a different shipping method is needed, we will gladly ship to satisfy your requirements. Custom shipments are typically sent freight collect.

Outside the USA:

Shipments to destinations outside the USA are made by either surface or air, as requested. Contact your HP sales office for details.

Operating Environments

Hewlett-Packard provides solutions to customer needs through products that must operate in the numerous environments. To address these needs, all new hardware designs are tested and evaluated to internal HP standards on operating environments before manufacturing release. These internal HP standards are derived from HP's experience with existing environments at customer installations and from other well-known standards, such as IEC, ISO, ANSI, and MILITARY standards. These codes are not used for evaluating production units. The classification codes, used to identify expected environments where HP products or systems may be used, are as follows:

A1– Rugged Environment
A2– Outdoor Environment (Portable)
B1– Portable General-Purpose Environment
B2– General-Purpose Environment
C1– Controlled Office Environment
C2– Controlled Computer Room Environment

The classes range from the severe environments found in heavy industrial areas unsuitable for operating personnel (Class A1) to the controlled environments found in dedicated computer rooms (Class C2). Most HP hardware products are designed to meet Class B2, applying parameters commonly found in general-purpose applications of light industrial and commercial facilities.

If you are considering a specific product, ask your HP sales representative what code is applicable to the product it was designed to (A1, A2, B1, B2, C1, C2) and the limits it met for the environmental parameter of concern.

Warranty

As an expression of confidence that our products will continue to meet the high standards of reliability and performance that our customers expect, Hewlett-Packard products carry the following limited warranty:

HP products are warranted against defects in materials and workmanship. If HP receives notice of such defects during the warranty period, HP shall, at its option, either repair or replace hardware products which prove to be defective.

Regional Offices
If no T&M sales office is listed for your country or area, please contact one of these main regional offices:

For more information on Hewlett-Packard Test & Measurement products, applications or services, please call your local Hewlett-Packard sales offices listed on pages 592-598. A current listing is also available at **http://www.tmo.hp.com/tmo/contacts/English/index.html**

United States
Hewlett-Packard Company
Test and Measurement Call Center
P.O. Box 4026
Englewood, CO 80155-4026
Tel: 1-800-452-4844

Canada
Hewlett-Packard (Canada) Ltd.
5150 Spectrum Way, H32
Mississauga, Ontario L4W 5G1
Tel: (905) 206-4725
Fax: (905) 206-4132

Europe
Hewlett-Packard S.A.
Route du Nant d'Avril 150
CH-1217 Meyrin 2
Geneva, Switzerland
Tel: (41-22) 780 8111
Fax: (41-22) 780 8542

Japan
Hewlett-Packard Japan Ltd.
Measurement Assistance Center
9-1, Takakura-Cho, Hachioji-Shi,
Tokyo 192, Japan
Tel: (81 426) 56 7832
Fax: (81 426) 56 7840

Latin America
Hewlett-Packard Co.
Latin American Region
Headquarters
5200 Blue Lagoon Drive, 9th Floor
Miami, Florida, U.S.A. 33126
Tel: (305) 267-4245/4220
Fax: (305) 267-4288

Australia/New Zealand
Hewlett-Packard Australia Ltd.
31-41 Joseph Street
Blackburn, Victoria 3130
Australia
Tel: 1 800 629 485 (Australia)
Tel: 0 800 738 378 (New Zealand)
Fax: (61 3) 9210 5489

Asia Pacific
Hewlett-Packard Asia Pacific Ltd.
17-21/F Shell Tower,
Times Square
1 Matheson Street,
Causeway Bay, Hong Kong
Tel: (852) 2599-7777
Fax: (852) 2506-9285

Local Area Sales Offices
Arranged alphabetically by country

Albania
Gener-Al sh.p.k.
Tirana Trade Centre
Rr. 'Durresit'
Tirana
Tel: +355-42- 23519
Fax: +355-42- 27966

Algeria
R.T.I.
Realisation Telematiques Internationales
Lot A, Villa No. 57
Baba-Hassen
Wilaya de Tipaza
Algerie
Tel: (213) 230-6430
Fax: (213) 230-6431

Angola
Handled by HiPerformance, South Africa

Argentina
Hewlett-Packard Argentina
Montaneses 2140
1428 Buenos Aires
Tel: (54 1) 787-7115
Fax: (54 1) 787-7287

Australia
Melbourne
Hewlett-Packard Australia Ltd.
31-41 Joseph Street
Blackburn, VIC 3130
Tel: (61 3) 9210 5408 or
1 800 629 485
Fax: (61 3) 9210 5489

Perth
Measurement Innovation (WA) Pty. Ltd.
Kishorn Court
Suite 3, 58 Kishorn Road
Mount Pleasant, WA 6153
Tel: (61/9) 316-2757
Fax: (61/9) 316-1392

Sydney
Hewlett-Packard Australia Ltd.
17-23 Talavera Road
North Ryde, N.S.W. 2113
Tel: (61/2) 9950-7444
Fax: (61/2) 9888-9072

Austria
Hewlett-Packard Ges.m.b.H
Lieblgasse1
1222 Vienna
Tel: 0222/25000-7006
Fax: 0222/25000-558

Bahrain
BAMTEC
P.O. Box 10373 Mezzanine Floor
Al-Hasan Building,
Diplomatic Area Manama
Tel: 073/232220
Fax: 073/275626

Belgium
Hewlett-Packard Belgium S.A./N.V.
Blvd. de la Woluwe 100-102
B 1200 Brussels
Tel: (32/2) 778-34-17
Fax: (32/2) 778-34-14

Belize
Handled by Setisa, El Salvador

Bolivia
Handled by Conatel, Uruguay

Brazil
Hewlett-Packard Brasil
Alameda Rio Negro, 750
06454-000-Alphaville -Barueri-
Sao Paulo
HP DIRECT: 0 800 130-266
Tel: (55-11) 7296-8155/8160
Fax: (55-11) 7296-8171

Hewlett-Packard Brasil
Rua Lauro Mueller, 116
Grupo 803-Edificio Torre Rio Sul
22290-160 Botafogo
Rio de Janeiro
Tel: (55-21) 541-4404
Fax: (55-21) 295-2195

Brunei
Komputer Wisman (Sdn) Bhd
Block A, Unit 1, Ground Floor,
Abdul Razak Complex
Jalan Gadong 3180
Negara Brunei Darussalam
Tel: 673-2-423918/425603
Fax: 673-2-441492

Bulgaria
S&T Bulgaria Ltd.
Hewlett-Packard Distributor
114 Vasil Levski Blvd.
1504 Sofia
Tel: +359-2-955 9573
Fax: +359-2-955 9290

Canada
Canadian Headquarters Office
Hewlett-Packard (Canada) Ltd.
5150 Spectrum Way
Mississauga, L4W 5G1
Tel: (905) 206-4725
Fax: (905) 206-4132

Alberta
Hewlett-Packard (Canada) Ltd.
150 6th Avenue S. W.
Petro Canada Tower, Ste. 3600
Calgary, T2P 3Y7
Tel: (403) 262-0777
Fax: (403) 237-9309

Hewlett-Packard (Canada) Ltd.
10155 - 102nd Street
Commerce Place, Suite 2100
Edmonton, T5J 4G8
Tel: (403) 425-4725
Fax: (403) 420-4550

British Columbia
Hewlett-Packard (Canada) Ltd.
13575 Commerce Parkway,
Suite 110
Richmond, V6V 2L1
Tel: (604) 270-2277
Fax: (604) 270-0859

Manitoba
Hewlett-Packard (Canada) Ltd.
200 Graham Avenue, Ste. 1000
Winnipeg, R3C 4L5
Tel: (204) 942-4725
Fax: (204) 989-3553

Nova Scotia
Hewlett-Packard (Canada) Ltd.
238 Brownlow Avenue, Ste. 103
Park Place Centre
Dartmouth, B3B 1Y2
Tel: (902) 468-4725
Fax: (902) 468-4311

New Brunswick
Moncton (see Dartmouth, NS)

Newfoundland
(see Dartmouth, NS)

Ontario
Hewlett-Packard (Canada) Ltd.
252 Pall Mall Street, Suite 100
London, N6A 5P6
Tel: (519) 646-2900
Fax: (519) 432-7871

Hewlett-Packard (Canada) Ltd.
5150 Spectrum Way, H32
Mississauga, L4W 5G1
Tel: (905) 206-4725
Fax: (905) 206-4739

Hewlett-Packard (Canada) Ltd.
2670 Queensview Drive
Ottawa, K2B 8K1
Tel: (613) 820-6483
Fax: (613) 820-0377

Prince Edward Island
(see Dartmouth, NS)

Quebec
Hewlett-Packard (Canada) Ltd.
17500 Trans Canada Highway
South Service Road
Kirkland, H9J 2X8
Tel: (514) 697-4232
Fax: (514) 697-6941

Quebec City (see Kirkland, PQ)

Saskatchewan
(see Winnipeg, MB)

Chile
(Multi-Industry)
ASC. S.A.
Los Alceres 2363
Santiago
Tel: (56-2) 237-0707
Fax: (56-2) 239-7179

(Telecom)
Coasin Chile S.A.
Holanda 1292
Santiago
Tel: (562) 225-0643
Fax: (562) 274-4588

(Datacom)
Rimpex Chile
Avda. Pedro de Valdivia 1646
Santiago
Tel: 562-340-7701/7702
Fax: 562-274-4107

China, People's Republic of
Beijing
China Hewlett-Packard Co., Ltd.
5-6/F West Wing Office
China World Trade Center
No. 1 Jian Guo Men Wei Avenue
Beijing 100004 PRC
Tel: (86/10) 6505-3888
Fax: (86/10) 6505-0394
Telex: 085-22601 CTSHP CN
Cable: 1920 Beijing

Chengdu
China Hewlett-Packard Co., Ltd.
22/F Daye Mansion
No. 39 Daye Road
Chengdu 610016 PRC
Tel: (86/28) 666 3888
Fax: (86/28) 666 5377

Guangzhou
China Hewlett-Packard Co., Ltd.
7/F T.P. Plaza
9/109 Liu Hua Road
Guangzhou 510010 PRC
Tel: (86/20) 8669-3888
Fax: (86/20) 8669-5074
Telex: 44556 GPHGZ CN

Shanghai
China Hewlett-Packard Co., Ltd.
10-12/F Novel Building
887 Huai Hai Zhong Lu
Shanghai 200020 PRC
Tel: (86/21) 6467-3888
Fax: (86/21) 6467-8523
Telex: 086-33577 CHPSB CN

Shenyang
China Hewlett-Packard Co., Ltd.
12/F Shenyang Sankei Torch
Building No. 262 Shifu Road,
Shenhe District Shenyang 110013 PRC
Tel: (86/24) 2790170, 2790171
Fax: (86/24) 2790232

Xi'an Branch Office
3/F East New Technology
Trade Center A16
Yanta Lu Zhong Duan
Xi'an 710054 PRC
Tel: (86/29) 552 9379
Fax: (86/29) 552 9243

Colombia
Instrumentacion Ltda.
Calle 115 No. 11-A-10
Bogota
Tel: (57-1) 612-1313
Fax: (57-1) 612-0805

Sycom, S.A. (Datacom)
Avenida El Dorado 9010
Bogota
Tel: (57-1) 410-1303
Fax: (57-1) 410-1196

Costa Rica
Coasin Costa Rica
200 Mts. Norte, 25 Mts. Oeste
Del Centro Cultural en San Pedro
Casa # 3552
San Jose
Tel: 506-283-8325
Fax: 506-225-6349

Croatia
Hermes-Plus
Hewlett-Packard Distributor
Osekovska 18
41000 Zagreb
Tel: 38-512-331061
Fax: 38-512 331930

Cyprus
Handled by G-Systems, Greece

Czech Republic
Hewlett-Packard
Ceskoslovensko sro
Novodvorska 82
14200 Praha 414
Tel: +420-2-474 3294
Fax: +420-2-474 3293

Denmark
Hewlett-Packard A/S
Kongevejen 25
DK-3460 Birkeroed
Tel: (+45) 45-99-10-00
Fax: (+45) 45-82-06-30

Dominican Republic
Esacomp, S.A.
Calle Seminario No. 55
Ens. Piantini
Santo Domingo
Tel: (809) 563-6350
Fax: (809) 565-0332

Ecuador
Complementos Electronicos
Av. General Enriquez 1800
San Rafael
Tel: (593-2) 334257
Fax: (593-2) 331595

Egypt
ORASCOM
Onsi Sawiris & Co.
P.O. Box 1191
160, 26th July Street
Aguza/Cairo
Tel: (202) 3015287
Fax: (202) 3442615
Telex: 92768 orscm un

El Salvador
SETISA
Col. Roma
Pje. Carbonell, No. 28
San Salvador
Tel: (503) 223-0993
Fax: (503) 279-2077

Finland
Hewlett-Packard Oy
Piispankalliontie 17
02200 Espoo (Helsinki)
Tel: (09) 887 2100
Fax: (09) 8872 2923

France
Hewlett-Packard France
Test et Mesure
Z.A. de Courtaboeuf
1 Avenue du Canada
91947 Les Ulis Cedex
Tel: 01 69 29 41 14
Fax: 01 69 29 65 09

Germany
For presales assistance or general information:
Hewlett-Packard GmbH
Test & Measurement
Tel: 0180/524-6330
Fax: 0180/524-6331

Bad Homburg
Hewlett-Packard GmbH
Hewlett-Packard Strasse 1
631352 Bad Homburg

Berlin
Hewlett-Packard GmbH
Lüntzowplatz 15
10785 Berlin

Böblingen
Hewlett-Packard GmbH
Schickardstrasse 2
71034 Böblingen

Hamburg
Hewlett-Packard GmbH
Überseering 16
22297 Hamburg

Hannover
Hewlett-Packard GmbH
Baumschulenallee 20-22
30625 Hannover

Leipzig
Hewlett-Packard GmbH
Wehlitzer Strasse 2
04435 Schkeuditz

München
Hewlett-Packard GmbH
Eschenstrasse 5
82024 Taufkirchen

Nürnberg
Hewlett-Packard GmbH
Emmericher Strasse 13
90411 Nürnberg

Ratingen
Hewlett-Packard GmbH
Pempelfurt Strasse 1
40882 Ratingen

Waldbronn (Karlsruhe)
Hewlett-Packard GmbH
Hewlett-Packard Strasse 8
76337 Waldbronn

Great Britain
See United Kingdom

Greece
G-Systems
Hewlett-Packard Distributor
76, Ymittou Street
116 34 Athens
Tel: (30/1) 7264045
Fax: (30/1) 726 40 20

Guatemala
EPTEL
12 Ave. 17-35 Zona 10
Guatemala
Tel: (502) 363-0423
Fax: (502) 363-0443

Honduras
Handled by Setisa, El Salvador

Hong Kong
Hewlett-Packard Co., Ltd.
17-21/F Shell Tower,
Times Square
1 Matheson Street
Causeway Bay, Hong Kong
Tel: (852) 2599-7777
Fax: (852) 2506-9256

Hungary
Hewlett-Packard Magyarorszag
KFT. Erzsébet
királyne útja 1/c
1146 Budapest
Tel: (36) 1 3430050
Fax: (36) 1 2527441

India
Bangalore
Hewlett-Packard India Pvt. Ltd.
Embassy Point
150 Infantry Road
Bangalore 560001
Tel: (91/80) 225-3024 or
209-1808
Fax: (91/80) 225-6186
Telex: 845-2773 HP IN

Bombay
Hewlett-Packard India Pvt. Ltd.
Unit 1, B Wing
Ground Floor, Neelam Center
Hind Cycle Road, Worli,
Bombay 400 025
Tel: (91/22) 493-4722 or
493-4723
Fax: (91/22) 493-7823
Telex: 11-76812 HPIB IN

Calcutta
Hewlett-Packard India Pvt. Ltd.
708 Central Plaza
2/6 Sarat Bose Road
Calcutta 700 020
Tel: (91/33) 745 4755
Fax: (91/33) 748 571

Hyderabad
Hewlett-Packard India Pvt. Ltd.
5-9-13 Taramandal Complex
9th Floor, Saifabad
Hyderabad 500 004
Tel: (91/40) 232-679
Fax: (91/40) 220.012 or 231.756
Telex: 425-2422 HPIL IN

New Delhi
Hewlett-Packard India Ltd.
Chandiwalla Estate
Ma Anandmai Ashram Marg
Kalkaji
New Delhi 110 019
Tel: (91/11) 682-6000
Fax: (91/11) 682-6030

Indonesia
Bandung
P.T. Berca Hardayaperkasa
Jalan Tengku Angkasa No. 33
Bandung 40132
Tel: (62-22) 250-8100
Fax: (62-22) 250-6757

Jakarta
P.T. Berca Hardayaperkasa
Jalan Abdul Muis No. 62
Jakarta 10160-Indonesia
Tel: (62/21) 380 0902
Fax: (62/21) 381 2044

Iran
Evertech
11 bis, Rue Toepffer
1206 Geneve
Tel: +41-22-346 92 92
Fax: +41-22-346 86 91
Telex: 421 787

Ireland
Hewlett-Packard Ireland Ltd.
Hewlett Packard House,
Stradbrook Road
Blackrock, Co. Dublin
Tel: 01 615 8222
Fax: 01 284 5134

Israel
Computation and Measurement Systems (CMS) Ltd.
11, Hashelosha Street
Tel-Aviv 67060
Tel: 972 (03) 538-03-80
Fax: 972 (03) 537-50-55
Telex: 371234 HPCMS

Italy
For information on any products or services call: 02 92 122 241
Hewlett-Packard Italiana S.p.A.
Via G. di Vittorio 9
20063 Cernusco s/N
Milan
Tel: (39/2) 92-122-241
Fax: (39/2) 92-104 069

Napoli
Hewlett-Packard Italiana S.p.A.
Via Emanuela Gianturco, 92/G
80146 Napoli (Na)
Tel: (39/81) 73-40-100
Fax: (39/81) 73-40-216

Roma Eur
Hewlett-Packard Italiana S.p.A.
Viale del Tintoretto, 200
00142 Roma Eur
Tel: (39/6) 54-831
Fax: (39/6) 54-01-661

Torino
Hewlett-Packard Italiana S.p.A.
Via Praglia, 15
10044 PIANEZZA TO
Tel: (39/11) - 9685.1
Fax: (30/11) - 968.5899

Japan
For presale assistance in product selection and other product or general information:
Hewlett-Packard Japan Ltd.
Test & Measurement
Measurement Assistance Center
Tel: 81-426-56-7832
Fax: 81-426-56-7840

Aichi
Hewlett-Packard Japan Ltd.
Nagoya Kokusai Center Bldg.
1-47-1 Nakono Nakamura-ku,
Nagoya-shi
Aichi 450

Hewlett-Packard Japan Ltd.
Nakane- Nissei Bldg.
4-25-18 Nishi-machi,
Toyota-shi
Aichi 471

Akita
Hewlett-Packard Japan Ltd.
Nihonseimei Akita Chuodori Bldg.
4-2-7 Nakadori, Akita-shi
Akita 010

Chiba
Hewlett-Packard Japan Ltd.
WBG Malibu East Bldg. 19F
2-6 Nakase
Mihama-ku, Chiba-shi
Chiba 261-71

Fukuoka
Hewlett-Packard Japan Ltd.
Daisan Hakata-Kaisei Bldg.
1-3-6 Hakataekiminami
Hakata-ku, Fukuoka-shi,
Fukuoka 812

Hiroshima
Hewlett-Packard Japan Ltd.
Nissei-Heiwakoen Bldg.
3-25 Nakajima-cho Naka-ku,
Hiroshima-shi, Hiroshima 730

Hokkaido
Hewlett-Packard Japan Ltd.
Sumitomo-seimei
Sapporo Chuo Bldg.
1-1-14 Minaminijo-higashi
Chuo-ku, Sapporo-shi,
Hokkaido 060

Hyogo
Hewlett-Packard Japan Ltd.
1-3-2 Muroya Nishi-ku, Kobe-shi
Hyogo 651-22

Kanagawa
Hewlett-Packard Japan Ltd.
9-32 Tamuracho, Atsugi-shi
Kanagawa 243

Hewlett-Packard Japan Ltd.
3-2-2 Sakado
Takatsu-ku, Kawasaki-shi
Kanagawa 213

Ibaraki
Hewlett-Packard Japan Ltd.
Mito Yomiuri-Kaikan Bldg.
2-4-2 Minami-machi, Mito-shi
Ibaraki 310

Hewlett-Packard Japan Ltd.
Tsukuba-Mitsui Bldg.
1-6-1 Takezono, Tsukuba-shi
Ibaraki 305

Ishikawa
Hewlett-Packard Japan Ltd.
Kanazawa MK Bldg,
98-8 Sainen-machi,
Kanazawa-shi, Ishikawa 920

Kyoto
Hewlett-Packard Japan Ltd.
Maeda SN Bldg.
518 Akinono-cho Nijyo-Kudaru
Karasuma, Nakagyo-ku
Kyoto 604

Miyagi
Hewlett-Packard Japan Ltd.
Yamaguchi Bldg.
1-1-31 Ichibancho Aoba-ku,
Sendai-shi, Miyagi 980

Nagano
Hewlett-Packard Japan Ltd.
Forum Honjo Bldg
2-4-1 Honjo,
Matsumoto-shi, Nagano 390

Osaka
Hewlett-Packard Japan Ltd.
Chuo Bldg.
5-4-20 Nishinakajima
Yodogawa-ku,
Osaka-shi, Osaka 532

Saitama
Hewlett-Packard Japan Ltd.
Mitsui-seimei Omiya
Miyamachi Bldg. 2-96-1
Miyamachi, Omiya-shi
Saitama 330

Hewlett-Packard Japan Ltd.
Nissei-Kumagaya Bldg.
2-42 Miya-machi, Kumagaya-shi
Saitama 360

Shizuoka
Hewlett-Packard Japan Ltd.
Kawasei-Rinkyo Bldg.
6-6 Hosojima-cho
Hamamatsu-shi
Shizuoka 435

Tochigi
Hewlett-Packard Japan Ltd.
Chiyodaseimei-Utsunomiya Bldg.
2-3-1 Odori, Utsunomiya-shi
Tochigi 320

Tokyo
Hewlett-Packard Japan Ltd.
NAF Bldg.
3-8-20 Takaido-higashi,
Suginami-ku
Tokyo 168

Hewlett-Packard Japan Ltd.
9-1 Takakura-cho, Hachioji-shi
Tokyo 192

Jordan
Scientific & Medical Supplies Co.
P.O. Box 1387
Amman
Tel: (962/6) 62-49-07
Fax: (962/6) 62-82-58
Telex: 21456 sabco jo

Korea
Seoul
Hewlett-Packard Korea Ltd.
HP Korea House
25-12, Yoido-dong
Youngdeung po-ku
Seoul, 150-010
Tel: (82/2) 769-0114
Fax: (82/2) 784-7084

Taegu
Hewlett-Packard Co. Ltd.
18/F Young Nam Tower B/D
111, Shin Cheon-dong, Dong-Gu
Taegu
Tel: (82/53) 754-2666
Fax: (82/53) 752-4696

Taejeon
Hewlett-Packard Co. Ltd.
8/F Hyundai B/D
1298 Doonsan-dong
Seo-gu, Taejon
Tel: (82/42) 480-2800-7
Fax: (82/42) 480-2828

Kuwait
Al-Khaldiya Electronics & Electricals Equipment Co.
P.O. Box 830
Safat 13009
Tel: (965) 48 13 049
Fax: (965) 48 12 983

Lebanon
Computer Information Systems C.I.S.
Lebanon Street, Chammas Bldg.
P.O.Box 11-6274
Dora-Beirut
Tel: (961/1) 405-413
Fax: (961/1) 601.906
Tel/fax: (3579) 514-256 (Cyprus based line)
Telex: 42309 chacis le

Malawi
Handled by HiPerformance, South Africa

Malaysia
Kuala Lumpur
Hewlett-Packard Sales (M) Sdn Bhd Ground Floor,
Wisma Cyclecarri
288 Jalan Raja Laut
50350 Kuala Lumpur
Tel: 1-800-88-8848 Toll Free
Fax: (60/3) 298-9157

Penang
Hewlett-Packard Sales (M) Sdn Bhd Bayan Lepas Free Trade Zone
11900 Bayan Lepas
Penang
Tel: (60/4) 642-3502
Fax: (60/4) 642-3511

Mauritus
Handled by HiPerformance, South Africa

Mexico
Hewlett-Packard de Mexico, S.A. de C.V.
Prolongacion Reforma No.700
Col. Lomas de Santa Fe
01210 Mexico D.F.
Tel: (525) 258-4389/258-4392
Fax: (52-5) 258-4301
HP-DIRECT: 01-800-506-4800

Morocco
SICOTEL
Complexe des Habous
Tour C, Avenue des Far
Casablanca 01
Tel: +212 (02) 31-22-70
Fax: +212 (02) 31-65-45
Telex: 27604

Mozambique
Handled by HiPerformance,
South Africa

Namibia
Handled by HiPerformance,
South Africa

The Netherlands
Hewlett-Packard Nederland B.V.
Postbus 667
1180 AR Amstelveen
Tel: (31-20) 547 6669
Fax: (31-20) 547 7765

New Zealand
Hewlett-Packard (N.Z.) Ltd.
186-190 Willis Street
Wellington
Tel: (64/4) 802-6800
Fax: (64/4) 802-6881

Nicaragua
Handled by Setisa, El Salvador

Nigeria
Management Information
Systems Co. Ltd.
3, Gerrard Road, Ikoyi
P.O. Box 53386
Lagos
Tel: (2341) 269.34.23
Fax: (2341) 269.34.19
Telex: 23582 DATEC NG

Norway
Hewlett-Packard Norge AS
Drammensveien 169
Postboks 60 Skóyen
N-0212 Oslo
Tel: (47) 22-73-57-59
Fax: (47) 22-73-56-19

Oman
IMTAC LLC
P.O. Box 51196
Al Hayek Street
Mina Al Fahal
Muscat
Tel: (968) 707-727
(968) 707-723
Fax: (968) 796-639
(968) 797-709

Pakistan
Islamabad
Mushko Electronics (PVT) Ltd.
68-W, Sama Plaza
Blue Area G-7
Islamabad 44000
Tel: 92-51-828-459/810-950
Fax: 92-51-816-190
Telex: 54001 Muski Pk

Karachi
Mushko Electronics (PVT) Ltd
Oosman Chambers
Abdullah Haroon Road
Karachi 74400
Tel: 92-21-566-0490
Fax: 92-21-566-0801
Telex: 29094 MUSKO PK

Panama
Electronico Balboa, S.A.
Edif. El Dorado
Ave El Paiscal #30
Apartado 4929
Panama 5
Tel: (507) 236-0722
Fax: (507) 236-1820

TT&A
Calle 51 y Manuels Maria Icaza
Campo Alegre Edf. Magna Corp.
5to piso, Ofc. 513 Aptdo. 6-8308
Panama 5
Tel: 507-223-8136
Fax: 507-223-8141

Paraguay
Handled by Conatel, Uruguay

Peru
Coasin Peru S.A.
Calle 1-No. 891 CORPAC
Lima 27
Tel: 511 224 3380
Fax: 511 224 1509

SATEL S.A.
Enrique Palacios No. 155
Lima 18
Tel: (511) 4462253
Fax: (511) 4440305

Philippines
Hewlett-Packard Philippines
Corporation, 9th floor,
Rufino Pacific Tower
6784 Ayala Avenue,
Makati City 1229
Tel: (63-2) 894-1451
Fax: (63-2) 811-1080, 811-0635
TMO Online Sales:
(63-2) 893-9959

Poland
Hewlett-Packard Polska
Ochota Park Office
Aleje Jerozolimskie 181
02-222 Warszawa
Tel: +48 (022) 6087700
Fax: +48 (022) 6087600

Portugal
Hewlett-Packard Portugal S.A.
Av. Marginal, Ed. Parque Oceano
Piso 5º-G-Stº Amaro de Oeiras
2780 Oeiras
Tel: (353/1) 482 8500
Fax: (353/1) 441 7071

Puerto Rico
Hewlett-Packard Puerto Rico
(3175) Centro Europa
1492 Ponce de Leon Avenue,
Suite 203 Santurce, 00907
Tel: (809) 289-8900
Fax: (809) 289-8925

TeleNetworks Inc.
189-2 O'Neill Street
Hato Rey, 00918
Tel: (787) 766-2829
Fax: (787) 764-4673

Qatar
Qatar Datamations Systems
Al Ahed Building, 5th floor
Al Muthaf Street
Doha
Tel: 974/43.99.00
Fax: 974/43.21.54
Telex: 4833

Romania
S&T Romania SRL
Centrul Sitraco-Plata Unirii
Bd. Dimitrie Cantemir 1
Et. II-210, Bucuresti
Tel: (40/1) 3307320
(40/1) 3307217
(40/1) 3307218
Service Hot Line: (40/1) 3307300
Fax: (40/1) 3307310

Russia/CIS
Hewlett-Packard Company
Representative Office
Kosmodamianskaya naberzhnaya
52, blgd. 1
113054 Moscow
Tel: +7 (095) 9169811
Fax: +7 (095) 9169848

Saudi Arabia
Modern Electronics Establishment
P.O. Box 22015
Al Nimer Building
Olaya Street
Riyadh 11495
Tel: (01) 4624266
Fax: (01) 4624404

Singapore
Hewlett-Packard Singapore
(Sales) Pte. Ltd
450 Alexandra Road
Singapore 119 960
Tel: 1800-292-8100
Fax: (65) 275-9841

Slovakia
S&T Slovakia
Hewlett-Packard Distributor
Polianky 5
SK 844 J4 Bratislava
Tel: 42 (07) 765896
Fax: 42 (07) 763408

Slovenia
Hermes-Plus
Hewlett-Packard Distributor
Slandrova 2
1231 Ljubljana-Crnuce
Tel: (386) 61-1895 200
Fax: (386) 61 1895 201

South Africa
Hewlett-Packard South Africa
(Pty.) Ltd
HP DIRECT
Private Bag
Wendywood 2144
Tel: 0800-11 6838
Fax: 27-11-8061213

Spain
Barcelona
Hewlett-Packard Española, S.A.
Avda. Diagonal, 605
08028 Barcelona
Tel: 34-3-401 9100
Fax: 34-3-430 8468

Bilbao
Hewlett-Packard Española, S.A.
Avda de Zugazarte
Helett-Packard Española, S.A.
Avda de zugazarte, 8
Edif El Abra, 4
48930 Las Arenas, Guecho
Tel: 34-6-398 2200
Fax: 34-6-398 2230

Madrid
Hewlett-Packard Española, S.A.
Crta N-VI km 16.500
28230 Las Rozas, Madrid
Tel: (34/91) 6311323
Fax: (34/91) 6311469

Sevilla
Hewlett-Packard Española, S.A.
Avda. Luis de Morales, 32
Edificio Forum, planta 3ª,
mòdulo1 41018 Sevilla
Tel: 34-5-455 2600
Fax: 34-5-455 2626

Valencia
Hewlett-Packard Española, S.A.
Plaza de América, 2 2 B
Edificio Zurich
46004 Valencia
Tel: 34-6-398 2200
Fax: 34-6-398 2230

Sri Lanka
Precision Technical Services (Pvt.)
Ltd., No. 2, R.A. De Mel Mawatha
Colombo 00500
Tel: (941) 597-860
Fax: (941) 597-863

Sweden
Kista
Hewlett-Packard Sverige AB
Skalholtsgatan 9
164 97 Kista
Tel: (46/8) 444 2277
Fax: (46/8) 444 2525

Göteborg
Hewlett-Packard Sverige AB
Vädursgatan 6
Box 5328
402 27 Göteborg
Tel: (46/31) 351 800
Fax: (46/31) 773 9742

For the latest updates and additions to this listing, visit HP's website:
http://www.hp.com/go/tmc98

Switzerland
Berne
Hewlett-Packard (Schweiz) AG
Meriedweg 11
3172 Niederwangen
(Berne)
Tel: 01-735-7236
Fax: 01-735-7703

Geneva
Hewlett-Packard (Suisse) SA
39, rue de Veyrot
1217 Meyrin 1
Tel: 022-780 41 11
Fax: 022-780 41 80

Zürich
Hewlett-Packard (Schweiz) AG
In der Luberzen 29
8902 Urdorf/Zürich
Tel: 01-735 7236
Fax: 01-735 7703

Taiwan, ROC
Hewlett-Packard Taiwan Ltd.
Hewlett-Packard Building
8/F No. 337, Fu Hsing North Road
Taipei, 10483
Tel: (886/2) 712-0404
Fax: (886/2) 718-9860

Chungli
Hewlett-Packard Taiwan Ltd.
No. 20 Kao-Shuang Road
Ping-Chen, 32404
Taoyuan Hsieh
Tel: (886/3) 492-9666
Fax: (886/3) 492-9669

Kaohsiung
Hewlett-Packard Taiwan Ltd.
12/F,10, Su Wei 4 Road
Lin-Ya District
Kaohsiung
Tel: (886/7) 330-1199
Fax: (886/7) 330-8568

Taichung
Hewlett-Packard Taiwan Ltd.
10F, 540, Sec. 1
Wen-Hsin Road
Taichung
Tel: (886/4) 327-0153
Fax: (886/4) 326-5274

Thailand
Hewlett-Packard (Thailand) Ltd.
23rd - 25th floor Vibulthani Tower
2 3199 Rama IV Road
Klong Toey, Bangkok 10110
Tel: (66/2) 661-3900
Fax: (66/2) 661-3946

Tunisia
Precision Electronique
5, rue de Chypre
Mutuelle Ville
1002 Tunis Belvedere
Tel: (216/1) 785-037
(216/1) 890-672
Fax: (216/1) 780-241
Telex: (0409) 18238 TELEC
TN

Turkey
Hewlett-Packard
Bilgisayar ve Olcum
Sistemleri A.S.
Karum Business Center, Suite 461
Iran Caddesi 21
06680 Kavaklidere
Ankara
Tel: (90/312) 468 87 70
Fax: (90/312) 468 87 78

Ukraine
S&T Ukraine Ltd
50, Popudrenko Str.
253094 Kiev
Tel: 380 (44) 513 6020 or
559 4763
Fax: 380 (44) 559 5033

United Arab Emirates
Abu Dhabi
Emitac Ltd.
P.O. Box 2711
Abu Dhabi
Tel: (971/2) 77-04-20
Fax: (971/2) 72-30-58
Telex: 46306

Dubai
Emitac Ltd.
Block 'B' Arenco Bldg.
Zabel Road
P.O. Box 8391
Dubai
Tel: (971/4) 37-75-91
Fax: (971/4) 37-08-99
Telex: 48710

United Kingdom
Hewlett-Packard Limited
Cain Road
Bracknell
Berkshire RG12 1HN
Tel: 01344 366666
Fax: (44/1344) 362852

United States
To request formal quotations, place orders, and other order information:
Test & Measurement Customer
Business Center
P.O. Box 4026
Englewood, CO 80155-4026
Tel: 1-800-829-4444

For presale assistance in product selection and other product or general information:
Test & Measurement Customer
Call Center
Tel: 1-800-452-4844

To request quotations or place orders for a U.S. government agency:
Hewlett-Packard
U.S. Government Business Center
P.O. Box 1487
Rockville, MD 20849-1487
Tel: (800) 468-8347
Fax: (800) 437-1085

Alabama
Hewlett-Packard Co. (3114)
935 Explorer Boulevard
Huntsville, AL 35806
Tel: (205) 971-2000
Fax: (205) 971-8899

Arizona
Hewlett-Packard Co. (2401)
8080 Pointe Parkway West
Phoenix, AZ 85044
Tel: (602) 273-8000
Fax: (602) 273-8022
(602) 273-8080

Hewlett-Packard Co. (2406)
3400 East Britannia Drive
Bldg. C, Suite 130
Tucson, AZ 85706
Tel: (602) 573-7400
Fax: (602) 573-7429

California
Hewlett-Packard Co. (2403)
1421 S. Manhattan Avenue
Fullerton, CA 92631
Tel: (714) 999-6700
Fax: (714) 758-7559

Hewlett-Packard Co. (2438)
130 Cremona, Suite A
Goleta, CA 93117
Tel: (805) 685-6100
Fax: (805) 685-6163

Irvine (see Fullerton)

Hewlett-Packard Co. (2417)
5245 Pacific Concourse Drive,
Suite 100
Los Angeles, CA 90045
Tel: (310) 643-5112
Fax: (310) 535-2601

Hewlett-Packard Co. (2426)
351 E. Evelyn Avenue,
Bldg. 333
Mountain View, CA 94041
Tel: (415) 694-2000
Fax: (415) 694-3594

Hewlett-Packard Co. (2415)
3831 N. Freeway Blvd., Bldg.C,
Suite 100
Sacramento, CA 95834
Tel: (916) 567-8500
Fax: (916) 567-8777

Hewlett-Packard Co. (2425)
50 Fremont Street, Suite 200
San Francisco, CA 94105
Tel: (415) 882-6800
Fax: (415) 882-6804

Hewlett-Packard Co. (2404)
9606 Aero Drive
San Diego, CA 92123
Tel: (619) 279-3200
Fax: (619) 268-8487
(619) 279-0560

Santa Barbara (see Goleta)

Hewlett-Packard Co. (2428)
5805 Sepulveda Blvd, Suite 800
Van Nuys, CA 91411
Tel: (818) 786-5800
Fax: (818) 779-2350

Ventura (see Van Nuys)

Colorado
Hewlett-Packard Co. (2441)
3005 Center Green Drive,
Suite 205
Boulder, CO 80301
Tel: (303) 938-3065
Fax: (303) 938-3025

Hewlett-Packard Co. (2411)
24 Inverness Place East
Englewood, CO 80112
Tel: (303) 649-5000
Fax: (303) 649-5787

Connecticut
Hewlett-Packard Co. (4458)
115 Glastonbury Blvd.
Glastonbury, CT 06033
Tel: (203) 633-8100
Fax: (203) 659-6087

Hewlett-Packard Co. (4457)
263 Tresser Blvd., 9th Floor
Stamford, CT 06901
Tel: (203) 324-1003
Fax: (203) 325-5680

District of Columbia
(see Rockville, MD)

Florida
Hewlett-Packard Co. (3179)
5900 N. Andrews, Suite 100
Fort Lauderdale, FL 33309
Tel: (305) 938-9800
Fax: (305) 938-2397

Hewlett-Packard Co. (3177)
6177 Lake Ellenor Drive
Orlando, FL 32809
Tel: (407) 859-2900
Fax: (407) 826-9295

Hewlett-Packard Co. (3166)
5550 Idlewild, Suite 150
Tampa, FL 33634
Tel: (407) 859-2900
Fax: (407) 826-9295

Georgia
Hewlett-Packard Co. (3108)
20 Perimeter Summit Blvd.
Atlanta, GA 30319
Tel: (404) 648-0000
Fax: (404) 648-7010

Hawaii
Hewlett-Packard Co. (2409)
3660 Waialae Ave, Suite 102
Honolulu, HI 96816
Tel: (808) 732-1566
Fax: (808) 739-3100

Illinois
Hewlett-Packard Co. (2619)
303 N. Hershey Road
Bloomington, IL 61704
Tel: (309) 664-4000
Fax: (309) 664-4100

Hewlett-Packard Co. (2601)
25 Northwest Point
Elk Grove Village, IL 60007
Tel: (708) 342-2000
Fax: (708) 342-2022

Hewlett-Packard Co. (2603)
1200 East Diehl Road
Naperville, IL 60566
Tel: (708) 245-3000
Fax: (708) 245-3600

Indiana
Hewlett-Packard Co. (2635)
111 E. Ludwig Road, Suite 108
Ft. Wayne, IN 46825
Tel: (219) 480-3700
Fax: (219) 480-3730

Hewlett-Packard Co. (2605)
201 W. 103rd Street, Suite 100
Indianapolis, IN 46290
Tel: (317) 582-4400
Fax: (317) 582-4500

Iowa
Hewlett-Packard Co. (2612)
4050 River Center Court
Cedar Rapids, IA 52402
Tel: (319) 393-0606
Fax: (319) 378-6226

Kansas
Hewlett-Packard Co. (2622)
P.O. Box 780408
3450 N. Rock Road, Suite 300
Wichita, KS 67226
Tel: (316) 636-4040
Fax: (316) 636-4966

Kentucky
Hewlett-Packard Co. (2623)
305 N. Hurstbourne Parkway,
Suite 100
Louisville, KY 40222-5141
Tel: (502) 329-4800
Fax: (502) 329-4890

Maryland
Hewlett-Packard Co. (4432)
3701 Koppers Street
Baltimore, MD 21227
Tel: (410) 644-5800
Fax: (410) 362-7650

Hewlett-Packard Co. (4430)
2101 Gaither Road
Rockville, MD 20850
Tel: (301) 258-2000
Fax: (301) 258-5986

Massachusetts
Hewlett-Packard Co. (4450)
29 Burlington Mall Road
Burlington, MA 01803-4182
Tel: (781) 270-7000
Fax: (781) 221-5240

Michigan
Hewlett-Packard Co. (2607)
39550 Orchard Hill Place Drive
Novi, MI 48376
Tel: (810) 380-2100
Fax: (810) 380-2450

Hewlett-Packard Co. (2617)
3033 Orchard Vista S.E.,
Suite 100
Grand Rapids, MI 49546
Tel: (616) 975-3200
Fax: (616) 975-3290

Minnesota
Hewlett-Packard Co. (2606)
2025 W. Larpenteur Avenue
St. Paul, MN 55113
Tel: (612) 644-1100
Fax: (612) 641-9787

Missouri
Hewlett-Packard Co. (2611)
6601 Winchester Avenue
P.O. Box 18230
Kansas City, MO 64133-8230
Tel: (816) 737-0071
Fax: (816) 737-4690

Hewlett-Packard Co. (2610)
530 Maryville Centre Drive
St. Louis, MO 63141
Tel: (314) 542-1500
Fax: (314) 542-1585

Nebraska
Hewlett-Packard Co. (2616)
2533 N. 117th Avenue
Omaha, NE 68164
Tel: (402) 493-0300
Fax: (402) 491-6230

New Jersey
Hewlett-Packard Co. (4415)
West 120 Century Road
Paramus, NJ 07653
Tel: (201) 599-5000
Fax: (201) 599-5629

Hewlett-Packard Co. (4417)
20 New England Ave. West
Piscataway, NJ 08854
Tel: (908) 562-6100
Fax: (908) 562-6406

New Mexico
Hewlett-Packard Co. (2402)
5130 Masthead NE
Albuquerque, NM 87109
Tel: (505) 823-6100
Fax: (505) 823-1243

Hewlett-Packard Co. (2420)
1362-C Trinity Drive
Los Alamos, NM 87544
Tel: (505) 662-6700
Fax: (505) 662-4312

New York
Hewlett-Packard Co. (4444)
114 Great Oaks Office Park
Albany, NY 12203
Tel: (518) 452-9947
Fax: (518) 452-8989

Buffalo (see Cheektowaga)

Hewlett-Packard Co. (4445)
Airport Commerce Park
305 Cayuga Road, Suite 160
Cheektowaga, NY 14225
Tel: (716) 264-4100
Fax: (716) 264-4150

Hewlett-Packard Co. (4440)
5010 Campuswood Drive
East Syracuse, NY 13057
Tel: (315) 463-2727
Fax: (315) 463-3150

Hewlett-Packard Co. (4442)
290 Woodcliff Drive
Fairport, NY 14450
Tel: (716) 264-4000
Fax: (716) 264-4150

Hewlett-Packard Co. (4409)
300 Westage Business Center,
Suite 200
Fishkill, NY 12524
Tel: (914) 897-1660
Fax: (914) 897-1698

Huntington (see Melville)

Hewlett-Packard Co. (4411)
7 Corporate Center Drive
Melville, NY 11747
Tel: (516) 753-0555
Fax: (516) 753-3438

Hewlett-Packard Co. (4412)
399 Park Avenue, 26th Floor
New York, NY 10022
Tel: (212) 350-6700
Fax: (212) 350-6810

Rochester (see Fairport)

North Carolina
Hewlett-Packard Co. (3142)
2000 Regency Parkway, Suite 600
Cary, NC 27511
Tel: (919) 467-6600
Fax: (919) 460-2296

Hewlett-Packard Co. (3145)
9401 Arrowpoint Blvd., Suite 100
Charlotte, NC 28273
Tel: (704) 527-8780
Fax: (704) 559-7444

Hewlett-Packard Co. (3111)
426 Gallimore Dairy Road,
Suite A
Greensboro, NC 27409
Tel: (910) 665-1800
Fax: (910) 668-1797

Raleigh (see Cary)

Ohio
Hewlett-Packard Co. (2624)
4501 Erskine Road
Cincinnati, OH 45242
Tel: (513) 985-6200
Fax: (513) 985-6300

Cleveland (see Strongsville)

Hewlett-Packard Co. (2614)
540 Office Center Place
Columbus, OH 43230-5321
Tel: (614) 478-6200
Fax: (614) 478-6299

Hewlett-Packard Co. (2604)
7887 Washington Village Drive
Dayton, OH 45459
Tel: (513) 291-7500
Fax: (513) 291-7600

Hewlett-Packard Co. (2608)
15885 Sprague Road
Strongsville, OH 44136
Tel: (216) 243-7300
Fax: (216) 234-7230

Oklahoma
Hewlett-Packard Co. (3182)
3525 NW 56th Street, Suite C100
Oklahoma City, OK 73112
Tel: (405) 946-9499
Fax: (405) 948-4760
Fax: (405) 948-4706

For the latest updates and additions to this listing, visit HP's website:
http://www.hp.com/go/tmc98

Hewlett-Packard Co.(3183)
6655 South Lewis, Suite 105
Tulsa, OK 74136
Tel: (918) 481-2285
Fax: (918) 481-2250

Oregon
Hewlett-Packard Co. (2413)
15115 S.W. Sequoia Parkway,
Suite 100
Portland, OR 97224
Tel: (503) 598-8000
Fax: (503) 598-8155

Pennsylvania
Hewlett-Packard Co. (2609)
111 Zeta Drive
Pittsburgh, PA 15238
Tel: (412) 782-0400
Fax: (412) 784-3340

Hewlett-Packard Co. (4420)
1400 Morris Drive, Suite 300
Wayne, PA 19087-5580
Tel: (610) 408-6000
Fax: (610) 408-6034

Tennessee
Hewlett-Packard Co. (3117)
404 BNA Drive
Bldg. 200, Suite 510
Nashville, TN 37217
Tel: (615) 367-4700
Fax: (615) 399-4616

Texas
Hewlett-Packard Co. (3197)
10415 III Morado Circle,
Suite 100
Austin, TX 78759
Tel: (512) 346-3855
Fax: (512) 338-7201

Dallas (see Richardson)

Hewlett-Packard Co. (2405)
4050 Rio Bravo, Suite 115
El Paso, TX 79902
Tel: (915) 485-9400
Fax: (915) 485-9420

Hewlett-Packard Co. (3187)
2000 West Loop South
Houston, TX 77027
Tel: (713) 439-5300
Fax: (713) 439-5495

Hewlett-Packard Co. (3185)
930 E. Campbell Road
Richardson, TX 75081
Tel: (214) 231-6101
Fax: (214) 699-4337

Hewlett-Packard Co. (3188)
14100 San Pedro Avenue,
Suite 100
San Antonio, TX 78232
Tel: (210) 494-9336
Fax: (210) 491-1299

Utah
Hewlett-Packard Co. (2412)
348 E. Winchester, Suite 100
Salt Lake City, UT 84107
Tel: (801) 265-6200
Fax: (801) 265-6390

Virginia
Chesapeake (see Glen Allen)

Hewlett-Packard Co. (4435)
3141 Fairview Park Drive,
Suite 300
Falls Church, VA 22042
Tel: (703) 204-2100
Fax: (703) 204-2425

Hewlett-Packard Co. (3113)
4401 Waterfront Drive, Suite 150
Glen Allen, VA 23060
Tel: (804) 747-7750
Fax: (804) 965-9297

Norfolk (see Glen Allen)

Richmond (see Glen Allen)

Roanoke (see Glen Allen)

Washington
Hewlett-Packard Co. (2410)
15815 S.E. 37th Street
Bellevue, WA 98006
Tel: (206) 643-4000
Fax: (206) 643-8748

Wisconsin
Hewlett-Packard Co. (2615)
250 North Patrick Blvd., Suite 100
Brookfield, WI 53045
Tel: (414) 879-2200
Fax: (414) 879-2218

Uruguay
Conatel S.A.
Ejido 1690
(11200) Montevideo
Tel: (598) 2 92 0314
Fax: (598) 2 93 2516

Venezuela
Hewlett-Packard de Venezuela
3ra. Transversal, Los Ruices Norte
Edificio Segre, Piso 3
Caracas
Tel: (58-2) 207-8357
Fax: (58-2) 207-8361

Vietnam
Hanoi
System Interlace Company
39 Mai Hac De Street
Hai Ba Trung District
Hanoi
Tel: (84-4) 822 9808/9
Fax: (84-4) 822 9553

Yugoslavia
IBIS Instruments
Pariske komune 22
11070 N. Beograd
Tel: 381-11-609650
Fax: 381-11-699627

Zambia
Handled by HiPerformance,
South Africa

Zimbabwe
Handled by HiPerformance,
South Africa

Service Centers 20

599

Asia Pacific

Australia
Hewlett-Packard Calibration Services
Australia, Ltd.
31-41 Joseph Street
Blackburn, Victoria
Tel: (1800) 802-540
Fax: (1800) 681-776

China
China Hewlett-Packard Co., Ltd.
5-6/F West Wing Office
China World Trade Center
No. 1 Jian Guo Men Wai Avenue
Beijing 100004
Tel: (8610) 6505-3888
Fax: (8610) 6505-0394

China Hewlett-Packard Co., Ltd.
Shanghai Branch Office
10-12/F, Yengxin Building
887 Huaihai Zhong Road,
Shanghai
Tel: (8621) 646 76 368
Fax: (8621) 646 75 868

Hong Kong
Hewlett-Packard Co., Ltd.
17-21/F Shell Tower,
Times Square,
1 Matheson Street,
Causeway Bay, Hong Kong
Tel: (852) 25 997 777
Fax: (852) 25 069 261

India
Hewlett-Packard India Ltd.
Embassy Point,
150, Infantry Road,
Bangalore 560 001
Tel: (9180) 220 33 80
Tel: (9180) 225 12 54
Fax: (9180) 225 61 86

Japan
Hewlett-Packard Japan Ltd.
27-15, Yabe 1-Chome,
Sagamihara, Kanagawa 229
Tel: (81427) 594 170
Fax: (81427) 593 846

Korea
Samsung Hewlett-Packard Co., Ltd.
7~8/F, Yoohwa Building,
23-7, Yoido-dong, Youngdeung po-ku
Seoul 150-010
Tel: (822) 3770-0400
Fax: (822) 3770-0444

Malaysia
Hewlett-Packard Sales (Malaysia), Sdn Bhd
No. 1, First Floor, Jalan 215
Off Jalan Kilang (51/206)
Section 51, 46050 Petaling Jaya
Selangor Darul Ehsan
Tel: (603) 794-0000
Fax: (603) 795-2950

New Zealand
Hewlett-Packard (N.Z.) Ltd.
186-190 Willis Street
P.O. Box 9443
Wellington
Tel: (64/4) 382-0400
Fax: (64/4) 384-3380

Philippines
Hewlett-Packard Phillipines Co.
150 Beach Road
9th Fl., Rufino Pacific Towers,
6784 Ayaia Avenue, Makati,
Metro Manila
Tel: (632) 894-1451
Fax: (632) 811-0635

Singapore
Hewlett-Packard Singapore (Sales) Pte, Ltd.
150 Beach Road
Block 4, Pasir Panjang Road,
#01-01, Alexandra Distripark,
118491
Tel: (65) 375 8350
Fax: (65) 273 1146

Taiwan
Hewlett-Packard Taiwan Ltd.
THM area
20, Kao Shuang Road,
Ping Chen, Tao-Yuan
Tel: (8863) 492 9666
Fax: (8863) 492 0779

Thailand
Hewlett-Packard (Thailand) Ltd.
23-25/F, Vibulthani Tower II
3199 Rama 4 Road, Klongtan
Klongtoey, Bangkok 10110
Tel: (662) 661 39 00-34
Fax: (662) 661 38 94

Europe

Austria
Hewlett-Packard Ges.m.b.H
Service Test & Measurement
Lieblgasse 1
1222 Vienna
Tel: 01-25000-7000
Fax: 01-25000-500

Belgium
Hewlett-Packard Belgium S.A./N.V.
Boulevard de la Woluwe 100/102
B 1200 Brussels
Tel: (32/2) 778-34-17
Fax: (32/2) 778-34-14

Denmark
Hewlett-Packard A/S
Kongevejen 25
DK-3460 Birkerod
Tel: (45) 45-99-12-88
Fax: (45) 45-82-06-30

Finland
Hewlett-Packard Oy
P.O. Box 68
02201 Espoo
Street Address:
Piispankalliontie 17
02200 Espoo
Finland
Tel: 358-9-8872 2360
Fax: 358-9-8872 2379

France
Hewlett-Packard France
Z.A. de Courtaboeuf
1, Avenue du Canada
91947 Les Ulis Cedex
Tel: (33) 1 69 82 6669
Fax: (33) 1 69 82 6230

Germany
Hewlett-Packard GmbH
Service Test & Measurement
Schickardstrasse 2
70134 Böblingen
Tel: 0180-524-6337
Fax: 0180-524-6338

Great Britain
Hewlett-Packard Ltd.
Test & Measurement Support
Eskdale Road
Winnersh Triangle
Wokingham
Berkshire RG41 5DZ
Tel: 01-344-366777
Fax: 01-344-366770

Italy
Hewlett-Packard Italiana S.p.A.
Via Giuseppe di Vittorio, 9
20063 Cernusco sul Naviglio,
Milano
Tel: (39/2) 92-121
Fax: (39/2) 92-104-069

Norway
Hewlett-Packard Norge AS
Drammensveien 169
P.O. Box 60 Skoeyen
N-0212 Oslo
Tel: +47-2273-5600
Fax: +47-2273-5610

Spain
Hewlett-Packard Española, S.A.
Carretera N-VI km 16,5 00
28230 Las Rozas
Madrid
Tel: (34/91) 631-13-23
Fax: (34/91) 631-14-69

Sweden
Hewlett-Packard Sverige AB
Skalholtsgatan 9
S-164 97 Kista
Tel: (46/8) 444-2000
Fax: (46/8) 444-2666

Switzerland
Hewlett-Packard (Schweiz) AB
Test & Measurement
Meriedweg 11
3172 Niederwangen/Berne
Tel: 031-980-32 57
Fax: 031-980-33 95

The Netherlands
Hewlett-Packard Nederland B.V.
Postbox 667
1180 AR Amstelveen
Tel: (31/20) 547-6669
Fax: (31/20) 647-8706

Latin America

Argentina
Hewlett-Packard Argentina
Montaneses 2140
1428 Buenos Aires
Tel: (54 1) 787 7294
Fax: (54 1) 787 7263

Brazil
Edisa Hewlett-Packard S.A.
Av. Aruana 125 – Tambor
Barueri – SP
06460-000
Tel: (55-11) 7296-4771
Fax: (55-11) 7296-4734

Mexico
Hewlett-Packard de Mexico, S.A. de C.V.
Prolongacion Reforma No. 700
Co. Lomas de Santa Fe
01210 Mexico, D.F.
Tel: (52-5) 326-4306
Fax: (52-5) 326-4301

Venezuela
Hewlett-Packard de Venezuela
3ra, Transversal Los Ruices Norte
Edificio Segre Pisos 1, 2 y3
Caracas 1071
Tel: (58-2) 239-4244
Fax: (58-2) 238-4008
(58-2) 239-3080

For the latest updates and additions to this listing, visit HP's website:
http://www.hp.com/go/tmc98

North America

Canada

Alberta
Hewlett-Packard (Canada) Ltd.
11120 178th Street
Edmonton, Alberta T5S 1P2
Tel: (403) 486-6666
Fax: (403) 489-8764

Ontario
Hewlett-Packard (Canada) Ltd.
5150 Spectrum Way
Mississauga, Ontario L4W 5GI
Tel: (905) 206-4725
Fax: (905) 206-4739

Quebec
Hewlett-Packard (Canada) Ltd.
17500 Trans Canada Highway
South Service Road
Kirkland, Quebec H9J 2X8
Tel: (514) 697-4232
Fax: (514) 697-6941

United States

California
Hewlett-Packard Co. (2403)
1421 S. Manhattan Avenue
Fullerton, CA 92631
Tel: (800) 403-0801
Fax: (888) 857-8161

Hewlett-Packard Co. (2451)
301 E. Evelyn Avenue, Bldg. 333
Mountain View, CA 94039
Tel: (415) 694-2620
Fax: (415) 694-3594

Hewlett-Packard Co. (24BR)
10090 Foothill Blvd.
Roseville, CA 95747
Tel: (800) 403-0801
Fax: (888) 857-8161

Colorado
Hewlett-Packard Co. (2411)
24 Inverness Place East
Englewood, CO 80112
Tel: (800) 403-0801
Fax: (888) 857-8161

Georgia
Hewlett-Packard Co. (3108)
2124 Barrett Park Drive, Suite A
Kennesaw, GA 30114
Tel: (800) 403-0801
Fax: (888) 857-8161

Illinois
Hewlett-Packard Co. (2613)
545 E. Algonquin Road
Arlington Heights, IL 60005
Tel: (847) 342-2000
Fax: (847) 342-2022

New Jersey
Hewlett-Packard Co. (4415)
150 Green Pond Road
Rockaway, NJ 07866
Tel: (800) 403-0801
Fax: (888) 857-8161

Texas
Hewlett-Packard Co. (3185)
930 E. Campbell Road
Richardson, TX 75081
Tel: (800) 403-0801
Fax: (888) 857-8161

Application Notes help you use Hewlett-Packard instruments to solve measurement problems. They are application-specific and typically include generic techniques with families of products.

How to Order
To obtain a free copy of any of the Application Notes listed on the following pages, just call your HP Call Center. Within the United States, call (800) 452-4844 and provide the HP customer service representative with the nine-digit literature number for each application note requested. Please limit your orders to five Application Notes per phone call. If there is not an HP Call Center near you, contact your local sales office (see pages 591-598 for listing) for Application Note requests.

Some Application Notes are also down loadable directly from the Test & Measurement area of HP's website: (http://www.hp.com/go/tmc98).

Amplifiers

Complete Analysis of Erbium-Doped Fiber Amplifiers (AN)
5965-0976E
Fundamentals of RF and Microwave, Noise Figure Measurement (AN 57-1)
5952-8255
Testing Amplifiers and Active Devices with the HP 8510 Network Analyzer
55963-2352E
Testing Magnetic Disk Read Circuits Using the HP 4195A (AN 357-4)
5950-2398
Amplifier Measurements Using the Scalar Network Analyzer (AN 345-1)
5954-1599
Extending Dynamic Range of Scalar Transmission Measurements Using the HP 8757A, 8756A, or 8755C Scalar Network Analyzers (AN 327-1)
5953-8882
Noise Figure Measurement Accuracy (AN 57-2)
5952-3706
S-Parameter Techniques for Faster, More Accurate Network Design (AN 95-1)
5952-1130

Amplitude Modulation

Spectrum Analysis AM and FM (AN 150-1)
5954-9130

Anechoic Chamber

Sound Power Measurements (AN 1230)
5091-4426E

Audio

Basic Operation & Application Guide HP 8904A Operation Made Easy (AN 8904A)
5953-8491

Aviation/Transportation

Real-Time System Measures Aircraft Flight Characteristics (AN 1253)
5962-7297E
VOR/ILS Testing with HP 8644A (AN 8644-2)
5951-6740

Battery Testing

Battery Charging/Discharging (AN 250-2)
5952-4033

Board Test

A Quality Test Demands a Quality Fixture
5965-6624E
Aztec Case Study – Benchmark Tests of Three In-Circuit Board Testers for a High-Volume Manufacturing Environment (AN)
5965-4744E
Connect Check Backgrounder (AN)
5965-5092E
Measurement Repeatability–The Key Performance Characteristic of Inspection Systems (AN)
5964-4015E
PCBA S-Ray Inspection – 1996 Article Compendium (AN)
5965-6366E
Running Rocky Mountain BASIC from Board Test BASIC (AN)
5965-5878E
Selective Retrieval for the HP 3070 Board Test System (AN)
5965-5879E
Vectorless Test Purchaser's Guide
5965-0805E

CAE

Hierarchical Modeling for Circuit Characterization (AN 1201-2)
5091-1668E
Incorporating Engineering Documentation in Series IV (AN 127)
5962-6276-E
Modeling Passive High-Speed Digital Structures (AN 2303-1)
5091-0971E
RF/Fiber Optic Interface, (PN E4600-1)
5962-8587E
Running EEsof Series IV on a PC X-Terminal (AN 128)
5962-7184E
Using the High Yield Software Package to Create Robust Designs, (PN 85150-5)
5962-9271E

Cable Measurements

Advanced TDR Techniques for Use with the HP 54120 Family of Digitizing Oscilloscopes (AN 62-3)
5952-1141
Balanced Circuit Measurement with an Impedance Analyzer/LCR Meter/Network Analyzer (AN 346-2)
5091-4480E
Communications Cable Testing
5964-0153E
Measuring the Characteristic Impedance of Balanced Cables (AN 339-4)
5950-2918

Calibration

Applications and Operation of the HP 8901A Modulation Analyzer (AN 286-1)
5952-8208

Applying Error Correction to Network Analyzer Measurements (AN 1287-3)
5965-7709E
Basic Operation & Application Guide HP 8902A Operation Made Easy (AN 8902A)
5953-8458
Noise, Figure Measurement Accuracy (AN 57-2)
5952-3706
Novel Combinations of Microwave Switches and Step Attenuators (AN 332-1)
5954-8892
Signal Generator (AN 388)
5952-2019

Compliance Testing

Compliance Testing to the IEC 1000-3-2 and (EN 61000-3-2) and IEC 1000-3-3 (EN 61000-3-3) Standards (AN 1273)
5964-1917E
Conformance Testing – An Essential Part of SDH Deployment
5965-1020E
Conformance Testing and Essential Part of SONET Deployment
5965-1432E

Component Test

A Guideline for Designing External DC Bias Circuits (AN 346)
5950-2912
Accurate and Efficient C-V Measurements
5965-5658E
Advanced Filter Evaluation and Limit Testing with the HP 4195A (AN 357-3)
5950-2933
Automated Characterization of Microwave VCOs Using the HP 5361A/B Pulse/CW Microwave Counter (AN 377-2)
5952-7988
Automated Extraction of Semiconductor Parameters Using the HP 4155A/4156A (AN 4156-2)
5963-1249E
Balanced Circuit Measurement with an Impedance Analyzer/LCR Meter/Network Analyzer (AN 346-2)
5091-4480E
Biasing Three-Terminal Devices for Test (AN 376-1)
5952-4193
Characteristic Impedance Measurement of PC Board Circuit Patterns Using the HP 4194A Impedance/Gain-Phase Analyzer (AN 339-2)
5950-2908
Characterizing Communications ICs With the HP 83000 Model F660
5962-9273E
Characterizing Components with a Microwave Tracking Source (AN 1212)
5091-2172E
Characterizing the Performance of High-Speed Digital-to-Analog Converters (AN 1210-16)
5962-6972
Complete S-Parameter and Distortion Measurement for Wideband Video Amplifiers (AN 357-2)
5950-2932
Constant Current Measurements Using the HP 4194A (AN 944-1)
5950-2923
Contact Resistance and Insulation Resistance Measurements of Electromechanical Components (AN 1224-1)
5091-4132E
Effective Impedance Measurement Using OPEN/SHORT/LOAD Correction (AN 346-3)
5091-6553E
Effective Insulation Resistance Testing Using a Scanner (AN 1224-6)
5091-6669E
Effective Multitap Transformer Testing Using a Scanner (AN 1239)
5091-6310E
Efficient Evaluation of LISNs and Voltage Probes for EMI Tests Using the HP 4194A (AN 364-1)
5950-2922
Electronic Characterization of IC Packages (AN 1255-5)
5962-9725E
Evaluating Chip Inductors Using the HP 4291A (AN 1255-2)
5091-9904E
Evaluation of Flash Memory Cells (AN 4156-4)
5965-5657E
Evaluation of Hot Carrier Induced Degradation of MOSFET Devices (AN 4156-3)
5963-1111E
Filter Test for Production and Incoming Inspection—HP 4194A Impedance Gain-Phase Analyzer (AN 339-11)
5952-7887
Fundamentals of RF and Microwave, Noise, Figure Measurement (AN 57-1)
5952-8255
High Accuracy and Fast RF Inductor Testing (AN 369-10)
5091-1596E
High Accuracy and Fast RF Inductor Testing (AN 369-10)
5091-1596E
High-Speed Lightwave Component Analysis (AN 1550-6)
5091-6478E
HP-IB Programming Hints for the HP 4194A (AN 339-12)
5950-2929
Impedance Characterization of Resonators Using the HP 4194A Impedance/Gain-Phase Analyzer (AN 339-1)
5950-2882
Impedance Measurement for Incoming Inspection–HP 4284A Application Information (AN 369-4)
5950-2952
Impedance Measurements...in Brief
5964-3558E
Impedance Testing Using a Scanner (AN 369-6)
5950-2975
In-Depth Characterization of Optical Components
5965-5286E
Insulation Resistance Measurement of the Plate Type Materials (AN 1224-2)
5091-4133E
Maximizing the Incoming Inspection Efficiency of Semiconductor Devices (AN 4156-6)
5963-2364E
Measurement of Capacitance Characteristics of Liquid Crystal Cell (AN 369-7)
5950-2994
Measurement of Power Devices Using External DC Power Supply (AN 4156-5)
5963-2365E
Measurements of Lightwave Component Reflections with the HP 8504B Precision Reflectometer (PN 8504-1)
5963-7191E
Measuring the Dielectric Constant of Solid Materials NHP 4194A Impedance/ Gain-Phase Analyzer (AN 339-13)
5950-2935
Memory Test Software Provides Cost-Effective Solutions to Testing Advanced SRAMs
5963-5078E
Microwave Switching from SPDT to Full Access Matrix (AN 332)
5953-6466
Multifrequency C-V Measurements and Doping Profile Analysis of Semiconductors Using the HP 4194A (AN 339-5)
5950-2919
Multifrequency C-V Measurements of Semiconductors—HP 4284A Application Information (AN 369-5)
5950-2953
Negative Impedance Measurements of Crystal Oscillators Using the HP 4194A (AN 339-9)
5950-2924
Network Analyzer Measurements: Filter and Amplifier Examples (AN 1287-4)
5965-7710E
Network, Spectrum, and Impedance Evaluation of IF Circuits—HP 4195A Network/Spectrum Analyzer (AN 357-1)
5950-2931
Novel Combinations of Microwave Switches and Step Attenuators (AN 332-1)
5954-8892

Parametric Analysis for Electronic Components and Circuit Evaluation Using the HP 4194A (AN 339)
5950-2856
Pre-Trigger Simplifies VCO Step Response Measurements (AN 358-4)
5952-7998
Simplified Analysis of Phase-Locked Loop Capture and Tracking Range (AN 1200-7)
5091-0391E
Testing Amplifiers and Active Devices with the HP 8510 Network Analyzer
5963-2352E
Testing Magnetic Disk Read Circuits Using the HP 4195A (AN 357-4)
5950-2398
Testing Switching Power Supplies Using the HP 4194A (AN 339-14)
5950-2977
Ultra Low Current DC Characterization of MOSFETs at the Wafer Level (AN 4156-1)
5963-2014E
Using Impedance Measurement to Evaluate Electronic Components and Materials–HP 4284A Application Information (AN 369-1)
5950-2949
Wide-Range DC Current Biased Inductance Measurement (AN 369-8)
5950-2367
Writing Flash Memory with HP 3070 Systems (AN)
5965-3248E

Computers & Peripherals

Characterizing IC Package with Impedance Measurements and the UTP3000 (AN 1210-1)
5091-1799E
Characterizing IC Packages with TDR/TDT and the UTP3000 Test Fixture (AN 1210-5)
5091-1803E
Design for Testability Using Boundry-Scan (AN 1210-7)
5091-1805E
Quick Identification of Periodic Jitter Sources (AN 1200-4)
5091-0388E
Simulating Noise Signals for Tolerance Testing (AN 1210-3)
5091-1801E
Time Domain Characterization of Magnetic Disk Drives (AN 358-3)
5952-7928
Timing Considerations in Clock Distribution Networks (AN 1210-10)
5091-5444E
Understanding and Minimizing Probing Effects (AN 1210-2)
5091-1800E

Crystal Filters

Efficient Evaluation of LISNs and Voltage Probes for EMI Tests Using the HP 4194A (AN 339-7)
5950-2922
Filter Test for Production and Incoming Inspection: HP 4194A Impedance Gain-Phase Analyzer (AN 339-11)
5952-7887

Crystals

Fundamentals of Quartz Oscillators (AN 200-2)
5965-7662E
Impedance Characterization of Resonators Using the HP 4194A Impedance/Gain-Phase Analyzer (AN 339-1)
5950-2882
Practical Design and Evaluation of High-Frequency Circuits (AN 317)
5953-6910

Data Acquisition

Digital Video Testing with the HP 16542A (AN 1225-3)
5091-5447E
HP VEE Design Characterization (AN 1206-2)
5091-1140E
On-Road Vehicle Testing
5964-0152E
Practical Strain Gauge Measurements (AN 290-1)
5952-8880
Prototype Jet Engine Characterization
5964-0149E
Sequential Single-Shot Optimizes Speed, Memory Depth, and Throughput (AN 1022)
5091-2278E

Data Communications

1995 ATM/Broadband Testing Seminar Handbook
5963-7508E
ATM Forum European Update
5964-4147E
Communications Cable Testing
5964-0153E
Conformance Testing – An Essential Part of SDH Deployment
5965-1020E
Conformance Testing and Essential Part of SONET Deployment
5965-1432E
Developing IT Service Level Management in the Distributed Enterprise
5964-6818E
Digital Radio Theory and Measurements (AN 355A)
5091-4777E
DS3 Network Interface Unit (AN 1)
5963-9927E
Ethernet Network Problems and Their Solutions
5091-7938E
Fast Characterization of Pulse-Width Encoded Data (AN 1200-5)
5091-0389E
FDDI Problems and Their Solutions
5091-6485E
Finding and Solving Problems with HP Ethernet Network
5091-7938E
Frame Relay Installation and Maintenance Using the HP Internet Advisor
5964-1960E
Frame Relay/SMDS Seminar Book
5963-9501E
Frequency Agile Jitter Measurement System (AN 1267)
5963-5353E
High-Speed BER Testing of SDH Components and Sub-Systems
5091-4799E
Histograms Simplify Analysis of Random Jitter (AN 1200-9)
5091-0393E
How to Achieve ATM Interoperability
5963-7509E
HP Internet Reporter–LAN and WAN Baselining and Benchmarking (AN 1274)
5964-2373E
Implementing ATM Signalling: Avoiding the Interoperability Pitfalls
5963-7514E
Introduction to SDH
5091-3935E
ISDN Primary Rate Testing
5963-2013E
Locating Errors in Gigabit Transmission Systems and Components
5963-2005E
Maximizing Revenue with In-Service Testing–Centralized Testing/Monitoring Systems (AN 1237-2)
5091-6349E
Mixing MPEG-II & ATM: Will It Work?
5963-7511E
Network and System Performance Management for Distributed Client Server Environments
5964-6817E
Operating LANs in an ATM Environment
5963-7513E
Planning an ISDN Application
5963-2171E
Quick Identification of Periodic Jitter Sources (AN 1200-4)
5091-0388E
Single Shot BPSK Signal Characterization (AN 358-8)
5952-8002

Simple Analysis of Frequency Modulation (AN 1200-6)
5091-0390E
Simplified Analysis of Phase-Locked Loop Capture and Tracking Range (AN 1200-7)
5091-0391E
Synchronizing Telecommunications Networks–Basic Concepts (AN 1264-1)
5963-6867E
Synchronizing Telecommunications Networks–Synchronizing SDH/SONET (AN 1264-2)
5963-9798E
Time Keeping and Frequency, Calibration (AN 52-2)
5952-7874
Token-Ring Troubleshooting Techniques with the HP Network Advisor
5091-9414E
Traffic Policing
5963-7510E
Using an X Terminal with the Broadband Series Test System
5963-2012E/EN
VCO Step Response Analysis Made Easy (AN 1200-3)
5091-0387E
WAN Interworking with ATM
5963-7512E

Data Converters

The Dynamic Range Benefits of Large Scale Dithered Analog-to-Digital Conversion in the HP 89410A and 89440A
5091-7668E
10-Megasample-per-Second Analog-to-Digital Converter with Filter and Memory/ HP E1430A
5962-9497E

Digital Communications

ATM Forum European Update
5964-4147E
Automatic Frequency Settling Time Measurement Speeds Time-to-Market for RF Designs
5964-4335E
CDPD Testing – HP 8921A Option 502/3 or 602/3
5965-5187E
Characterization of Frequency Agile Sources with the HP 5371A Frequency and Time Interval Analyzer (AN 358-1)
5952-7924
Conformance Testing – An Essential Part of SDH Deployment
5965-1020E
Conformance Testing and Essential Part of SONET Deployment
5965-1432E
Developing IT Service Level Management in the Distributed Enterprise
5964-6818E
Digital Radio Theory and Measurements (AN 355A)
5091-4777E
DS3 Network Interface Unit (AN 1)
5963-9927E
Evaluating Tributary Jitter from the SDH Network (AN 1258)
5962-9551E
Examine Channel Switching Characteristics of Cellular Radios (AN 1200-10)
5091-0394E
Frame Relay/SMDS Seminar Book
5963-9501E
Getting the Most Out of Your T1 and DDS Services
5091-6174E
High Productivity Measurements in Digital, Transmission (AN 387)
5959-7898
High-Speed BER Testing of SDH Components and Sub-Systems
5091-4799E
High-Speed Timing Acquisition and Statistical Jitter Analysis Using the HP 5370B Universal Time Interval Counter (AN 191-7)
5952-7908
How to Achieve ATM Interoperability
5963-7509E
HP Internet Reporter – LAN and WAN Baselining and Benchmarking (AN 1274)
5964-2373E
Implementing ATM Signalling: Avoiding the Interoperability Pitfalls
5963-7514E
Introduction to SDH
5091-3935E
ISDN Primary Rate Testing
5963-2013E
Jitter and Wander Analysis in Digital Communication with the HP 5371A Frequency and Time Interval Analyzer (AN 358-2)
5952-7925
LMDS–The Wireless Interactive Broadband Access Service (AN 1296)
5965-9376E
Measuring Demodulator Image Rejection Using the HP 8980A Vector Analyzer (AN 1200-7)
5952-3703
Measuring Microwave Radio Antenna Return Loss Using the HP 11758T Digital Radio Test System (AN 379-2)
5959-8749
Operating LANs in an ATM Environment
5963-7513E
Planning an ISDN Application
5963-2171E
Testing Digital MW Receivers with a Calibrated Source (AN 343-6)
5952-0800
Traffic Policing
5963-7510E
WAN Interworking with ATM
5963-7512E

Digital Data Transmission

Characterizing Transient Timing Errors in Disk and Tape Drives (AN 358-6)
5952-8000
Clock Rate Independent Jitter Measurements for Digital Communications Systems (AN 358-5)
5952-7999
Connecting Hewlett-Packard Test Sets for In-Service Testing of PDH/SDH Networks (AN)
5965-5898E
Evaluating Tributary Jitter from the SONET Network (AN 1252)
5091-6804E
HP NetMetrix Operation Positioning: Switched Technology
5965-4711E
HP NetMetrix RMON2 Delivered Through HP NetMetrix Solutions (AN 1283)
5965-7497E
Jitter and Wander Analysis in Digital Communication with the HP 5371A Frequency and Time Interval Analyzer (AN 358-2)
5952-7925
Modeling Passive High-Speed Digital Structures (AN 1203-1)
5091-0971E
Standard and CRC-4 Frame Testing (AN 1211-1)
5091-2070E
Testing n x 64 kb/s Services (AN 1211-2)
5091-2069E
Testing Sub-rate Data Services (AN 1211-3)
5091-2072E
The Quest for Quality: The ATM Impairment Testing Handbook (AN)
5965-4992E

Disk Drive Test

Bearing Runout Measurements (AN 243-7)
5965-5387E
Component Test (AN 369-3)
5950-2951
Measurement of Impedance of Magnetic Head (AN 369-12)
5965-6663E
Synthesizing Magnetic Disk Read and Servo Signals with HP 8770A Arbitrary Waveform System (AN 314-2)
5954-6357
Non-Contact Measurements with Laser Interferometers (AN 325-12)
5091-3078E
Testing Magnetic Disk Read Circuits Using the HP 4195A (AN 357-4)
5950-2398
Time Domain Characterization of Magnetic Disk Drives (AN 358-3)
5952-7928

Distortion

Eight Hints for Making Better Spectrum Analyzer Measurements (AN)
5965-7009E
Non-Contact Measurements with Laser Interferometers (AN 325-12)
5091-3078E

ECM/ECCM

Simplified Analysis of Phase-Locked Loop Capture and Tracking Range (AN 1200-7)
5091-0391E
Single Shot Frequency Profiling of Chirped Radars Made Easy (AN 1200-8)
5091-0392E

EMI/EMC

Cookbook for EMC Precompliance Measurements (AN 1290-1)
5964-2151E
Efficient Evaluation of LISNs and Voltage Probes for EMI Tests Using the HP 4194A (AN 364-1)
5950-2922

Electrical Length

Electrical Characterization Methods for MCM Substrates (AN 1210-14)
5091-5724E
Measuring Electrical Length (Delay) of Cables with HP 5345A Electronic Counter (AN 174-10)
5952-7326

Electronic Warfare (EW)

Automatic Frequency Profiling of Chirped Radar Pulses Using the HP 5361A/B Pulse/CW Microwave Counter (AN 377-1)
5952-7987
Exceptionally-Complex Signal Simulation for Multi-Signal Environments in Radar/EW Test (AN 314-4)
5952-3702
Microwave Switching from SPDT to Full Access Matrix (AN 332)
5953-6466
Novel Combinations of Microwave Switches and Step Attenuators (AN 332-1)
5954-8892
Practical Strain Gauge Measurements (AN 290-1)
5952-8880
Single Shot Frequency Profiling of Chirped Radars Made Easy (AN 1200-8)
5091-0392E
Vector Modulation Measurements/Coherent Pulsed Tests of Radar and EW Systems (AN 043-3)
5954-6366
Voltage Controlled Oscillators Characterization Using the HP 5350B/5351B/5352B CW Microwave Frequency Counter to Measure Transfer Characteristics and Modulation Sensitivity (AN 181-2)
5952-7852

Emulation, Microprocessors

Digital Video Testing with the HP 16542A (AN 1225-3)
5091-5447E
Distributed Emulation for Toshiba R3900 Family
5965-1529E

Error Analysis

Fundamentals of RF and Microwave, Power Measurement (AN 64-1)
5952-8178
Jitter and Wander Analysis in Digital Communication with the HP 5371A Frequency and Time Interval Analyzer (AN 358-2)
5952-7925

Fiber Optics

Beginner's Guide to Using the HP8146A Optical Time Domain Reflectometer
5963-3775E
Conformance Testing – An Essential Part of SDH Deployment
5965-1020E
Conformance Testing and Essential Part of SONET Deployment
5965-1432E
Frequency Agile Jitter Measurement System (AN 1267)
5963-5353E
High-Speed BER Testing of SDH Components and Sub-Systems
5091-4799E
High-Speed Lightwave Component Analysis (AN 1550-6)
5091-6478E
Introduction to SDH
5091-3935E
Lightwave Measurements with the HP 71400 Lightwave Signal Analyzer (AN 371)
5954-9137E
Locating Errors in Gigabit Transmission Systems and Components
5963-2005E
Polarization-Dependent Loss Measurements – Using Modular Polarization Dependent Loss Test Systems (PN 11896-1)
5963-5762E
Pulse Testing 980-nm Pump Laser-Diodes in Optical Fiber
5963-6988E
RF/Fiber Optic Interface, (PN E4600-1)
5962-8587E
Synchronizing Telecommunications Networks – Basic Concepts (AN 1264-1)
5963-6867E
Synchronizing Telecommunications Networks – Synchronizing SDH/SONET (AN 1264-2)
5963-9798E

Fourier Analysis

Control System Development Using Dynamic Signal Analyzers (AN 243-2)
5953-5136
Control System Measurement Fundamentals Using Dynamic Signal Analyzers and Accessories (AN 243-6)
5091-5886E
The Fundamentals of Modal Testing (AN 243-3)
5954-7957E
Non-Contact Measurements with Laser Interferometers (AN 325-12)
5091-3078 E
Precision Time-Domain Measurement Using the HP E1430A
5962-0015E

Frequency

Analyzing Phase-Locked Loop Capture & Tracking (AN 358-13)
5952-8007
Analyzing Phase-Locked Loop Transients in the Modulation Domain (AN 358-7)
5952-8001
Characterizing Barker Coded Modulation in Radar Systems (AN 358-2)
5952-8004
Characterizing Chirp Coded Modulation in Radar Systems (AN 358-11)
5952-8005
Downconverted Measurements Using the HP 89410A and HP 89441A, (PN 89400-9)
5091-8691E
Examine GMSK Modulation in GSM and PCN Mobile Communications Systems (AN 1200-11)
5091-7201E
Frequency Profile Using an HP 5345A Electronic Frequency Counter and on HP 5359A Time Synthesizer (AN 287-2)
5952-7530
Frequency Profile Using an HP 5370A Universal Time Interval Counter and an HP 5359A Time Synthesizer (AN 287-3)
5952-7549
Fundamentals of Microwave Frequency Counters (AN 200-1)
5952-7484
Fundamentals of the Electronic Counters
5965-7660E

Measuring Fractional Frequency Standard Deviation (Sigma) Versus Averaging Time (TAU) (AN 174-7)
5952-7344
Radar System Characterization and Testing Using the HP 5345A Counters (AN 174-14)
5952-7892
Signal Generator (AN 388)
5952-2019
Single Shot Frequency Profiling of Chirped Radars Made Easy (AN 1200-8)
5091-0392E
Time Keeping and Frequency, Calibration (AN 52-2)
5952-7874
Understanding Frequency Counter Specifications (AN 200-4)
5965-7664E

Frequency Modulation

Characterization of Frequency Agile Sources with the HP 5371A Frequency and Time Interval Analyzer (AN 358-1)
5952-7924
Characterizing Barker Coded Modulation in Radar Systems (AN 358-2)
5952-8004
Characterizing Chirp Coded Modulation in Radar Systems (AN 358-11)
5952-8005
Clock Rate Independent Jitter Measurements for Digital Communications Systems (AN 358-5)
5952-7999
Examine GMSK Modulation in GSM and PCN Mobile Communications Systems (AN 1200-11)
5091-7201E
Modulation Domain Techniques for Measuring Complex Radar Signals (AN 358-9)
5952-8003
Peak Deviation and Center Frequency Measurements for CT2 and DECT Radios (AN 1200-12)
5091-7202E
Simple Analysis of Frequency Modulation (AN 1200-6)
5091-0390E
Spectrum Analysis AM and FM (AN 150-1)
5954-9130
Spectrum Analyzer Basics (AN 150)
5952-0292

Frequency Stability - Short-Term

Analyzing Phase-Locked Loop Capture & Tracking (AN 358-13)
5952-8007
Characterizing Chirp Coded Modulation in Radar Systems (AN 358-11)
5952-8005
Fundamentals of Microwave Frequency Counters (AN 200-1)
5952-7484
Histograms Simplify Analysis of Random Jitter (AN 1200-9)
5091-0393E
Jitter and Wander Analysis in Digital Communication with the HP 5371A Frequency and Time Interval Analyzer (AN 358-2)
5952-7925
Quick Identification of Periodic Jitter Sources (AN 1200-4)
5091-0388E
Signal Generator (AN 388)
5952-2019
Simplify Frequency Stability Measurements with Built-in Allan Variance Analysis (AN 358-12)
5952-8006
Time Keeping and Frequency Calibration (AN 52-2)
5952-7874

Frequency Standards

Time Keeping and Frequency Calibration (AN 52-2)
5952-7874

Frequency Synthesizers

Automated Characterization of Microwave VCOs Using the HP 5361A/B Pulse/CW Microwave Counter (AN 377-2)
5952-7988
Examine Channel Switching Characteristics of Cellular Radios (AN 1200-10)
5091-0394E
External Frequency Doubling of the HP 8662A Synthesized Signal Generator (AN 283-2)
5952-8217
Pre-Trigger Simplifies VCO Step Response Measurements (AN 358-4)
5952-7998
Signal Generator (AN 388)
5952-2019
Simplified Analysis of Phase-Locked Loop Capture and Tracking Range (AN 1200-7)
5091-0391E
VCO Step Response Analysis Made Easy (AN 1200-3)
5091-0387E

Global Positioning

GPS and Precision Timing Applications (AN 1272)
5965-2791E
Increasing Power Transmission System Uptime (AN 1271)
5964-0398E

Group Delay

Floating Measurements and Guarding (AN 123)
5952-2153
Measuring Electrical Length (Delay) of Cables with HP 5345A Electronic Counter (AN 174-10)
5952-7326

IC Testing

Automatic Path Delay Compensation (AN 398-5)
5091-1935E
Correlation of Timing Measurements (AN 398-2)
5952-2311
Design for Testability Using Boundry-Scan (AN 1210-7)
5091-1805E
Digital Video Testing with the HP 16542A
5091-5447E
Electrical Characterization Methods for MCM Substrates
5091-5724E
High-Speed Continuity/Shorts Test on the HP 82000 (AN 398-4)
5091-1364L
Histograms Simplify Analysis of Random Jitter (AN 1200-9)
5091-0393E
Measuring CMOS Quiescent Power Supply Current (IDDQ) with the HP 82000 (AN 398-3)
5091-1363L
Monitoring of Ultrasonic Wire Bonding Machines (AN 393)
5952-2143
Pulsed Characteristics of Power Semiconductors Using Electronic Loads (AN 1246)
5091-7636E
Quick Identification of Periodic Jitter Sources (AN 1200-4)
5091-0388E
Segmentation: A Technique for Adapting the HP 83000 Model F660 to Test High-Density High-Speed SRAMS (AN 1248)
5091-8845E
Synchronizing the HP 82000 to External Equipment (AN 390)
5953-6339
Using the HP 82000 for 1 Gb/s (AN 398-1)
5952-2301

Impedance

A Guideline For Designing External DC Bias Circuits (AN 346)
5950-2912
Balanced Circuit Measurement with an Impedance Analyzer/LCR Meter/Network Analyzer (AN 346-2)
5091-4480E
Basics of Measuring the Dielectric Properties of Materials (AN 1217-1)
5091-3300E
Characteristic Impedance Measurement of PC Board Circuit Patterns Using the HP 4194A Impedance/Gain-Phase Analyzer (AN 339-2)
5950-2908
Characterizing IC Package with Impedance Measurements and the UTP3000 (AN 1210-1)
5091-1799E
Characterizing IC Packages with TDR/TDT and the UTP3000 Test Fixture (AN 1210-5)
5091-1803E
Component Test (AN 369-3)
5950-2951
Constant Current Measurements Using the HP 4194A (AN 944-1)
5950-2923
Contact Resistance and Insulation Resistance Measurements of Electromechanical Components (AN 1224-1)
5091-4132E
Crosstalk and Impedance Measurements of PC Board Patterns: HP 4194A Application Information (AN 339-3)
5952-7863
Dynamic Component Test Using Vector Modulation Analysis (AN 343-2)
5954-6367
Effective Impedance Measurement Using OPEN/SHORT/LOAD Correction (AN 346-3)
5091-6553E
Effective Insulation Resistance Testing Using a Scanner (AN 1224-6)
5091-6669E
Efficient Evaluation of LISNs and Voltage Probes for EMI Tests Using the HP 4194A (AN 364-1)
5950-2922
Electrical Characterization Methods for MCM Substrates (AN 1210-14)
5091-5724E
Electronic Characterization of IC Packages (AN 1255-5)
5962-9725E
Evaluating Chip Inductors Using the HP 4291A (AN 1255-2)
5091-9904E
HP-IB Programming Hints for the HP 4194A (AN 339-12)
5950-2929
Impedance Characterization of Resonators Using the HP 4194A Impedance/Gain-Phase Analyzer (AN 339-1)
5950-2882
Impedance Measurement for Incoming Inspection—HP 4284A Application Information (AN 369-4)
5950-2952
Impedance Measurements...in Brief
5964-3558E
Impedance Testing Using a Scanner with the HP 54120 Family of Digitizing Oscilloscopes (AN 369-6)
5950-2975
Insulation Resistance Measurement of the Plate Type Materials (AN 1224-2)
5091-4133E
Measurement of Capacitance Characteristics of Liquid Crystal Cell (AN 369-7)
5950-2994
Measuring the Characteristic Impedance of Balanced Cables (AN 339-4)
5950-2918
Measuring the Dielectric Constant of Solid Materials—HP 4194A Impedance/Gain-Phase Analyzer (AN 339-13)
5950-2935
Negative Impedance Measurements of Crystal Oscillators Using the HP 4194A (AN 339-9)
5950-2924
Network, Spectrum, and Impedance Evaluation of IF Circuits: HP 4195A Network/Spectrum Analyzer
5950-2931
Permittivity Measurements of PC Board and Substrate Materials Using the HP 4291A and HP 16453A (AN 1255-3)
5962-6973E
Practical Design and Evaluation of High-Frequency Circuits (AN 317)
5953-6910
Static Head Testing for Disk Drives (AN 339-6)
5952-7871
Testing Magnetic Disk Read Circuits Using the HP 4195A (AN 357-4)
5950-2398
Using Impedance Measurement to Evaluate Electronic Components and Materials: HP 4284A Application Information (AN 89-1)
5950-2949
Wide-Range DC Current Biased Inductance Measurement (AN 369-8)
5950-2367

Insertion Gain/Loss

Balanced Circuit Measurement with an Impedance Analyzer/LCR Meter/Network Analyzer (AN 346-2)
5091-4480E
Noise, Figure Measurement Accuracy (AN 57-2)
5952-3706

Interface Bus (HP-IB)

Fast Characterization of Pulse-Width Encoded Data (AN 1200-5)
5091-0389E

Internet

Riding the Internet Wave: Ensuring Safe, Solid Internet Services for the Enterprise
5965-9371E

Jitter

Analyzing Phase-Locked Loop Capture & Tracking (AN 358-13)
5952-8007
Analyzing Phase-Locked Loop Transients in the Modulation Domain (AN 358-7)
5952-8001
Characterizing Transient Timing Errors in Disk and Tape Drives (AN 358-6)
5952-8000
Evaluating Tributary Jitter from the SDH Network (AN 1258)
5962-9551E
Frequency Agile Jitter Measurement System (AN 1267)
5963-5353E
Fundamentals of Time Interval Measurements (AN 200-3)
5965-7663
High-Speed Timing Acquisition and Statistical Jitter Analysis Using the HP 5370B Universal Time Interval Counter (AN 191-7)
5952-7908
Histograms Simplify Analysis of Random Jitter (AN 1200-9)
5091-0393E
Jitter and Wander Analysis in Digital Communication with the HP 5371A Frequency and Time Interval Analyzer (AN 358-2)
5952-7925
Monitoring of Ultrasonic Wire Bonding Machines (AN 1210-9)
5091-1807E
Signal Generator (AN 388)
5952-2019
Time Domain Characterization of Magnetic Disk Drives (AN 358-3)
5952-7928

Laser Interferometers

Disk Drive Servo-Track Writing with Laser Interferometers (AN 325-11)
5952-7984
Non-Contact Measurements with Laser Interferometers (AN 325-12)
5091-3078E
Submicron Positioning with the HP 5527A Laser Position Transducer System and HP 10936A Servo-Axis Board (AN 325-10)
5952-7942

Lightwave

Beginner's Guide to Using the HP8146A Optical Time Domain Reflectometer
5963-3775E
Complete Analysis of Erbium-Doped Fiber Amplifiers (AN)
5965-0976E
Evaluating Tributary Jitter from the SDH Network (AN 1258)
5962-9551E
Evaluating Tributary Jitter from the SONET Network (AN 1252)
5091-6804E
Frequency Agile Jitter Measurement System (AN 1267)
5963-5353E
High-Speed Lightwave Component Analysis (AN 1550-6)
5091-6478E
High-Speed Timing Acquisition and Statistical Jitter Analysis Using the HP 5370B Universal Time Interval Counter (AN 191-7)
5952-7908
HP 71452B Optical Spectrum Analyzer—EDFA Testing with the Interpolation Technique, (PN 71450-1)
5963-7146E
Jitter and Wander Analysis in Digital Communication with the HP 5371A Frequency and Time Interval Analyzer (AN 358-2)
5952-7925
In-Depth Characterization of Optical Components
5965-5286E
Lightwave Measurements with the HP 71400 Lightwave Signal Analyzer (AN 371)
5954-9137E
Locating Errors in Gigabit Transmission Systems and Components
5963-2005E
Measurements of Lightwave Component Reflections with the HP 8504B Precision Reflectometer, (PN 8504-1)
5963-7191E
Optical Spectrum Analysis Basics
5963-7145E
Polarization-Dependent Loss Measurements – Using Modular Polarization Dependent Loss Test Systems, (PN 11896-1)
5963-5762E
Pulse Testing 980-nm Pump Laser-Diodes in Optical Fiber
5963-6988E
RF/Fiber Optic Interface, (PN E4600-1)
5962-8587E
Synchronizing Telecommunications Networks—Synchronizing SDH/SONET (AN 1264-2)
5963-9798E

Logic Analysis/Logic Analyzers

Designing a Custom Interface for a Logic Analyzer Using HP User Definable Design Tools (AN 1244-2)
5091-8839E
Digital Video Testing with the HP 16542A (AN 1225-3)
5091-5447E
Intel 80960CA Software Debug using a Logic Analyzer and an In-Circuit Debugger
5963-3544E
Minimizing Intrusion Effects When Probing with a Logic Analyzer (AN 1244-1)
5962-8620E
Minimizing Intrusion Effects When Probing With a Logic Analyzer (AN 1244-1)
5962-8620E
PC Network Connectivity with the HP 16500L Interface Module (AN 1245)
5091-6908E
Timing Characterization Using the HP 16517/18A with Intel Pentium Processor Measurement Examples (AN 1261)
5091-8798E
VME/VXI Applications—How the Right Preprocessor Interface Can Simplify Logic Analysis (AN 392-3)
5952-3058

Loop Gain

Analyzing Phase-Locked Loop Capture & Tracking (AN 358-13)
5952-8007

MMS Products

Lightwave Measurements with the HP 71400 Lightwave Signal Analyzer (AN 371)
5954-9137E

Machine Tool Calibration

Machine Tool Calibration Using the HP 5528A Laser Measurement System (AN 325-2)
5952-7708

Manufacturing

Capture and Apply Deep Vector Sequences to a Device-Under-Test
5952-8074
Life and Stability of the HP 5DX Sealed X-ray Tube (AN)
5964-4014E
Monitoring of Ultrasonic Wire Bonding Machines (AN 393)
5952-2143
Reducing Fixture-Induced Test Failures (AN 340-1)
5091-0395E
RTAP in Process Manufacturing
5964-0120E
Vectorless Test Purchaser's Guide
5965-0805E

Materials Measurement

Basics of Measuring the Dielectric Properties of Materials (AN 1217-1)
5091-3300E
Dielectric Constant Measurement of Solid Materials (AN 380-1)
5950-2390
Evaluation of Colloids by Dielectric Spectroscopy Materials (AN 380-3)
5963-6634E
Materials Characterization With a New Dielectric Spectrometer–Novocontrol BDS 60000 System Based On HP 4291A
5964-6522E
Permittivity Measurement of Frequency Dependent Electronics Materials
5964-1506E
Permittivity Measurements of PC Board and Substrate Materials Using the HP 4291A and HP 16453A (AN 1255-3)
5962-6973E

Measurement and Control

Characterizing the Performance of High-Speed Digital-to-Analog Converters (AN 1210-16)
5962-6972
Control System Development Using Dynamic Signal Analyzers (AN 243-2)
5953-5136
Control System Measurement Fundamentals Using Dynamic Signal Analyzers and Accessories (AN 243-6)
5091-5886E
Direct Characterization of Motion Control Systems (AN 1200-2)
5091-0386E
Disk Drive Servo–Track Writing with Laser Interferometers (AN 325-11)
5952-7984
HP BASIC for Windows
5964-6019E
HP VEE for Windows/Dynamic Data Exchange Between HP VEE for Windows and Microsoft Excel, (PN 2120-2)
5962-9850E
HP VEE for Windows/Using a Dynamic Link Library (DLL) with HP VEE for Windows, (PN 2120-3)
5962-9852E
HP VEE for Windows (PN 2120-1)
5962-9849E
Integrating External Code with HP VEE (AN 1206-3)
5091-3071E
Introduction to HP Standard Instrument Control Library
5963-2228E
Measuring Electrical Length (Delay) of Cables with HP 5345A Electronic Counter (AN 174-10)
5952-7326
Non-Contact Measurements with Laser Interferometers (AN 325-12)
5091-3078E
Real-Time System Measures Aircraft Flight Characteristics (AN 1253)
5962-7297E
Reducing Fixture-Induced Test Failures (AN 340-1)
5091-0395E
Simplified Motor Spin-up Analysis (AN 1200-1)
5091-0385E
Sharing Data with HP VEE (AN)
5965-5709E
Submicron Positioning with the HP 5527A Laser Position Transducer System and HP 10936A Servo-Axis Board (AN 325-10)
5952-7942
VXI Access for BASIC/UX
5964-3669E

Mechanical Products

Monitoring of Ultrasonic Wire Bonding Machines (AN 1210-9)
5091-1807E
Simplified Motor Spin-up Analysis (AN 1200-1)
5091-0385E

Microprocessors

Designing a Custom Interface for a Logic Analyzer Using HP User Definable Design Tools (AN 1244-2)
5091-8839E
Digital Video Testing with the HP 16542A
5091-5447E
Minimizing Intrusion Effects when Probing with a Logic Analyzer (AN 1244-1)
5962-8620E
Timing Characterization Using the HP 16517/18A with Intel Pentium Processor Measurement Examples (AN 1261)
5091-8798E
VME/VXI, Applications: How the Right Preprocessor Interface can Simplify Logic, Analysis (AN 392-3)
5952-3058

Microwave Components

Amplifier Measurements Using the Scalar Network Analyzer (AN 345-1)
5954-1599
Examine Channel Switching Characteristics of Cellular Radios (AN 1200-10)
5091-0394E
Simplified Analysis of Phase-Locked Loop Capture and Tracking Range (AN 1200-7)
5091-0391E

Microwave and RF

A Guide to Microwave Upconversion (AN 314-5)
5953-2342
Advanced TDR Techniques for Use with the HP 54120 Family of Digitizing Oscilloscopes (AN 62-3)
5952-1141
Application Guide to the HP 5355/56 Automatic Frequency Converte (AN 291-1)
5952-7541
Applications and Operation of the HP 8901A Modulation Analyzer (AN 286-1)
5952-8208
Automated Characterization of Microwave VCOs Using the HP 5361A/B Pulse/CW Microwave Counter (AN 377-2)
5952-7988
Automatic Frequency Settling Time Measurement Speeds Time-to-Market for RF Designs
5964-4335E
Basics of Measuring the Dielectric Properties of Materials (AN 1217-1)
5091-3300E
Characterization of Frequency Agile Sources with the HP 5371A Frequency and Time Interval Analyzer (AN 358-1)
5952-7924
Characterizing Barker Coded Modulation in Radar Systems (AN 358-10)
5952-8004
Complete S-Parameter and Distortion Measurement for Wide Band Video Amplifiers (AN 357-2)
5950-2932
Component Test (AN 369-3)
5950-2951
Digital Radio Theory and Measurements (AN 355A)
5091-4777E
Examine Channel Switching Characteristics of Cellular Radios (AN 1200-10)
5091-0394E
Examine GMSK Modulation in GSM and PCN Mobile Communications Systems (AN 1200-11)
5091-7201E
Extending Dynamic Range of Scalar Transmission Measurements Using the HP 8757A, 8756A, or 8755C Scalar Network Analyzers (AN 327-1)
5953-8882
Final Test and Alignment for Cellular Phones
5964-0147E
Fundamentals of RF and Microwave, Power Measurement (AN 64-1A)
5965-6630E
Fundamentals of RF and Microwave, Noise, Figure Measurement (AN 57-1)
5952-8255
High Accuracy and Fast RF Inductor Testing (AN 369-10)
5091-1596E
HP 8921A Cell Site Test Set TACS Base Station Testing (PN 8921-2)
5962-0157E
HP 8921A Cell Site Test Set (PN 8921-1)
5962-9475E
Lightwave Measurements with the HP 71400 Lightwave Signal Analyzer (AN 371)
5954-9137E
Microwave Switching from SPDT to Full Access Matrix (AN 332)
5953-6466
Modeling Passive High-Speed Digital Structures (AN 2303-1)
5091-0971E
Novel Combinations of Microwave Switches and Step Attenuators (AN 332-1)
5954-8892
Peak Deviation and Center Frequency Measurements for CT2 and DECT Radios (AN 1200-12)
5091-7202E
Practical Design and Evaluation of High-Frequency Circuits (AN 317)
5953-6910
Pre-Trigger Simplifies VCO Step Response Measurements (AN 358-4)
5952-7998

Radar System Characterization and Testing Using the HP 5345A Counters (AN 174-14)
5952-7892
S-Parameter Design (AN 154)
5952-1087
Single Shot Frequency Profiling of Chirped Radars Made Easy (AN 1200-8)
5091-0392E
Spectrum Analysis AM and FM (AN 150-1)
5954-9130
Spectrum Analyzer Basics (AN 150)
5952-0292
Testing Digital MW Receivers with a Calibrated Source (AN 343-6)
5952-0800
Time-Capture Capabilities of the HP 89400 Series Vector Signal Analyzers, (PN 89400-10)
5091-8686E
Using Impedance Measurement to Evaluate Electronic Components and Materials—HP 4284A Application Information (AN 369-1)
5950-2949
Using the IBASIC Programming Environment on the HP 8920 Test Set Family (PN 8920-1)
5963-0046E
VHF Transceiver Testing
5964-0148E
Voltage Controlled Oscillators Characterization Using the HP 5350B/5351B/5352B CW Microwave Frequency Counter to Measure Transfer Characteristics and Modulation Sensitivity (AN 181-2)
5952-7852

Mixers

Network, Spectrum, and Impedance Evaluation of IF Circuits—HP 4195A Network/ Spectrum Analyzer (AN 357-1)
5950-2931

Mobile Communications

Examine Channel Switching Characteristics of Cellular Radios (AN 1200-10)
5091-0394E
Examine GMSK Modulation in GSM and PCN Mobile Communications Systems (AN 1200-11)
5091-7201E
Peak Deviation and Center Frequency Measurements for CT2 and DECT Radios (AN 1200-12)
5091-7202E
Simple Analysis of Frequency Modulation (AN 1200-6)
5091-0390E
Simplified Analysis of Phase-Locked Loop Capture and Tracking Range (AN 1200-7)
5091-0391E

Modulation

Analyzing Phase-Locked Loop Transients in the Modulation Domain (AN 358-7)
5952-8001
Applications and Operation of the HP 8901A Modulation Analyzer (AN 286-1)
5952-8208
Basic Operation and Application Guide, HP 8904A Operation Made Easy (AN 8904A)
5953-8491
Characterization of Frequency Agile Sources with the HP 5371A Frequency and Time Interval Analyzer (AN 358-1)
5952-7924
Characterizing Barker Coded Modulation in Radar Systems (AN 358-10)
5952-8004
Characterizing Chirp Coded Modulation in Radar Systems (AN 358-11)
5952-8005
Characterizing Transient Timing Errors in Disk and Tape Drives (AN 358-6)
5952-8000
Clock Rate Independent Jitter Measurements for Digital Communications Systems (AN 358-5)
5952-7999
Digital Radio Theory and Measurements (AN 355)
5952-2857
Examine GMSK Modulation in GSM and PCN Mobile Communications Systems (AN 1200-11)
5091-7201E
Fast Characterization of Pulse-Width Encoded Data (AN 1200-5)
5091-0389E
Frequency and Phase Profiling Simplified with the HP 5361B Pulse/CW Microwave Counter (AN 377-4)
5952-8023
Jitter and Wander Analysis in Digital Communication with the HP 5371A Frequency and Time Interval Analyzer (AN 3)
5952-7925
Measuring Demodulator Image Rejection Using the HP 8980A Vector Analyzer (AN 1200-7)
5952-3703
Measuring Microwave Radio Antenna Return Loss Using the HP 11758T Digital Radio Test System (AN 379-2)
5959-8749
Modulation Domain Techniques for Measuring Complex Radar Signals (AN 358-9)
5952-8003
Practical Strain Gauge Measurements (AN 290-1)
5952-8880
Programming HP FASS with WGL (PN 8791-2)
5963-0988E
Radar System Characterization and Testing Using the HP 5345A Counters (AN 174-14)
5952-7892
Receiver Testing with HP 8770 Arbitrary Waveform Synthesizer System (AN 314-1)
5954-6358
Single Shot BPSK Signal Characterization (AN 358-8)
5952-8002
Single Shot Frequency Profiling of Chirped Radars Made Easy (AN 1200-8)
5091-0392E
Spectrum Analysis AM and FM (AN 150-1)
5954-9130
Understanding the Fundamental Principles of Vector Network Analyzers (AN 1287-1)
5965-7707E
Vector Modulation Measurements: Measurement Applications for Digital Microwave Radio (AN 343-1)
5954-6365
Voltage Controlled Oscillators Characterization Using the HP 5350B/5351B/5352B CW Microwave Frequency Counter to Measure Transfer Characteristics and Modulation Sensitivity (AN 181-2)
5952-7852

Motion Control

Direct Characterization of Motion Control Systems (AN 1200-2)
5091-0386E
Disk Drive Servo–Track Writing with Laser Interferometers (AN 325-11)
5952-7984
Non-Contact Measurements with Laser Interferometers (AN 325-12)
5091-3078 E
Simplified Motor Spin-up Analysis (AN 1200-1)
5091-0385E
Submicron Positioning with the HP 5527A Laser Position Transducer System and HP 10936A Servo-Axis Board (AN 325-10)
5952-7942

Network Analysis, RF, Microwave and Lightwave

17 Fixtures, Test Sets, and Accessories for the HP 8751A (AN 1202-2)
5091-1985E
3 Steps to Better Baseband, IF, and RF Design with the HP 8751A (AN 1202-3)
5091-2348E
Advanced Filter Evaluation and Limit Testing with the HP 4195A (AN 357-3)
5950-2933
Advanced TDR Techniques for Use with the HP 54120 Family of Digitizing Oscilloscopes (AN 62-3)
5952-1141
Analyzing Phase-Locked Loop Capture and Tracking (AN 358-13)
5952-8007

Applying Error Correction to Network Analyzer Measurements (AN 1287-3)
5965-7709E
Balanced Circuit Measurement with an Impedance Analyzer/LCR Meter/Network Analyzer (AN 346-2)
5091-4480E
Basics of Measuring the Dielectric Properties of Materials (AN 1217-1)
5091-3300E
Bipolar Transistor Modeling (AN 1201-4)
5091-2503E
Choosing the Right Analyzer for Baseband and IF Applications, (PN 3589-1)
5091-2318E
Complete S-Parameter and Distortion Measurement for Wide Band Video Amplifiers (AN 357-2)
5950-2932
Control System Loop Gain Measurements (AN 243-5)
5091-3809E
Crosstalk and Impedance Measurements of PC Board Patterns: HP 4194A Application Information (AN 339-3)
5952-7863
Designing Impedance Matching Networks with the HP 8751A (AN 1202-1)
5091-1560E
Dynamic Signal Analyzer Applications (AN 243-1)
5091-2777E
Efficient Microwave Bias and Test Using HP 4142B Modular Source/Monitor (AN 1205)
5091-0522E
Electrical Characterization Methods for MCM Substrates
5091-5724E
Exploring the Architectures of Network Analyzers (AN 1287-2)
5965-7708E
Fundamentals of Signal Analysis (AN 243)
5952-8898E
Modeling Passive High-Speed Digital Structures (AN 1203-1)
5091-0971E
Network Analyzer Measurements: Filter and Amplifier Examples (AN 1287-4)
5965-7710E
Network, Spectrum, and Impedance Evaluation of IF Circuits: HP 4195A Network/Spectrum Analyzer
5950-2931
Product Integration Guide for HP Network Monitoring and Analysis Solutions
5963-3886E
Understanding the Fundamental Principles of Vector Network Analyzers (AN 1287-1)
5965-7707E

Networks, Computer and Communications

1995 ATM/Broadband Testing Seminar Handbook
5963-7508E
Connecting Hewlett-Packard Test Sets for In-Service Testing of PDH/SDH Networks (AN)
5965-5898E
Ensuring that the NewWAN Doesn't Lose its Luster
5963-3334E/EN
Ethernet Network Problems and Their Solutions
5091-7938E
Evaluating Tributary Jitter from the SDH Network (AN 1258)
5962-9551E
FDDI Problems and Their Solutions
5091-6485E
Finding and Solving Problems with HP Ethernet Network
5091-7938E
Frame Relay Installation and Maintenance Using the HP Internet Advisor
5964-1960E
HP Internet Reporter – Network Baselining and Benchmarking
5963-3653E
HP NetMetrix Characterization and Performance
5963-3766E
HP NetMetrix RMON2 Delivered Through HP NetMetrix Solutions (AN 1283)
5965-7497E
Synchronizing Telecommunications Networks: Fundamentals of Synchronization Planning (AN 1264-3)
5963-6978E
The Quest for Quality: The ATM Impairment Testing Handbook (AN)
5965-4992E
Token-Ring Troubleshooting Techniques with the HP Network Advisor
5091-9414E

Noise

Better Noise Measurement with the HP 3588A and 3589A (AN 1213)
5091-2496E
Fast Characterization of Pulse-Width Encoded Data (AN 1200-5)
5091-0389E
Fundamentals of RF and Microwave Noise Figure Measurement (AN 57-1)
5952-8255
Noise Figure Measurement Accuracy (AN 57-2)
5952-3706
Pulsed Carrier Phase Noise, Measurements Using the HP 3048A Phase Noise, Measurement System (AN 386)
5951-6743
Quick Identification of Periodic Jitter Sources (AN 1200-4)
5091-0388E
Signal Generator (AN 388)
5952-2019
Simulating Noise Signals for Tolerance Testing (AN 1210-3)
5091-1801E
Time Domain Characterization of Magnetic Disk Drives (AN 358-3)
5952-7928
Troubleshooting Simultaneous Switching Noise Problems (AN 1222)
5091-3754E

Oscillators

Analyzing Phase-Locked Loop Capture and Tracking (AN 358-13)
5952-8007
Analyzing Phase-Locked Loop Transients in the Modulation Domain (AN 358-7)
5952-8001
Applications and Operation of the HP 8901A Modulation Analyzer (AN 286-1)
5952-8208
Automated Characterization of Microwave VCOs Using the HP 5361A/B Pulse/CW Microwave Counter (AN 377-2)
5952-7988
Examine Channel Switching Characteristics of Cellular Radios (AN 1200-10)
5091-0394E
Fundamentals of Microwave Frequency Counters (AN 200-1)
5952-7484
Fundamentals of Quartz Oscillators (AN 200-2)
5965-7662E
Negative Impedance Measurements of Crystal Oscillators Using the HP 4194A (AN 339-9)
5950-2924
Network, Spectrum, and Impedance Evaluation of IF Circuits: HP 4195A Network/Spectrum Analyzer
5950-2931
Pre-Trigger Simplifies VCO Step Response Measurements (AN 358-4)
5952-7998
Time Keeping and Frequency Calibration (AN 52-2)
5952-7874
VCO Step Response Analysis Made Easy (AN 1200-3)
5091-0387E
Voltage Controlled Oscillators Characterization Using the HP 5350B/5351B/5352B CW Microwave Frequency Counter to Measure Transfer Characteristics and Modulation Sensitivity (AN 181-2)
5952-7852

Oscilloscopes

Advanced TDR Techniques for Use with the HP 54120 Family of Digitizing Oscilloscopes (AN 62-3)
5952-1141
Characterizing IC Package with Impedance Measurements and the UTP3000 (AN 1210-1)
5091-1799E
Characterizing IC Packages with TDR/TDT and the UTP3000 Test Fixture (AN 1210-5)
5091-1803E
Design for Testability Using Boundry-Scan (AN 1210-7)
5091-1805E
Differential Measurements on Wideband Signals
5091-3863E
Electrical Characterization Methods for MCM Substrates
5091-5724E
HP 54600A Product Evaluation
5091-2037E
Microprobing Essentials for Fine Pitch Modules (AN 1242)
5091-6657E
Monitoring of Ultrasonic Wire Bonding Machines (AN 1210-9)
5091-1807E
Semi-Automated Product Testing
5091-2281E
Sequential Single-Shot Optimizes Speed, Memory Depth, and Throughput (AN 1022)
5091-2278E
Simulating Noise Signals for Tolerance Testing (AN 1210-3)
5091-1801E
Timing Considerations in Clock Distribution Networks (AN 1210-10)
5091-5444E
Troubleshooting Simultaneous Switching Noise Problems (AN 1222)
5091-3754E
Understanding and Minimizing Probing Effects (AN 1210-2)
5091-1800E

Phase Linearity

Complete S-Parameter and Distortion Measurement for Wide Band Video Amplifiers (AN 357-2)
5950-2932
Fundamentals of Microwave Frequency Counters (AN 200-1)
5952-7484
Voltage Controlled Oscillators Characterization Using the HP 5350B/5351B/5352B CW Microwave Frequency Counter to Measure Transfer Characteristics and Modulation Sensitivity (AN 181-2)
5952-7852

Phase Stability

Analyzing Phase-Locked Loop Capture and Tracking (AN 358-13)
5952-8007
Histograms Simplify Analysis of Random Jitter (AN 1200-9)
5091-0393E
Jitter and Wander Analysis in Digital Communication with the HP 5371A Frequency and Time Interval Analyzer (AN 358-2)
5952-7925
Phase Noise Performance of the HP 89400 Series Vector Signal Analyzers, (PN 89400-11)
5963-0039E
Time Keeping and Frequency, Calibration (AN 52-2)
5952-7874

Phase-Locked Loops

Analyzing Phase-Locked Loop Transients in the Modulation Domain (AN 358-7)
5952-8001
Analyzing Phase-Locked Loop Capture and Tracking (AN 358-13)
5952-8007

Physical/Mechanical Design and Test

Airframe Testing
5964-0154E
Effective Machinery Measurements Using Dynamic Signal Analyzers (AN 243-1)
5962-7276E
Electronic Heater Valves Testing
5964-0150E
The Fundamentals of Modal Testing (AN 243-3)
5954-7957E
Fundamentals of Signal Analysis (AN 243)
5952-8898E
Jet Engine Controller Testing
5964-0155E
Jet Engine Testing
5964-0156E
Modeling Passive High-Speed Digital Structures (AN 1203-1)
5091-0971E
On-Road Vehicle Testing
5964-0152E
Prototype Jet Engine Characterization
5964-0149E
RTAP in Electric Utilities
5964-0119E
RTAP in Energy Management
5964-0121E
RTAP in Pipelines
5964-0118E
RTAP in Process Manufacturing
5964-0120E
Simplified Motor Spin-up Analysis (AN 1200-1)
5091-0385E
Vehicle Body Testing
5964-0151E

Power Measurement

Applications and Operation of the HP 8901A Modulation Analyzer (AN 286-1)
5952-8208
Basic Operation and Application Guide HP 8902A Operation Made Easy (AN 8902A)
5953-8458
Compliance Testing to the IEC 1000-3-2 and (EN 61000-3-2) and IEC 1000-3-3 (EN 61000-3-3) Standards (AN 1273)
5964-1917E
Fundamentals of RF and Microwave, Power Measurement (AN 64-1A)
5965-6630E
HP 6800 Series AC Power Source/Analyzer
5963-7044E
Increasing Power Transmission System Uptime
5964-0398E
Traveling Wave Fault Location in Power Transmission Systems (AN 1276-1)
5965-5296E

Power Supplies

Biasing Three-Terminal Devices for Test (AN 376-1)
5952-4193
Compliance Testing to the IEC 1000-3-2 and (EN 61000-3-2) and IEC 1000-3-3 (EN 61000-3-3) Standards (AN 1273)
5964-1917E
DC Power Supply Handbook (AN 90B)
5952-4020
Pulsed Characteristics of Power Semiconductors Using Electronic Loads (AN 1246)
5091-7636E
Testing Switching Power Supplies Using the HP 4194A (AN 339-14)
5950-2977

Power Transistors

Measurement of Power Devices Using External DC Power Supply (AN 4156-5)
5963-2365E
Pulsed Characteristics of Power Semiconductors Using Electronic Loads (AN 1246)
5091-7636E

Preprocessors

Designing a Custom Interface for a Logic Analyzer Using HP User Definable Design Tools (AN 1244-2)
5091-8839E
Minimizing Intrusion Effects when Probing with a Logic Analyzer (AN 1244-1)
5962-8620E
VME/VXI Applications—How the Right Preprocessor Interface Can Simplify Logic Analysis (AN 392-3)
5952-3058

Production Test

Aztec Case Study - Benchmark Tests of Three In-Circuit Board Testester for a High-Volume Manufacturing Environment (AN)
5965-4744E
Battery Testing (AN 372-2)
5952-4191
Capture and Apply Deep Vector Sequences to a Device-Under-Test
5952-8074
Characterizing Communications ICs with the HP 83000 Model F660
5962-9273E
Connect Check Backgrounder (AN)
5965-5092E
Contact Resistance and Insulation Resistance Measurements of Electromechanical Components (AN 1224-1)
5091-4132E
Device Characterization with the HP 4062UX and IC-CAP (AN 1201-6)
5091-3811E
HP BASIC for Windows
5964-6019E
Insulation Resistance Measurement of the Plate Type Materials (AN 1224-2)
5091-4133E
Integrating External Code with HP VEE (AN 1206-3)
5091-3071E
Life and Stability of the HP 5DX Sealed X-ray Tube (AN)
5964-4014E
Measurement Repeatability–The Key Performance Characteristic of Inspection Systems (AN)
5964-4015E
Monitoring of Ultrasonic Wire Bonding Machines (AN 393)
5952-2143
Parametric Analysis for Electronic Components and Circuit Evaluation Using the HP 4194A (AN 339)
5950-2856
PCBA S-Ray Inspection–1996 Article Compendium (AN)
5965-6366E
Peak Deviation and Center Frequency Measurements for CT2 and DECT Radios (AN 1200-12)
5091-7202E
Power Supply Testing (AN 372-1)
5952-4190
Practical Strain Gauge Measurements (AN 290-1)
5952-8880
Running Rocky Mountain BASIC From Board Test BASIC (AN)
5965-5878E
Selective Retrieval for the HP 3070 Board Test System (AN)
5965-5879E
Vectorless Test Purchaser's Guide
5965-0805E
VXI Access for BASIC/UX
5964-3669E
Wafer Probing with the HP 83000 Model F330t
5962-0117E

Protocol Analysis

Frame Relay/SMDS Seminar Book
5963-9501E
SS7 Protocol Testing with PT Series Protocol Testers
5962-9408E
Using an X Terminal with the Broadband Series Test System
5963-2012E/EN

Pulse Measurements

Analyzing Phase-Locked Loop Transients in the Modulation Domain (AN 358-7)
5952-8001
Automatic Frequency Profiling of Chirped Radar Pulses Using the HP 5361A/B Pulse/CW Microwave Counter (AN 377-1)
5952-7987
Characterizing Barker Coded Modulation in Radar Systems (AN 358-10)
5952-8004
Characterizing Transient Timing Errors in Disk and Tape Drives (AN 358-6)
5952-8000
Frequency Profiling without a Pulse Generator (AN 377-3)
5952-7991
Fundamentals of Microwave Frequency Counters (AN 200-1)
5952-7484
Modulation Domain Techniques for Measuring Complex Radar Signals (AN 358-9)
5952-8003
Radar System Characterization and Testing Using the HP 5345A Counters (AN 174-14)
5952-7892
Single Shot Frequency Profiling of Chirped Radars Made Easy (AN 1200-8)
5091-0392E

Radar

Automatic Frequency Profiling of Chirped Radar Pulses Using the HP 5361A/B Pulse/CW Microwave Counter
5952-7987
Characterization of Frequency Agile Sources with the HP 5371A Frequency and Time Interval Analyzer (AN 358-1)
5952-7924
Characterizing Barker Coded Modulation in Radar Systems (AN 358-2)
5952-8004
Characterizing Chirp Coded Modulation in Radar Systems (AN 358-11)
5952-8005
Exceptionally-Complex Signal Simulation for Multi-Signal Environments in Radar/EW Test (AN 314-4)
5952-3702
Frequency and Phase Profiling Simplified with the HP 5361B Pulse/CW Microwave Counter (AN 377-4)
5952-8023
Low Phase Noise Applications of the HP 8662A and 8663A Synthesized Signal Generators (AN 283-3)
5953-8435
Microwave Switching from SPDT to Full Access Matrix (AN 332)
5953-6466
Millimeter Measurements Using the HP 3048A Phase Noise Measurement System (AN 385)
5951-6749
Novel Combinations of Microwave Switches and Step Attenuators (AN 332-1)
5954-8892
Pre-Trigger Simplifies VCO Step Response Measurements (AN 358-4)
5952-7998
Programming HP FASS with WGL (PN 8791-2)
5963-0988E
Pulsed Carrier Phase Noise Measurements Using the HP 3048A Phase Noise Measurement System (AN 386)
5951-6743
Radar System Characterization and Testing Using the HP 5345A Counters (AN 174-14)
5952-7892
Simplified Analysis of Phase-Locked Loop Capture and Tracking Range (AN 1200-7)
5091-0391E
Single Shot Frequency Profiling of Chirped Radars Made Easy (AN 1200-8)
5091-0392E
VCO Step Response Analysis Made Easy (AN 1200-3)
5091-0387E
Vector Modulation Measurements/Coherent Pulsed Tests of Radar and EW Systems (AN 043-3)
5954-6366
Voltage Controlled Oscillators Characterization Using the HP 5350B/5351B/5352B CW Microwave Frequency Counter to Measure Transfer Characteristics and Modulation Sensitivity (AN 181-2)
5952-7852

Receivers

Applications and Operation of the HP 8901A Modulation Analyzer (AN 286-1)
5952-8208
Basic Operation and Application Guide HP 8902A Operation Made Easy (AN 8902A)
5953-8458
Measuring Microwave Radio Antenna Return Loss Using the HP 11758T Digital Radio Test System (AN 379-2)
5959-8749
Receiver Testing with HP 8770 Arbitrary Waveform Synthesizer System (AN 314-1)
5954-6358
Signal Generator (AN 388)
5952-2019
Testing Digital MW Receivers with a Calibrated Source (AN 343-6)
5952-0800
Vector Modulation Measurements: Measurement Applications for Digital Microwave Radio (AN 343-1)
5954-6365

Reflectometers

Advanced TDR Techniques for Use with the HP 54120 Family of Digitizing Oscilloscopes (AN 62-3)
5952-1141
Beginner's Guide to Using the HP8146A Optical Time Domain Reflectometer
5963-3775E

Rotating Machinery

Direct Characterization of Motion Control Systems (AN 1200-2)
5091-0386E
Simplified Motor Spin-up Analysis (AN 1200-1)
5091-0385E

S-Parameters

Complete S-Parameter and Distortion Measurement for Wide Band Video Amplifiers (AN 357-2)
5950-2932
Designing Impedance Matching Networks with the HP 8751A (AN 1202-1)
5091-1560E
Electrical Characterization Methods for MCM Substrates
5091-5724E
Exploring the Architectures of Network Analyzers (AN 1287-2)
5965-7708E
S-Parameter Techniques for Faster, More Accurate Network Design (AN 95-1)
5952-1130

Satellite Communications

Frequency and Phase Profiling Simplified with the HP 5361B Pulse/CW Microwave Counter (AN 377-4)
5952-8023
Simple Analysis of Frequency Modulation (AN 1200-6)
5091-0390E
Time Keeping and Frequency, Calibration (AN 52-2)
5952-7874
VCO Step Response Analysis Made Easy (AN 1200-3)
5091-0387E

Secure Data Transmission

Riding the Internet Wave: Ensuring Safe, Solid Internet Services for the Enterprise
5965-9371E

Semiconductors

Accurate and Efficient C-V Measurements
5965-5658E
An Automated DC Parameter Measurement System for Power Modules and Smart Power ICs Using the HP 4142B (AN 1216-2)
5091-3472E
Analysis of Semiconductor Capacitance Characteristics Using the HP 4280A 1 MHz C Meter/C-V Plotter (AN 322)
5953-6939
Automated Extraction of Semiconductor Parameters using the HP 4155A/4156A (AN 4156-2)
5963-1249E
Automation of DC Characterization and Analysis of Semiconductor Devices (AN 383-2)
5090-0299
Bipolar Transistor Modeling (AN 1201-4)
5091-2503E
Characterizing Communications ICs with the HP 83000 Model F660
5962-9273E
Characterizing IC Packages with TDR/TDT and the UTP3000 Test Fixture (AN 1210-5)
5091-1803E
(AN 1210-16) Characterizing the Performance of High-Speed Digital-to-Analog Converters
5962-6972
Contact Resistance and Insulation Resistance Measurements of Electromechanical Components (AN 1224-1)
5091-4132E
DC Parametric Analysis of Semiconductor Devices (AN G002)
5950-2928
Design for Testability Using Boundry-Scan (AN 1210-7)
5091-1805E
Device Characterization with the HP 4062UX and IC-CAP (AN 1201-6)
5091-3811E
Efficient Microwave Bias and Test Using HP 4142B Modular Source/Monitor (AN 1205)
5091-0522E
Evaluation of Electromigration Using the SWEAT Procedure (AN 4156-7)
5963-1110E
Evaluation of Flash Memory Cells (AN 4156-4)
5965-5657E
Evaluation of Hot Carrier Induced Degradation of MOSFET Devices (AN 4156-3)
5963-1111E
Evaluation of Hot Carrier Induced Degradation of MOSFET Devices Application Flyer (AN)
5964-9113E
Evaluation of Oxide Reliability Using V-Ramp/J-Ramp Test (AN 4156-8)
5963-1248E
Hierarchical Modeling for Circuit Characterization (AN 1201-2)
5091-1668E
High Speed Wafer Probing with the HP 83000 Model F660
5963-5402E
High-Speed DC Characterization of Semiconductor Devices from Sub pA to 1A (AN 356)
5950-2930
HP 4155A/4156A Semiconductor Parameter Analyzer–Edition 1 Programming Guide for HP 4145A/B Users
5963-3201E
Insulation Resistance Measurement of the Plate Type Materials (AN 1224-2)
5091-4133E
Low Current Measurement with HP E65250A Switch Mainframe
5964-9112E
Maximizing the Incoming Inspection Efficiency of Semiconductor Devices (AN 4156-6)
5963-2364E
Measurement of Power Devices Using External DC Power Supply (AN 4156-5)
5963-2365E
Memory Test Software Provides Cost-Effective Solutions to Testing Advanced SRAMs
5963-5078E
Microprobing Essentials for Fine Pitch Modules (AN 1242)
5091-6657E

Model Parameter Monitoring with the HP 4062UX, IC-CAP and IC-MS (AN 1201-5)
5091-3525E
Monitoring of Ultrasonic Wire Bonding Machines (AN 1210-9)
5091-1807E
Multifrequency C-V Measurements and Doping Profile Analysis of Semiconductors Using the HP 4194A (AN 339-5)
5950-2919
Multifrequency C-V Measurements of Semiconductors—HP 4284A Application Information (AN 369-5)
5950-2953
Op Amp/Comparator Test Solution (AN 1262)
5963-2322E
Optimizing the Incoming Inspection of Semiconductor Devices (AN 4156-6)
5963-2364E
Performing High-Speed Parameter Extractions on High-Power Devices Using the HP 4142B (AN 1216-1)
5091-3218E
Precision Evaluation of Flash Memory Cells (AN 4062-2)
5091-6806E
Role of DC Parametric Test in High Speed Digital (AN 339-20)
5952-7936
Semiconductor Measurements with the HP 4140B Picoammeter/DC Voltage Source (AN 238)
5952-8840
Simplification of DC Characterization and Analysis of Semiconductor Devices (AN 383-1)
5950-2396
Static Head Testing for Disk Drives (AN 339-6)
5952-7871
Techniques and Applications for High Throughput and Stable Characterization (AN 356-1)
5950-2954
The HP 4062UX Provides High Performance Data Management and Powerful Networking Capabilities (Transfer Data to BD/DA System) (AN 382-1)
5950-2393
Ultra Low Current DC Characterization at the Wafer Level (AN 4070-1)
5965-7352E
Ultra Low Current DC Characterization of MOSFETs at the Wafer Level (AN 4156-1)
5963-2014E
Ultra Low Current Semiconductor DC Parameter Measurement System Using HP 4140B (AN 238-1)
5952-8873
Wafer Probing with the HP 83000 Model F330t
5962-0117E
Writing Flash Memory with HP 3070 Systems (AN)
5965-3248E

Signal Conditioning

Understanding and Minimizing Probing Effects (AN 1210-2)
5091-1800E

Signal Generators

Pre-Trigger Simplifies VCO Step Response Measurements (AN 358-4)
5952-7998
VOR/ILS Testing with HP 8644A (AN 8644-2)
5951-6740

Signal Sources

Characterizing Components with a Microwave Tracking Source (AN 1212)
5091-2172E
External Frequency Doubling of the HP 8662A Synthesized Signal Generator (AN 283-2)
5952-8217
Millimeter Measurements Using the HP 3048A Phase Noise Measurement System (AN 385)
5951-6749
Pulsed Carrier Phase Noise Measurements Using the HP 3048A Phase Noise Measurement System (AN 386)
5951-6743

Smith Chart

Designing Impedance Matching Networks with the HP 8751A (AN 1202-1)
5091-1560E
S-Parameter Techniques for Faster, More Accurate Network Design (AN 95-1)
5952-1130

Sound

Sound Power Measurements (AN 1230)
5091-4426E

Spectrum Analysis

Advanced Filter Evaluation and Limit Testing with the HP 4195A (AN 357-3)
5950-2933
Choosing the Right Analyzer for Baseband and IF Applications (PN 3589-1)
5091-2318E
Complete S-Parameter and Distortion Measurement for Wide Band Video Amplifiers (AN 357-2)
5950-2932
Downconverted Measurements Using the HP 89410A and HP 89441A (PN 89400-9)
5091-8691E
Eight Hints for Making Better Spectrum Analyzer Measurements (AN)
5965-7009E
Fundamentals of Signal Analysis (AN 243)
5952-8898E
HP 71452B Optical Spectrum Analyzer—EDFA Testing with the Interpolation Technique (PN 71450-1)
5963-7146E
Network, Spectrum, and Impedance Evaluation of IF Circuits—HP 4195A Network/Spectrum Analyzer (AN 357-1)
5950-2931
Non-Contact Measurements with Laser Interferometers (AN 325-12)
5091-3078 E
Optical Spectrum Analysis Basics
5963-7145E
Phase Noise Performance of the HP 89400 Series Vector Signal Analyzers (PN 89400-11)
5963-0039E
Precision Time-Domain Measurement Using the HP E1430A
5962-0015E
Spectrum Analysis AM and FM (AN 150-1)
5954-9130
Spectrum Analyzer Basics (AN 150)
5952-0292
Testing Magnetic Disk Read Circuits Using the HP 4195A (AN 357-4)
5950-2398

Standards

Advanced TDR Techniques for Use with the HP 54120 Family of Digitizing Oscilloscopes (AN 62-3)
5952-1141
Contribution of Hewlett-Packard Clocks to the BIH's International Atomic Time Scale (IATS) (AN 52-4)
5965-9782E
Cookbook for EMC Precompliance Measurements (AN 1290-1)
5964-2151E
Fundamentals of Time and Frequency Standards (AN 52-1)
5952-7870
Time Keeping and Frequency, Calibration Stripline Device Measurements: (AN 52-2)
5952-7874

Characterizing Barker Coded Modulation in Radar Systems (AN 358-10)
5952-8004
Characterizing Components with a Microwave Tracking Source (AN 1212)
5091-2172E
Control System Development Using Dynamic Signal Analyzers (AN 243-2)
5953-5136
Dynamic Signal Analyzer Applications (AN 243-1)
5091-2777E
Frequency and Phase Profiling Simplified with the HP 5361B Pulse/CW Microwave Counter (AN 377-4)
5952-8023
Low Phase Noise Applications of the HP 8662A and 8663A Synthesized Signal Generators (AN 283-3)
5953-8435
Millimeter Measurements Using the HP 3048A Phase Noise Measurement System (AN 385)
5951-6749
Modulation Domain Techniques for Measuring Complex Radar Signals (AN 358-9)
5952-8003
Pulsed Carrier Phase Noise, Measurements Using the HP 3048A Phase Noise, Measurement System (AN 386)
5951-6743
Single Shot Frequency Profiling of Chirped Radars Made Easy (AN 1200-8)
5091-0392E

Switching

Microwave Switching from SPDT to Full Access Matrix (AN 332)
5953-6466
Novel Combinations of Microwave Switches and Step Attenuators (AN 332-1)
5954-8892
Pre-Trigger Simplifies VCO Step Response Measurements (AN 358-4)
5952-7998
Troubleshooting Simultaneous Switching Noise Problems (AN 1222)
5091-3754E

Stripline Device Measurements

Electrical Characterization Methods for MCM Substrates (AN 1210-14)
5091-5724E

Swept-Frequency Measurements

Analyzing Phase-Locked Loop Transients in the Modulation Domain (AN 358-7)
5952-8001

Synthesizers/Signal Generators

Analyzing Phase-Locked Loop Transients in the Modulation Domain (AN 358-7)
5952-8001
External Frequency Doubling of the HP 8662A Synthesized Signal Generator (AN 283-2)
5952-8217
Millimeter Measurements Using the HP 3048A Phase Noise Measurement System (AN 385)
5951-6749
Pulsed Carrier Phase Noise, Measurements Using the HP 3048A Phase Noise, Measurement System (AN 386)
5951-6743
Signal Generator (AN 388)
5952-2019

Tape Recording

Fast Characterization of Pulse-Width Encoded Data (AN 1200-5)
5091-0389E
Histograms Simplify Analysis of Random Jitter (AN 1200-9)
5091-0393E
Time Domain Characterization of Magnetic Disk Drives (AN 358-3)
5952-7928

Telecommunications

Amplifier Measurements Using the Scalar Network Analyzer (AN 345-1)
5954-1599
Cellular Call Processing
5964-0159E
Evaluating Tributary Jitter from the SDH Network (AN 1258)
5962-9551E
Examine GMSK Modulation in GSM and PCN Mobile Communications Systems (AN 1200-11)
5091-7201E
Getting the Most Out of Your T1 and DDS Services
5091-6174E
HP SmartClock-Improving Oscillator Long-Term Stability for Synchronization Applications (AN 1279)
5964-6725E
High Productivity Measurements in Digital Transmission (AN 387)
5959-7898
High-Speed DC Characterization of Semiconductor Devices from Sub pA to 1A (AN 356)
5950-2930
High-Speed Lightwave Component Analysis (AN 1550-6)
5091-6478E
Lightwave Measurements with the HP 71400 Lightwave Signal Analyzer (AN 371)
5954-9137E
Maximizing Revenue With In-Service Testing: Introduction (AN 1237-1)
5091-6009E
Maximizing Revenue With In-Service Testing–Centralized Testing/Monitoring Systems (AN 1237-2)
5091-6349E
Simple Analysis of Frequency Modulation (AN 1200-6)
5091-0390E
Simplified Analysis of Phase-Locked Loop Capture and Tracking Range (AN 1200-7)
5091-0391E
SS7 Protocol Testing With PT Series Protocol Testers
5962-9408E
Standard and CRC-4 Frame Testing (AN 1211-1)
5091-2070E
Synchronizing Telecommunications Networks: Fundamentals of Synchronization Planning (AN 1264-3)
5963-6978E
Testing n x 64 kb/s Services (AN 1211-2)
5091-2069E
Testing Sub-rate Data Services (AN 1211-3)
5091-2072E
The Personal Handy Phone System in Japan's Wireless Communication Market
5964-6753E
Vector Modulation Measurements—Measurement Applications for Digital Microwave Radio (AN 343-1)
5954-6365

Test Systems

Airframe Testing
5964-0154E
An Automated DC Parameter Measurement System for Power Modules and Smart Power ICs Using the HP 4142B (AN 1216-2)
5091-3472E
Automated Characterization of Microwave VCOs Using the HP 5361A/B Pulse/CW Microwave Counter (AN 377-2)
5952-7988
Automated Extraction of Semiconductor Parameters Using the HP 4155A/4156A (AN 4156-2)
5963-1249E

Environmental Test of Automotive Radio and Engine Controllers
5964-0157E
Evaluation of Electromigration Using the SWEAT Procedure (AN 4156-7)
5963-1110E
Evaluation of Hot Carrier Induced Degradation of MOSFET Devices (AN 4156-3)
5963-1111E
Evaluation of Oxide Reliability Using V-Ramp/J-Ramp Tests (AN 4156-8)
5963-1248E
High-Speed Continuity/Shorts Test on the HP 82000 (AN 398-4)
5091-1364L
HP VEE for Windows/Dynamic Data Exchange Between HP VEE for Windows and Microsoft Excel, (PN 2120-2)
5962-9850E
HP VEE for Windows/Using a Dynamic Link Library (DLL) with HP VEE for Windows, (PN 2120-3)
5962-9852E
HP VEE for Windows, (PN 2120-1)
5962-9849E
HP-IB Programming Hints for the HP 4194A (AN 339-12)
5950-2929
Introduction to HP Standard Instrument Control Library
5963-2228E
Jet Engine Controller Testing
5964-0155E
Jet Engine Testing
5964-0156E
Low Phase Noise Applications of the HP 8662A and 8663A Synthesized Signal Generators (AN 283-3)
5953-8435
Measurement of Power Devices Using External DC Power Supply (AN 4156-5)
5963-2365E
Microwave Switching from SPDT to Full Access Matrix (AN 332)
5953-6466
Millimeter Measurements Using the HP 3048A Phase Noise Measurement System (AN 385)
5951-6749
Model Parameter Monitoring with the HP 4062UX, IC-CAP and IC-MS (AN 342-7)
5091-3525E
Novel Combinations of Microwave Switches and Step Attenuators (AN 332-1)
5954-8892
Automatic Path Delay Compensation (AN 398-5)
5091-1935E
Automation of DC Characterization and Analysis of Semiconductor Devices (AN 383-2)
5090-0299
Automotive Relay Module Testing
5964-0158E
Battery Testing (AN 372-2)
5952-4191
Correlation of Timing Measurements (AN 398-2)
5952-2311
Device Characterization with the HP 4062UX and IC-CAP (AN 1201-6)
5091-3811E
Optimizing the Incoming Inspection of Semiconductor Devices (AN 4156-6)
5963-2364E
Peak Deviation and Center Frequency Measurements for CT2 and DECT Radios (AN 1200-12)
5091-7202E
Power Supply Testing (AN 372-1)
5952-4190
Pulsed Carrier Phase Noise Measurements Using the HP 3048A Phase Noise Measurement System (AN 386)
5951-6743
Pulsed Characteristics of Power Semiconductors Using Electronic Loads (AN 1246)
5091-7636E
Synchronizing the HP 82000 to External Equipment (AN 390)
5953-6339
Ultra Low Current DC Characterization of MOSFETs at the Wafer Level (AN 4156-1)
5963-2014E
Using the HP 82000 for 1 Gb/s (AN 398-1)
5952-2301

Time/Timekeeping

Contribution of Hewlett-Packard Clocks to the BIH's International Atomic Time Scale (IATS) (AN 52-4)
5965-9782E
Correlation of Timing Measurements (AN 398-2)
5952-2311
Fundamentals of Time and Frequency Standards (AN 52-1)
5952-7870
GPS and Precision Timing Applications (AN 1272)
5965-2791E
HP SmartClock-Improving Oscillator Long-Term Stability for Synchronization Applications (AN 1279)
5964-6725E
Increasing Power Transmission System Uptime
5964-0398E
Synchronizing Telecommunications Networks – Basic Concepts (AN 1264-1)
5963-6867E
The Science of Timekeeping (AN 1289)
5965-7984E
Time Keeping and Frequency, Calibration (AN 52-2)
5952-7874
Time-Capture Capabilities of the HP 89400 Series Vector Signal Analyzers, (PN 89400-10)
5091-8686E

Time-Interval

Characterizing Chirp Coded Modulation in Radar Systems (AN 358-11)
5952-8005
Characterizing Transient Timing Errors in Disk and Tape Drives (AN 358-6)
5952-8000
Clock Rate Independent Jitter Measurements for Digital Communications Systems (AN 358-5)
5952-7999
Correlation of Timing Measurements (AN 398-2)
5952-2311
Determining Digital Circuit Timing Tolerance to Optimize Adjustment or Design (AN 191-2)
5952-7488
Fundamentals of Time Interval Measurements (AN 200-3)
5965-7663
Histograms Simplify Analysis of Random Jitter (AN 1200-9)
5091-0393E
Quick Identification of Periodic Jitter Sources (AN 1200-4)
5091-0388E
Time Keeping and Frequency Calibration (AN 52-2)
5952-7874
Timing Considerations in Clock Distribution Networks (AN 1210-10)
5091-5444E

Timing Analysis

Accurate Transmission Line Fault Location Using Synchronized Sampling
5964-6640E
Characterizing Barker Coded Modulation in Radar Systems (AN 358-10)
5952-8004
Characterizing Transient Timing Errors in Disk and Tape Drives (AN 358-6)
5952-8000
Electrical Characterization Methods for MCM Substrates (AN 1210-14)
5091-5724E
Fast Characterization of Pulse-Width Encoded Data (AN 1200-5)
5091-0389E
High-Speed Timing Acquisition and Statistical Jinner Analysis Using the HP 5370B Universal Time Interval Counter (AN 191-7)
5952-7908

Histograms Simplify Analysis of Random Jitter (AN 1200-9)
5091-0393E
Increasing Power Transmission System Uptime
5964-0398E
Modulation Domain Techniques for Measuring Complex Radar Signals (AN 358-9)
5952-8003
Pre-Trigger Simplifies VCO Step Response Measurements (AN 358-4)
5952-7998
Quick Identification of Periodic Jitter Sources (AN 1200-4)
5091-0388E
Timing Characterization Using the HP 16517/18A with Intel Pentium Processor Measurement Examples (AN 1261)
5091-8798E
Timing Considerations in Clock Distribution Networks (AN 1210-10)
5091-5444E

Transforms

Fundamentals of Signal Analysis (AN 243)
5952-8898E

Transistors

Automated Extraction of Semiconductor Parameters Using the HP 4155A/4156A (AN 4156-2)
5963-1249E
Biasing Three-Terminal Devices for Test (AN 376-1)
5952-4193
Bipolar Transistor Modeling (AN 1201-4)
5091-2503E
Evaluation of Hot Carrier Induced Degradation of MOSFET Devices (AN 4156-3)
5963-1111E
Evaluation of Oxide Reliability Using V-Ramp/J-Ramp Tests (AN 4156-8)
5963-1248E
Measurement of Power Devices Using External DC Power Supply (AN 4156-5)
5963-2365E
Optimizing the Incoming Inspection of Semiconductor Devices (AN 4156-6)
5963-2364E
Pulsed Characteristics of Power Semiconductors Using Electronic Loads (AN 1246)
5091-7636E
S-Parameter Techniques for Faster, More Accurate Network Design (AN 95-1)
5952-1130
Ultra Low Current DC Characterization of MOSFETs at the Wafer Level (AN 4156-1)
5963-2014E

Transmission Lines

Accurate Transmission Line Fault Location Using Synchronized Sampling
5964-6640E
Advanced TDR Techniques for Use with the HP 54120 Family of Digitizing Oscilloscopes (AN 62-3)
5952-1141
Electrical Characterization Methods for MCM Substrates
5091-5724E
S-Parameter Design (AN 154)
5952-1087
Standard and CRC-4 Frame Testing (AN 1211-1)
5091-2070E
Testing n x 64 kb/s Services (AN 1211-2)
5091-2069E
Testing Sub-Rate Data Services (AN 1211-3)
5091-2072E
Traveling Wave Fault Location in Power Transmission Systems (AN 1276-1)
5965-5296E

Troubleshooting and Debugging Analog, Digital and Logic

An Automated DC Parameter Measurement System for Power Modules and Smart Power ICs Using the HP 4142B (AN 1216-2)
5091-3472E
Application Guide to the HP 5355/56 Automatic Frequency Converter (AN 291-1)
5952-7541
Automatic Path Delay Compensation (AN 398-5)
5091-1935E
Automation of DC Characterization and Analysis of Semiconductor Devices (AN 383-2)
5090-0299
Basic Operation and Application Guide HP 8904A Operation Made Easy (AN 8904A)
5953-8491
Battery Charging/Discharging (AN 250-2)
5952-4033
Battery Testing (AN 372-2)
5952-4191
Better Noise Measurement with the HP 3588A and 3589A (AN 1213)
5091-2496E
Biasing Three-Terminal Devices for Test (AN 376-1)
5952-4193
Characteristic Impedance Measurement of PC Board Circuit Patterns Using the HP 4194A Impedance/Gain-Phase Analyzer (AN 339-2)
5950-2908
Component Test (AN 369-3)
5950-2951
Configuration of a Two-Tone Sweeping Generator (AN 312-1)
5952-9316
Constant Current Measurements Using the HP 4194A (AN 339-8)
5950-2923
Correlation of Timing Measurements (AN 398-2)
5952-2311
DC Parametric Analysis of Semiconductor Devices (AN G002)
5950-2928
DC Power Supply Handbook (AN 90B)
5952-4020
Designing a Custom Interface for a Logic Analyzer Using HP User Definable Design Tools (AN 1244-2)
5091-8839E
Determining Digital Circuit Timing Tolerance to OptimizeAdjustment or Design (AN 191-2)
5952-7488
Floating Measurements and Guarding (AN 123)
5952-2153
High Accuracy and Fast RF Inductor Testing (AN 369-10)
5950-2930
High-Speed Continuity/Shorts Test on the HP 82000 (AN 398-4)
5091-1364L
High-Speed DC Characterization of Semiconductor Devices from Sub pA to 1A (AN 356)
5950-2930
HP 54600A Product Evaluation
5091-2037E
HP VEE Design Characterization (AN 1206-2)
5091-1140E
Intel 80960CA Software Debug using a Logic Analyzer and an In-Circuit Debugger
5963-3544E
Maximizing Revenue with In-Service Testing: Introduction (AN 1237-1)
5091-6009E
Measuring CMOS Quiescent Power Supply Current (IDDQ) with the HP 82000 (AN 398-3)
5091-1363L
Microprobing Essentials for Fine Pitch Modules (AN 1242)
5091-6657E
Microprobing with the MTS-2200 Fine Pitch Probing System (AN 1240)
5091-6148E
Minimizing Intrusion Effects When Probing with a Logic Analyzer (AN 1244-1)
5962-8620E
Multifrequency C-V Measurements and Doping Profile Analysis of Semiconductors Using the HP 4194A (AN 339-5)
5950-2919

PC Network Connectivity with the HP 16500L Interface Module (AN 1245)
5091-6908E
Power Supply Testing (AN 372-1)
5952-4190
Pulsed Characteristics of Power Semiconductors Using Electronic Loads (AN 1246)
5091-7636E
Multifrequency C-V Measurements of Semiconductors: HP 4284A Application Information (AN 369-5)
5950-2953
Semiconductor Measurements with the HP 4140B Picoammeter/DC Voltage Source (AN 238)
5952-8840
Simplification of DC Characterization and Analysis of Semiconductor Devices (AN 383-1)
5950-2396
Synchronizing the HP 82000 to External Equipment (AN 390)
5953-6339
Techniques and Applications for High Throughput and Stable Characterization (AN 356-1)
5950-2954
Testing Switching Power Supplies Using the HP 4194A (AN 339-14)
5950-2977
Timing Characterization Using the HP 16517/18A with Intel Pentium Processor Measurement Examples (AN 1261)
5091-8798E
Troubleshooting Simultaneous Switching Noise Problems (AN 1222)
5091-3754E
Ultra Low Current Semiconductor DC Parameter Measurement System Using HP 4140B (AN 238-1)
5952-8873
Understanding and Minimizing Probing Effects (AN 1210-2)
5091-1800E
VME/VXI, Applications: How the Right Preprocessor Interface Can Simplify Logic, Analysis (AN 392-3)
5952-3058
Wide-Range DC Current Biased Inductance Measurement (AN 369-8)
5950-2367

Troubleshooting and Debugging RF, MW, LW and Communications

17 Fixtures, Test Sets, and Accessories for the HP 8751A (AN 1202-2)
5091-1985E
3 Steps to Better Baseband, IF, and RF Design with the HP 8751A (AN 1202-3)
5091-2348E
A Guide to Microwave Upconversion (AN 314-5)
5953-2342
Accurate Transmission Line Fault Location Using Synchronized Sampling
5964-6640E
Advanced Filter Evaluation and Limit Testing with the HP 4195A (AN 357-3)
5950-2933
Amplifier Measurements Using the Scalar Network Analyzer (AN 345-1)
5954-1599
Analysis of Semiconductor Capacitance Characteristics Using the HP 4280A 1 MHz C Meter/C-V Plotter (AN 322)
5953-6939
Applications and Operation of the HP 8901A Modulation Analyzer (AN 286-1)
5952-8208
Automated Characterization of Microwave VCOs Using the HP 5361A/B Pulse/CW Microwave Counter (AN 377-2)
5952-7988
Automatic Frequency Profiling of Chirped Radar Pulses Using the HP 5361A/B Pulse/CW Microwave Counter
5952-7987
Balanced Circuit Measurement with an Impedance Analyzer/LCR Meter/Network Analyzer (AN 346-2)
5091-4480E
Characterizing Components with a Microwave Tracking Source (AN 1212)
5091-2172E
Characterizing IC Package with Impedance Measurements and the UTP3000 (AN 1210-1)
5091-1799E
Characterizing IC Packages with TDR/TDT and the UTP3000 Test Fixture (AN 1210-5)
5091-1803E
Complete S-Parameter and Distortion Measurement for Wide Band Video Amplifiers (AN 357-2)
5950-2932
Crosstalk and Impedance Measurements of PC Board Patterns—HP 4194A Application Information (AN 339-3)
5952-7863
Designing Impedance Matching Networks with the HP 8751A (AN 1202-1)
5091-1560E
Differential Measurements on Wideband Signals
5091-3863E
Dynamic Signal Analyzer Applications (AN 243-1)
5091-2777E
Effective Impedance Measurement Using OPEN/SHORT/LOAD Correction (AN 346-3)
5091-6553E
Efficient Evaluation of LISNs and Voltage Probes for EMI Tests Using the HP 4194A (AN 339-7)
5950-2922
Ethernet Network Problems and Their Solutions
5091-7938E
Examine Channel Switching Characteristics of Cellular Radios (AN 1200-10)
5091-0394E
Examine GMSK Modulation in GSM and PCN Mobile Communications Systems (AN 1200-11)
5091-7201E
Extending Dynamic Range of Scalar Transmission Measurements Using the HP 8757A, 8756A, or 8755C Scalar Network Analyzers (AN 327-1)
5953-8882
External Frequency Doubling of the HP 8662A Synthesized Signal Generator (AN 283-2)
5952-8217
FDDI Problems and Their Solutions
5091-6485E
Filter Test for Production and Incoming Inspection: HP 4194A Impedance Gain-Phase Analyzer (AN 339-11)
5952-7887
Frequency Profile Using an HP 5345A Electronic Frequency Counter and on HP 5359A Time Synthesizer (AN 287-2)
5952-7530
Frequency Profiling without a Pulse Generator (AN 377-3)
5952-7991
Fundamentals of Microwave Frequency Counters (AN 200-1)
5952-7484
Fundamentals of Quartz Oscillators (AN 200-2)
5952-7507
Fundamentals of RF and Microwave Power Measurement (AN 64-1)
5952-8178
Fundamentals of RF and Microwave, Noise, Figure Measurement (AN 57-1)
5952-8255
High Productivity Measurements in Digital Transmission (AN 387)
5959-7898
High-Speed Lightwave Component Analysis (AN 1550-6)
5091-6478E
Impedance Characterization of Resonators Using the HP 4194A Impedance/ Gain-Phase Analyzer (AN 339-1)
5950-2882
Impedance Measurement for Incoming Inspection—HP 4284A Application Information (AN 369-4)
5950-2952
Impedance Testing Using a Scanner (AN 369-6)
5950-2975
Lightwave Measurements with the HP 71400 Lightwave Signal Analyzer (AN 371)
5954-9137E

Measuring Demodulator Image Rejection Using the HP 8980A Vector Analyzer (AN 343-4)
5952-3703
Measuring Microwave Radio Antenna Return Loss Using the HP 11758T Digital Radio Test System (AN 379-2)
5959-8749
Measuring the Characteristic Impedance of Balanced Cables (AN 339-4)
5950-2918
Microwave Switching from SPDT to Full Access Matrix (AN 332)
5953-6466
Millimeter Measurements Using the HP 3048A Phase Noise Measurement System (AN 385)
5951-6749
Negative Impedance Measurements of Crystal Oscillators Using the HP 4194A (AN 339-9)
5950-2924
Network, Spectrum, and Impedance Evaluation of IF Circuits—HP 4195A Network/ Spectrum Analyzer (AN 357-1)
5950-2931
Noise Figure Measurement Accuracy (AN 57-2)
5952-3706
Novel Combinations of Microwave Switches and Step Attenuators (AN 332-1)
5954-8892
Parametric Analysis for Electronic Components and Circuit Evaluation Using the HP 4194A (AN 339)
5950-2856
Practical Design and Evaluation of High-Frequency Circuits (AN 317)
5953-6910
Pre-Trigger Simplifies VCO Step Response Measurements (AN 358-4)
5952-7998
Pulsed Carrier Phase Noise, Measurements Using the HP 3048A Phase Noise, Measurement System (AN 386)
5951-6743
Radar System Characterization and Testing Using the HP 5345A Counters (AN 174-14)
5952-7892
Receiver Testing with HP 8770 Arbitrary Waveform Synthesizer System (AN 314-1)
5954-6358
S-Parameter Techniques for Faster, More Accurate Network Design (AN 95-1)
5952-1130
Signal Generator (AN 388)
5952-2019
Simple Analysis of Frequency Modulation (AN 1200-6)
5091-0390E
Simplify Frequency Stability Measurements with Built-in Allan Variance Analysis (AN 358-12)
5952-8006
Simulating Noise Signals for Tolerance Testing (AN 1210-3)
5091-1801E
Single Shot BPSK Signal Characterization (AN 358-8)
5952-8002
Single Shot Frequency Profiling of Chirped Radars Made Easy (AN 1200-8)
5091-0392E
Spectrum Analysis AM and FM (AN 150-1)
5954-9130
Spectrum Analyzer Basics (AN 150)
5952-0292
Standard and CRC-4 Frame Testing (AN 1211-1)
5091-2070E
Testing Digital MW Receivers with a Calibrated Source (AN 343-6)
5952-0800
Testing n x 64 kb/s Services (AN 1211-2)
5091-2069E
Testing Sub-rate Data Services (AN 1211-3)
5091-2072E
The HP 4062UX Provides High Performance Data Management and Powerful Networking Capabilities (Transfer Data to BD/DA System) (AN 382-1)
5950-2393
Timing Considerations in Clock Distribution Networks (AN 1210-10)
5091-5444E
Token-Ring Troubleshooting Techniques with the HP Network Advisor
5091-9414E
Using the HP 82000 for 1 Gb/s (AN 398-1)
5952-2301
Vector Modulation Measurements/Coherent Pulsed Tests of Radar and EW Systems (AN 043-3)
5954-6366
Vector Modulation Measurements—Measurement Applications for Digital Microwave Radio (AN 343-1)
5954-6365

Troubleshooting and Debugging Other

Basics of Measuring the Dielectric Properties of Materials (AN 1217-1)
5091-3300E
Characterizing Transient Timing Errors in Disk and Tape Drives (AN 358-6)
5952-8000
Contact Resistance and Insulation Resistance Measurements of Electromechanical Components (AN 1224-1)
5091-4132E
Control System Development Using Dynamic Signal Analyzers (AN 243-2)
5953-5136
Control System Measurement Fundamentals Using Dynamic Signal Analyzers and Accessories (AN 243-6)
5091-5886E
Digital Video Testing with the HP 16542A (AN 1225-3)
5091-5447E
Direct Characterization of Motion Control Systems (AN 1200-2)
5091-0386E
Disk Drive Servo-Track Writing with Laser Interferometers (AN 325-11)
5952-7984
Effective Insulation Resistance Testing Using a Scanner (AN 1224-6)
5091-6669E
Effective Multitap Transformer Testing Using a Scanner (AN 1224-5)
5091-6310E
HP-IB Programming Hints for the HP 4194A (AN 339-12)
5950-2929
Insulation Resistance Measurement of the Plate Type Materials (AN 1224-2)
5091-4133E
Low-Level RF Leakage Measurements (AN 1204)
5952-2789
Machine Tool Calibration Using the HP 5528A Laser Measurement System (AN 325-2)
5952-7708
Magnetic Head Measurement Using a Constant Test Current—HP 4284A Application Information (AN 369-3)
5950-2951
Measurement of Capacitance Characteristics of Liquid Crystal Cell (AN 369-7)
5950-2994
Measuring the Dielectric Constant of Solid Materials—HP 4194A Impedance/ Gain-Phase Analyzer (AN 339-13)
5950-2935
Monitoring of Ultrasonic Wire Bonding Machines (AN 1210-9)
5091-1807E
Monitoring of Ultrasonic Wire Bonding Machines (AN 393)
5952-2143
Non-Contact Measurements with Laser Interferometers Extractions on High-Power Devices Using the HP 4142B (AN 325-12)
5091-3078 E
Practical Strain Gauge Measurements (AN 290-1)
5952-8880

Semi-automated Product Testing
5091-2281E
Sequential Single-Shot Optimizes Speed, Memory Depth, and Throughput (AN 1022)
5091-2278E
Simplified Motor Spin-up Analysis (AN 1200-1) (AN 1200-1)
5091-0385E
Sound Power Measurement (AN 1230)
5091-4426E
Submicron Positioning with the HP 5527A Laser Position Transducer System and HP 10936A Servo-Axis Board (AN 325-10)
5952-7942
Synthesizing Magnetic Disk Read and Servo Signals with HP 8770A Arbitrary Waveform System (AN 314-2)
5954-6357
Testing Magnetic Disk Read Circuits Using the HP 4195A (AN 357-4)
5950-2398
Time Domain Characterization of Magnetic Disk Drives (AN 358-3)
5952-7928
Using Impedance Measurement to Evaluate Electronic Components and Materials—HP 4284A Application Information (AN 369-1)
5950-2949

VXI

Airframe Testing
5964-0154E
Communications Cable Testing
5964-0153E
HP VEE Design Characterization (AN 1206-2)
5091-1140E
HP VEE for Windows/Dynamic Data Exchange Between HP VEE for Windows and Microsoft Excel (PN 2120-2)
5962-9850E
HP VEE for Windows / Using a Dynamic Link Library (DLL) with HP VEE for Windows (PN 2120-3)
5962-9852E
HP VEE for Windows (PN 2120-1)
5962-9849E
Jet Engine Testing
5964-0156E
Real-Time System Measures Aircraft Flight Characteristics (AN 1253)
5962-7297E
Sharing Data with HP VEE (AN)
5965-5709E
VME/VXI Applications: How the Right Preprocessor Interface Can Simplify Logic Analysis (AN 392-3)
5952-3058
VXI Access for BASIC/UX
5964-3669E

Vector Measurements

S-Parameter Techniques for Faster, More Accurate Network Design (AN 95-1)
5952-1130
Time-Capture Capabilities of the HP 89400 Series Vector Signal Analyzers (PN 89400-10)
5091-8686E
Vector Modulation Measurements/Coherent Pulsed Tests of Radar and EW Systems (AN 043-3)
5954-6366
Vector Modulation Measurements—Measurement Applications for Digital Microwave Radio (AN 343-1)
5954-6365

Video/TV

1996 Digital Video Test Symposium – Attendee's Handbook (AN)
5965-0964E
Digital Video Testing with the HP 16542A
5091-5447E
Fast Characterization of Pulse-Width Encoded Data (AN 1200-5)
5091-0389E
High-Speed DC Characterization of Semiconductor Devices from Sub pA to 1A (AN 356)
5950-2930
Illegal Colors: What They Are and How to Prevent Them (AN 1250-1)
5091-8863
Mixing MPEG-II and ATM: Will It Work?
5963-7511E
Simplified Analysis of Phase-Locked Loop Capture and Tracking Range (AN 1200-7)
5091-0391E

Voltage

Applications and Operation of the HP 8901A Modulation Analyzer (AN 286-1)
5952-8208

Voltage-Controlled Oscillator

Analyzing Phase-Locked Loop Transients in the Modulation Domain (AN 358-7)
5952-8001
Pre-Trigger Simplifies VCO Step Response Measurements (AN 358-4)
5952-7998
Simplified Analysis of Phase-Locked Loop Capture and Tracking Range (AN 1200-7)
5091-0391E
Voltage Controlled Oscillators Characterization Using the HP 5350B/5351B/5352B CW Microwave Frequency Counter to Measure Transfer Characteristics and Modulation Sensitivity (AN 181-2)
5952-7852

Voltage Regulators

Pulsed Characteristics of Power Semiconductors Using Electronic Loads (AN 1246)
5091-7636E

Wave Analysis

Electrical Characterization Methods for MCM Substrates (AN 1210-14)
5091-5724E

Wireless

CDPD Testing – HP 8921A Option 502/3 or 602/3 (AN)
5965-5187E
Digital Radio Theory and Measurements (AN 355)
5952-2857
Examine Channel Switching Characteristics of Cellular Radios (AN 1200-10)
5091-0394E
Examine GMSK Modulation in GSM and PCN Mobile Communications Systems (AN 1200-11)
5091-7201E
Final Test and Alignment for Cellular Phones
5964-0147E
LMDS–The Wireless Interactive Broadband Access Service (AN 1296)
5965-9376E
Peak Deviation and Center Frequency Measurements for CT2 and DECT Radios (AN 1200-12)
5091-7202E
Simple Analysis of Frequency Modulation (AN 1200-6)
5091-0390E
Simplified Analysis of Phase-Locked Loop Capture and Tracking Range (AN 1200-7)
5091-0391E
VHF Transceiver Testing
5964-0148E

1

(AN 1) DS3 Network Interface Unit
5963-9927E
(AN 1022) Sequential Single-Shot Optimizes Speed, Memory Depth, and Throughput
5091-2278E
(AN 1200-1) Simplified Motor Spin-up Analysis
5091-0385E
(AN 1200-10) Examine Channel Switching Characteristics of Cellular Radios
5091-0394E
(AN 1200-11) Examine GMSK Modulation in GSM and PCN Mobile Communications Systems
5091-7201E
(AN 1200-12) Peak Deviation and Center Frequency Measurements for CT2 and DECT Radios
5091-7202E
(AN 1200-2) Direct Characterization of Motion Control Systems
5091-0386E
(AN 1200-3) VCO Step Response Analysis Made Easy
5091-0387E
(AN 1200-4) Quick Identification of Periodic Jitter Sources
5091-0388E
(AN 1200-5) Fast Characterization of Pulse-Width Encoded Data
5091-0389E
(AN 1200-6) Simple Analysis of Frequency Modulation
5091-0390E
(AN 1200-7) Analysis of Phase-Locked Loop Capture and Tracking Range
5091-0391E
(AN 1200-8) Single Shot Frequency Profiling of Chirped Radars Made Easy
5091-0392E
(AN 1200-9) Histograms Simplify Analysis of Random Jitter
5091-0393E
(AN 1201-2) Hierarchical Modeling for Circuit Characterization
5091-1668E
(AN 1201-4) Bipolar Transistor Modeling
5091-2503E
(AN 1201-5) Model Parameter Monitoring with the HP 4062UX, IC-CAP and IC-MS
5091-3525E
(AN 1201-6) Device Characterization with the HP 4062UX and IC-CAP
5091-3811E
(AN 1202-1) Designing Impedance Matching Networks with the HP 8751A
5091-1560E
(AN 1202-2) 17 Fixtures, Test Sets, and Accessories for the HP 8751A
5091-1985E
(AN 1202-3) 3 Steps to Better Baseband, IF, and RF Design with the HP 8751A
5091-2348E
(AN 1203-1) Modeling Passive High-Speed Digital Structures
5091-0971E
(AN 1204) Low-Level RF Leakage Measurements
5952-2789
(AN 1205) Efficient Microwave Bias and Test Using HP 4142B Modular Source/Monitor
5091-0522E
(AN 1206-2) HP VEE Design Characterization
5091-1140E
(AN 1206-3) Integrating External Code with HP VEE
5091-3071E
(AN 1210-1) Characterizing IC Package with Impedance Measurements and the UTP3000
5091-1799E
(AN 1210-10) Timing Considerations in Clock Distribution Networks
5091-5444E
(AN 1210-14) Electrical Characterization Methods for MCM Substrates
5091-5724E
(AN 1210-16) Characterizing the Performance of High-Speed Digital-to-Analog Converters
5962-6972
(AN 1210-2) USUnderstanding and Minimizing Probing Effects
5091-1800E
(AN 1210-3) Simulating Noise Signals for Tolerance Testing
5091-1801E
(AN 1210-4) Characterizing Jitter of A D Flip-Flop
5091-1802E
(AN 1210-5) Characterizing IC Packages with TDR/TDT and the UTP3000 Test Fixture
5091-1803E
(AN 1210-6) Characterizing Jitter with a Digitizing Oscilloscope
5091-1804E
(AN 1210-7) Design for Testability Using Boundry-Scan
5091-1805E
(AN 1210-8) Improving Jitter in Computer Clocks
5091-1806E
(AN 1210-9) Monitoring of Ultrasonic Wire Bonding Machines
5091-1807E
(AN 1210-9) Multiprocessing with HP Measurement Coprocessors
5091-1547E
(AN 1211-1) Standard and CRC-4 Frame Testing
5091-2070E
(AN 1211-2) Testing n x 64 kb/s Services
5091-2069E
(AN 1211-3) Testing Sub-Rate Data Services
5091-2072E
(AN 1212) Characterizing Components with a Microwave Tracking Source
5091-2172E
(AN 1213) Better Noise Measurement with the HP 3588A and 3589A
5091-2496E
(AN 1216-1) Performing High-Speed Parameter Extractions on High-Power Devices Using the HP 4142B
5091-3218E
(AN 1216-2) An Automated DC Parameter Measurement System for Power Modules and Smart Power ICs Using the HP 4142B
5091-3472E
(AN 1217-1) Basics of Measuring the Dielectric Properties of Materials
5091-3300E
(AN 1222) Troubleshooting Simultaneous Switching Noise Problems
5091-3754E
(AN 1224-1) Contact Resistance and Insulation Resistance Measurements of Electro-mechanical Components
5091-4132E
(AN 1224-2) Insulation Resistance Measurement of the Plate Type Materials
5091-4133E
(AN 1224-3) Effective Transformers/LF Coils Testing
5091-4134E
(AN 1224-4) Effective Electrolytic Capacitor Testing
5091-4783E
(AN 1224-5) Effective Multitap Transformer Testing Using a Scanner
5091-6310E
(AN 1224-6) Effective Insulation Resistance Testing Using a Scanner
5091-6669E
(AN 1225-1) Imaging and DSP Testing with the HP 16542A
5091-5445E
(AN 1225-2) Cache Hit or Miss Analysis with the HP 16542A
5091-5446E
(AN 1225-3) Digital Video Testing with the HP 16542A
5091-5447E
(AN 1225-4) Analog-to-Digital Converter Testing with the HP 16542A
5091-5448E
(AN 123) Floating Measurements and Guarding
5952-2153
(AN 1230) Sound Power Measurement
5091-4426E
(AN 1237-1) Maximizing Revenue with In-Service Testing: Introduction
5091-6009E
(AN 1237-2) Maximizing Revenue with In-Service Testing: Centralized Testing/Monitoring Systems
5091-6349E

2

(AN 238-1) Ultra Low Current Semiconductor DC Parameter Measurement System Using HP 4140B
5952-8873
(AN 243) Fundamentals of Signal Analysis
5952-8898E
(AN 243-1) Effective Machinery Measurements Using Dynamic Signal Analyzers
5962-7276E
(AN 243-2) Control System Development Using Dynamic Signal Analyzers
5953-5136
(AN 243-2) Control System Development Using Dynamic Signal Analyzers
5953-5136
(AN 243-3) The Fundamentals of Modal Testing
5954-7957
(AN 243-4) Fundamentals of the z-Domain and Mixed Analog/Digital Measurements
5952-7250
(AN 243-5) Control System Loop Gain Measurements
5091-3809E
(AN 243-6) Control System Measurement Fundamentals Using Dynamic Signal Analyzers and Accessories
5091-5886E
(AN 243-7) Bearing Runout Measurements
5965-5387E
(AN 250-2) Battery Charging/Discharging
5952-4033
(AN 283-2) External Frequency Doubling of the HP 8662A Synthesized Signal Generator
5952-8217
(AN 283-3) Low Phase Noise Applications of the HP 8662A and 8663A Synthesized Signal Generators
5953-8435
(AN 286-1) Applications and Operation of the HP 8901A Modulation Analyzer
5952-8208
(AN 287-2) Frequency Profile Using an HP 5345A Electronic Frequency Counter and on HP 5359A Time Synthesizer
5952-7530
(AN 287-3) Frequency Profile Using an HP 5370A Universal Time Interval Counter and an HP 5359A Time Synthesizer
5952-7549
(AN 290-1) Practical Strain Gauge Measurements
5952-8880
(AN 291-1) Application Guide to the HP 5355/56 Automatic Frequency Converter
5952-7541

3

(AN 312-1) Configuration of a Two-Tone Sweeping Generator
5952-9316
(AN 314-1) Receiver Testing with HP 8770 Arbitrary Waveform Synthesizer System
5954-6358
(AN 314-2) Synthesizing Magnetic Disk Read and Servo Signals with HP 8770A Arbitrary Waveform System
5954-6357
(AN 314-4) Exceptionally-Complex Signal Simulation for Multi-Signal Environments in Radar/EW Test
5952-3702
(AN 314-5) A Guide to Microwave Upconversion
5953-2342
(AN 317) Practical Design and Evaluation of High-Frequency Circuits
5953-6910
(AN 322) Analysis of Semiconductor Capacitance Characteristics Using the HP 4280A 1 MHz C Meter/C-V Plotter
5953-6939
(AN 325-10) Submicron Positioning with the HP 5527A Laser Position Transducer System and HP 10936A Servo-Axis Board
5952-7942
(AN 325-11) Disk Drive Servo-Track Writing with Laser Interferometers
5952-7984
(AN 325-12) Non-Contact Measurements with Laser Interferometers Extractions on High-Power Devices Using the HP 4142B
5091-3078 E
(AN 325-2) Machine Tool Calibration Using the HP 5528A Laser Measurement System
5952-7708
(AN 327-1) Extending Dynamic Range of Scalar Transmission Measurements Using the HP 8757A, 8756A, or 8755C Scalar Network Analyzers
5953-8882
(AN 332) Microwave Switching from SPDT to Full Access Matrix
5953-6466
(AN 332-1) Novel Combinations of Microwave Switches and Step Attenuators
5954-8892
(AN 339) Parametric Analysis for Electronic Components and Circuit Evaluation Using the HP 4194A
5950-2856
(AN 339-1) Impedance Characterization of Resonators Using the HP 4194A Impedance/Gain-Phase Analyzer
5950-2882
(AN 339-11) Filter Test for Production and Incoming Inspection: HP 4194A Impedance Gain-Phase Analyzer
5952-7887
(AN 339-12) HP-IB Programming Hints for the HP 4194A
5950-2929
(AN 339-13) Measuring the Dielectric Constant of Solid Materials NHP 4194A Impedance/ Gain-Phase Analyzer
5950-2935
(AN 339-14) Testing Switching Power Supplies Using the HP 4194A
5950-2977
(AN 339-2) Characteristic Impedance Measurement of PC Board Circuit Patterns Using the HP 4194A Impedance/ Gain-Phase Analyzer
5950-2908
(AN 339-20) Role of DC Parametric Test in High Speed Digital
5952-7936
(AN 339-3) Crosstalk and Impedance Measurements of PC Board Patterns: HP 4194A Application Information
5952-7863
(AN 339-4) Measuring the Characteristic Impedance of Balanced Cables
5950-2918
(AN 339-5) Multifrequency C-V Measurements and Doping Profile Analysis of Semiconductors Using the HP 4194A
5950-2919
(AN 339-6) Static Head Testing for Disk Drives
5952-7871
(AN 339-7) Efficient Evaluation of LISNs and Voltage Probes for EMI Tests Using the HP 4194A
5950-2922
(AN 339-8) Constant Current Measurements Using the HP 4194A
5950-2923
(AN 339-9) Negative Impedance Measurements of Crystal Oscillators Using the HP 4194A
5950-2924
(AN 340-1) Reducing Fixture-Induced Test Failures
5091-0395E
(AN 342-7) Model Parameter Monitoring with the HP 4062UX, IC-CAP and IC-MS
5091-3525E
(AN 343-1) Vector Modulation Measurements: Measurement Applications for Digital Microwave Radio
5954-6365

(AN 343-2) Dynamic Component Test Using Vector Modulation Analysis
5954-6367
(AN 343-4) Measuring Demodulator Image Rejection Using the HP 8980A Vector Analyzer
5952-3703
(AN 343-6) Testing Digital MW Receivers with a Calibrated Source
5952-0800
(AN 345-1) Amplifier Measurements Using the Scalar Network Analyzer
5954-1599
(AN 346) A Guideline For Designing External DC Bias Circuits
5950-2912
(AN 346-2) Balanced Circuit Measurement with an Impedance Analyzer/LCR Meter/Network Analyzer
5091-4480E
(AN 346-3) Effective Impedance Measurement Using OPEN/SHORT/LOAD Correction
5091-6553E
(AN 355) Digital Radio Theory and Measurements
5952-2857
(AN 355A) Digital Radio Theory and Measurements
5091-4777E
(AN 356) High-Speed DC Characterization of Semiconductor Devices from Sub pA to 1A
5950-2930
(AN 356-1) Techniques and Applications for High Throughput and Stable Characterization
5950-2954
(AN 357-1) Network, Spectrum, and Impedance Evaluation of IF Circuits—HP 4195A Network/Spectrum Analyzer
5950-2931
(AN 357-2) Complete S-Parameter and Distortion Measurement for Wideband Video Amplifiers
5950-2932
(AN 357-3) Advanced Filter Evaluation and Limit Testing with the HP 4195A
5950-2933
(AN 357-4) Testing Magnetic Disk Read Circuits Using the HP 4195A
5950-2398
(AN 358-1) Characterization of Frequency Agile Sources with the HP 5371A Frequency and Time Interval Analyzer
5952-7924
(AN 358-10) Characterizing Barker Coded Modulation in Radar Systems
5952-8004
(AN 358-11) Characterizing Chirp Coded Modulation in Radar Systems
5952-8005
(AN 358-12) Simplify Frequency Stability Measurements with Built-in Allan Variance Analysis
5952-8006
(AN 358-13) Analyzing Phase-Locked Loop Capture and Tracking
5952-8007
(AN 358-2) Jitter and Wander Analysis in Digital Communication with the HP 5371A Frequency and Time Interval Analyzer
5952-7925
(AN 358-3) Time Domain Characterization of Magnetic Disk Drives
5952-7928
(AN 358-4) Pre-Trigger Simplifies VCO Step Response Measurements
5952-7998
(AN 358-5) Clock Rate Independent Jitter Measurements for Digital Communications Systems
5952-7999
(AN 358-6) Characterizing Transient Timing Errors in Disk and Tape Drives
5952-8000
(AN 358-7) Analyzing Phase-Locked Loop Transients in the Modulation Domain
5952-8001
(AN 358-8) Single Shot BPSK Signal Characterization
5952-8002
(AN 358-9) Modulation Domain Techniques for Measuring Complex Radar Signals
5952-8003
(AN 364-1) Efficient Evaluation of LISNs and Voltage Probes for EMI Tests Using the HP 4194A
5950-2922
(AN 369-1) Using Impedance Measurement to Evaluate Electronic Components and Materials–HP 4284A Application Information
5950-2949
(AN 369-3) Magnetic Head Measurement Using a Constant Test Current—HP 4284A Application Information
5950-2951
(AN 369-4) Impedance Measurement for Incoming Inspection–HP 4284A Application Information
5950-2952
(AN 369-5) Multifrequency C-V Measurements of Semiconductors: HP 4284A Application Information
5950-2953
(AN 369-6) Impedance Testing Using a Scanner with the HP 54120 Family of Digitizing Oscilloscopes
5950-2975
(AN 369-7) Measurement of Capacitance Characteristics of Liquid Crystal Cell
5950-2994
(AN 369-8) Wide-Range DC Current Biased Inductance Measurement
5950-2367
(AN 369-10) High Accuracy and Fast RF Inductor Testing
5091-1596E
(AN 369-12) Measurement of Impedance of Magnetic Head
5965-6663E
(AN 371) Lightwave Measurements with the HP 71400 Lightwave Signal Analyzer
5954-9137E
(AN 372-1) Power Supply Testing
5952-4190
(AN 372-2) Battery Testing
5952-4191
(AN 376-1) Biasing Three-Terminal Devices for Test
5952-4193
(AN 377-1) Automatic Frequency Profiling of Chirped Radar Pulses Using the HP 5361A/B Pulse/CW Microwave Counter
5952-7987
(AN 377-2) Automated Characterization of Microwave VCOs Using the HP 5361A/B Pulse/CW Microwave Counter
5952-7988
(AN 377-3) Frequency Profiling Without a Pulse Generator
5952-7991
(AN 377-4) Frequency and Phase Profiling Simplified with the HP 5361B Pulse/CW Microwave Counter
5952-8023
(AN 379-2) Measuring Microwave Radio Antenna Return Loss Using the HP 11758T Digital Radio Test System
5959-8749
(AN 380-1) Dielectric Constant Measurement of Solid Materials
5950-2390
(AN 380-3) Evaluation of Colloids by Dielectric Spectroscopy Materials
5963-6634E
(AN 381) A Test Set-Up for Characterizing High-Speed Logic Devices
5953-6329
(AN 381-1) Test Setup for At-Speed Schmitt-Trigger Characterization
5953-6334
(AN 382-1) The HP 4062UX Provides High Performance Data Management and Powerful Networking Capabilities (Transfer Data to BD/DA System)
5950-2393
(AN 383-1) Simplification of DC Characterization and Analysis of Semiconductor Devices
5950-2396

(AN 383-2) Automation of DC Characterization and Analysis of Semiconductor Devices
5090-0299
(AN 392-1) Aerospace and Defense Applications: How the Right Preprocessor Interface Can Simplify Logic, Analysis
5952-3056E
(AN 392-2) PC and PC Add-on Applications—How the Right Preprocessor Interface Can Simplify Logic Analysis
5952-3057E
(AN 392-3) VME/VXI Applications—How the Right Preprocessor Interface Can Simplify Logic Analysis
5952-3058
(AN 392-4) Workstation/Server Applications: How the Right Preprocessor Interface Can Simplify Logic, Analysis
5952-3059E
(AN 392-5) Computer Peripheral Applications—How the Right Preprocessor Interface Can Simplify Logic Analysis
5952-3060E
(AN 393) Monitoring of Ultrasonic Wire Bonding Machines
5952-2143
(AN 394) Digitizing Oscilloscope Option 001 Telecommunications Mask
5952-3288D
(AN 398-1) Using the HP 82000 for 1 Gb/s
5952-2301
(AN 398-2) Correlation of Timing Measurements
5952-2311
(AN 398-3) Measuring CMOS Quiescent Power Supply Current (IDDQ) with the HP 82000
5091-1363L
(AN 398-4) High-Speed Continuity/Shorts Test on the HP 82000
5091-1364L
(AN 398-5) Automatic Path Delay Compensation
5091-1935E
(AN 385) Millimeter Measurements Using the HP 3048A Phase Noise Measurement System
5951-6749
(AN 386) Pulsed Carrier Phase Noise Measurements Using the HP 3048A Phase Noise Measurement System
5951-6743
(AN 387) High Productivity Measurements in Digital Transmission
5959-7898
(AN 388) Signal Generator
5952-2019
(AN 390) Synchronizing the HP 82000 to External Equipment
5953-6339

4

(AN 4062-2) Precision Evaluation of Flash Memory Cells
5091-6806E
(AN 4070-1) Ultra Low Current DC Characterization at the Wafer Level
5965-7352E
(AN 4156-1) Ultra Low Current DC Characterization of MOSFETs at the Wafer Level
5963-2014E
(AN 4156-2) Automated Extraction of Semiconductor Parameters Using the HP 4155A/4156A
5963-1249E
(AN 4156-3) Evaluation of Hot Carrier Induced Degradation of MOSFET Devices
5963-1111E
(AN 4156-4) Evaluation of Flash Memory Cells
5965-5657E
(AN 4156-5) Measurement of Power Devices Using External DC Power Supply
5963-2365E
(AN 4156-6) Maximizing the Incoming Inspection Efficiency of Semiconductor Devices
5963-2364E
(AN 4156-7) Evaluation of Electromigration Using the SWEAT Procedure
5963-1110E
(AN 4156-8) Evaluation of Oxide Reliability using V-Ramp/ J-Ramp Test
5963-1248E
(AN 43-3) Vector Modulation Measurements/Coherent Pulsed Tests of Radar and EW Systems
5954-6366

5

(AN 52-1) Fundamentals of Time and Frequency Standards
5952-7870
(AN 52-2) Time Keeping and Frequency Calibration
5952-7874
(AN 52-4) Contribution of Hewlett-Packard Clocks to the BIH's International Atomic Time Scale (IATS)
5965-9782E
(AN 57-1) Fundamentals of RF and Microwave, Noise Figure Measurement
5952-8255
(AN 57-2) Noise Figure Measurement Accuracy
5952-3706

6

(AN 62) TDR Fundamentals for Use with HP 54120T Digitizing Oscilloscope and TDR
5954-2681
(AN 62-2) TDR Techniques for Differential Systems for Use with the HP 54120 Family of Digitizing Oscilloscopes
5091-0219E
(AN 62-3) Advanced TDR Techniques for Use with the HP 54120 Family of Digitizing Oscilloscopes
5952-1141
(AN 64-1A) Fundamentals of RF and Microwave Power Measurements
5965-6630E

8

(AN 8644-2) VOR/ILS Testing with HP 8644A
5951-6740
(AN 8902A) Basic Operation and Application Guide HP 8902A Operation Made Easy
5953-8458

9

(AN 90B) DC Power Supply Handbook
5952-4020
(AN 944-1) Constant Current Measurements Using the HP 4194A
5950-2923
(AN 95-1) S-Parameter Techniques for Faster, More Accurate Network Design
5952-1130

E

(AN E5250A-2) Evaluation of Hot Carrier Induced Degradation of MOSFET Devices Application Flyer
5964-9113E

G

(AN G002) DC Parametric Analysis of Semiconductor Devices
5950-2928

Additional Entries without Application Note Numbers

10-Megasample-per-Second Analog-to-Digital Converter with Filter and memory/ HP E1430A
5962-9497E
1995 ATM/Broadband Testing Seminar Handbook
5963-7508E
1996 Digital Video Test Symposium – Attendee's Handbook
5965-0964E
A Quality Test Demands a Quality Fixture
5965-6624E
Accurate and Efficient C-V Measurements
5965-5658E
Accurate Transmission Line Fault Location Using Synchronized Sampling
5964-6640E
Airframe Testing
5964-0154E
ATM Forum European Update
5964-4147E
Automatic Frequency Settling Time Measurement Speeds Time-to-Market for RF Designs
5964-4335E
Automotive Relay Module Testing
5964-0158E
Aztec Case Study – Benchmark Tests of Three In-Circuit Board Testers for a High-Volume Manufacturing Environment
5965-4744E
Bearing Runout Measurements
5964-1934E
Beginner's Guide to Using the HP8146A Optical Time Domain Reflectometer
5963-3775E
Capture and Apply Deep Vector Sequences to a Device-Under-Test
5952-8074
CDPD Testing–HP 8921A Option 502/3 or 602/3
5965-5187E
Cellular Call Processing
5964-0159E
Characterizing Communications ICs with the HP 83000 Model F660
5962-9273E
Communications Cable Testing
5964-0153E
Complete Analysis of Erbium-Doped Fiber Amplifiers
5965-0976E
Conformance Testing – An Essential Part of SDH Deployment
5965-1020E
Conformance Testing and Essential Part of SONET Deployment
5965-1432E
Connect Check Backgrounder
5965-5092E
Connecting Hewlett-Packard Test Sets for In-Service Testing of PDH/SDH Networks
5965-5898E
Developing IT Service Level Management in the Distributed Enterprise
5964-6818E
Differential Measurements on Wideband Signals
5091-3863E
Digital Video Testing with the HP 16542A
5091-5447E
Distributed Emulation for Toshiba R3900 Family
5965-1529E
Eight Hints for Making Better Spectrum Analyzer Measurements
5965-7009E
Electronic Heater Valves Testing
5964-0150E
Ensuring that the NewWAN Doesn't Lose its Luster
5963-3334E/EN
Environmental Test of Automotive Radio and Engine Controllers
5964-0157E
Ethernet Network Problems and Their Solutions
5091-7938E
FDDI Problems and Their Solutions
5091-6485E
Final Test and Alignment for Cellular Phones
5964-0147E
Finding and Solving Problems with HP Ethernet Network
5091-7938E
Frame Relay Installation and Maintenance Using the HP Internet Advisor
5964-1960E
Frame Relay/SMDS Seminar Book
5963-9501E
Getting the Most Out of Your T1 and DDS Services
5091-6174E
High Speed Wafer Probing with the HP 83000 Model F660
5963-5402E
High-Speed BER Testing of SDH Components and Sub-Systems
5091-4799E
How to Achieve ATM Interoperability
5963-7509E
HP BASIC for Windows
5964-6019E
HP 4155A/4156A Semiconductor Parameter Analyzer – Edition 1 Programming Guide for HP 4145A/B Users
5963-3201E
HP 54600A Product Evaluation
5091-2037E
HP 6800 Series AC Power Source/Analyzer
5963-7044E
HP Internet Reporter – Network Baselining and Benchmarking
5963-3653E
HP NetMetrix Characterization and Performance
5963-3766E
HP NetMetrix Operation Positioning: Switched Technology
5965-4711E
Impedance Measurements...in Brief
5964-3558E
Implementing ATM Signalling: Avoiding the Interoperability Pitfalls
5963-7514E
In-Depth Characterization of Optical Components
5965-5286E
Increasing Power Transmission System Uptime
5964-0398E
Intel 80960CA Software Debug using a Logic Analyzer and an In-Circuit Debugger
5963-3544E
Introduction to HP Standard Instrument Control Library
5963-2228E
Introduction to SDH
5091-3935E
ISDN Primary Rate Testing
5963-2013E
Jet Engine Controller Testing
5964-0155E
Jet Engine Testing
5964-0156E
Life and Stability of the HP 5DX Sealed X-Ray Tube
5964-4014E
Locating Errors in Gigabit Transmission Systems and Components
5963-2005E
Low Current Measurement with HP E65250A Switch Mainframe
5964-9112E

Materials Characterization with a New Dielectric Spectrometer-Novocontrol BDS 60000 System Based On HP 4291A
5964-6522E
Measurement Repeatability – The Key Performance Characteristic of Inspection Systems
5964-4015E
Measuring Demodulator Image Rejection Using the HP 8980A Vector Analyzer
5952-3703
Memory Test Software Provides Cost-Effective Solutions to Testing Advanced SRAMs
5963-5078E
Mixing MPEG-II and ATM: Will It Work?
5963-7511E
Network and System Performance Management for Distributed Client Server Environments
5964-6817E
On-Road Vehicle Testing
5964-0152E
Operating LANs in an ATM Environment
5963-7513E
Optical Spectrum Analysis Basics
5963-7145E
PCBA S-Ray Inspection – 1996 Article Compendium
5965-6366E
Permittivity Measurement of Frequency Dependent Electronics Materials
5964-1506E
Planning an ISDN Application
5963-2171E
Precision Time-Domain Measurement Using the HP E1430A
5962-0015E
Product Integration Guide for HP Network Monitoring and Analysis Solutions
5963-3886E
Protocol Testing With PT Series Protocol Testers
5962-9408E
Prototype Jet Engine Characterization
5964-0149E
Pulse Testing 980-nm Pump Laser-Diodes in Optical Fiber
5963-6988E
Riding the Internet Wave: Ensuring Safe, Solid Internet Services for the Enterprise
5965-9371
RTAP in Electric Utilities
5964-0119E
RTAP in Energy Management
5964-0121E
RTAP in Pipelines
5964-0118E
RTAP in Process Manufacturing
5964-0120E
Running Rocky Mountain BASIC from Board Test BASIC
5965-5878E
Selective Retrieval for the HP 3070 Board Test System
5965-5879E
Semi-Automated Product Testing
5091-2281E
Sharing Data with HP VEE
5965-5709E
SS7 Protocol Testing With PT Series Protocol Testers
5962-9408E
Testing Amplifiers and Active Devices with the HP 8510 Network Analyzer
5963-2352E
The Dynamic Range Benefits of Large Scale Dithered Analog-to-Digital Conversion in the HP 89410A and 89440A
5091-7668E
The Personal Handy Phone System in Japan's Wireless Communication Market
5964-6753E
The Quest for Quality: The ATM Impairment Testing Handbook
5965-4992E
Token-Ring Troubleshooting Techniques with the HP Network Advisor
5091-9414E
Traffic Policing
5963-7510E
Using an X Terminal with the Broadband Series Test System
5963-2012E/EN
Vectorless Test Purchaser's Guide
5965-0805E
Vehicle Body Testing
5964-0151E
VHF Transceiver Testing
5964-0148E
VXI Access for BASIC/UX
5964-3669E
Wafer Probing with the HP 83000 Model F330t
5962-0117E
WAN Interworking with ATM
5963-7512E
Writing Flash Memory with HP 3070 Systems
5965-3248E

Hewlett-Packard offers a variety of free publications to help you choose the products that best meet your needs, benefit from applications knowledge acquired by users inside and outside of HP, and maintain your HP products. These publications range from catalogs, brochures, application notes, product notes, and programming aids to service notes and general maintenance periodicals. The number and types of free publications vary with each product family. A summary of available publications is provided below. Brief descriptions of major publications follow the summary.

Instruments and Systems

Product Information: *Test & Measurement News, Telecommunications News* and *The Hewlett-Packard Journal* (see Periodicals column two), brochures, technical specification sheets, and video tapes.

Catalogs: For listings and descriptions of Hewlett-Packard specialty product catalogs, see pages 635–639.

Product Literature Types

Awareness Brochures are your first contact with T&M products. These brochures introduce you to specific products and new technologies and services. They help you identify or assess needs for test and measurement instruments or systems.

Photo Cards serve the same introductory purpose as an Awareness Brochure. However, Photo Cards differ from Awareness Brochures in that the cards present value positioning, features, benefits, and specifications in a very abbreviated form.

Product Overviews introduce a product (or family of products) and provide enough information for you to make a purchasing decision. These documents are for less complex, less costly products for which you do not need a lot of technical specifictions.

Technical Specifications communicate comprehensive product data, specifications, and warranty information to provide you with a precise and thorough understanding of a product's performance capabilities. These documents contain detailed product specifications for the time when competitive products are evaluated, "short lists" are determined, and final selections of products are made.

Configuration Guides communicate configuration options by defining components of a product or a system and all relevant configuration requirements. Configuration information is required during selection and ordering stages of the purchase process.

Price Lists communicate current pricing information—model numbers, prices, disclaimers, and other necessary information.

Periodicals

Test & Measurement News: Four times per year, Test & Measurement News announces the latest HP electronic measuring instruments and accessories, computer/controller, component, and telecom products. Newly released product literature such as brochures, application notes, and catalogs are also described.

Telecommunications News: Four times per year, this periodical offers useful information for public network operators in the U.S. Articles highlight HP solutions, products, literature, and training.

The Hewlett-Packard Journal: Six times per year, the journal communicates technical information from the laboratories of HP to all of the fields served by HP. It contains in-depth design descriptions of current hardware and software products, research papers, and up-to-date general information such as advances in technology.

Application Information

Application Notes help solve your measurement, computation, and design problems. They offer the benefit of the applications research and experience of both HP customers and HP engineers. Some are tutorial, others describe how-to procedures. All of the publications are oriented to multiple products. A listing of test and measurement application notes begins on page 604.

Product Notes are product-specific aids that supplement the operating and service manuals supplied with HP instruments. They describe applications for specific instruments. Product Notes include analysis of specifications and characteristics, with the goal of obtaining improved performance over limited operating conditions and narrower environmental limits.

Service Information

Service Notes contain product-specific service information for HP electronic products. Subjects include product improvements, modifications, and procedures for troubleshooting, maintenance, and repair. Service Notes are published, as appropriate, throughout the life of a product. All new, instrument-related Service Notes are announced in Bench Briefs.

You can obtain Service Notes from a Group 3 fax machine as follows: Call (208) 344-4809 and after the instructions, press 4, then 2. The password is 76683. An index is recommended for first-time users.

Bench Briefs provide timely application information for those who repair and calibrate HP instruments. Subjects include troubleshooting tips and descriptions of new technologies, components, tools, and equipment. Also, new, instrument-related Service Notes are listed in Bench Briefs as they become available.

How to Obtain Free Publications

To obtain any of the publications described on this page, see the inside back cover, or contact your local sales office (page 591).

How to Obtain Specialty Catalogs & Directories

To order any specialty catalog or directory on the following four pages, complete and return the business reply card at the end of this catalog.

On page 635 is a list of specialty catalogs, relevant to users of test and measurement products, and available free from Hewlett-Packard.

Hewlett-Packard Press Offers Technical Book Series

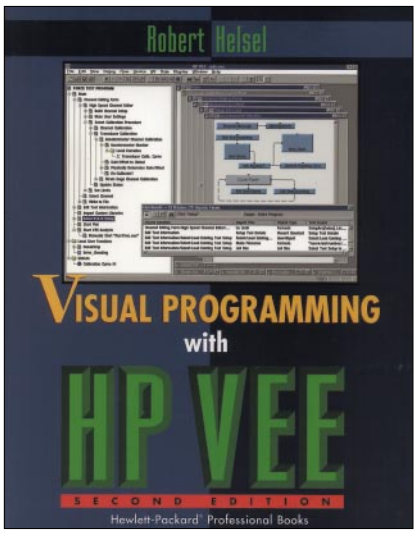
Hewlett-Packard Press is HP's retail book publishing program that provides information on emerging technologies, industry standards, and HP solutions for today and the next century. PTR Prentice Hall publishes the Hewlett-Packard Professional Books series. Authors are HP staff and industry experts. Published titles cover a broad range of subjects including T&M technologies, computer architectures, HP-UX system administration and DCE.

Books can be ordered by the ISBN number from your local HP representative or directly from the publisher (U.S.):

- For single book orders call (515) 284-6761; for 10 or more copies and corporate discounts, call (201) 236-7146.
- For a free HP Professional Books catalog, call (201) 236-7122.

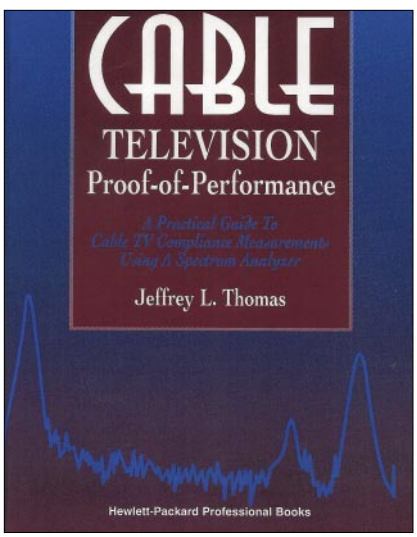
New titles, book descriptions, and a list of U.S. technical bookstores can be found on the World Wide Web at:

- Hewlett-Packard (http://www.hp.com/go/retailbooks)
- Prentice Hall (http://www.prenhall.com)



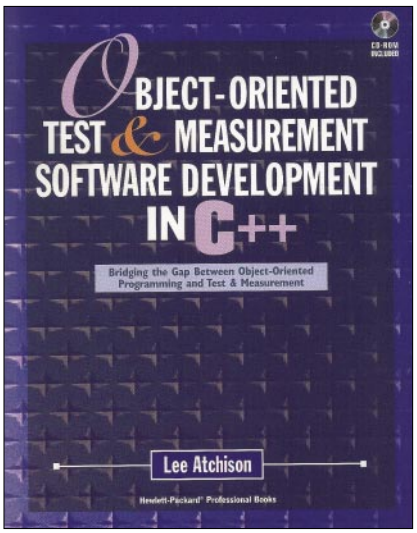
Visual Programming with HP VEE,
by Robert Helsel, 384 pages,
ISBN 0-13-533548-5

The fastest and easiest way to learn HP VEE 3.2. Includes a disk with an evaluation copy of HP VEE.



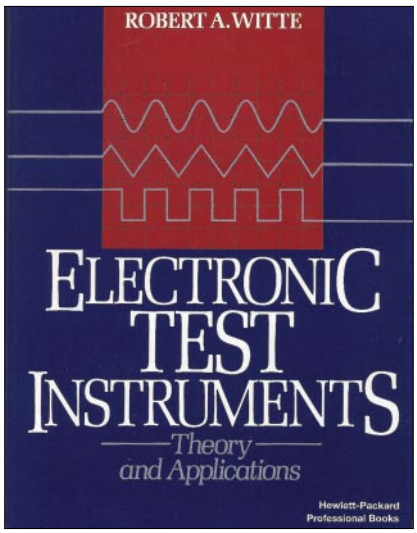
Cable Television Proof-of-Performance,
by Jeffrey L. Thomas, 250 pages,
ISBN 0-13-306382-8 (30638-1)

Helps the cable technician and engineer make fast, accurate measurements using almost any quality spectrum analyzer. Teaches basic cable television measurements with graphics, examples, tips and procedures.



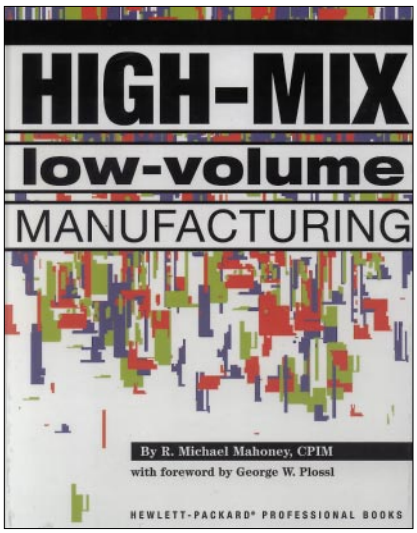
Object-Oriented Test and Measurement Software Development in C++: Bridging the Gap Between Object-Oriented Programming and Test Measurement,
by Lee Atchison, 416 pages
ISBN 0-13-227950-9

Teaches object-oriented design and programming principles and how they can help test and measurement system developers build more efficient and reliable applications. Learn, step-by-step, the design of an object-oriented test and measurement system and fundamental object concepts, such as inheritance. Specific information on how to use object-oriented techniques for error-handling is provided.



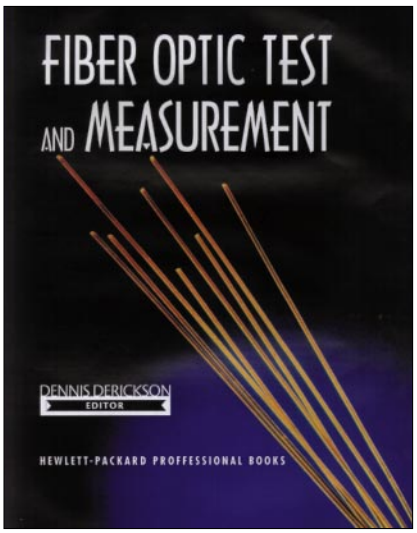
Electronic Test Instruments, Theory and Applications,
by Robert Witte, 416 pages,
ISBN 0-13-253147-X (25314-6)

Moves the reader from an understanding of electric theory to practical electronic instruments. Provides the available instruments, their advantages, disadvantages, and how to choose an appropriate instrument for a particular job.



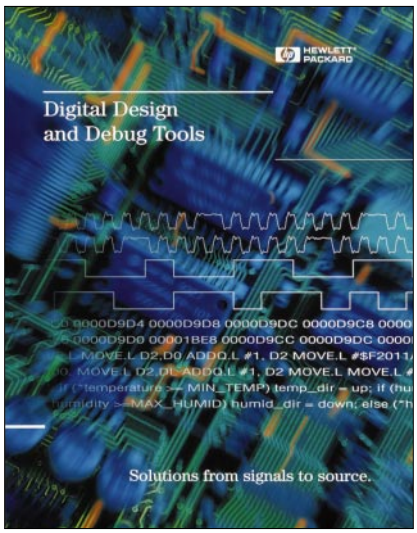
High-Mix Low-Volume Manufacturing,
by Michael R. Mahoney, 222 pages,
ISBN 0-13-255688-X

A "no-fluff" manager's guide to high-mix, low-volume manufacturing techniques. Introduces basic concepts ranging from just-in-time manufacturing to MRPII and advanced scheduling. Explains cross-functional relationships that impact flexible manufacturing. Describes multiple-constraint synchronization, planning, and modeling. Also tells how to apply performance measurements and metrics.



Fiber Optic Test and Measurement,
by Dennis Derickson, 672 pages,
ISBN 0-13-534330-5

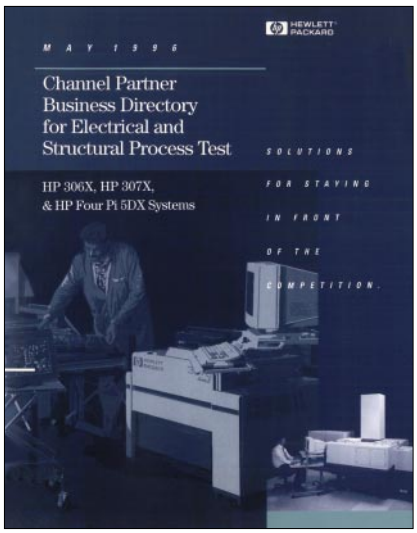
Authoritative, complete, up-to-date test and measurement information for engineers who design and maintain fiber-optic networks. Covers measurement principles, system-level measurements, the principles and limitations of current fiber-optic testing equipment, and much more. Emphasizes practical issues more than theory.



Digital Design and Debug Tools
5965-7693E

Announcing a new catalog for R&D engineers who design and debug computer systems, automotive systems, embedded systems, consumer electronics and communication equipment.

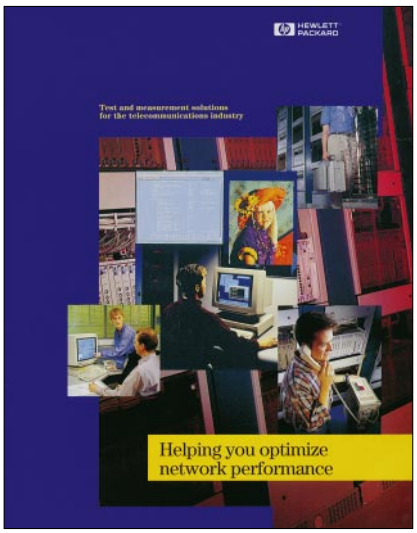
The Digital Design and Debug Tools catalog contains product information, specifications and pricing for HP's logic analyzers, emulators, processor probes, mixed-signal oscilloscope and PCI bus verification tools. This bi-annual cata-log provides the digital designer with the ability to subscribe to the catalog to ensure they are kept up-to-date on new debug tools available from HP.



Channel Partner Business Directory for Electrical and Structural Process Test
5965-1201E

As many HP manufacturing customers focus more on their core competencies, they increasingly turn to dedicated, experienced industry experts for their fixturing and programming needs. This directory summarizes the board test solutions offered by the dedicated, experienced industry specialists in the HP Channel Partners Program. These third-party experts can facilitate bringing an HP board test system to a functioning, profitable manufacturing tool that meets specific test requirements. Their products and services include engineering analysis, data entry services, CAD translation, program development for high-volume production, and the design, construction, and on-site installation of turnkey fixtures such as SMD and bed-of-nails fixtures.

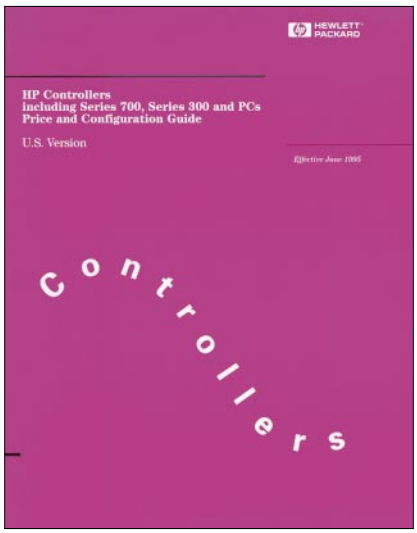
HP's corporate-wide Channel Partners Program successfully develops strategic alliances and global relationships with selected independent consultants and complementary hardware and software vendors. HP and its Channel Partners work together to produce high-quality, timely, cost-effective test solutions.



Test and Measurement Solutions for the Telecommunications Industry
5966-1038E

This catalog summarizes, in one convenient place, HP's test and measurement solutions for the telecommunications industry, with particular emphasis on the needs of network operators, both wireline and wireless. The over 100 products described range from portable protocol test sets to complete distributed monitoring systems. This makes it easy to find just the right instrument, or instruments, to match the need for ensuring the network quality of service and optimizing performance. In addition, there is a complete set of tools for developing the management information necessary to keep the network operating at a high level, as well as planning for its future needs.

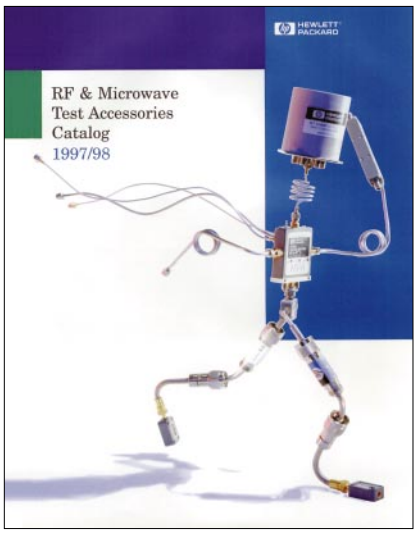
These products are specifically for those responsible for local telephone service, long-distance communications service, cellular service, CATV operation, and private network operation. To help find the best complete solution, maintenance and management tools are organized by both network types, such as LAN, WAN Cellular; and by technologies, such as Ethernet, Token Ring, ATM/B-ISDN, PDH transmission, SDH/SONET, as well as microwave and fiber transmission.



HP Controllers: Series 700, Series 300, and PCs
5964-1589EUS, US only

This 172-page catalog/configuration guide describe HP controllers that are based on industry-standard operating systems, including MS-DOS, HP-UX, and LYNX-RT, as well as the HP BASIC instrument control environment. The document explains a typical controller configuration and presents forms that aid configuring and ordering systems.

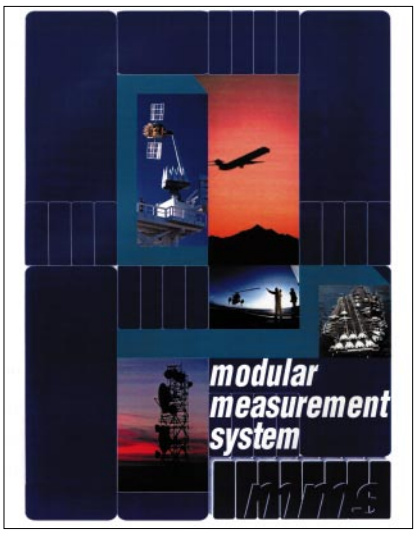
Six chapters describe high-performance PA-RISC HP 9000 Series-700 workstation controllers and related add-on products, external peripherals, X-terminals, software, racks and accessories, and documentation. Five chapters cover HP 9000 Series-300 instrument controllers in similar detail. PC-based controller components, including embedded VXI PCs and PC interfaces, and PC-based software are also described. Complementary product suppliers are listed, as well.



RF and Microwave Test Accessories Catalog
5964-9527E

This catalog contains general purpose RF and microwave accessories for test and measurement applications. Products featured in this catalog include switches, attenuators, amplifiers, detectors, couplers, waveguide and a variety of other products.

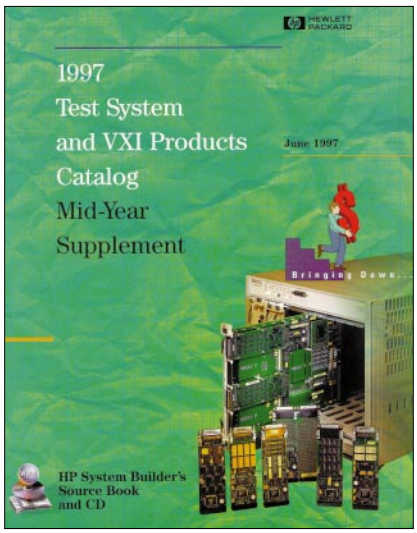
Large sections are prefaced with an applications discussion, key specification description, and product family overviews. Detailed specifications, drawings, and photographs are provided for a wide array of accessories.



Modular Measurement System: HP 70000 Family and Others
5965-2818E

This 180-page Modular Measurement System (MMS) catalog contains product information on all MMS products available from HP and other third-party vendors. Catalog highlights include an MMS over-view, configuration examples, and 100 pages of instrument information (often including specifications and ordering information). Featured are the MMS high performance spectrum analyzers including the HP 71910A/P Wide Bandwidth Receiver.

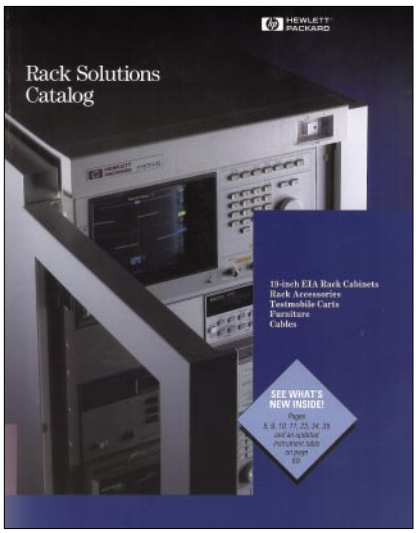
System building blocks, including mainframes, displays, tracking generators, and an external mixer interface module show you how to configure an instrument or system for unique applications using off-the-shelf modules. The catalog also includes a comprehensive discussion of service and support, with a listing of documentation available through HP Call Centers.



1997 Test Systems and VXI Products Catalog & Supplement
5965-8791E

The definitive source book of HP's VXI offerings, the 1997 HP 75000 Family of VXI Components, Systems, and Services catalog has a revised and expanded format that enables you to configure VXI systems and order appropriate products and services.

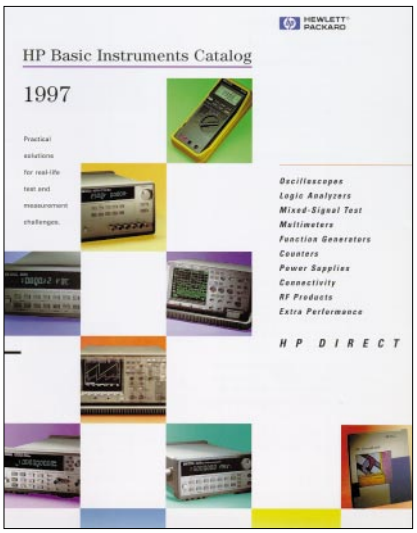
The catalog presents HP's extensive line of B- and C-sized mainframes, embedded controllers, scanning A/D converters, multimeters, switches, and disk storage devices. The VXI *plug & play* standard now supported on many HP VXI modules is highlighted. New and updated versions of software are covered, including HP VEE for Windows 95, HP TestExec SL, and HP BASIC for Windows. The '97 VXI catalog also describes new subsystems for general-purpose, automotive, and telecommunication applications.



Rack Solutions Catalog
5965-9759EN

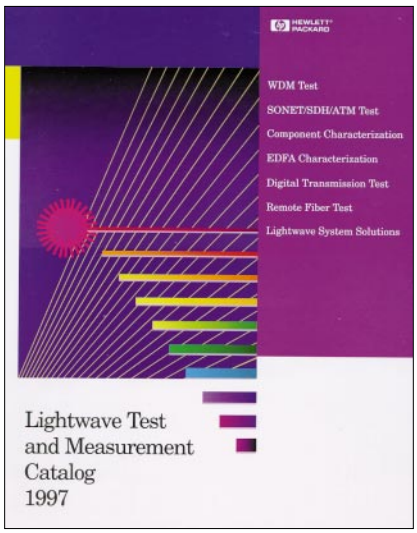
This 86-page catalog showcases the racks used for organizing and managing all T&M products. It provides an overview about rack cabinets, including features and specifications. Sections on rack accessories and controller rack mount kits, instrument rack mount kits, and testmobile carts are included as well. Also, cable, uninterruptible power supply, and furniture information is provided.

A large section showcases integration information and guidelines. It describes how you can receive your equipment racked and ready to use, and discusses other issues such as safety design, ergonomic and aesthetic design, and racks, equipment installation and cabling services. A rack and accessories ordering guide and stability worksheets are also included.



HP Basic Instruments Catalog
5965-7748EN

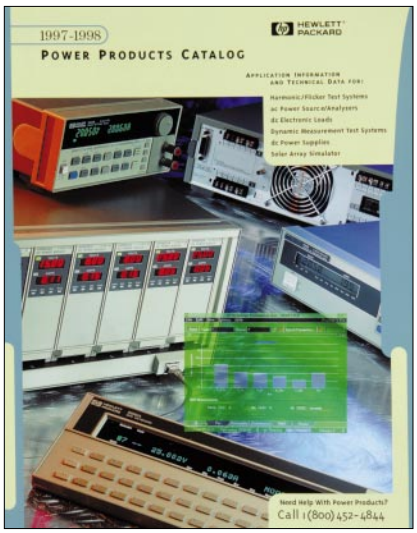
The most recent key specifications, photos, and descriptions of HP's line of basic instrument products are featured in this full-color, bi-annual catalog. Oscilloscopes, logic analyzers, digital multimeters, counters, power supplies and function/arbitrary waveform generator are highlighted. In addition, there's information on software, HP-IB cards, and cables. This one-stop shopping guide also includes the most current prices and ordering information.



Lightwave Test and Measurement Catalog 1997
5965-5480E

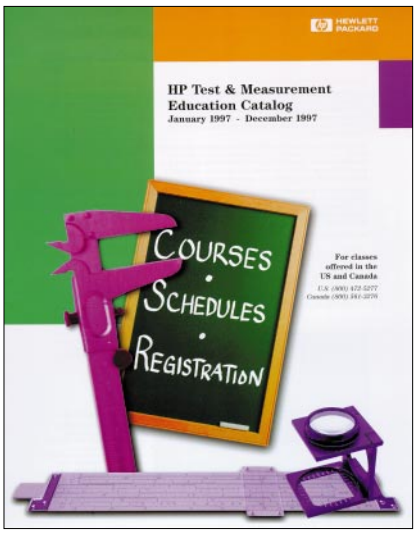
This catalog offers a new products section, which covers the mini-OTDR, tunable laser source, broadband light and digital sources, digital communication analyzer, multi-wavelength meter and lightwave test system solutions. Chapters cover power, spectral, polarization, and return loss measurement techniques. A variety of analyzers are described, including: lightwave signal, lightwave component, time-domain, error performance, and SONET/SDH generators and analyzers. Optical accessories are also discussed.

Reference literature is provided along with tutorials on measurement applications.



1997-1998 Power Products Catalog
5965-5284LE, E

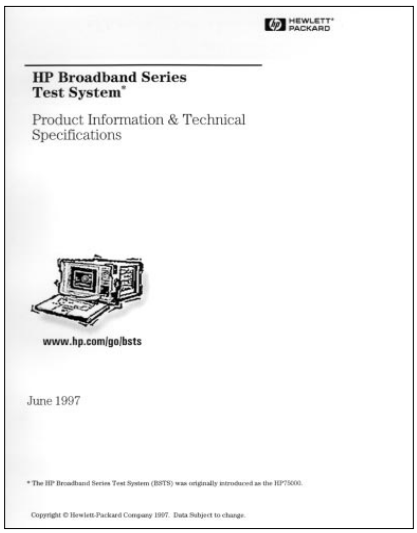
HP's entire line of power supplies, electronic loads, modular power systems, power test systems, ac sources, harmonic/flicker test systems, and solar array simulators are featured in this catalog. New products, such as the HP 66300 series dynamic measurement dc sources, HP 6811A 375VA ac source, and the graphical user's interface are included. Selection guides, complete product specifications, and application information help you make the right choice of power products for your applications.



HP Test & Measurement Education Catalog
5965-6145E

This publication lists all T&M customer education courses offered in the United States and Canada. It features 37 pages of scheduled, on-site, self-paced, and service-training courses, and includes several class offerings for each of the following subjects: quick-start training and productivity assistance, computer-aided test and general-purpose instruments, low-frequency signal analysis, RF and microwave, HP-EEsof, datacom/telecom, board test, digital design and characterization/embeddded software development, semiconductor test, ATS 2000, selected open systems, UNIX, HP-UX, and networking.

Registration information and phone numbers for further details about specific courses, as well as an HP course subject index, are provided. In addition, HP's new information line, which enables you to access current course scheduling, availability, data sheets, and new course offerings through a touch-tone phone and fax machine, is described.



HP Broadband Series Test System Product Information & Technical Specifications
5966-0035E

This catalog clearly shows the full depth and breadth of the HP Broadband Series Test System, the industry-standard ATM/BISDN test system for R&D engineering, product development, field trials and QA testing. The HP BSTS is a modular system designed so that you can expand your system as your testing needs evolve.

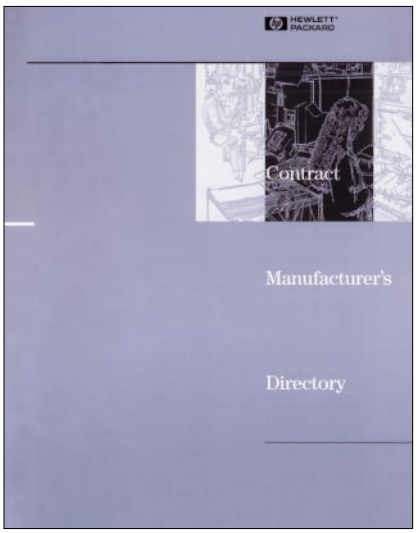
Included in the catalog are the technical specifications and product information for each BSTS hardware and software module, as well as the Broadband Communications Map, product listings and an index of available related literature such as application and solution notes.

DSA Accessory Catalog
5964-8939E

A wide variety of laboratory-quality sensors and supplies (from Hewlett-Packard and other leading manufacturers) that complement dynamic signal analyzers (DSAs) are presented in this 20-page catalog. These accessories empower you to perform accurate and successful measurements in acoustic, vibration, modal analysis, and other physical test applications.

Free field and pressure microphones, as well as microphone power supplies, preamplifiers, calibrators, adapters, and a microphone storage case are described. A new Sound Intensity Probe has been added which meets IEC 1043 Class 1 specifications.

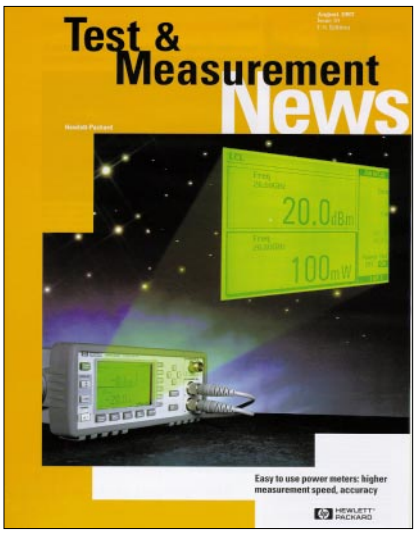
Vibration transducers and several types of accelerometers, as well as an assortment of cables, are highlighted.



Contract Manufacturer's Directory
5965-9793E

If you currently outsource any of your manufacturing, or are considering doing it, this catalog is an invaluable guide for choosing a contract manufacturer (CM) to monitor manufacturing processes and your product quality using HP board test equipment.

The catalog lists more than 70 companies worldwide that manufacture loaded printed circuit boards under contract to OEMs and use HP 3070 or 3065 systems for in-circuit testing. Listings include the company and site contact name, address, phone, and fax number(s). Each contract manufacturer describes services offered, geographic area services, industry certifications, and information about other pertinent equipment used at the facility.



Subcribe now! Keep up to date with these free quarterly newsletters.

To obtain a free subscription to Test & Measurement News *or* Telecommunications News, *call your local sales office. Or send your request on the reply card at the back of this catalog.*

Telecommunications News

If you work for a telecommunication service provider or network operator, you need the specialized information presented in Hewlett-Packard *Telecommunications News.* This quarterly newsletter is customized for the communications standards in your country and is available in English, French, Italian, German, Russian, and Spanish. Each issue provides technical and application information to help you meet the challenges of optimizing the performance of your networks and delivering improved services in a rapidly changing environment.

Timely articles feature practical network development, performance, and maintenance advice, training opportunities, product solutions, and more. Many stories include offers for more detailed information about the topic or product. It's easy and convenient to request this literature with a reply card or toll-free number. Your HP sales representative can also send you more information.

Test & Measurement News

Learn more about Hewlett-Packard's latest test and measurement products and services every three months by subscribing to *Test & Measurement News.* This informative newsletter also describes current application notes, article reprints, catalogs, and other literature. It's easy and convenient to request detailed product information and available literature. Just use the reply card in the issue, call the toll-free number, or contact your HP sales representative.

HP mails *Test & Measurement News* to customers around the world, publishing editions in English, French, Italian, German, and Spanish.