General Purpose
Test Instruments Catalogue

Autumn/Winter 2002

Agilent Technologies

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Table of Contents

Coping with next-generation wireless transceivers

The new era of anytime, anywhere, any device wireless connectivity is changing the way we live, play and work. With more people using more services, the elements of the new wireless networks have to provide high levels of functionality and performance to dependably deliver multiple new capabilities, including voice, data, multimedia, text messages and the wireless Web.

Squeezing more information – and more kinds of information – into a fixed amount of RF spectrum demands a lot from the art and science of digital modulation. These advanced modulation techniques make new capabilities and services possible, but they can also complicate every stage of the product life cycle, from design to development, manufacturing to deployment and operation. Add to that the complexities of designing for conformance with multiple standards around the world and the simple goal of just finishing the project can seem anything but simple.

Even as signals and modulation schemes become more complex, an essential part of the wireless communications story remains constant: the age-old problems that affect transmitters, receivers and the components they use. A transmitter still has to send a clean, stable signal that does not interfere too much with other transmitters nearby. Receivers have to find and lock on to the right signal, and that still depends on parameters such as sensitivity and selectivity. Components have to deliver new levels of capability and performance, where vendors and developers have to characterise and verify those attributes.

In our line of work, with engineers create many types of wireless devices and we have gathered a few insights that may help you deal with some of the challenges you face today with the next generation of transmitters, receivers and components. Here are some examples:

Enhancing transmitter performance
Delivering voice, data, the Web and more depends on digital techniques that must provide consistently clean, stable signals. In transmitter designs, modulation quality and adjacent channel power ratio (ACPR) are the two key – and sometimes conflicting – indicators of performance. A few key measurements can help you find the underlying problems when a transmitter does not meet specifications, and also find the optimum operating point.

Checking modulation quality. Two types of error vector magnitude (EVM) measurements are useful for troubleshooting modulation quality problems in transmitters. *Composite EVM* checks the modulation quality of a multi-channel signal – regardless of its channel configuration – enabling tests such as the evaluation of W-CDMA downlink signals with different loading.

In contrast, *symbol EVM* measures multiple slots and can reveal long-cycle problems such as phase noise. What is more, symbol EVM provides a measure of modulation quality that determines the error rate for a specific code channel at the symbol level, even in the presence of multiple codes. At low spreading factors (SFs) – and therefore high data rates – chip modulation errors have a significant effect on symbol EVM. However, at high SFs chip modulation errors have very little effect on symbol EVM. Baseband engineers can therefore use symbol EVM to evaluate symbol quality and analyse how specific impairments affect the quality of channels at different data rates.

Reducing ACPR. The other major parameter to control in a transmitter is ACPR, which is sometimes referred to as adjacent channel leakage ratio (ACLR). In one of the key dilemmas of transmitter design, finding the optimum operating point for the power amplifier often means a tradeoff between modulation quality (EVM) and ACPR.

Page 20. The E4446A and E4448A PSAs offer high-performance spectrum analysis up to 50 GHz with a leading-edge combination of flexibility, speed, accuracy and dynamic range.

Page 23. Reach up to 50 GHz with exceptional stability and four receivers for TRL/LRM calibration in the new E8362/3/4A precision network analysers.

Page 31. The 54830B Infiniium oscilloscopes employ an innovative MegaZoom deep-memory architecture to provide instant response to control changes and maximum resolution at all times.
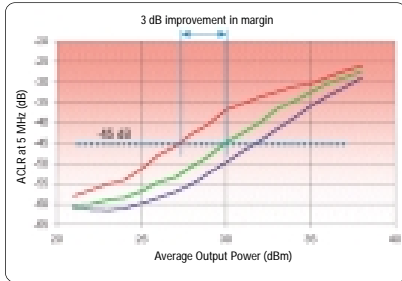
In this example, the use of clipping provides a 3 dB improvement (green line) in the worst-case ACLR (red line). Assuming a 12 dB peak-to-average power ratio, this could mean the difference between designing the amplifier to run at 15 W or 30 W peak power handling.

If the transmitter's worst-case EVM occurs at a higher average output power than the worst-case ACPR, there is an opportunity to use baseband clipping to artificially limit the peaks. Of course, clipping will turn the largest signals into square waves so it should be applied prior to the transmit filter to prevent the generation of spurious signals in the amplifier. The net result is typically improved ACPR performance, slightly lower modulation quality and a higher operating point for the amplifier.

Coping with interference in mobile stations
A key measure of any wireless communication system is the quality of voice conversations and the dependability of data connections. As wireless devices multiply, so does the interference that mobile stations (MS) must overcome to ensure successful transmission and reception. A few tell-tale measurements can help you identify MS designs that either generate excess interference or have trouble dealing with interference.

Conquering compression. When an MS design fails an interference test, the culprit may be high instantaneous power levels in the transmitter's amplifier. Too large a transmit signal can drive the amplifier into saturation, causing compression and ultimately, clipping and distortion, which are two of the most common power-related causes of interference.

You can check for compression by measuring the complementary cumulative distribution function (CCDF) before and after the amplifier and comparing the results. If measurements in front of the amplifier show higher CCDF than those after the amplifier, you can be sure the amplifier is compressing or clipping at least part of the time.

Reducing errors. When the incoming signal is impaired by interference or other factors

along the signal path, the MS receiver may exhibit sensitivity problems. These are likely to show up as a high bit error rate (BER), which you can check by measuring BER versus input power. A high BER at high input power may be due to impairments such as quadrature skew, I/Q imbalance, phase reversal or frequency drift.

For high BER at low input power, the analogue front end may have a noise figure higher than expected. If so, you may be able to isolate the cause by measuring the noise figure and gain (or loss) of each stage of the receiver. If the measurement is normal, the gain of the analogue front end may be low, there may be a problem with the detection algorithm in the digital portion of the receiver or a spurious signal may be desensitising the receiver.

Accelerating wireless communications
Sharing insights and best practices is just one of the ways Agilent can help you accelerate the evolution of wireless voice, data, multimedia and more. We provide application information, design tools, test equipment and engineering services that assist in product development, manufacturing, deployment and operation.

For a wealth of industry, technology and application information, please visit
www.agilent.com/find/measurements.

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Page 32. View 18 time-aligned channels (2 analogue and 16 digital) simultaneously with bandwidths up to 500 MHz in the new 54640 series scopes equipped with MegaZoom deep memory.

Page 55. When timing is critical, the new Agilent 81133A/34A pulse/pattern generators provide the high resolution, low jitter and very fast transitions you need.

Page 60. The Agilent Connectivity Suite offers easy connectivity to standard PC and network interfaces, fast test code development and a subscription service that delivers the latest tools, documentation and updates.

Optimise test productivity and reduce costs with tailored service and support

- *Decrease learning curves with focused training*
- *Maintain instruments at peak performance*
- *Access expert educators and consultants*

In a constantly changing environment you want a partner who is responsive to your business needs. Agilent provides end-to-end service and support solutions, tailored to your unique needs and designed to maximise equipment utilisation and test productivity. Our seasoned measurement specialists provide a full range of value-added services, standardised worldwide, offering assistance throughout the life cycle of your equipment:

1. ***Choosing the right equipment.*** Our test specialists assist you to make the best equipment and service choices to meet your business goals.

2. ***Getting up and running quickly.*** Agilent provides a comprehensive suite of services to ensure you meet your time-to-market and time-to-volume goals.

3. ***Maximising the return on your investment.*** Agilent's responsive services and support ensure the highest possible throughput from your equipment.

4. ***Keeping your equipment at peak performance.*** Agilent's flexible repair and calibration services help you avoid costly downtime.

5. ***Upgrading or replacing your equipment.*** Make the most of your investment with advice on redesign and redeployment, migration assistance and a cost-effective Trade-up program.

Professional engineering services
Increasing operational efficiency across design, test and manufacturing

Fault Detective test diagnostics	Accelerating diagnosis of functional test failures with a unique software and service solution
Test code optimisation	Optimising test plans and code for wireless appliance functional test
Test data management	Organising and storing test data for further analysis and reporting
Test plan development	Assisting and advising on test strategy and definition
NFA measurement characterisation	Making accurate noise figure and gain measurements with noise figure analysers
Understanding VNA time-domain analysis	Using VNAs for impedance measurements and fault location in time or distance
Waveforms for ESG signal generators	Creating automated custom signal and waveform applications

Support solutions
Innovative programs to meet your business goals and get more from your test equipment

Repair services	Agilent repair technicians are factory-trained with the latest information, parts and technical resources. Choose from prepaid up-front repair options, per-incident service or annual repair contracts that can be provided onsite or as a return-to-Agilent service.
Calibration services	Guarantee measurement confidence with instruments that operate at peak precision. All calibration measurements are traceable to international standards for reliable, accurate results. Choose on-site or return-to-Agilent service, as and when needed or on a regular schedule.
Custom services	System uptime, equipment management and parts services are designed for customers who prefer to maintain their equipment themselves or have other options to consider.

Make better measurements in less time with Agilent Accelerated Education

- *Improve test and measurement productivity with new hands-on skills*
- *Get a thorough refresher on the latest test techniques*
- *Choose from standard or customised programs*

Having up-to-date measurement skills is key to solving problems more effectively and efficiently, getting new products to market faster and improving profitability. With the Agilent Accelerated Education Curriculum, you will become productive quickly as Agilent's global experts share their real-world test and measurement expertise. Your investment in Accelerated Education will pay for itself quickly in improved productivity.

Advantages for new hires
With today's intense competitive challenges and rapidly evolving technologies, few companies can afford the luxury of on-the-job training. Even new hires are expected to be productive immediately. Get the test and measurement expertise you need quickly, so you can become a valuable contributor faster.

Advantages for experienced engineers
With today's rapid and dramatic changes in technology, even top engineers' skills can get out-of-date quickly. Seasoned engineers can often benefit from a quick refresher course in the latest test and measurement technologies and techniques.

Flexible, convenient and cost effective
The Agilent Accelerated Education Curriculum offers specific training to meet your needs and delivers it in a format that works best for you:

- **Standard or custom curricula.** Our standard curricula cover the most vital topics in test and measurement fundamentals, RF and microwave fundamentals and optical networking technology. Or create your own cost-effective curriculum by combining courses from Agilent's extensive class catalogue, covering a wide variety of subjects in measurement fundamentals, technology training, product operation training and application training.

- **Flexible delivery options.** Accelerated courses can be delivered in a choice of formats, including face-to-face sessions at your site or ours, or on-demand eLearning modules available over the Internet (limited classes available in this format).

Standard curricula
- **Test and Measurement Fundamentals** (H7250B-500) Provides a firm foundation in the basic concepts and skills required for the broad electronics industry. Courses include *Measurement Process Fundamentals, Metrology Basics, Measurement Automation,* and *Measurement Uncertainties.*

- **Optical Networking Technology** (H7250B-400) Takes you beyond the fundamentals of optical networking. Courses include *Understanding & Characterising Optical*

Transmitters & Receivers, Understanding Optical Passive Device Characterisation, Understanding DWDM, and *Understanding Lightwave Technology.*

- **RF and Microwave Fundamentals** (H7250B-600) Covers the basic test and measurement concepts and skills required by engineers working with RF and microwave technology. Courses include *Connector Care, Spectrum Analysis, Network Analysis Basics, Noise Figure Measurements, Signal Generator and Source Basics, Transmission Line Fundamentals,* and *Power Measurement Basics.*

Why Agilent?
When you choose the Agilent Accelerated Education Curriculum, you get more than a training package. You get a reliable, experienced partner committed to your success. As a global leader in the test and measurement industry, we train thousands of students every year.

For the complete range of training services available from Agilent, including the Accelerated Education Curriculum, visit **www.agilent.com/find/measurements**.

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Information to help bring your ideas to life

- *Wide variety of print, online and web-cast resources to help you accelerate design verification and testing*

- *Application notes and technical notes with time-saving advice on successful test techniques*

- *Free Back to Basics seminars to help review or teach the fundamentals*

- *Quick-hints brochures help with specific product applications*

Great ideas and good tools get you most of the way there. Complete the equation with practical measurement information and that will accelerate your design and test efforts. Based on your feedback and requests, we continue to develop a variety of resources you can rely on to use test equipment more efficiently and more effectively.

- **Agilent Measurement Solutions.** This newsletter, published three times a year, continues in the tradition of *Test & Measurement News, Insight* and other publications that have offered quick hints and technology updates on a variety of hot-topic applications. Available both in print and online.

- **Application notes.** With hundreds of application notes in dozens of categories, this extensive library is one of the most complete sources of

measurement information available anywhere. You can also access several technical notes that offer application advice for specific Agilent products. For a quick example, see the wireless LAN measurement tip on the following page and others throughout the catalogue.

- **Back to Basics.** Whether you would like to help a new team member get up to speed on test techniques or just brush up on the fundamentals yourself, take advantage of the free Back to Basics series of interactive webcasts and full-day seminars *(seating is limited)*. These cover spectrum and network analysis, power measurements, signal generation and logic analysis.

- **Quick hints and tutorials.** Download copies of our popular application hints series and

review important measurement-quality topics with online tutorials.

For an up-to-date list of seminars, tradeshows and e-Seminars in Europe, please visit **www.agilent.com/find/events_europe.**

All of this information is available at **www.agilent.com/find/measurements**.

Make sure you sign up for automated email notification too. You can select application information in a variety of technical specialties and the privacy and personalisation features ensure that you get only the information you request (see inside front cover for more details).

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Whether you are looking for a simple accessory or a complete measurement solution, Agilent Call Centre specialists are ready to process your calls efficiently and effectively. Our Customer Care specialists quickly assess your needs and either handle your request immediately or connect you with a test and measurement engineer for a technical consultation. Either way, we will get you back to work as quickly as possible.

Practical advice for productive test and measurement

MEASUREMENT TIP: TUNING DESIGNS TO ENSURE WLAN INTEROPERABILITY

By all accounts, wireless local area network (WLAN) products based on the IEEE 802.11b specification – Wi-Fi devices – are doing well in the marketplace. Much of this success is attributed to Wi-Fi certification testing that ensures interoperability between products from multiple manufacturers.

Certification happens late in the race to market, but the roots of interoperability reach back to the earlier stages of product design and development. In the early stages, each manufacturer optimises its designs differently – a useful practice that can translate into different (but in-spec) behaviour in transmitters and receivers. This is the end user's nightmare scenario: one vendor's products work with each other but not with equivalent devices from another maker.

You can help ensure cross-vendor interoperability by tuning your WLAN transmitter and receiver designs. For transmitters, error vector magnitude (EVM) with equalization is an informative measure of modulation quality that can help identify underlying problems such as non-linear distortion, phase noise and spurious signals. Receiver designs can be made more robust by testing them with a variety of impaired signals, either in hardware with a flexible signal-generation solution or in a computer-based simulation.

The challenge continues
Such issues have been challenging with Wi-Fi and are even tougher with the 5 GHz WLAN products. With their higher transmit frequencies and Orthogonal Frequency Division Multiplexing (OFDM) based signalling scheme, devices based on IEEE 802.11a or HIPERLAN/2 may also prove to be more difficult to integrate and manufacture.

Agilent measurement tools help you quickly isolate the sources of interoperability problems, whether they are in the transmitter or receiver, RF or baseband. In manufacturing, these tools can generate process metrics, troubleshoot process problems or even grade device performance.
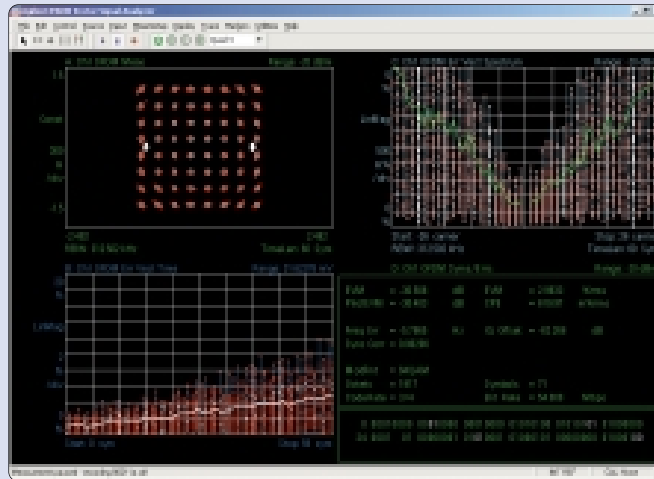
For this IEEE 802.11a signal, the overall EVM measurement (top parameter, lower right) is acceptable, but viewing EVM versus symbol time (lower left) and carrier (upper right) shows the effect of an IQ timing error.
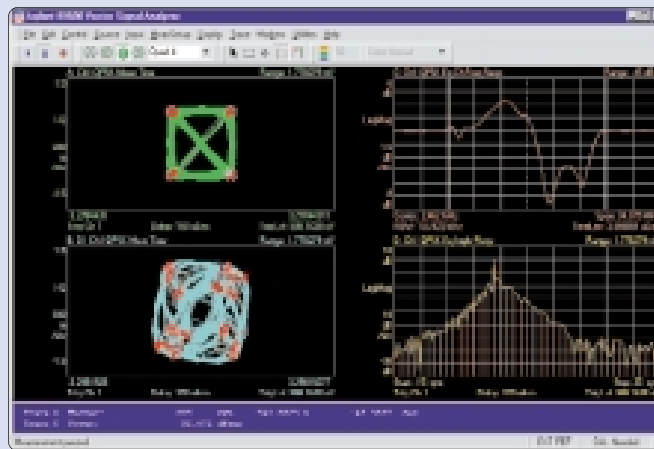
Adaptive equalization can compensate for linear distortion, making it easier to identify and quantify non-linear distortion and spurious errors.

Getting the rest of the story
Sharing insights and best practices is just one way Agilent can help accelerate the drive to market with new wireless networking products. The Agilent Interoperability Certification Labs and Agilent's network of test partners are ready to help too. They have tested hundreds of Wi-Fi devices and can offer vital insights into clearing the qualification hurdle.

To learn more, please visit **www.agilent.com/find/measurements**, *where you can request the free CD-ROM* Bluetooth™ & Wireless LAN Test Products, Systems and Services.

Speeding optimised designs from concept to implementation
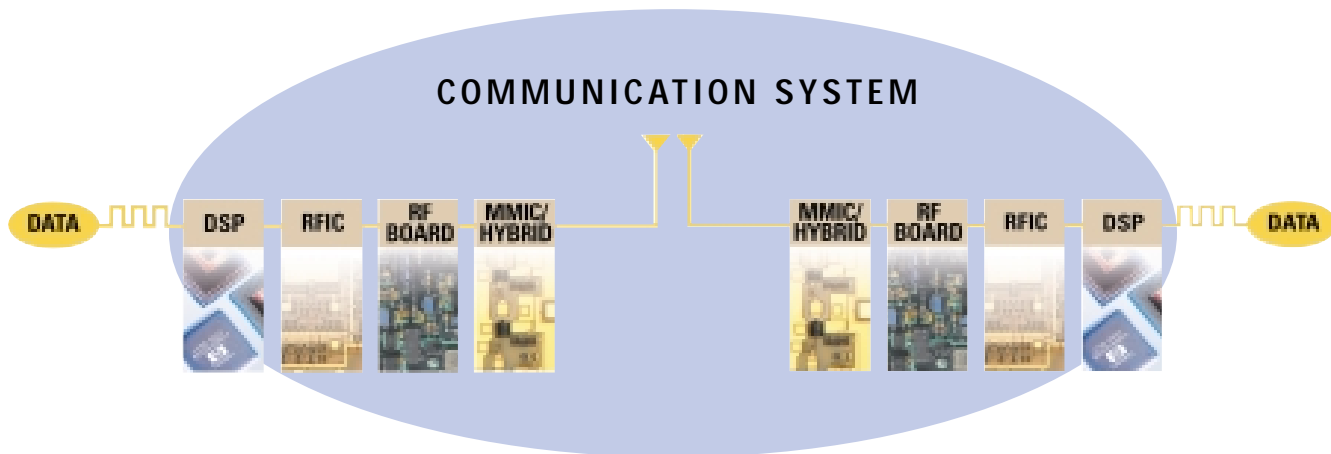
A Unified Environment for Communications Signal Path Design.
Powerful tools for system, RFIC, MMIC, RF board, hybrid and baseband/DSP
design in one integrated environment.

- *Quickly explore design options and tradeoffs from RF to baseband/DSP*

- *Ease the design process with proven RF, microwave, RFIC and baseband/DSP design tools that combine leading-edge technology with built-in application expertise*

- *Meet the most demanding design challenges with application-focused design suites*

- *Save development time with comprehensive design and verification environments and integrated test links to signal generators, network analysers and other Agilent instruments*

The Agilent Advanced Design System (ADS) helps designers meet the multidimensional challenge of mixed-signal design, from RF to digital to baseband. When equipped with Agilent's broad range of high-performance design tools, project teams can quickly explore a host of ideas and then simulate the electrical and physical characteristics of the most promising design candidates.

ADS offers complete design integration for products ranging from mobile phones and pagers to wireless networks and radar systems.

Boost productivity with integrated design tools

ADS is a powerful suite of electronic design automation (EDA) software that can simulate the entire communications signal path. It integrates a wide variety of proven RF, mixed-signal and electromagnetic design tools into a single, flexible environment. Seamless integration minimises the need for data or design transfer, and ADS works with other EDA frameworks for full compatibility within your overall design process.

Use ADS and its highly integrated links and support as a basis for your design verification solution. ADS can be used for virtual prototyping, debugging, or as an aid in manufacturing test.

To enhance engineering productivity and shorten time-to-market, ADS software offers a high level of design automation and applications intelligence. This proven software environment is easily

extensible: you can customise ADS by adding design suites focused on your particular application needs (see page 9). All suites share a common database, user interface and display. ADS and the six design suites run on PCs and workstations, with complete file compatibility between platforms and across networks.

Optimise system performance and resolve design conflicts

With RF mixed-signal co-simulation, you can examine RF and mixed-signal interactions and make architectural tradeoffs. For instance, you can explore alternatives and decide whether to implement a particular filter in the baseband stage or in the RF section. ADS lets you choose either a baseband design flow or an analogue/ RF track. You can build the physical design for the RF portions in ADS, then choose to integrate with other third-party EDA frameworks.

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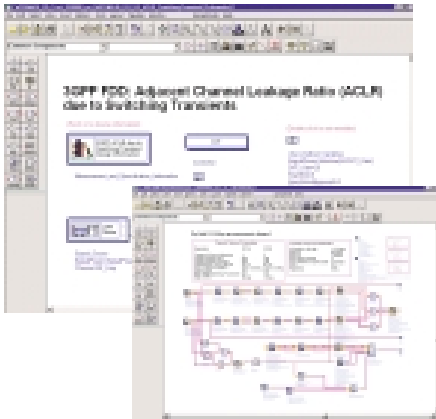
Simulating top-level ACLR due to switching transients in 3GPP system user equipment.
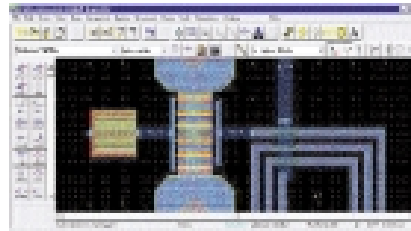
MMIC and RFIC front-to-back design solutions are supported by all major foundries.

Verification of real-world signals through connected solutions.

Meet the unique challenges of your application

Customise ADS for demanding applications and design flows from RF chips and boards to microwave circuits and baseband/DSP elements. All suites share a common database, user interface and data display.

| Design Suite	Version		
	Designer	**Designer Pro**	**Designer Pro Premier**
Communication System Designer Provides a unified environment from system concept to implementation.	Validates RF system designs. RF simulator and linear/non-linear RF block models predict the performance of complete RF systems.	Offers RF and floating-point DSP modeling and design to simulate critical specifications such as BER and EVM. Allows bi-directional co-simulation with MATLAB®. Expandable to include HDL co-simulation.	Adds fixed-point analysis, HDL co-simulation, verification via the Adaptive Waveform Comparator, and propagation models for GSM, CDMA, TDMA and other standards.
DSP Designer The ability to verify DSP algorithms in conjunction with mixed systems helps you isolate and avoid RF/analogue/DSP integration problems.	Uses the Agilent Ptolemy fixed-point simulator and libraries for system-level DSP algorithm development.	Integrates the analysis and simulation of RF, DSP and analogue systems to determine RF/DSP design tradeoffs. Expandable floating and fixed-point capabilities.	Helps analyse interaction between DSP content and the rest of the communications system. Helps co-simulate and generate HDL codes for analysis and validate more levels of system abstraction.
RFIC Designer Realise the most demanding RFIC designs through leading-edge simulation and optimisation. RFIC Designer links to third-party EDA solutions and libraries and is supported by major silicon foundries around the world.	N/A	Provides an integrated time, frequency and modulation-domain simulation environment for schematics containing a combination of models for devices, behavioural blocks, layout parasitics and off-chip components.	Adds user-defined element modelling, statistical design, RF system models and convolution simulation.
RF Board Designer Confidently design RF boards to specification by accurately predicting, optimising and rendering PCB designs for manufacturing. The results are fewer board turns, lower development costs and shorter time to market.	Base simulator capability for linear circuits. Includes accurate models, libraries and unique Agilent EEsof tools.	Provides an integrated environment for design and verification of RF board components. Designers and design teams benefit from leading-edge simulator technology, advanced modelling, a physical design environment and yield optimisation tools.	Adds RF system models and Circuit Envelope for analysis of complex modulated signals. Provides end-to-end architecture, design and implementation capabilities.
Microwave Circuit Designer A complete solution for developing high-frequency designs, including MMICs and hybrids, with optimised performance and manufacturing yield.	Combines high frequency simulation and optimisation with accurate models, libraries, and physical design tools.	A powerful solution for microwave component designers. Adds an integrated physical design environment and yield optimisation and maximisation tools.	Offers expanded capabilities for microwave system designers. Additions include RF system-level analysis, simulation of complex digitally modulated RF signals and tools to create custom models.
	Precision Modelling System	**RF Modelling System**	**Pulsed Modelling System**
Precision, RF and Pulsed Modelling Systems Complete, single-source systems configured for specific frequency ranges and applications to accurately measure non-linear devices.	A complete measurement system for high-frequency active devices. Includes an Agilent 8510C network analyser for ac measurements up to 20 GHz (optionally 26.5 GHz or 50 GHz).	Designed for modelling at frequencies below 3 GHz (optionally to 6 GHz) using the Agilent 8753 or PNA network analysers.	Improves device characterisation and modelling by incorporating thermal effects on device performance.

MATLAB® is a U.S. registered trademark of The MathWorks, Inc.

Practical precision for every application and budget
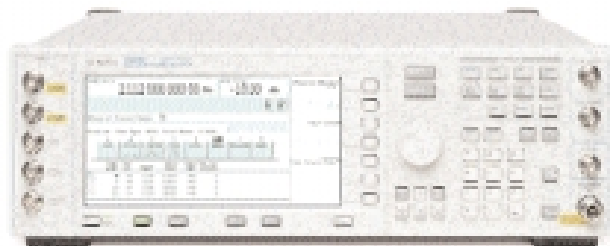
- *Test and simulate communications systems with versatile digital modulation and precise level accuracy*

- *Create complex signals with comprehensive analogue modulation and excellent frequency and level control*

- *Use the high output power of Agilent microwave signal generators to eliminate external amplifiers in analogue modulation and LO applications*

Agilent's RF and microwave signal generators handle applications ranging from low-frequency navigation signals to cellular mobile radio to millimetre-wave satellite systems.

Agilent's RF signal generators are designed for testing of analogue and digital communications systems. Flexible options meet the requirements of most current and proposed air interface standards, letting you simulate the performance of a communication system.

Spectral purity and switching speed are critical measures of an RF signal generator. That is where

our high-performance signal generators excel, making them ideal for in-channel and out-of-channel receiver testing and phase-noise measurements.

Agilent microwave signal generators meet the demanding requirements of signal simulation, local oscillator and stimulus/response test applications. The synthesised signal generators provide excellent frequency resolution, level control, signal purity and modulation.

MEASUREMENT TIP: OPTIMISING SIGNALS FOR CDMA TESTS
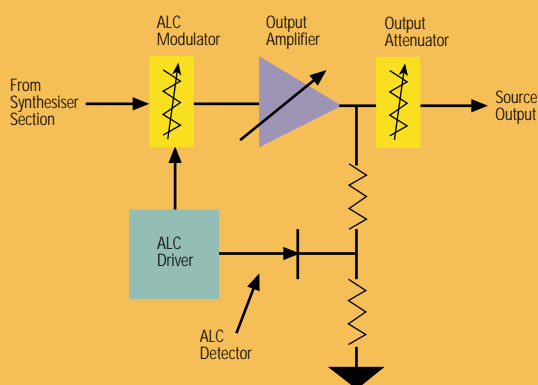
Agilent ESG signal generators let you manually select output amplifier and attenuator settings to optimise signal quality.

To ensure expected performance and interoperability levels, the various CDMA standards set strict limits on receiver and transmitter operation. One of the most demanding tests is adjacent channel leakage ratio (ACLR). With high-speed data over CDMA, interference is a major concern because it can limit overall system capacity. Verifying a receiver's ability to handle interference is therefore an important design concern.

When setting up an ACLR test, make sure your signal generator is optimised to deliver the necessary signal quality. Specifically select a combination of output amplifier and output attenuator settings that keep the signal generator's noise level below the noise level you are trying to measure in the device under test.

As an example, the Agilent ESG lets you decouple the amplifier and attenuator settings and set each one manually (under normal operation, the instrument's CPU optimises them in tandem for best overall performance).

For example, both of the following combinations will yield output power of –5 dBm:

Amplifier	Attenuator
+15 dBm	–20 dB
–5 dBm	0 dB

Both will produce a –5 dBm signal, but the first will produce a signal that is not compatible with the CDMA test specification, while the second will.

Agilent RF Signal Generators

	Frequency range	Key features and applications
ESG Vector Signal Generator **E4438C** (see page 12)	250 kHz to 6 GHz	Same as ESG-D series plus: up to 160 MB waveform memory; 6 GB hard drive; 100 MHz sample clock; up to 160 MHz modulation BW; adjustable carrier-to-noise ratio (Eb/No); differential I/Q outputs; fast frequency switching; high-speed BER; and LAN connectivity.
ESG-D/DP series **E4430-37B** (see page 12)	250 kHz to 4 GHz	Analogue and digital modulation. Optional modulation formats for W-CDMA, cdma2000, EDGE, GSM, *Bluetooth*, WLAN and others. Custom formats also available.
ESG-A/AP series **E4400B, E4420-26B** (see page 12)	250 kHz to 4 GHz	Analogue modulation. Excellent level accuracy, built-in function generator, electronic attenuator and step sweep at an economical price.
8648A/B/C/D (www.agilent.com/find/measurements)	9 kHz to 4 GHz	Low-cost synthesised signal generator series for manufacturing and service applications.
8644B (www.agilent.com/find/measurements)	252 kHz to 2.06 GHz	Very low SSB phase noise and spurious. A performance signal generator for RF design and manufacturing.
8664A (www.agilent.com/find/measurements)	100 kHz to 6 GHz	Low non-harmonic spurious and SSB phase noise (Opt. 004, low-noise enhancement). Excels in basic receiver testing, out-of-channel receiver testing (Opt. 004), and radar testing (Opt. 008, pulse modulation).

Agilent Microwave Signal Generators

	Frequency range	Key features and applications
PSG-A series **E8251A, E8254A** (see page 14)	250 kHz to 40 GHz	Optimised for analogue modulation applications that need high output power and low phase noise.
PSG-L series **E8241A, E8244A** (see page 14)	250 kHz to 40 GHz	Optimised for local oscillator (LO) applications that need high output power. Offers industry-leading cost and performance.

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Normal W-CDMA Test Model 1 with 64 DPCH. The +15/–20 dBm combination of amplifier/attenuator settings produces a signal with higher sideband noise for the ACLR test because the amplifier is set at a high level.

In contrast, the –5/0 dBm combination produces a low-noise signal optimised for W-CDMA Test Model 1 with 64 DPCH. Note the 7 dB improvement in ACLR performance, from approximately –61 dBc to –68 dBc.

Flexible precision, even as new standards emerge

The fully channel-coded W-CDMA personality offers independent data channels, 16 OCNS, compressed mode and adjustable carrier-to-noise ratio in a single instrument.

- *Frequency range up to 6 GHz*
- *Modulation bandwidth up to 160 MHz*
- *Sample rates up to 100 MHz*
- *Waveform playback up to 32 megasamples (160 MB)*

With development work underway on 2.5G, 3G and even 4G systems, RF signal generators need to keep pace. Whether you need analogue, digital or vector signal generation – or a combination – the versatile and flexible Agilent ESG family will help keep you on the leading edge.

Signals for next-generation wireless
The premier member of the family is the Agilent E4438C ESG Vector Signal Generator, which meets the needs of engineers who are designing and developing the next generation of wireless communications systems. The vector signal generator offers comprehensive capabilities for evaluating the performance of 2.5G, 3G and broadband systems in R&D and production test environments.

The ESG Vector Signal Generator supports most of the modulation formats in use today, including W-CDMA, cdma2000, cdma2000-1xEV, EDGE, GSM, *Bluetooth* and 802.11a. It also provides versatile analogue modulation, filtering and burst shapes and custom digital modulation (for user-defined formats). Digital features also include broadband analogue I and Q inputs as well as differential I and Q outputs.

For long, complex arbitrary signals, its internal memory can hold 32 MSa (160 MB). The built-in hard drive (6 GB) provides storage for a multitude of waveforms and enables rapid recall without the need to regenerate them every time. You can also store multiple test scenarios, and customise them with the powerful waveform sequencer.

Ready for future developments
As the most advanced member of the ESG series family, the ESG Vector Signal Generator meets your signal needs today and has the power to handle whatever tomorrow may bring. It offers exceptional accuracy, spectral purity and our

fastest frequency-switching speed. External RF bandwidth of 160 MHz and a 50 Msymbols/s internal baseband generator provide essential capability for the higher data and symbol rates of 3G and broadband wireless. Wireless LAN designers can count on the 100 MHz sample data rate and the 16 bit, 400 MHz DACs to deliver the performance you need to generate 16-22 MHz bandwidths for 802.11a and 802.11b.

Reliable performance at competitive prices
For less demanding applications, the ESG series also includes the popular ESG-A, -AP, -D and -DP models, which continue to deliver precise frequency and level control, and a variety of customisable modulation formats. With frequency ranges up to 4 GHz, they are ideal for testing receivers, local oscillators, RF components and subsystems. Electronic attenuators help ensure reliability and repeatability, even with constant use.

MEASUREMENT TIP: IMPROVING TOI MEASUREMENTS
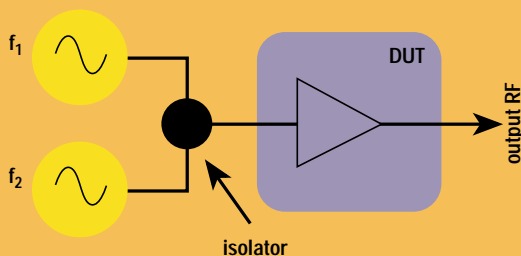
Amplifier testing: Reduced intermodulation distortion means better TOI measurements
The basic approach to the third-order intercept (TOI) measurement is to combine two CW sources at the input of an amplifier. The frequencies of each source are slightly offset from each other but remain within the bandwidth of the amplifier. The non-linearities of an amplifier will produce upper and lower third-order mixing products:

$$f_L = 2f_1 - f_2$$
$$f_U = 2f_2 - f_1$$

where f_1 and f_2 are the output frequencies of the two sources.

Spurious signals from the CW sources can corrupt the measurement. When selecting a source, check the non-harmonic spurious level specifications: they should be well below the third-order products expected from the amplifier under test.

Create new signals for new formats

Create new signals quickly by teaming your ESG signal generator with the new Signal Studio suite of PC-based software tools. Signal Studio has an intuitive graphical user interface that lets you set various signal parameters for flexible waveform generation. Once the waveforms are downloaded, the ESG is automatically set up to generate the signal. Versions are now available for cdma2000-1xEV, *Bluetooth*, 802.11b, 802.11a and enhanced multitone.
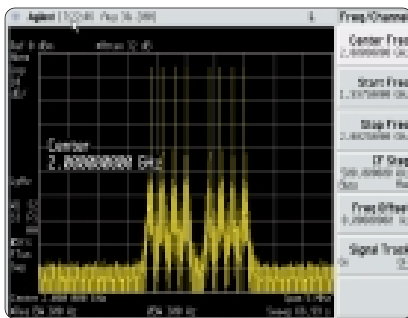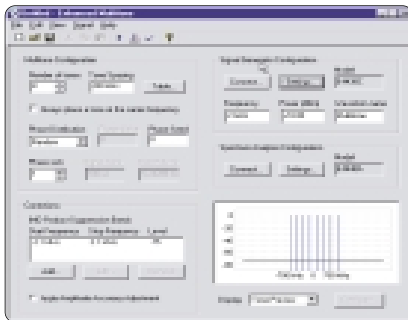
*Download a free evaluation copy of Signal Studio at **www.agilent.com/find/measurements**.*

Agilent E4438C ESG Series Signal Generator (digital models[1])	
Frequency range	1, 2, 3, 4 or 6 GHz
Frequency switching speed	<14 msec in CW mode
Output power, typical	+19 dBm at 1 GHz
Level accuracy	±0.5 dB up to 2 GHz
Amplitude switching speed	<19 msec in CW mode
Phase noise, typical	<–133 dBc/Hz at 20 kHz offset, 1 GHz carrier frequency
RF bandwidth	80 MHz using internal modulation, 160 MHz using external modulation, 3 dB bandwidth
Baseband memory	8 or 32 MSa (40 or 160 MB)
Baseband sample rate	Up to 100 MSa/s
Signal storage space	6 GB hard drive
Connectivity	10BaseT LAN, GPIB, RS-232C
Applications	W-CDMA, cdma2000, cdma2000-1xEV, cdmaOne, EDGE, GSM, *Bluetooth*, 802.11a, 802.11b, AWGN, NADC, PDC, PHS, DECT, TETRA, Custom and all analogue applications

Ordering information
E4438C ESG Vector Signal Generator (must order frequency option)
Frequency options
    Opt. 501 250 kHz to 1 GHz frequency range
    Opt. 502 250 kHz to 2 GHz frequency range
    Opt. 503 250 kHz to 3 GHz frequency range
    Opt. 504 250 kHz to 4 GHz frequency range
    Opt. 506 250 kHz to 6 GHz frequency range (requires Option UNJ)
Hardware options
    Opt. UNB High output power with mechanical attenuator
      (mechanical attenuator included with Option 506)
    Opt. UNJ Enhanced phase noise performance
      (includes high-stability timebase, Option 1E5)
    Opt. UN7 Internal bit-error-rate analyser
    Opt. 001 Internal baseband generator with 8 MSa memory
    Opt. 002 Internal baseband generator with 32 MSa memory
    Opt. 005 6 GB hard drive (Option 001 or 002 required)
    Opt. 1E5 High-stability timebase
Signal generation personalities
    Opt. 400 3GPP W-CDMA-FDD personalities
    Opt. 401 cdma2000 and IS-95A personalities
    Opt. 402 TDMA personalities (includes GSM, EDGE, NADC, others)
    Opt. 403 Calibrated noise personality
Software personalities
    Opt. 404 cdma2000-1xEV-DO Signal Studio software
    Opt. 405 Wireless LAN (802.11b) Signal Studio software
    Opt. 406 *Bluetooth* Signal Studio software
    Opt. 408 Enhanced multitone utility
    Opt. 410 Wireless LAN (802.11a) Signal Studio software

[1] Some specifications may reflect optional performance.

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The test system can also introduce sources of error. For instance, if two signals are input to a combiner, the non-linearities of the sources will create intermodulation products at the same frequencies as those created by the amplifier under test. The secret to suppressing these intermodulation products is better isolation of signal sources. Intermodulation products can be reduced either through better isolation of the signal sources or by suppressing the power that transfers from one source to the other.

When more than two signals are involved, the challenge of suppressing intermodulation increases exponentially as every signal generates intermodulation products with every other signal. As a result, creating an acceptable multitone test signal can be a frustrating, time-consuming process.

The new Signal Studio Enhanced Multitone Utility works with ESG signal generators and PSA spectrum analysers to suppress multitone intermodulation automatically. Using a predistortion technique that cancels out measured intermodulation, the software iterates this process until it yields a signal with satisfactory intermodulation levels.

*Learn more in Source Basics, available free online at **www.agilent.com/find/measurements**.*

Get clean signals for high-power applications

- *SSB phase noise less than −110 dBc (20 kHz offset, 10 GHz carrier)*
- *Optional SSB phase noise less than −98 dBc (1 kHz offset, 10 GHz carrier)*
- *Maximum output power of +20 dBm at 20 GHz or +14 dBm at 40 GHz*
- *Easy frequency extension to 110 GHz with Agilent 83550 series millimetre heads*

The Agilent PSG series signal generators are ideally suited for component design and manufacturing, offering high frequency coverage and wide bandwidth analogue modulation.

Models optimised for LO and analogue modulation needs

Select the PSG model that best meets your frequency, sweep, modulation and output power requirements. The PSG-L series is optimised for LO needs at industry-leading price and performance. The PSG-A series excels at analogue modulation, offering AM, FM, phase-modulation and pulse-modulation capabilities. Both series are available in 20 GHz and 40 GHz models.

In the PSG-A series, maximum FM deviation is 16 MHz at 20 GHz and 32 MHz at 40 GHz. The FM mode is fully synthesised for rates below 10 kHz, providing stable, low-noise FM in narrowband applications. For pulse modulation above 3.2 GHz, minimum pulse width is 20 ns.

More power, less equipment

The PSG series microwave signal generators eliminate the need for external amplifiers and reduce overall equipment and test costs by offering high power output: optionally +20 dBm at 20 GHz or +14 dBm at 40 GHz. This is especially useful for production test of MMDS, LMDS and point-to-point radios that use microwave sources as LOs. High output power is also well suited to testing of converters, transceivers, ODUs and radios.

Digital sweeps of frequency and level

For swept measurements, the PSG series offers digital sweep capabilities such as step and list functions for both frequency and amplitude, either separately or simultaneously. Every frequency in the sweep is fully synthesised and there is no power blanking between points within a band. When sweeping power, the sweep range covers up to 40 dB without switching the attenuator.

Compatible replacements

The PSG series replaces the Agilent 836xx and 837xx series of microwave synthesisers. In automated test systems, the PSG series instruments are SCPI-compatible with the previous products.

MEASUREMENT TIP: UPCONVERSION MIXERS FOR MODULATED MICROWAVE
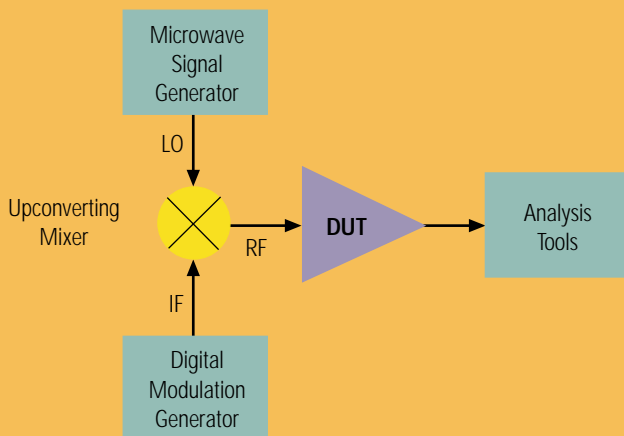
Testing microwave power amplifiers these days offers an intriguing signal generation challenge. Not only do the signals need to be clean and accurate as always, but they need to provide the wide range of digital modulation formats used in today's communication systems.

A typical solution to this challenge is combining a microwave signal source with a versatile digital signal generator via an upconversion mixer:
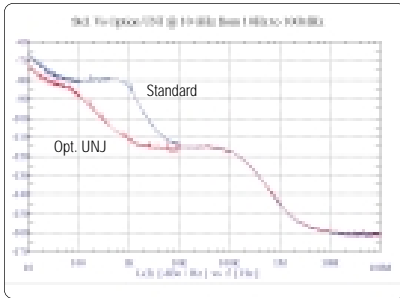
Comparing phase-noise performance for the standard instrument and Option UNJ.

Agilent PSG Series Microwave Signal Generators

Frequency range	250 kHz to 20 GHz or 40 GHz	
Output power		
20 GHz models	**Standard**	**Option 1EA**
250 kHz to 3.2 GHz	+13 dBm to –20 dBm	+16 dBm to –20 dBm
>3.2 GHz to 20 GHz	+13 dBm to –20 dBm	+20 dBm to –20 dBm
40 GHz models	**Standard**	**Option 1EA**
250 kHz to 3.2 GHz	+9 dBm to –20 dBm	+15 dBm to –20 dBm
>3.2 GHz to 20 GHz	+9 dBm to –20 dBm	+18 dBm to –20 dBm
>20 GHz to 40 GHz	+9 dBm to –20 dBm	+14 dBm to –20 dBm

CW level accuracy (dB)	**Output power**		
	>+10 dBm	**+10 dBm to –10 dBm**	**–10 dBm to –20 dBm**
250 kHz to 2 GHz	±0.6	±0.6	±1.4
>2 GHz to 20 GHz	±0.8	±0.8	±1.2
>20 GHz to 40 GHz	±1.0	±0.9	±1.3

SSB phase noise (CW)	**Offset from carrier**	
	20 kHz (standard)	**1 kHz (Opt. UNJ)**
250 kHz to 250 MHz	–130 dBc/Hz	–110 dBc/Hz
>250 MHz to 500 MHz	–136 dBc/Hz	–124 dBc/Hz
>500 MHz to 1 GHz	–130 dBc/Hz	–118 dBc/Hz
>1 GHz to 2 GHz	–124 dBc/Hz	–112 dBc/Hz
>2 GHz to 3.2 GHz	–120 dBc/Hz	–108 dBc/Hz
>3.2 GHz to 10 GHz	–110 dBc/Hz	–98 dBc/Hz
>10 GHz to 20 GHz	–104 dBc/Hz	–92 dBc/Hz
>20 GHz to 40 GHz	–98 dBc/Hz	–86 dBc/Hz

Ordering information
PSG-A Series
  E8251A   250 kHz to 20 GHz
  E8254A   250 kHz to 40 GHz
PSG-L Series
  E8241A   250 kHz to 20 GHz
  E8244A   250 kHz to 40 GHz
Option UNJ Enhanced phase-noise performance (includes high-stability timebase, Opt. 1E5)
(Please refer to online data sheet for complete list of options.)

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Given the demands on signal quality, the mixer needs careful consideration. Among the attributes to look for are:

- **Low conversion loss:** These tests often require large signal amplitudes, but adding an amplifier to the signal chain adds noise and distortion as well. If at all possible, make sure the mixer's conversion loss is low enough so you can skip the amplifier.

- **Low distortion:** Since you are introducing another layer of modulation into the picture, use a mixer with the lowest possible intermodulation distortion.

- **Wide IF:** The wider the IF, the farther the image responses will be from your test signal. An IF below 1 GHz, for instance, might put image responses so close that you will need high-performance filters to suppress them. In contrast, with an IF of several GHz or more, you can simplify, and perhaps even eliminate, the filtering altogether.

Moreover, if you can take advantage of a mixer inside one of the signal generators, you can simplify the measurement chain that much more. The Agilent PSG family, for instance, offers an optional internal mixer ideally suited to this purpose.

A full spectrum of signal analysis solutions

- *From basic to high performance, spectrum analysis and vector signal analysis*

- *Exceptional speed, accuracy and phase noise*

- *One-button, standards-based measurements*

- *Built-in automation capabilities*

- *Transmit/receive testing with Agilent ESG-D signal generators*
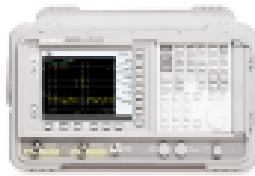
E4402B
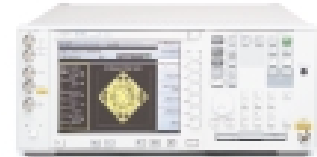
E4406A

E4440A

89640A

RF and microwave signals are becoming more complex, carrying even more information at higher frequencies and in narrower channels. Agilent offers several spectrum analyser families that address measurement needs in the lab, on the production line and even in the field.

Cover the basics
Agilent ESA series spectrum analysers offer a flexible, affordable range of signal analysis solutions. The ESA-L series provides fast, accurate spectrum analysis at affordable prices. The more capable

ESA-E series delivers enhanced performance and capabilities such as optional measurement personalities.

Get world-class performance
The PSA series offers Agilent's highest-performance spectrum analysis, with excellent specifications, advanced flexibility and ease of use in a single analyser. Optional measurement personalities let you customise your analyser for a variety of specific applications.

See multiple perspectives
Detailed analysis of complex signals – in existing or emerging formats – requires the ability to view those signals from many perspectives. Agilent vector signal analysers (VSAs) provide comprehensive time, frequency and modulation domain capabilities for measurement and analysis of complex, modulated signals.

MEASUREMENT TIP: THOROUGH AUTOMATED TESTS IN LESS TIME

With careful test design, it is relatively easy to cut test times on the manufacturing line without cutting corners on the quality or thoroughness of your tests. Here is a selection of time-saving ideas developed specifically for spectrum analysers but also applicable to nearly all bus-connected instruments. Some are more obvious than others, but they are all worth a quick check in your test planning.

Test structure and sequence
- Start by considering the entire test plan and identifying the best candidates for significant speed

improvements. Evaluate each test step by weighing its contribution to overall test time against the possibility for speed improvements.

- Minimise DUT connections and reconnections. A high-level look at test programs can reveal possibilities to group tests under a single connection.

- Minimise the number of GPIB transactions by grouping commands together whenever possible.

Individual features and functions
- Disable analyser displays when working remotely.

- Compare the time required by one-button measurements with accomplishing the same task via multiple standard commands. The one-button measurements are optimised for speed and are usually, but not always, the fastest way to accomplish a given task over the bus.

- Avoid autoranging or automatic attenuator setting, unless you explicitly need them during a test.

- Minimise use of the reset (*RST) command. It sets the instrument back to a known state, but usually

Agilent Spectrum Analyser Application Recommendations

Optional application-specific solutions [1]	ESA-L series Basic spectrum analysis (page 18)	ESA-E series Flexible mid-performance platform (page 18)	PSA series Advanced, high-performance platform (page 20)
Bluetooth		x	
Cable/broadcast TV	x	x	
Cable fault location		x	
cdma2000			x
cdma2000 1xEV-DO			x
cdmaOne		x	x
EDGE			x
EMI precompliance		x [2]	
GSM/DCS1800/PCS1900		x	x
GPRS		x	
Modulation analysis		x	
NADC			x
PDC			x
Phase noise		x	x
W-CDMA			x

[1] Generally available as a combination of optional hardware and measurement personalities   [2] Available in Agilent E7400 series

Agilent Vector Signal Analyser Application Recommendations

Application-specific solutions	PSA series With optional digital demodulation (page 20)	89400 VSA series Versatile instruments (page 21)	89600 VSA series PC-based system (page 21)	E4406A VSA Transmitter tester (page 21)
Flexible modulation analysis [1]	x [2]	x	x	x [2]
Information bandwidth	narrow/wide [4]	narrow	wide	narrow
Standards-based production and design verification	x			x
Non-standard signal analysis		x	x	
Software simulation, integration and analysis			x [3]	
Base/mobile station test	x			x

[1] "Flexible modulation analysis" refers to an analyser's ability to demodulate non-standard and custom–made signals
[2] Through 89601A software [3] Through a link to Agilent Advanced Design System EDA software (pages 8–9) [4] With 70 MHz IF output

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consumes a lot of time. You may be able to set individual parameters as needed in less time.

- Turn off automatic alignments and calibrations. Manage these functions explicitly, rather than letting the instrument do them automatically, to make sure they are performed only as often as needed.

- Understand the speed vs. repeatability tradeoff for your particular measurement and choose the fastest technique that offers the required repeatability. You will often need to explore several measurement possibilities to understand the tradeoffs, but the effort can pay off in markedly reduced test times.

- Do not use markers in the analyser to retrieve multiple measurement points from a single trace. It is generally faster to transfer the trace data to the computer and extract measurement points there.

Other considerations
- Consider using LAN instead of GPIB for large data transfers.

- Use the binary data format, which is much faster than ASCII text format.

- Make sure you are using the latest version of the instrument firmware to take advantage of the latest speed improvements.

Learn more about a wide variety of analyser topics, free online at
www.agilent.com/find/measurements.

Verify your designs practically anywhere: bench, line or field

- *Fast sweeps and measurements*
- *Continuously phase-locked synthesiser*
- *New multi-offset ACPR for 2G and 3G signals*
- *Optional one-button measurements of GSM/GPRS, Bluetooth and more*
- *Rugged case and weatherproof front panel*
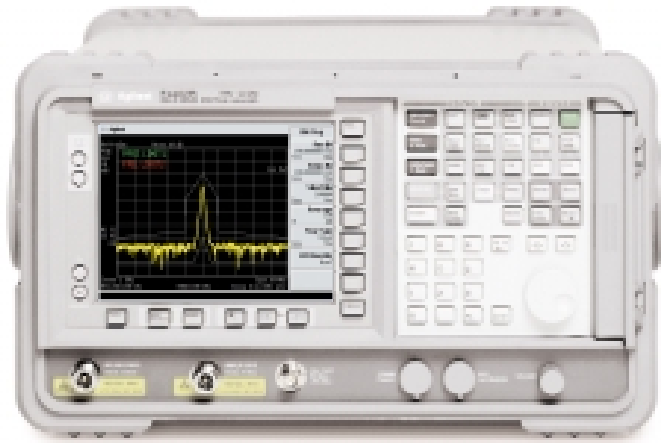
The Agilent ESA-E and ESA-L series spectrum analysers offer a flexible range of solutions for R&D, manufacturing and field service. For basic spectrum analysis, the ESA-L series spectrum analysers provide a great combination of speed and accuracy at prices so low you can put one on every engineer's bench. The more capable ESA-E series offers a colour display and a wider range of functions, including optional one-button measurement personalities for specialised applications.

ESA-L: Affordable speed and accuracy

The Agilent ESA-L series provides basic spectrum analysis without scrimping on speed or accuracy. These affordable, fully synthesised analysers are available in three frequency ranges: 1.5 GHz, 3.0 GHz and 26.5 GHz. They feature fast 4 millisecond RF sweeps and 30 measurement-per-second updates to the display or through the GPIB interface.

For fieldwork, these rugged, portable analysers feature a rubber-encased frame and a weather-resistant front panel that allows operation in rain and high humidity. Continuous background alignment ensures accurate measurements, even when

the outside temperature varies. A snap-on, rechargeable battery option enables cordless operation for up to 1.9 hours.

ESA-E: Flexible for the future

To help keep you on the leading edge, the Agilent ESA-E series offers a constantly expanding set of features and measurement capabilities. Its six-slot card cage is a flexible measurement platform that lets you choose the performance you need now and easily upgrade later.

You can also customise the ESA-E to meet specific testing requirements. Measurement personalities, downloaded into the analyser's memory, transform the ESA-E into a focused solution for applications such as phase noise, GSM/GPRS, cdmaOne, *Bluetooth* and modulation analysis. The modulation analysis personality measures error vector magnitude (EVM) of 2G and 3G signals, and displays constellation diagrams, eye diagrams and more.

### New enhancements for expanded capabilities
- All ESAs now include average (RMS) detection, required in the 3GPP W-CDMA output RF spectrum emissions section for compliant measurements.

For EMC and device test applications, the new log sweep function in the ESA-E series makes it easy to correlate compliance data in the industry-standard log frequency format. If you already own an ESA analyser, you can download a free firmware update from **www.agilent.com/find/measurements**.

- A new software link utility lets you combine ESA-E analysers with the 89601A vector signal analysis software for powerful demodulation and analysis of digital communication signals. The utility is available via options 229 or 231 for ESA-E models equipped with options B7D, B7E and 1D5 or B74.

- Option 230 provides remote control of basic analyser functions via the Internet, as well as remote viewing through a Web browser, including waterfall and spectrogram displays.

- Now you can upgrade 8590-based test systems with the ESA's faster speed, better accuracy and wider dynamic range – without scrapping your software investment. Option 290 enables the ESA series to accept over 130 of the most popular 8590 series programming commands.

www.agilent.com/find/measurements   Please contact your nearest Agilent office.

18
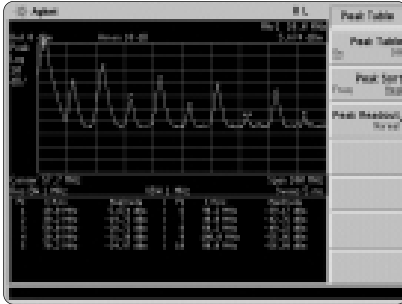
Measure multiple signals in minimal time: get the frequency and amplitude of up to 10 signals in just milliseconds.
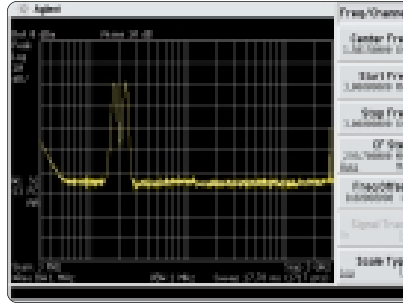
Log sweep resolves signals in the lower band frequencies while still looking at the whole band.
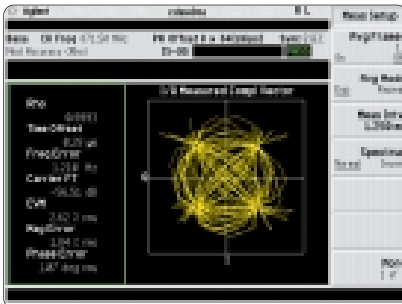
Make one-button measurements with standards-compliant personalities such as cdmaOne, GSM/GPRS and Bluetooth.

Six offsets in the ACPR measurement allow rapid assessment of components that handle multicarrier signals.

Automated expertise for easier EMI measurements

Early evaluation of EMI performance and compliance is an essential part of a successful design. The Agilent E7400A series of EMC analysers uses the ESA-E series platform to provide precompliance measurements for design analysis.

Agilent's one-box solutions make in-house EMC precompliance testing a simple reality. They include preprogrammed, automated measurements, interactive software and automatic remeasure functions for consistent, repeatable results. Recent enhancements to the E7400A series include remote viewing and control over the Internet.

- *E7401A EMC analyser, 9 kHz to 1.5 GHz*
- *E7402A EMC analyser, 30 Hz to 3.0 GHz*
- *E7403A EMC analyser, 30 Hz to 6.7 GHz*
- *E7404A EMC analyser, 30 Hz to 13.2 GHz*
- *E7405A EMC analyser, 30 Hz to 26.5 GHz*

Agilent ESA Series Spectrum Analysers

	ESA-L series E4411/03/08B	ESA-E series E4401/02/04/05/07B
Frequency range standard	9 kHz to 1.5, 3.0 or 26.5 GHz	30 Hz[1] to 1.5, 3.0, 6.7, 13.2 or 26.5 GHz[2]
Resolution BW range	1 kHz to 5 MHz	1 Hz[1] to 5 MHz
Dynamic range (maximum third-order)	83 dB/83 dB/82 dB	109 dB/108 dB/108 dB/108 dB/108 dB[1]
Sensitivity Displayed average noise level (DANL)	–117 dBm	–150 dBm[1, 4] or –166 dBm[1, 3, 4]
Phase noise at 1 GHz at 10 kHz offset at 10 MHz offset	–90 dBc/Hz	–90 dBc/Hz –137 dBc/Hz[1]
Accuracy Overall amplitude accuracy Span accuracy Frequency accuracy	±1.1 dB (9 kHz to 3 GHz) ±1.0% ±2,001 Hz (at 1 GHz)	±1.0 dB (9 kHz to 3 GHz) ±0.5% ±101 Hz (at 1 GHz)
Speed Minimum RF sweep Minimum zero-span sweep Local measurement rate	4 ms 4 ms ≥28 meas/second[4]	1 ms 25 ns[1] ≥40 meas/second[4]

[1] Optional
[2] To 325 GHz with external mixing
[3] With optional built-in preamp
[4] Nominal

High performance for the toughest design challenges

- *High speeds for fast low-level spur searches*

- *TOI of +17 dBm and sensitivity of −153 dBm gives wide dynamic range*

- *All-digital IF gives superior accuracy and linearity*

- *One-button RF power measurements for popular wireless formats*

- *Measurement personalities with digital modulation analysis for 2G/3G applications*
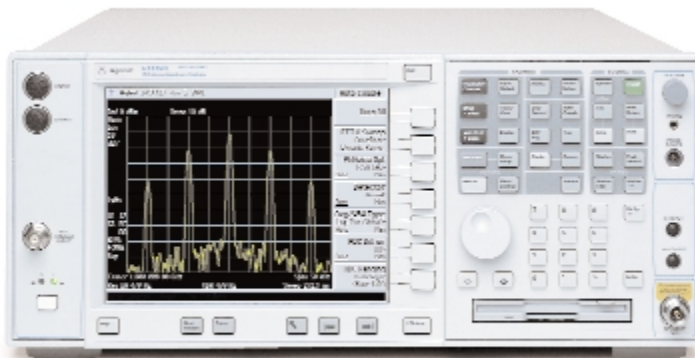
In wireless communications, aerospace and defense or general R&D and manufacturing, great performance is the starting point for great measurements. The Agilent PSA series offers high-performance spectrum analysis up to 50 GHz with powerful one-button measurements, a versatile feature set and a leading-edge combination of flexibility, speed, accuracy and dynamic range.

Accelerate your time-to-insight
Make accurate measurements quickly and easily or access unprecedented levels of setup control for advanced customisation. Phase noise optimisation, 160 resolution bandwidth settings, a 2 dB step attenuator, a full detector suite, and swept and FFT modes are standard in every PSA spectrum analyser.

Connect to the world via LAN, GPIB, floppy drive, IntuiLink toolbars for MS Office or BenchLink, our Web Remote SA instrument control software. Drivers for Agilent VEE, National Instruments LabView and LabWindows make it easy to create new measurements and collect results.

Expand the capability of your PSA
Characterise the phase noise and jitter of sources with the optional phase noise measurement personality.

Test today's popular formats with a suite of one-button power measurements, including multi-offset adjacent channel power, CCDF, and TOI. Add optional measurement personalities to perform modulation analysis on W-CDMA, GSM, EDGE, cdma2000, 1xEV-DO, cdmaOne, NADC, and PDC signals or connect to the Agilent 89601A vector signal analysis software for flexible vector modulation analysis.
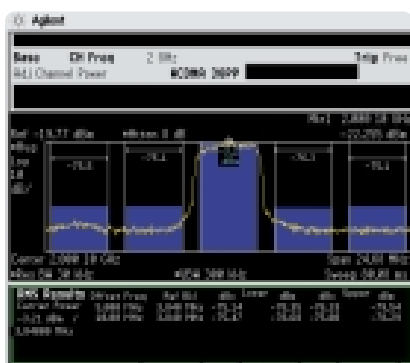
Perform one-button measurements such as W-CDMA adjacent channel power ratio (ACPR).

Agilent PSA Series Spectrum Analysers		*NEW*
	E4443A/E4445A/E4440A	E4446A/E4448A
Frequency range	3 Hz to 6.7, 13.2 or 26.5 GHz	3 Hz to 44 or 50 GHz
Dynamic range (maximum third order) W-CDMA ACPR	113 dB (<3 GHz) 78 dB[1] (<3 GHz)	Visit **www.agilent.com/find/measurements** for details
Sensitivity Displayed average noise level (DANL)	−153 dBm/−166 dBm[2] (10 MHz to 3 GHz)	−151 dBm/−164 dBm[2] (10 MHz to 3 GHz)
Phase noise at 1 GHz 10 kHz offset 1 MHz offset 10 MHz offset	−114 dBc/Hz −144 dBc/Hz −148 dBc/Hz	−114 dBc/Hz −144 dBc/Hz −148 dBc/Hz
Accuracy Overall amplitude accuracy Span accuracy	±0.65 dB/±0.24 dB[3] (<3 GHz) ±0.2% of span	±0.65 dB/±0.24 dB[3] (<3 GHz) ±0.2% of span
Speed Minimum RF sweep Minimum zero-span sweep Local measurement rate	1 ms 1 µs ≥50/second	1 ms 1 µs ≥50/second
Resolution BW range (Swept and FFT)	1 Hz to 8 MHz (10% steps) 4, 5, 6, 8 MHz	1 Hz to 8 MHz (10% steps) 4, 5, 6, 8 MHz

[1] Typical with noise correction
[2] With optional built-in preamplifier
[3] 95% confidence

Uncover RF and DSP problems throughout your block diagram
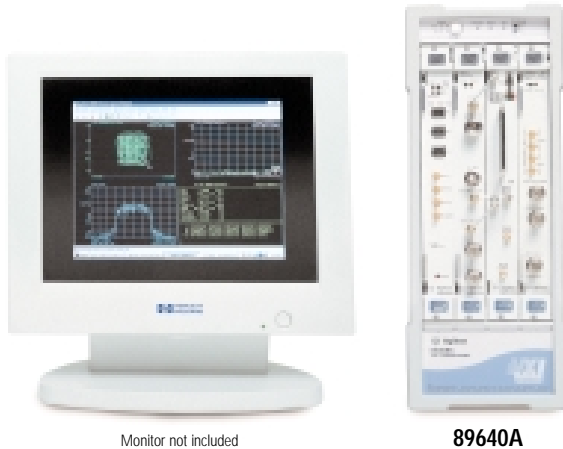
Monitor not included

89640A

- *89600 series PC-based VSA for analysis of wideband (<36 MHz) systems and devices*

- *89400 series VSA for narrowband (<8 MHz) R&D applications*

- *E4406A VSA Transmitter Tester for one-button, standards-based testing in manufacturing and design verification*

Detailed analysis of wireless communication components and devices requires the ability to look at signals in many formats and in many different ways. Agilent vector signal analysers (VSAs) provide comprehensive time-, frequency- and modulation-domain capabilities for fast measurement and analysis of wireless signals.

A VSA's strength is in its ability to perform signal analysis separately from signal acquisition and also demodulate complex and time-varying signals. It preserves both the magnitude and phase information of a signal, allowing advanced analysis of time, frequency and modulation characteristics.

Using these capabilities, you can uncover symbol timing errors, incorrect filtering, DAC

overflow, spurious signals riding underneath the modulation envelope and many other common RF and DSP problems.

89600 series VSA, dc to 6.0 GHz

Choose from four models of PC-based VSAs for wideband signal analysis with a 36 MHz information bandwidth. Analyse to even higher frequencies with the 89611A and your own downconverter. Covering a wide range of modulation formats, the 89600 series offers flexible demodulation with adjustable parameters. The 89600 also has links to the Agilent Advanced Design System for integration with design, simulation and analysis tools.

You can also apply this analysis power to a wide range of measurements on both oscilloscopes

and other signal analysers. The software component of the 89600 series, the 89601A vector signal analysis software, can control Agilent ESA-E series, PSA series and the E4406A signal analyser, as well as the 54800 series Infiniium oscilloscopes.

89400 series VSA, dc to 2.65 GHz

Offering flexible demodulation for design trouble-shooting, the 89400 family provides accurate measurements with low phase noise. Perform 8 MHz signal analysis in the RF range, or 10 MHz at baseband. The integrated, coherent source enables translated frequency response measurements.

E4406A VSA, 7 MHz to 4 GHz

One-button, standards-based measurements make the E4406A ideal for design verification and manufacturing, where its speed and ease of use increases throughput. It measures multiple wireless formats, including W-CDMA, cdma2000, 1xEV-DO, cdmaOne and GSM/EDGE. An optional baseband IQ input extends demodulation analysis to baseband signals. It is also compatible with the 89601A VSA software for additional troubleshooting measurements and flexible vector modulation analysis.

Agilent Vector Signal Analysers			
	89400 VSA series	**89600 VSA series**	**E4406A VSA**
Frequency range	**89410A**: dc to 10 MHz **89441A**: dc to 2.65 GHz **89441V**: VSB/QAM	**89641A**: dc to 6.0 GHz **89640A**: dc to 2.7 GHz **89610A**: dc to 40 MHz **89611A**: 70 MHz IF	7 MHz to 4 GHz
Sensitivity at 1 GHz	–160 dBm/Hz	–159 dBm/Hz	–106 dBm (1 kHz RBW)
Phase noise	–116 dBc/Hz (10 kHz offset)	–99 dBc/Hz (20 kHz offset)	-99 dBc/Hz (10 kHz offset)
Amplitude accuracy	±1.0 dB	±2.0 dB	±0.6 dB
Information bandwidth	8 MHz	36 MHz	8 MHz
Resolution BW range	<1 Hz to 3 MHz	<1 Hz to 10 MHz	10 Hz to 7.5 MHz

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Tackle the most demanding active and passive devices

- *Excellent measurement accuracy*
- *Fast, precise, integrated synthesised sources*
- *Choice of integrated S-parameter or T/R test sets*
- *Advanced automation and flexible options to boost capabilities*

From precision design work to high-volume manufacturing, component test manufacturers demand fast, accurate measurements. Agilent offers a host of RF and microwave vector network analysers that are ready to tackle the most challenging active and passive networks, devices, components and subsystems.

Choose the right mix of cost capability and performance for your application. Pick error-corrected S-parameter or economical transmission/reflection measurements.

Squeeze more performance from your designs with exceptional accuracy. Wide dynamic range and low trace noise make it easy to see the stopband and passband of even the highest-rejection filters.

On the production line, advanced productivity features such as automated pass/fail testing and segmented sweeps help accelerate test throughput. Built-in sequencing, programming and connectivity capabilities can increase the flexibility of your test systems and decrease the cost of test.

Agilent Network Analysers

	E8356/7/8A E8362/3/4A E8801/2/3A N3381/2/3A (page 23)	E5070A E5071A (page 24)	8753ES/ET (page 25)	8719ES/ET 8720ES/ET 8722ES/ET (page 26)	8712ES/ET 8714ES/ET (page 27)
Frequency range	E835x/E880x/N338x: 300 kHz to 3, 6 or 9 GHz E836x: 45 MHz to 20, 40 or 50 GHz	300 kHz to 3 GHz or 8.5 GHz	30 kHz to 3 GHz or 6 GHz	50 MHz to 13.5, 20 or 40 GHz	300 kHz to 1.3 GHz or 3 GHz
System dynamic range at test port	E835x/E880x/N338x: 128 dB E836x: 123 dB	122 dB	110 dB	8719/20ES: 100 dB 8722ES: 93 dB 8719/20ET: 104 dB 8722ET: 97 dB	8712ES: 104 dB 8714ES: 101 dB 8712ET: 115 dB 8714ET: 114 dB
# of ports	2 or 3	2, 3 or 4	2	2	2
Power range	E835x/E880x/N338x: –85 dBm to +10 dBm E836x: –87 dBm to +3 dBm	–50 dBm to 0 dBm	–85 dBm to +10 dBm	8719/20ES: –70 dBm to +5 dBm 8722ES: –75 dBm to –5 dBm 8719/20ET: –10 dBm to +10 dBm 8722ET: –15 dBm to 0 dBm	8712ES: –60 dBm to +13 dBm 8714ES:–60 dBm to +9 dBm 8712ET: –60 dBm to +15 dBm 8714ET: –60 dBm to +10 dBm
Key advantages	Up to 50 GHz frequency coverage Exceptional dynamic range for high-rejection measurements TRL and mixed-connector calibration Advanced automation	Multiport measurements as fast as 9.6 µs/point Balanced measurements Matching circuit simulation Port characteristic impedance conversion	Integrated T/R or S-parameter test set Frequency offset mode for frequency transition devices Optional time-domain analysis	Integrated T/R or S-parameter test set TRL calibration for non-coaxial environments Frequency offset mode for frequency transition devices Optional time-domain analysis	Cost-effective S-parameter analysis up to 3 GHz Fast sweep for faster component test

Precision network analysis for today and tomorrow

New
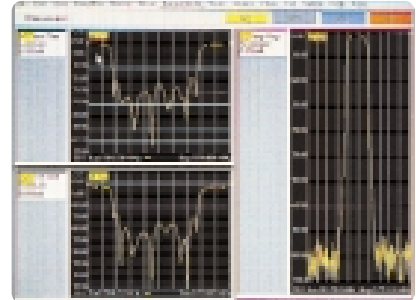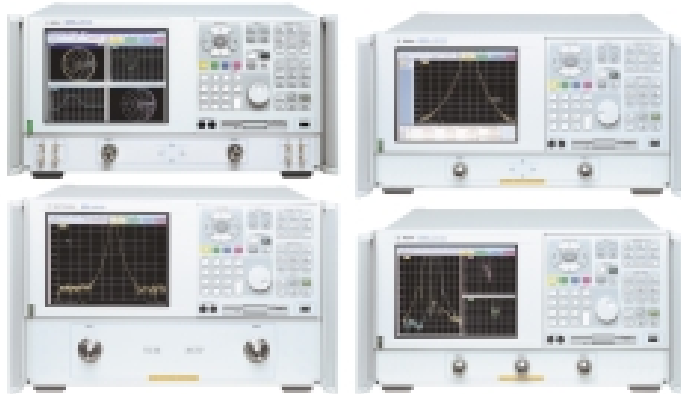
Arrange windows for custom viewing or select standard viewing configurations.

- *Up to 50 GHz frequency coverage*
- *USB controlled electronic calibration (ECal)*
- *Exceptional dynamic range for your high-rejection measurements*
- *Windows 2000 interface*

Rapid evolution of communications technology presents a growing challenge to component manufacturers. Agilent's PNA series network analysers meet that challenge with the right combination of fast sweep speeds, wide dynamic range, low trace noise and flexible connectivity.

E8362/3/4A
These new models bring the PNA platform's superior performance to microwave frequencies. With exceptional stability (0.06dB/˚C) and four receivers for TRL/LRM calibration, the

E8362/3/4A models are ideal for your high-performance microwave components.

E8356/7/8A
The original 2 port RF members of the family provide TRL/LRM calibration (4 receiver enabled) for in-fixture and on-wafer devices, standard bias-Ts for active devices and standard direct receiver access for extended dynamic range.

E8801/2/3A
These less expensive, 2 port analysers offer performance that is similar to the E8356/7/8A. A host of optional capabilities lets you custom-fit an analyser to your unique applications.

N3381/2/3A
With fast, simultaneous measurements of all paths, these 3 port models are ready to tackle components such as circulators, duplexers, splitters, couplers and base station combiner/divider units (CDUs). Full 3 port error correction ensures outstanding accuracy.

Powerful automation tools make the PNA series well suited for both R&D and manufacturing. The familiar Windows® interface reduces the time spent learning how to use the instrument, letting users focus on measurements. Test programmes can be executed in the analyser or an external PC; you can programme easily using COM/DCOM or use SCPI commands.

Agilent PNA Series Network Analysers

	E8362/3/4A	E8356/7/8A	E8801/2/3A	N3381/2/3A
Frequency range	45 MHz to 20/40/50 GHz	300 kHz to 3/6/9 GHz		
Number of ports	2	2	2	3
System dynamic range at test port	94 dB to 500 MHz 119 dB to 2 GHz 122 dB to 10 GHz 123 dB to 20 GHz 114 dB to 30 GHz 110 dB to 40 GHz 109 dB to 45 GHz 104 dB to 50 GHz	125 dB to 1 MHz 128 dB to 3 GHz 118 dB to 6 GHz 113 dB to 9 GHz		
Power range	–25 dBm to +5 dBm*	–85 dBm to +10 dBm		
Trace noise (typical)	<0.010 dB rms to 500 MHz <0.006 dB rms to 50 GHz (1 kHz BW)	<0.002 dB rms (1 kHz BW)		

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Ready for new generation, multiport RF devices

- *2, 3 or 4 built-in test ports with full port calibration*
- *Multiport measurements as fast as 9.6 µs/point*
- *Balanced measurements to interpret mixed-mode S-parameters*
- *Matching-circuit simulation*
- *Port characteristic impedance conversion*

New-generation wireless handsets depend on advanced RF components from duplexers and couplers to balanced SAW filters. Fast, accurate testing is crucial, and Agilent's ENA series network analysers offer comprehensive measurement capabilities for advanced multiport devices.

The Agilent E5070A (3 GHz) and E5071A (8.5 GHz) offer 2, 3 or 4 test ports for simultaneous measurement of all signal paths in components with up to 4 ports. This minimises the number of

sweeps required for multiport S-parameter measurements and helps increase test throughput. Built-in balanced measurements, matching-circuit simulation and port characteristic impedance conversion all contribute to reducing the overall cost of test.

The ENA series also accelerates test system development and expands your customization capabilities. Built-in Visual Basic® for Applications (VBA) lets you develop test programs in the ENA

series or import Visual Basic programs from an external PC. You can even create a custom user interface that uses a touch screen (optional) on the 10.4" LCD display.

On the production line, the ENA's excellent measurement accuracy improves test quality and repeatability. And with wide dynamic range and very low trace noise, the ENA series offers performance that will meet testing needs today and into the future.
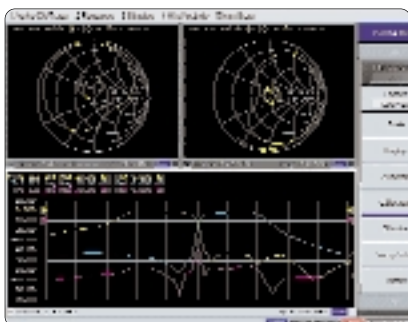
This duplexer measurement is displayed in multiple formats for rapid interpretation of essential test results.

Agilent ENA Series RF Network Analysers

	E5070A	E5071A
Frequency range	300 kHz to 3 GHz	300 kHz to 8.5 GHz
Number of ports	2, 3 or 4	2, 3 or 4
System dynamic range at test port	120 dB, 3.0 MHz to 1.5 GHz 122 dB, 1.5 GHz to 3.0 GHz	120 dB, 3.0 MHz to 1.5 GHz 122 dB, 1.5 GHz to 4.0 GHz 120 dB, 4.0 GHz to 6.0 GHz 117 dB, 6.0 GHz to 7.5 GHz 110 dB, 7.5 GHz to 8.5 GHz
Power at test port	−15 dBm to 0 dBm w/o ATTN −50 dBm to 0 dBm w/ ATTN	−15 dBm to 0 dBm w/o ATTN −50 dBm to 0 dBm w/ ATTN
Trace noise, 3 kHz BW	0.001 dB rms, 3.0 MHz to 3.0 GHz	0.001 dB rms, 3.0 MHz to 4.2 GHz 0.003 dB rms, 4.2 GHz to 7.5 GHz 0.005 dB rms, 7.5 GHz to 8.5 GHz

Visual Basic® and the Visual Basic logo are registered trademarks of Microsoft Corporation in the U.S. and/or other countries.

Accelerate the analysis of challenging RF devices
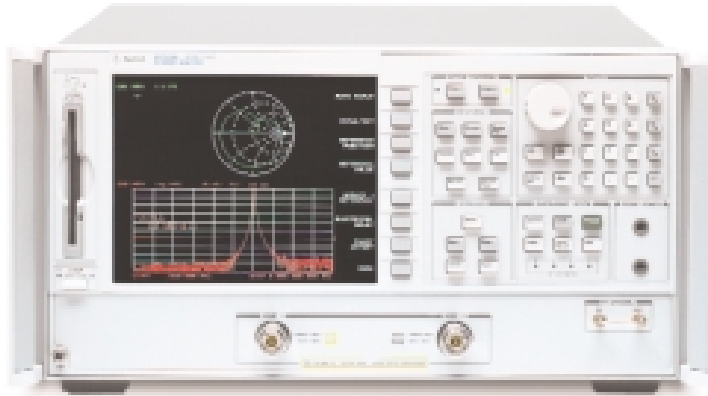
- *Integrated T/R or S-parameter test set*
- *Up to 110 dB dynamic range*
- *Precise measurement of bilateral devices with enhanced reflection calibration*
- *Optional time-domain analysis of transmission and reflection*

The Agilent 8753ES and 8753ET RF network analysers offer outstanding speed, accuracy and ease of use on the production floor or in R&D. The high-performance 8753ES offers forward and reverse measurements through its integrated S-parameter test set (50 Ω or 75 Ω). The more economical 8753ET performs forward measurements with its built-in transmission/reflection test set (50 Ω).

Both models provide a full range of magnitude and phase measurements up to 3 GHz or 6 GHz.

Four display channels and a colour display present a variety of results from the two independent measurement channels.

Time-saving productivity functions such as test sequencing and limit testing make it easy to characterise active and passive networks, devices, components and subsystems. Swept-list-frequency mode optimises speed, accuracy and dynamic range by defining a sweep as a series of segments, each with its own frequency range, power level, number of points and IF bandwidth. Frequency

offset mode allows independent tuning of source and receiver when measuring frequency-translating devices. Power sweep mode characterises the non-linear behavior of a device.

For coaxial environments, the 8753ES offers a variety of calibrations, including adapter removal and electronic calibration (ECal). Automatic control of Agilent ECal modules enables hands-off switching between impedance standards.

The 8753 lets you use as many as 4 display channels.

Agilent RF Network Analysers		
	8753ES	**8753ET**
Frequency range	Standard: 30 kHz to 3 GHz Optional: 30 kHz to 6 GHz	Standard: 300 kHz to 3 GHz Optional: 300 kHz to 6 GHz
Number of ports	2	2
System dynamic range at test port	100–110 dB, 300 kHz to 3 GHz 105 dB, 3 GHz to 6 GHz	110 dB, 300 kHz to 3 GHz 105 dB, 3 GHz to 6 GHz
Power at test port	–85 dBm to +10 dBm	–20 dBm to +5 dBm
Trace noise (typical), 3 kHz BW	<0.006 dB rms, 300 kHz to 3 GHz <0.010 dB rms, 3 GHz to 6 GHz	<0.006 dB rms, 300 kHz to 3 GHz <0.010 dB rms, 3 GHz to 6 GHz

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Boost the design and production of microwave components

- *Fast sweeps and data transfers*
- *Excellent measurement accuracy*
- *TRL calibration for non-coaxial environments*
- *Power meter calibration*
- *Internal automation with test sequencing*

The Agilent 8720E family of vector network analysers can help improve your microwave designs in R&D and maximise your measurement throughput in manufacturing. This family includes S-parameter (ES models) and transmission/reflection analysers (ET models).

ES models provide both forward and reverse measurements with full 2 port calibration for optimum accuracy. ET models provide transmission and reflection measurements in the forward direction at an affordable price. All models combine a synthesised source with an integrated test set, covering frequencies from 50 MHz to 13.5, 20 or 40 GHz.

For coaxial environments, the 8720E family offers a variety of calibrations, including adapter removal and electronic calibration (ECal). TRL calibration (ES models) enhances accuracy for non-coaxial environments such as wafer-probing or waveguide.

Optional time-domain analysis helps locate mismatches while gating can remove unwanted responses. Simplify the task of tuning cavity filters by using the time-domain reflection response to identify which resonators and coupling apertures need adjustment.

Direct sampler access allows transmission measurements that bypass the coupler for improved signal-to-noise ratio. The high-power test set supports amplifier measurements up to 20 watts. Frequency offset mode lets the analyser's source and receiver operate at different frequencies for mixer testing.
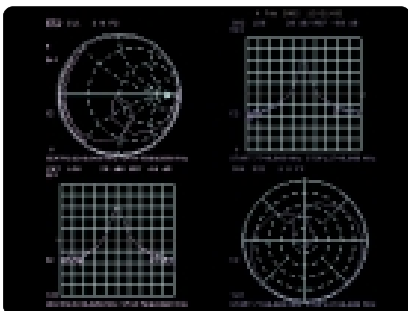
The 8720E family lets you use as many as 4 display channels.

Agilent Microwave Network Analysers		
	8719ES, 8720ES, 8722ES	**8719ET, 8720ET, 8722ET**
Frequency range	8719ES: 50 MHz to 13.5 GHz 8720ES: 50 MHz to 20 GHz 8722ES: 50 MHz to 40 GHz	8719ET: 50 MHz to 13.5 GHz 8720ET: 50 MHz to 20 GHz 8722ET: 50 MHz to 40 GHz
Number of ports	2	2
System dynamic range at test port	8719/20ES: 77 dB to 100 dB 8722ES: 67 dB to 93 dB	8719/20ET: 102 dB to 104 dB 8722ET: 84 dB to 97 dB
Power at test port	8719/20ES: –70 dBm to +5 dBm 8722ES: –75 dBm to –5 dBm to 20 GHz –75 dBm to –10 dBm to 40 GHz Step attenuator option extends minimum power by 55 dB	8719/20ET: –10 dBm to +10 dBm 8722ET: –15 dBm to 0 dBm to 20 GHz –15 dBm to –5 dBm to 40 GHz Option 007 adds +5 dBm to min/max power levels
Trace noise (typical), 3 kHz BW	<0.03 dB rms to 13.5 GHz <0.04 dB rms to 20 GHz <0.15 dB rms to 40 GHz	<0.03 dB rms to 13.5 GHz <0.04 dB rms to 20 GHz <0.15 dB rms to 40 GHz

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Thorough component testing at mass-production prices

- *Both magnitude and phase measurements on 50 Ω and 75 Ω devices*
- *Measurements up to 3 GHz*
- *S-parameter tests for maximum speed and accuracy*
- *Fast sweeps for faster component test*
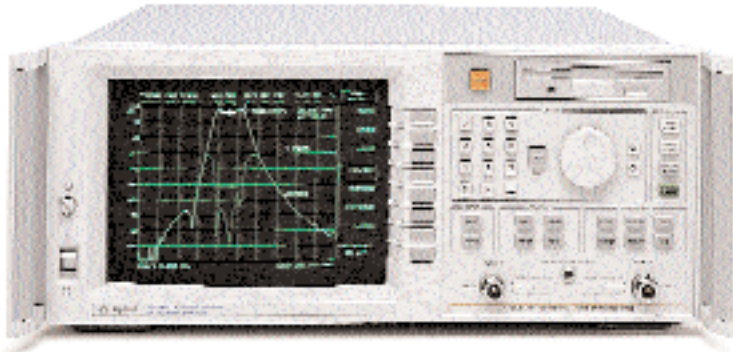
The value-priced Agilent 8712ES and 8714ES models let you measure forward and reverse characteristics with a single connection to the device under test. They also provide full 2 port calibration for maximum accuracy. If you are on a tight budget but still need reliable network analysis, the economical 8712ET and 8714ET models offer integrated transmission/reflection test sets.

No matter which model you choose, you will get fast sweeps with a 1 Hz resolution source. All models provide broadband detection for scalar characterisation of mixers and other frequency-translation devices, as well as narrowband detection for vector analysis of high-rejection devices with more than 100 dB dynamic range.

Optional time-domain analysis helps locate mismatches and gating can remove unwanted responses. The time-domain reflection response helps identify which resonators and coupling apertures need adjustment when tuning cavity fillers.

All four analysers are packed with productivity features: automated pass/fail testing, save and recall of setup states, data markers, VGA output, built-in Instrument BASIC and a LAN interface.

Agilent 8712E Series Network Analysers	
8712ET	300 kHz to 1.3 GHz, T/R test set
8712ES	300 kHz to 1.3 GHz, S-parameter test set
8714ET	300 kHz to 3.0 GHz, T/R test set
8714ES	300 kHz to 3.0 GHz, S-parameter test set

MEASUREMENT TIP: CHARACTERISING NEXT-GENERATION COMPONENTS

Handset makers are constantly trying to increase performance, reduce weight and extend battery life while also simplifying the manufacturing process. Collectively, those needs are driving the integration of discrete components into multifunction modules. However, as the level of integration increases, it becomes more difficult to describe and verify device performance.

A growing number of new device designs use balanced circuits to achieve better receiver performance. In theory, the two leads of a well-balanced circuit will cancel the effects of noise, either incoming or radiated. In practice, it can be very challenging to evaluate, characterise, interpret and understand the performance of these circuits.

The analytical solution is called *mixed-mode S-parameters.* By accounting for common- and differential-mode inputs and outputs, the mixed-mode matrix provides "mode conversion" terms that characterise the all-important symmetry of a balanced circuit. As a balanced circuit loses symmetry, its performance benefits fade. Conversion from differential to common mode can cause radiated EMI problems, perhaps when the stimulus appears on a ground return. Conversely, conversion from common to differential mode can mean increased EMI susceptibility.

For a closer look at mixed-mode S-parameters in action, please refer to Application Note 1373-6, Agilent Balanced Measurement Example: Baluns, *available at* **www.agilent.com/find/measurements**.

Test high-performance RF systems with confidence

- *Intuitive operation for quick setup and sure results*

- *Eight predefined wireless configurations, including* Bluetooth

- *Trace display plus analysis screen with real-time delta marker measurements of time, peak, average and peak-to-average ratio*

- *Analyser software for pulse and statistical analysis*
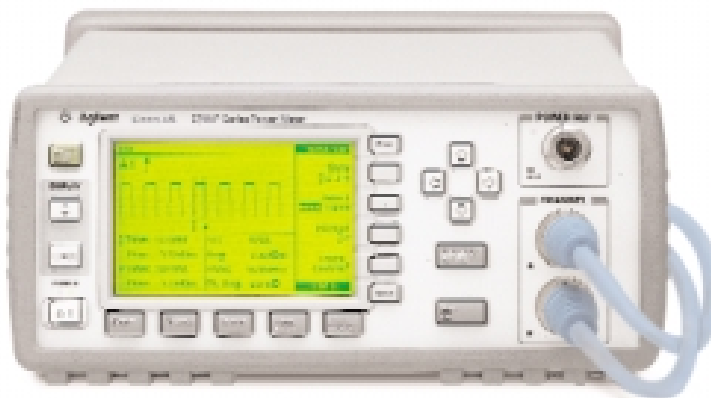
Make sure your RF products go out the door with performance you can count on. With absolute accuracy of ±0.02 dB (±0.5%), the Agilent EPM and EPM-P single- and dual-channel power meters deliver confident results for today's advanced communication systems.

EPM-P series: Versatile high performance
EPM-P series meters (E4416A and E4417A), together with the Agilent E9320 family of sensors, are single-box solutions that measure peak, peak-to-average ratio and average power, along with time-gated measurements. Versatile triggering features make it easy to capture signals of interest.

EPM series: Confident average power measurements
If average power meets your application requirements, the lower-cost EPM series meters (E4418B and E4419B) deliver accurate, repeatable results.

Agilent power sensors
Choose from more than 30 precision-matched power sensors. The E441xA family of CW sensors covers 10 MHz to 26.5 GHz. E9300 sensors offer CW and average power from 9 kHz to 18 GHz – even when measuring complex digital modulation formats. The versatile E9320 sensors team with the EPM-P meters to offer CW, peak, average and time-gated measurements (50 MHz to 18 GHz) and are available in modulation bandwidths for GSM, CDMA and W-CDMA.

Agilent EPM and EPM-P Series Power Meters

	E4416A	E4417A	E4418B	E4419B
Frequency Range [1]	9 kHz to 110 GHz			
Power Range [1] with E-Series CW E-Series E9300 8480 Series	–70 dBm to +20 dBm –60 dBm to +44 dBm –70 dBm to +44 dBm			
E-Series E932xA	–65 dBm to +20 dBm		N/A	N/A
Measurement speed with E-Series sensors	Up to 1,000 readings/sec with E9320 sensors		Up to 200 readings/sec	Up to 100 readings/sec on each channel
Standard interfaces	GPIB, RS-232 and RS-422			

Agilent E-Series Power Sensors

	Sensor Type	Frequency Range	Video BW	Power Range	Connector
E4412A	CW power	10 MHz to 18 GHz	N/A	–70 dBm to +20 dBm	N (m)
E4413A	CW power	50 MHz to 26.5 GHz	N/A	–70 dBm to +20 dBm	APC –3.5 mm (m)
E9301A	Average power	10 MHz to 6 GHz [2]	N/A	–60 dBm to +20 dBm	N (m)
E9301B	Average power	10 MHz to 6 GHz [2]	N/A	–30 dBm to +44 dBm	N (m)
E9301H	Average power	10 MHz to 6 GHz [2]	N/A	–50 dBm to +30 dBm	N (m)
E9304A	Average power	9 kHz to 6 GHz	N/A	–60 dBm to +20 dBm	N (m)
E9321A [3]	Peak/average power	50 MHz to 6 GHz [2]	300 kHz	–65 dBm to +20 dBm	N (m)
E9322A [3]	Peak/average power	50 MHz to 6 GHz [2]	1.5 MHz	–60 dBm to +20 dBm	N (m)
E9323A [3]	Peak/average power	50 MHz to 6 GHz [2]	5 MHz	–60 dBm to +20 dBm	N (m)

[1] Sensor-dependent
[2] 18 GHz models available. Contact Agilent Technologies for more information.
[3] For use with Agilent E9288A sensor cable

Give your designs an edge by optimising noise figure
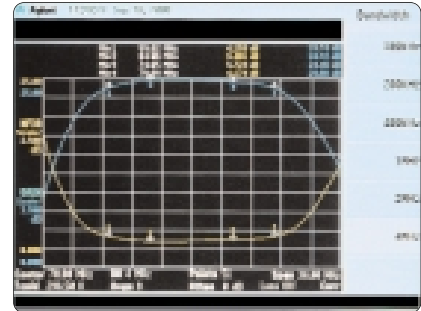
An integrated 17 cm colour display provides single- or split-screen views of simultaneous gain and noise figure measurements.

- **Easy measurement of amplifiers and frequency-converting devices**

- **Low instrument uncertainty ensures accurate, repeatable results**

- **One-box analysers to 26.5 GHz, even higher with custom solutions**

- **Complementary noise sources simplify setup and improve accuracy**

Give your products a competitive edge by measuring and reducing noise figure. Agilent noise figure measurement solutions deliver fast, accurate and repeatable results in the lab and on the production line.

NFA series: Comprehensive characterisation
NFA series noise figure analysers provide new capabilities that can simplify both R&D and production-test applications. Ease-of-use features help engineers and technicians set up complex tests quickly and correctly, view measurements in different formats and print the results or save them to disk. Pass/fail testing is simpler too with on-screen limit lines.

SNS series: Greater measurement integrity
The SNS series noise sources complement the NFA series, simplifying measurement setup and improving measurement accuracy. Rather than manually loading the unique excess noise ratio (ENR) calibration factors into the noise figure analyser, ENR data is stored electronically inside the noise source and downloads automatically when you connect the source to the analyser. SNS series noise sources can also measure the ambient temperature of the measurement environment to enable the measurements to maintain the highest levels of accuracy. The SNS series includes the N4000A 18 GHz frequency coverage with 6 dB ENR; N4001A 18 GHz frequency coverage with 15 dB ENR and N4002A 26 GHz frequency coverage with 15 dB ENR.

Agilent NFA Series Noise Figure and Gain

N8972A, N8973A, N8974A, N8975A		Noise source ENR		
		4 dB to 7 dB	**12 dB to 17 dB**	**20 dB to 22 dB**
Noise figure	Measurement range	0 dB to 20 dB	0 dB to 30 dB	0 dB to 35 dB
	Instrument uncertainty **N8972A** (10 MHz to 1.5 GHz) **N8973A/74A/75A** (10 MHz to 3.0 GHz) **N8974A/75A** (>3.0 GHz)	±<0.1 dB ±<0.05 dB ±<0.15 dB	±<0.1 dB ±<0.05 dB ±<0.15 dB	±<0.15 dB ±<0.1 dB ±<0.2 dB
Gain[1]	Measurement range	−20 dB to +40 dB		
	Instrument uncertainty	±<0.17 dB		

Agilent NFA Series Measurement Speed[2] (nominal)

	Frequency range	8 averages	64 averages
N8972A	(10 MHz to 1.5 GHz)	<100 ms/measurement	<80 ms/measurement
N8973A	(10 MHz to 3.0 GHz)	<50 ms/measurement	<42 ms/measurement
N8974A	(10 MHz to 3.0 GHz)	<50 ms/measurement	<42 ms/measurement
	(3.0 GHz to 6.7 GHz)	<70 ms/measurement	<50 ms/measurement
N8975A	(10 MHz to 3.0 GHz)	<50 ms/measurement	<42 ms/measurement
	(3.0 GHz to 26.5 GHz)	<70 ms/measurement	<50 ms/measurement

[1] For measurement bandwidths below 4 MHz and spacing between measurement points below 3 MHz, gain uncertainty may increase to a maximum of ±0.7 dB.

[2] Corrected noise figure and gain measured on a 3 dB pad with a repetitive sweep of 101 points from 600 MHz to 1.0 GHz (or from 4.0 GHz to 6.0 GHz) with a 4 MHz measurement bandwidth.

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Performance you can put to work every day

- *A full selection of scopes for product development, research and education*

- *Wide range of bandwidths to meet your needs*

- *Unique 2 + 16 channel mixed-signal models with MegaZoom deep memory and patented high-definition display in the 54600 series*

- *Infiniium scopes combine high performance with powerful simplicity*

Long lists of features and impressive-sounding specifications look great in a brochure, but how does your scope actually perform on the job, day in and day out? With input from engineers around the world, Agilent scopes go beyond the simple numbers to offer unique capabilities that accelerate the troubleshooting process.

A new way to see inside your circuits
The Agilent 54600 series oscilloscopes (page 32) provide a unique way to observe and analyse circuit behavior. With the combination of MegaZoom deep memory and nearly twice the horizontal display resolution of any other digital scope, these models highlight important signal features and minimise your troubleshooting

time. With configurations offering 2 or 4 analogue channels or 2 analogue + 16 digital channels, you can choose the right solution for your unique needs.

Advanced performance, simple operation
Need fast, precise measurements with high bandwidths and sampling up to 8 GSa/s? Choose from the Infiniium 54800 series scopes on page 31 or the 500 MHz 54640 series scopes on page 32. The new MegaZoom Infiniium scopes offer a new level of deep-memory usability at affordable prices. A unique Windows®-based approach to measurement makes high-performance capabilities simple without requiring extensive learning and relearning.

Agilent 60 MHz to 500 MHz Oscilloscopes

	Repetitive bandwidth	Max. sample rate	Channels	Max. memory depth	Special features	Page
54621A	60 MHz	200 MSa/s	2	4 MB	High-definition display, serial triggering standard (SPI, CAN, USB, I²C) **MEGA**Zoom	32
54621D	60 MHz	200 MSa/s	2 analogue, 16 digital	4 MB		32
54622A	100 MHz	200 MSa/s	2	4 MB		32
54622D	100 MHz	200 MSa/s	2 analogue, 16 digital	4 MB		32
54624A	100 MHz	200 MSa/s	4	4 MB		32
NEW **54641A**	350 MHz	2 GSa/s	2	8 MB	High-definition display, serial triggering standard (SPI, CAN, USB, I²C) **MEGA**Zoom	32
NEW **54641D**	350 MHz	2 GSa/s	2 analogue, 16 digital	8 MB		32
NEW **54642A**	500 MHz	2 GSa/s	2	8 MB		32
NEW **54642D**	500 MHz	2 GSa/s	2 analogue, 16 digital	8 MB		32

Windows® is a registered trademark of Microsoft Corporation.

Agilent 600 MHz to 2.25 GHz Oscilloscopes

	Repetitive bandwidth	Max. sample rate	Channels	Max. memory depth	Special features	Page
NEW **54830B**	600 MHz	4 GSa/s	2	4 MB standard 16 MB optional	Lowest-cost Infiniium with deep memory **MEGA**Zoom	31
NEW **54831B**	600 MHz	4 GSa/s	4		Lowest-cost 4 channel Infiniium with deep memory **MEGA**Zoom	31
NEW **54832B**	1 GHz	4 GSa/s	4		High bandwidth with deep-memory Infiniium **MEGA**Zoom	31
54845B	1.5 GHz	8 GSa/s	4	64 kB	Wide bandwidth with fastest sample rate	31
54846B	2.25 GHz	8 GSa/s	4		Highest-performance Infiniium oscilloscope	31

High-performance scopes with fast, usable and affordable deep memory

New

- *Simple tasks are simple again; advanced features are easy to access and control*

- *Bandwidths up to 2.25 GHz, sample rates up to 8 GSa/s and memory depths up to 16 M points*

- *VoiceControl option (English only) for hands-free operation*

- *Extensive connectivity makes it easy to document and share your work*

- *Superior probing solution with bandwidths up to 4 GHz*

Agilent Infiniium 54800 series oscilloscopes combine the high performance of digital technology with the simple look and feel of analogue scopes.

With the advanced MegaZoom technology, the new 54830B series offers all the benefits of instant response, even with the deepest memory on; optimum resolution that never misses fast events and affordable memory up to 16 M points.

A simple, analogue-like front panel, Windows-based interface and powerful connectivity capabilities make high-performance features easily accessible and uncomplicated.

Turn to page 32 to see how IBM used Infiniium deep memory to quickly solve a problem that had been taking several weeks with conventional instruments.

Agilent Infiniium Oscilloscopes

	54830B	54831B	54832B	54845B	54846B
Bandwidth	600 MHz	600 MHz	1 GHz	1.5 GHz	2.25 GHz
Channels	2	4	4	4	4
Max. sample rate	4 GSa/s	4 GSa/s	4 GSa/s	8 GSa/s	8 GSa/s
Memory depth	up to 4 MB (2 MB/ch) standard up to 16 MB optional			32 kB on all channels, 64 kB on 2 channels	
Trigger mode	Edge, glitch, pattern, delay by time/events, setup/hold violation, pulse width, rise/fall time violation, video, line				
Storage	5.0 GB hard drive, 3.5" 1.44 MB/120 MB Super Disk, CD-ROM drive				
Interfaces	GPIB, RS-232, Centronics, 10/100 Mb/s LAN, USB, VGA, PS/2 mouse and keyboard				

See insert for our newest oscilloscopes!

Combined with Infiniium scopes, new active probes give you an accurate insight into your high-speed devices.

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www.agilent.com/find/measurements

Unique troubleshooting solutions for analogue-digital design challenges

New

- *60, 100, 350 and 500 MHz bandwidths*
- *View 18 time-aligned channels (2 analogue and 16 digital) simultaneously*
- *Troubleshoot mixed analogue and digital designs with responsive MegaZoom deep memory*
- *Patented high-definition display reveals subtle details that the typical scope will not show you*
- *Standard serial trigger including I²C, SPI, CAN frame and USB frame trigger*
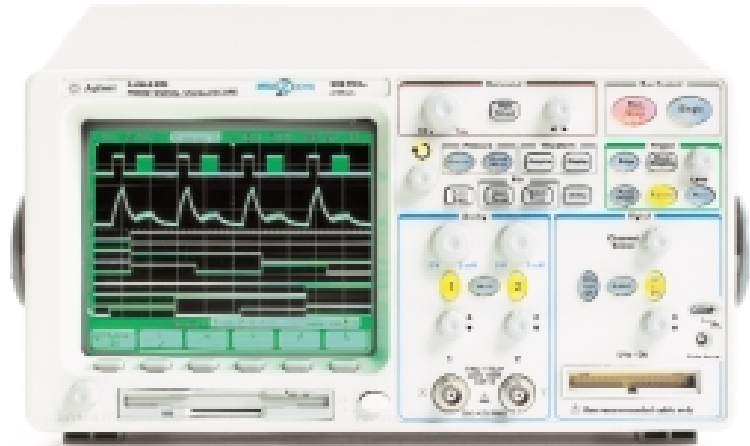
New 350 MHz and 500 MHz bandwidths extend the performance of Agilent scopes while continuing to solve your toughest problems. R&D engineers who work with both analogue and digital content can capture all signals of interest at once, view analogue and digital signals simultaneously and identify important details quickly. With 2 analogue and 16 digital channels on one instrument, Agilent MegaZoom deep memory and nearly twice the horizontal resolution of any

digital scope on the market, it is like opening a new window to see inside your circuits.

You will see subtle details from narrow transients to distorted edges and intermittent defects, with greater fidelity than you have probably ever seen before in any digital scope.

The exclusive MegaZoom technology enables fast, responsive displays and up to 8 million samples of memory. With a single measurement,

you can collect 10 milliseconds of data and still view 5-nanosecond details using simple pan-and-zoom controls.

The 54600 series scopes now offer powerful new serial trigger capabilities standard, including enhanced I²C, SPI, CAN frame, USB frame trigger and hardware frequency counter measurements that allow 4 digit accuracy with 5 digit resolution.

To upgrade your scope with the latest system software, visit
www.agilent.com/find/measurements.

Finding hidden component problems at IBM using deep-memory scopes

Every engineer knows the feeling: the CPU is doing everything it is supposed to do and everything else is in order, but the system still does not function correctly.

Mark Andresen, an Advisory Engineer with IBM's Server Group, recently found himself in just such a scenario. One of the company's PCI interface card products was mysteriously failing on the production line, but the problem affected only some units and not others. He narrowed the problem to cards using flash memory modules from one particular vendor and observed the startup sequence on these cards with a logic analyser (Figure 1). By the time the active-low reset signal was pulled high, the memory module

should have received a chip select pulse and begun generating valid data, but its outputs were still in tristate mode and the chip select activity was nowhere to be seen.

Mark needed a way to capture the entire start-up sequence with enough resolution to find fast-moving signals. It was the classic length-versus-resolution tradeoff. To capture all the relevant activity, he had to use a very slow timebase. The slower the timebase, the lower the resolution. This meant the expected chip select activity could have actually been taking place in between samples.

A high-speed, conventional-memory scope did not help either, since it did not have enough memory to catch the entire 160 ms reset-read cycle with sufficient resolution.
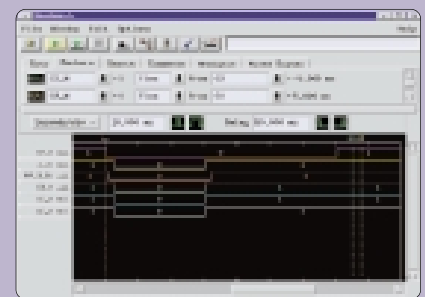

Figure 1: The flash memory module was receiving the correct control signals after the reset signal (RP_N, top trace) went inactive but its outputs were still tristated and expected chip select activity (in the area outlined by the display markers) was nowhere to be seen.

Finally, a deep-memory scope uncovered the problem. Figure 2 shows that the CPU was,

Agilent 54600 Series Oscilloscopes

	54621A	54621D	54622A	54622D	54624A	54641A	54641D	54642A	54642D
Bandwidth	60 MHz	60 MHz	100 MHz	100 MHz	100 MHz	350 MHz	350 MHz	500 MHz	500 MHz
Channels	2	2 + 16 digital	2	2 + 16 digital	4	2	2 + 16 digital	2	2 + 16 digital
Maximum sample rate	200 MSa/s					2 GSa/s			
Maximum memory depth	4 MB					8 MB			
Trigger modes	Edge, pulse width, pattern, TV, sequence, duration, enhanced I²C, SPI, CAN frame, USB frame trigger								
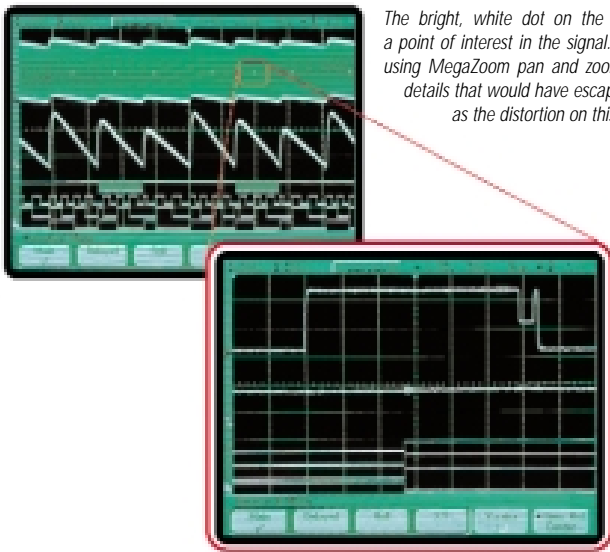
The bright, white dot on the upper display highlights a point of interest in the signal. Dial in for a closer look using MegaZoom pan and zoom, and you will see the details that would have escaped a regular scope, such as the distortion on this square wave.
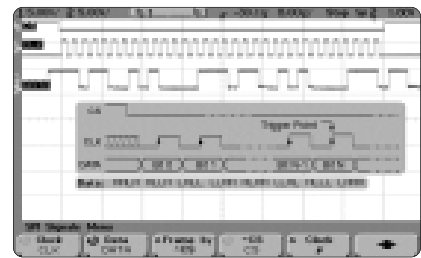
With serial communication trigger mode, verifying handshaking is easier than ever.

Please contact your nearest Agilent office.   **www.agilent.com/find/measurements**

in fact, generating chip select activity shortly after the reset signal went inactive high. Now Mark knew the memory module was getting the right commands at the right time. Now, why was the memory not responding?

Initially, because deep memory captured much more data than was actually shown onscreen, zooming in for a closer look at the chip select activity was as simple as telling the scope where to look and lowering the timebase setting (Figure 3). Now it was obvious that the CPU was indeed pulsing the chip select line as expected – nearly two dozen times, in fact – trying to get the memory module to respond.

Mark next turned his attention to the voltage profile of the chip select signal earlier in the reset sequence. Thanks to some design considerations elsewhere in the system, the power supply level
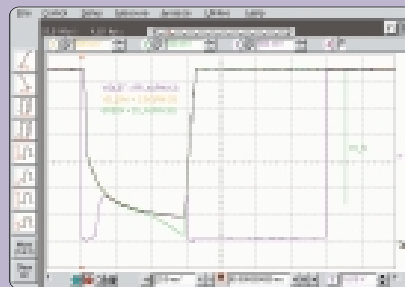
Figure 2: A high-resolution deep-memory waveform capture uncovered chip select activity (CS_N) shortly after the chip reset signal (RP_N) went inactive high.

dropped to 1.1 volts for a period of roughly 20 ms. This chip should have been able to handle this, but it got stuck in an indeterminate state whenever this happened. Fortunately, IBM had

Figure 3: Zooming in on the captured data with 5000X magnification revealed nearly two dozen individual chip select commands.

been second-sourcing memory modules from three other suppliers so Mark and his team were able to simply drop the faulty part without making any circuit changes.

Fast, accurate answers throughout the design/debug cycle
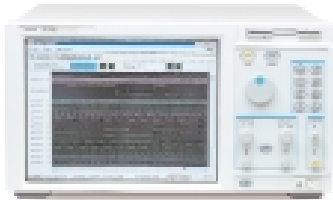
16702B
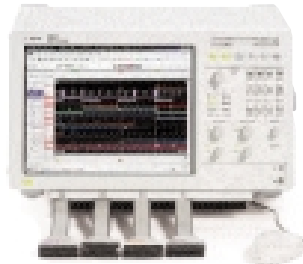
1680A

1690A

Logic *Wave*

Your digital design challenges certainly are not getting any easier so make sure your debugging tools keep pace.

- For the most demanding applications, the Agilent 16700B and 16702B modular logic analysis systems deliver timing analysis up to 4 GHz and state analysis up to 1.5 Gb/s. Both can be configured with up to 8,160 channels to handle the most complex multibus, multi-processor architectures.

- With a new level of simplicity in benchtop logic analysis, the Agilent 1680 and 1690 series analysers offer intuitive, single-window operation. A variety of new trigger capabilities lets you trigger the way you think during troubleshooting.

- The unique Agilent Logic *Wave* E9340A PC-hosted logic analyser fills the needs of engineers looking for basic, economical logic analysis or personal troubleshooting tools to complement a primary logic analysis system.

No matter which system you choose, you can complete the solution with our wide array of digital test accessories, cables, connectors, trace port analysers and emulation probes.
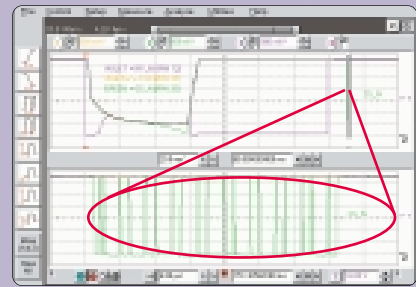
Selecting a Logic Analysis Solution

	16700B, 16702B Modular Logic Analysis Systems (page 35)	1680, 1690 Series Benchtop Logic Analysers (pages 42–43)	E9340A Logic *Wave* PC-Hosted Logic Analyser (www.agilent.com/ find/measurements)	54620 and 54640 Series Mixed-Signal Oscilloscopes (pages 32–33)	Trace Port Analysers (page 40)	Run Control Emulation Probes (page 40)
State analysis	100 MHz to 1.5 Gb/s	200 MHz	100 MHz	N/A	Processor-dependent	N/A
Timing analysis	Up to 4 GHz	Up to 800 MHz	250 MHz	Up to 1 GSa/s	N/A	N/A
Transitional timing	Most modules	200 MHz	N/A	N/A	N/A	N/A
2 GHz timing zoom	Most modules	N/A	N/A	N/A	N/A	N/A
Logic channels	Up to 8,160	Up to 136	32	16	Processor-dependent	N/A
Inverse assembly	Broad coverage	Select coverage	N/A	N/A	N/A	N/A
Optional analysis toolsets	See page 39	N/A	N/A	N/A	N/A	N/A
Emulation	See page 40	N/A	N/A	N/A	See page 40	See page 40
Advantages	Modular flexibility and highest performance	Best price/ performance	Excellent basic state and timing analysis	Low-cost timing analysis	Real-time functional debugging of embedded processors	Low-cost run control
	Most comprehensive feature set	Small footprint	Single-screen operation	Deep memory with MegaZoom	Links to industry-leading debuggers	Links to industry-leading debuggers
	Optional oscilloscope and pattern generator	Choice of either bench-top or cost-saving PC-hosted model		Integrated oscilloscope channels		
	Touch screen	Single-screen operation				
	Multiple bus analysis	Offline analysis				
	Deepest memory					

Simplicity and power for conquering the most complex systems

- *16702B with touch-screen interface makes it easy to master powerful logic analysis*

- *1.5 Gb/s state analysis and 2 GHz timing zoom*

- *High-capacity hard drives and expanded system RAM*

From capturing signals to understanding critical interactions, the Agilent 16700B and 16702B logic analysis systems offer an unmatched combination of accurate, reliable measurements and intuitive simplicity.

With state analysis up to 1.5 Gb/s and timing up to 4 GHz, you are ready for today's ultrafast systems. To simplify signal capture, analysis probes provide customised support for hundreds of standard microprocessors and buses. Modular design with a wide selection of state/timing, pattern generation, scope and emulation modules means you pay for only the power you need today, with the flexibility to add more as your needs evolve.

Simple operation for maximum productivity

The Agilent 16700B and 16702B continue to advance the powerful simplicity that has made them favoured tools among engineers around the globe. The touch-screen interface, knobs and dedicated hot keys in the 16702B eliminate the need for an external mouse and keyboard, making the system easier than ever to use.

The graphical user interface, enlarged to 12.1" in the 16702B, lets you choose the type and quantity of information to display at every step in the debugging cycle. And the unique Setup Assistant will get you to real results in a hurry.

The power to handle today's digital systems

From initial board turn-on through system integration, these systems provide the tools design teams need for fast, effective troubleshooting. Modular configurations support up to 8,160 channels of state and timing analysis. A full suite of emulation tools, from integrated processor execution control to precise correlation between measurements and real-time software trace, helps untangle hardware and software interaction during system integration.

Capture deep traces to the internal high-capacity 9 GB hard drive or the optional 18 GB external drive. A built-in CD-ROM drive simplifies software upgrades, too.

Agilent 16700B and 16702B Logic Analysis Systems	
16700B mainframe	Five measurement module slots, one emulation module slot
16702B mainframe	Five measurement module slots, one emulation module slot
16701B expansion mainframe	Five measurement module slots, two emulation module slots
Memory depth	8 K to 64 M (depending on module selection)

Ordering information
16700B mainframe
16702B mainframe
16701B expansion mainframe
Option 008 18 GB external data drive
Option 012 multiframe (connect up to 8 mainframes and expanders)
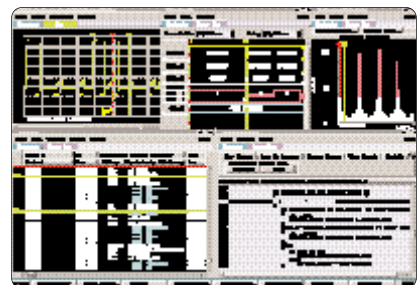
Get a complete, simultaneous view of your system, from analogue signals to source code, along with extensive performance analysis and run-control tools.

Please contact your nearest Agilent office.

www.agilent.com/find/measurements

35

Build unique measurement solutions for demanding applications

- *Choose from a wide variety of state/timing, scope, pattern generation and emulation modules*

- *State analysis up to 1.5 Gb/s, 2 GHz timing zoom, memory depths up to 64 M samples*

- *Up to 8,160 time-correlated channels in a system*

- *Accelerate display rates and advanced searches with deep-memory 1674X and 1675X modules*

Capture and conquer with powerful state and timing modules

Agilent state and timing modules offer the speed are and memory depth to isolate and analyse pipelined architectures and split transactions.

Agilent 16740A, 16741A, 16742A, 16750A/B, 16751A/B and 16752A/B modules provide simultaneous high-speed state and 2 GHz timing measurements on all channels through the same probe.

1.5 Gb/s logic analysis for LVDS and other differential signals

If you are using differential signalling in your latest high-speed design, the 16760A state and timing analysis module has differential inputs that can acquire signals at rates up to 1.5 Gb/s. Its 64 M samples of memory ensure you have the memory needed to troubleshoot complex systems.

Transitional timing and timing store qualification

Transitional timing analysis mode stores information only when changes occur, so long periods of inactivity do not waste memory. Similarly, store qualification helps you save memory during timing analysis by storing only data of interest.

Agilent State and Timing Analysis Modules

	16710A/11A/12A	16715A	16716A	16717A	16740A/41A/42A	16750A/51A/52A 16750B/51B/52B	16760A
Maximum state clock	100 MHz	167 MHz	167 MHz	333 MHz	200 MHz	400 MHz	1.5 Gb/s
Maximum timing sampling rate (half/full channels)	500/250 MHz	667/333 MHz	667/333 MHz	667/333 MHz	800/400 MHz	800/400 MHz	800 MHz
2 GHz timing zoom	No	No	Yes	Yes	Yes	Yes	No
Transitional timing	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Eye finder	No	Yes	Yes	Yes	Yes	Yes	Yes
Memory depth (half/full channels) [1]	16710A: 16/8 K 16711A: 64/32 K 16712A: 256/128 K	4/2 M	1 M/512 K	4/2 M	16740A: 2/1 M 16741A: 8/4 M 16742A: 32/16 M	16750A/B: 8/4 M 16751A/B: 32/16 M 16752A/B: 64/32 M	128/64 M[4]
Setup/hold time Window With eye finder Adjustment resolution	4.0 ns[2] N/A 500 ps	2.5 ns 1.25 ns 100 ps	2.5 ns 1.25 ns 100 ps	2.5 ns 1.25 ns 100 ps	2.5 ns[3] 1.25 ns 100 ps	2.5 ns[3] 1.25 ns 100 ps	1 ns 500 ps 10 ps
Channels per module	102	68	68	68	68	68	34
Maximum channels on a single timebase and trigger	204	340	340	340	340	340	170

[1] Increased memory depth in half-channel timing mode only

[2] Minimum setup/hold specified for single-clock, single-edge acquisition. Single-clock, multi-edge setup/hold window add 0.5 ns. Multiclock, multi-edge setup/hold window add 1 ns.

[3] Minimum setup/hold specified for single-clock, single-edge acquisition. For multiclock or multi-edge acquisition, setup/hold window is 3 ns.

[4] 128 M memory in half-channel 1,250 Mb/s and 1,500 Mb/s modes only

New eye displays keep your confidence high when margins are low

As timing and voltage margins continue to shrink, confidence in signal integrity becomes an increasingly vital part of design validation. The eye diagram in advanced oscilloscopes has become a validation tool of choice for signal integrity experts.

On systems with multiple buses and hundreds of individual lines, however, tackling 2 or 4 signals at a time with a scope can add 2 or 3 weeks or more to development.

Now you can get that same eye diagram capability in your logic analyser and cover up to 170 channels at a time. Instead of spending weeks validating margins, complete the process in a few days or even hours. The new eye scan feature, now included free with the Agilent 16700B and 16702B, works with the 16760A state/timing module to deliver eye diagrams with one-button simplicity. The eye scan feature gives a rapid,

comprehensive overview across hundreds of signals. If it uncovers questionable signals, you can dive in for a closer look with an oscilloscope.

Flexible analysis tools

The eye scan capability includes cursors to pinpoint individual values, histograms to show trends, limit tests and slope calculations. You can set a variety of test parameters to optimise displays and to balance statistical richness versus overall test time.

Identify InfiniBand system problems at the protocol view

Get new insights into tough system problems caused by the increasing use of protocol on higher- and higher-speed inter-chip interconnects. InfiniBand (IB) protocol analysis tools for the 16700 series logic analysis system and highly tuned IB analysis and IB data generation in the E2950 series provide thorough IB analysis.

For more information, please visit
www.agilent.com/find/measurements.
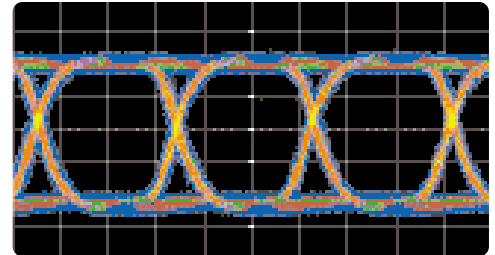
Eye scan is a fast, simple way to verify signal integrity in complex, high-speed digital systems.

MEASUREMENT TIP: FASTER SIGNAL INTEGRITY MEASUREMENTS
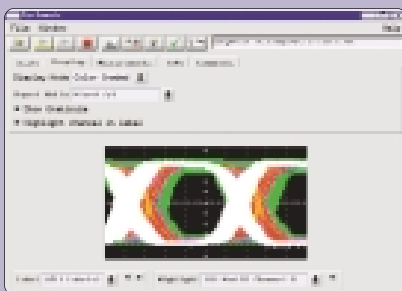
Quickly identify non-compliant signals by highlighting individual channels.

The eye scan capability is a powerful tool for checking signal integrity across tens or even hundreds of signals at once. To get the most out of eye scan, use it to thoroughly examine all signals under all the conditions that might influence signal integrity – and on multiple prototypes.

For example, if you are designing an edge router, there may be specific data patterns in packets that cause pattern-dependent delay, leading to jitter. Simulate a variety of stimulus patterns while using eye scan to monitor eye-opening quality.

In a computer, there may be data patterns that induce pattern-dependent delay or simultaneous switching noise, which can lead to an unacceptable closing of the data valid window.

You may also want to vary power supply voltage or temperature while monitoring signal integrity using eye scan.

Once eye scan has given you a comprehensive overview of signal integrity, you can then identify trouble situations. In some cases, eye scan will give you enough diagnostic information directly (such as with skew between two signals); in others, you will want to explore in detail with a scope.

Learn more about using eye scan in the application note Saving Time with Multiple-Channel Signal Integrity Measurements. *Call Agilent Technologies for a free copy or download it at* **www.agilent.com/find/measurements**.

Create advanced stimulus-response tests up to 300 MHz

Team the Agilent 16720A digital pattern generator with other system modules to simulate components still under development and test systems under a variety of operating scenarios. Use up to five 48 channel generators to create vectors up to 240 bits. Develop complex tests with state-to-pattern macros, repeat loops and pattern fills.
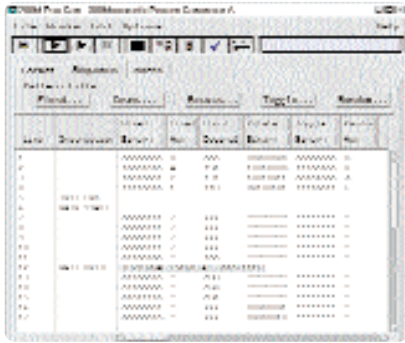
Agilent 16720A Pattern Generator Module		
	Half channels	**Full channels**
Maximum clock speed	300 MHz	180 MHz
Memory depth	16 M vectors	8 M vectors
Channels per card	24	48
Channels per timebase	120	240
Stimulus commands	Initialize, block, repeat, and break macros	
Logic levels supported	5 V TTL, 3 state TTL, 3 state CMOS, 3 state 3.3 V, ECL, 5 V PECL, 3.3 V LVPECL, 3 state 2.5 V, 3 state 1.8 V, LVDS	

Pod options for 16720A
Option 011 TTL clock pod & lead set
Option 013 3 state TTL/CMOS data pod & lead set
Option 014 TTL data pod & lead set
Option 015 2.5 V clock pod & lead set
Option 016 2.5 V 3 state data pod & lead set
Option 017 3.3 V clock pod & lead set
Option 018 3.3 V 3 state data pod & lead set
Option 021 ECL clock pod & lead set
Option 022 ECL (terminated) data pod & lead set
Option 023 ECL (unterminated) data pod & lead set
Option 031 5 V PECL clock pod & lead set
Option 032 5 V PECL data pod & lead set
Option 033 3.3 V LVPECL clock pod & lead set
Option 034 3.3 V LVPECL data pod & lead set
Option 041 1.8 V clock pod & lead set
Option 042 1.8 V 3 state data pod & lead set
Option 051 LVDS clock pod & lead set
Option 052 LVDS data pod & lead set

High-performance digitising oscilloscope

The Agilent 16534A digitising oscilloscope module offers the advantages of a full-featured, deep-memory, colour scope integrated into your logic analyser. Automatic measurements simplify signal analysis, and cross-module triggering lets you set up mixed-domain triggers with both parametric and logical trigger conditions.
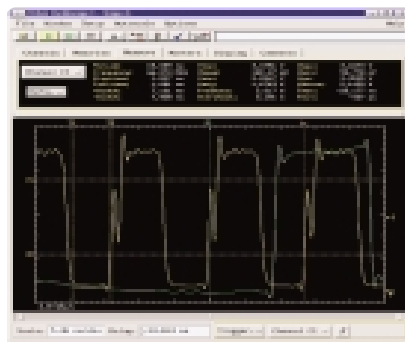
Agilent 16534A Digitising Oscilloscope Module	
Bandwidth	500 MHz
Maximum sampling rate	2 GSa/s
Memory depth	32 K
Channels per card	2
Maximum number of channels on a single trigger and timebase	8

Find root causes faster and boost system performance

Check out these optional post-processing tools for the 16700 series.

| Application	Agilent Tool
Debug parallel data communications buses Display logic analyser trace information at a protocol level for UTOPIA, POS-PHY 1-3, MII and GMII buses. Powerful trigger macros allow triggering on standard or custom protocol fields.	B4640B data communications tool
Debug the new storage area network technology Measure InfiniBand interconnect traffic and relate it to other channel adapter or system bus signals. Full IB protocol decode allows high-level view and measurement of this complex, high-performance interconnect.	N4206A InfiniBand protocol analysis tool
Extend your view of Gigabit Ethernet IP systems 1000Base-X Gigabit Ethernet systems can be measured at the "ten bit interface" (TBI) interconnect to provide full IP and Ethernet packet decode. Real-time packet measurements, postprocessed disparity and CRC computation provide high-level visibility of IP traffic.	N4212A Gigabit Ethernet protocol analysis tool
Debug and validate MPEG-2 based systems Display trace information at a protocol level. Powerful trigger macros allow triggering on standard or custom protocol fields. Also analyse transport stream, program stream and packetized elementary stream directly.	B4645B MPEG-2 protocol analysis tool
Debug your real-time code at the source level Correlate a logic analyser trace with the high-level source code that produced it. Set up the logic analyser trace by simply pointing and clicking on a line of source code.	B4620B source correlation tool
Optimise your target system's performance Profile your target system's performance to identify system bottlenecks and to identify areas needing optimization.	B4600B system performance analysis tool
Solve your serial communications problems Convert serial bit streams to parallel format for easy viewing and analysis. Supports serial data and protocols that use bit stuffing to maintain clock synchronization. Works up to 1 GHz.	B4601B serial analysis tool
Customize your trace for greater insight Create custom tools using the C programming language. Custom tools can analyse captured data and present it in a form that makes sense to you.	B4605B tool development kit
Measure GigaBit protocol with RapidIO Display RapidIO packets for 8 and 16 bit LP-LVDS interconnects.	N4215A RapidIO protocol analysis tool
Protocol decode for OC-192, POS-PHY L4, SPI4-2 Display IP and ethernet packet decode for the latest OIF standard.	N4214A POS-PHY L4 protocol analysis tool
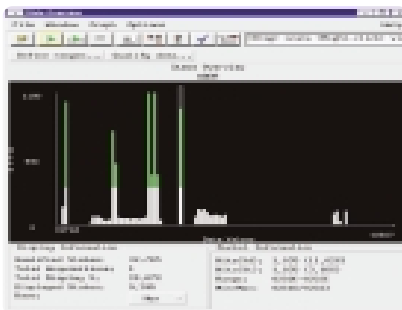
The B4600B system performance analysis toolset highlights the areas that will provide maximum leverage when you are working to improve your design's performance.
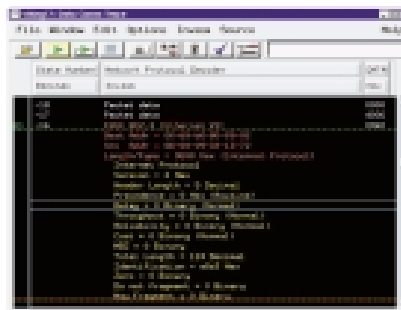
The B4640B data communications toolset offers a new level of insight into link layer bus protocols and data packets.
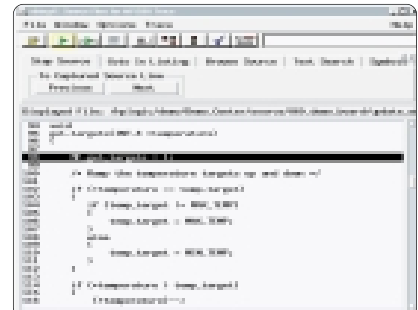
With source-line referencing in the B4620B source correlation toolset, you can trigger other measurements from a specific point in the source code and view time-correlated displays across system domains.

Please contact your nearest Agilent office.

www.agilent.com/find/measurements

Customised processor support and powerful emulation

Agilent and Third-Party Processor Support

Device manufacturer or architecture and name	Run control emulation probes Link to the processor's debug port for a convenient way to download code, modify memory and registers and control program execution.	Emulation modules Add the same emulation capability of an emulation probe as part of an integrated solution built around your 16700 series logic analyser.	Trace port analysers Provide emulation and real-time execution trace information; can be integrated with the 16700 series for coordinated system analysis.	Inverse assembly/probing support Save time and improve measurements with probes designed specifically for the most popular families of microprocessors, microcontrollers, DSP chips, popular buses and FPGAs. Provides disassembly of processor mnemonics plus the use of Samtec and Mictor connectors.
Actel				ACT 1280
Altera				EPM5192-P
AMD				29xxx, 186CC 186/188 EM/ES
Analogue Devices				ADSP 21xx
ARM®7/9TDMI	E5900B #300	E5901B #300		ARM7, ARM7-Thumb, ARM9, ARM9-Thumb
ARM7/9-ETM			E5904B #300	
GTE				65816
IBM PPC 4xx IBM PPC 6xx IBM PPC 7xx	E5900B #060 E5900B #060 E5900B #070	E5901B #060 E5901B #060 E5901B #070	E5904B #060	PowerPC 403/405/601/603/740/750/750Cxe
IDT				R3041/51/52/81/82, R4000, R4400 PC, R4600/4700, R4640/50, R5000, R32364, R36100, RC32332/4/55, RC64474/4574, RC64475/4575
Intel® Pentium,® Pentium w/ MMX Intel Pentium Pro, II, III, & Celeron™				8080, 8085, 8031/51, 8086/8, 80x86, 80200, 80860XR, 80960, Celeron Pentium, Pentium II, Pentium III, Pentium Pro, Pentium II Xeon™, Pentium III Xeon™, Pentium II Mobile, Strong ARM-110, IXP1200
Motorola PPC 6xx Motorola PPC 7xx Motorola MPC 8xx Motorola MPC 74xx Motorola MPC 82xx Motorola M CORE	E5900B #060 E5900B #070 E5900B #080 E5900B #110 E5900B #100 E5900B #090	E5901B #060 E5901B #070 E5901B #080 E5901B #110 E5901B #100 E5901B #090		68000/08/10, 680x, 68HC11, 68HC12, 68020, 68030, 68040, 68060, 683xx, 68302, PowerPC 555/565, 601/603/604, MPC740/745/750/755, MPC 7400/10/40/50, MPC 801/823/850/855/860/862, MPC 8240/55/60/64/65/66, 860 ESAR, M*CORE, DSP 56xxx, 88xxx
National				NS32016, HPC16003/4/64
NEC				7810/11, V25, V830, VR4100, VR4111, VR4200, VR4300, R5000, R5432, R5464
NKK				NR46xx, NR4700
PACE				P1750
Performance				R4000/4400PC
QED				5230/31, 5260/61, 5270/71, 7000
Rockwell				6502
Siemens				80C165/166/167, 80C5xx, R4000/4400PC
Texas Instruments				320Cxx, 320C20x, 320C24x, 34010, 370CXX, 320C62XX, 470R1X
Toshiba TMPR, 3900,	E5900A #800*	E5901A #800*	E5903A #800*	R3900, R4000/4400PC R4000, R4400PC
Toshiba TMPR 3927	E5900A #810*		E5903A #810*	
Xilinx				XC4xxx
Zilog				Z80, Z180, Z8001/2

*Scheduled for discontinuance in 2002

Agilent and Third-Party Bus Support

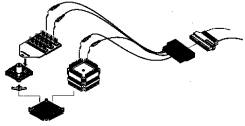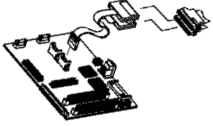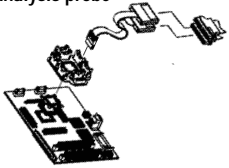|						
AGP2X, AGP4X, AGP8X	APIC	CAN	Compact PCI	DDR	EISA	Fibre Channel
Firewire (IEEE 1394)	GPIB, HPIB (IEEE488)	HyperTransport	I²C	ISA	JTAG (IEEE 1149.1, 1149.5)	PC 100/133
PCI CardBus	PCI-EIO	PCI Mezzanine	PCI/EXT-32/64	RAMBUS	RS-232, RS-449	SCSI, Ultra SCSI, SCSI LVD
SIMM, DIMM	USB 1.1, USB 2.0	VME 64	VXI			

For more information, refer to *Processor and Bus Support for Agilent Technologies Logic Analysers* at **www.agilent.com/find/measurements** or contact your nearest Agilent office.
ARM is a registered trademark of ARM Limited. Intel and Pentium are U.S. registered trademarks and Celeron is a U.S. trademark of Intel Corporation.

Create **quality connections** to your target systems

The quality of your physical and electrical connections can mean the difference between a good measurement and a bad one – particularly on today's high-density chip packages. Cost, time and convenience are important considerations too. Here is an overview of the four major approaches to probing; you can find complete information about all these accessories at **www.agilent.com/find/measurements**.

Approach	Advantages	Limitations	Key accessories
Connecting to individual test points with flying leads	Most flexible method Flying lead probes are included with all Agilent logic analyser modules (except 16760A)	Can be time-consuming when measuring multiple channels Least space-efficient method	Lead sets IC clips SMD clips Wedge probe adapters
Connecting to all pins on a quad flat-pack (QFP) package	Rapid access to all pins on QFP packages Very reliable connections	Adapter requires a small amount of clearance around the chip	Elastomeric probe adapters $^1/_4$ flexible adapters
Designing connectors into the target system	Very reliable connections Saves time when making multiple connections	Requires planning in the design stage Requires small amount of dedicated board space Slight incremental cost	High-density probe adapters Moderate-density probe adapters 16760A-specific probes
Using a processor or bus specific analysis probe	Easiest and fastest connection to supported processors and buses	Moderate to significant incremental cost Usable only for the supported processor or bus Might require a small amount of clearance around the chip	Analysis probes *(see page 40 for list of supported processors and buses)*

For more information on specific solutions, refer to *Probing Solutions for Agilent Logic Analysis Systems* at **www.agilent.com/find/measurements** or contact your nearest Agilent office.

MEASUREMENT TIP: UNDERSTANDING THE EFFECT OF CONNECTOR STUBS
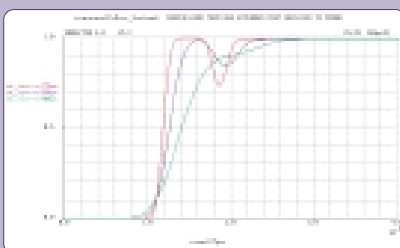
In the good old days of sub-100 MHz clock speeds, adding stub traces on your PC boards was a simple and generally trouble-free way to provide logic analyser connections. However, at today's higher speeds, even a short stub can produce unacceptable degradations to signal quality and bandwidth.

At high frequencies, board traces must be treated as transmission lines and stubs behave as unterminated branches on those lines. The resulting impedance mismatches can substantially alter the signals seen by the logic analyser, sometimes even more than the probe itself.

For instance, here is the simulated effect that a 1" stub has on the signal seen at the probe tip (at left). The ringing is caused by reflections and re-reflections created by that unterminated stub. These reflections will cause data-dependent jitter, reducing both time and voltage margins.

Learn how to handle these challenges and many others in the application note Designing High-Speed Digital Systems for Logic Analyser Probing. *Call Agilent Technologies for a free copy or download it at*
www.agilent.com/find/measurements.

Intuitive logic analysis that works the way you think
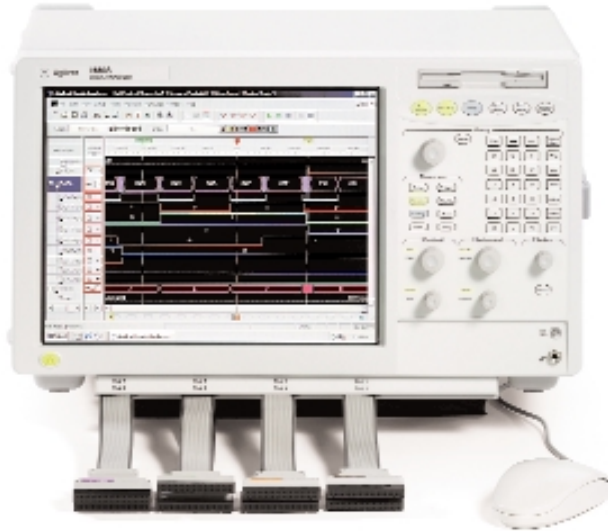
Choose the configuration that fits your work style: the 1680 benchtop series or the 1690 PC-hosted series.

- ***34 to 136 channels to fit your application and budget needs***

- ***200 MHz state analysis, up to 800 MHz timing and 4 M deep memory, 200 MHz transitional timing***

- ***Familiar Windows interface with efficient single-screen operation***

The Agilent 1680 and 1690 series logic analysers combine performance with intuitive triggering and a familiar Windows user interface. Perform all operations within the single-screen home base using pull-down menus and icons. Advanced functions are just a mouse click away.

Trigger the way you think
Quick, Simple and Advanced Trigger functions take the complexity out of triggering. Simple Trigger makes it easy to define events in terms of edges and patterns. To see if a suspect event ever recurs, just draw a box around the event in the display and let Quick Trigger do the rest. Just drag

and drop graphical icons with sentence-like structures in the Advanced Trigger menu to customise complex trigger scenarios.

Performance with headroom
To help you keep up with today's fast processors while providing the power to cover future technology trends, the 1680 and 1690 series offer 200 MHz state analysis and 200 MHz transitional timing. They also provide up to 800 MHz timing and 4 M memory depths to let you capture the complete picture with high resolution.

Fitting your work style
Select either a benchtop or PC-hosted model to integrate into your debug environment. Both provide a small footprint to save valuable workspace. Cable flexibility lets you conveniently access your target from the front or back of the 1680 series analysers.

Plus, you can make the most efficient use of your time and equipment. While your analyser is running to capture an elusive system crash, you can explore previously captured data using the offline analysis capability.

Find answers faster
The 1680 and 1690 series were built for fast troubleshooting. Traverse traces quickly using the beginning, trigger and end icons. Quickly scroll and zoom to get just the view you want. And you'll always know where the displayed data fits in the overall measurement trace.

Protect your 1670G series investment
The Agilent 1670G series benchtops are still available to extend your existing test system, or take advantage of our Trade-up program (see back cover) to leverage your investment toward new 1680 or 1690 series models.

Take a test drive
Agilent offers several ways to experience the intuitive interface of the 1680 and 1690 series logic analysers. Just download the free application software or call Agilent Technologies to find out about evaluation unit availability.

Agilent 1680 and 1690 Series Logic Analysers				
Benchtop models	**1680A, 1680AD**	**1681A, 1681AD**	**1682A, 1682AD**	**1683A, 1683AD**
PC-hosted models	**1690A, 1690AD**	**1691A, 1691AD**	**1692A, 1692AD**	**1693A, 1693AD**
Channels	136	102	68	34
State speed	200 MHz on all channels			
Timing speed	400/800 MHz (full/half channels)			
Transitional timing speed	200 MHz on all channels			
Memory depth	1680A and 1690A series models: 256 K state, 512 K timing (1 M on half channels), 256 K transitional timing 1680AD and 1690AD series models: 1 M state, 2 M timing (4 M on half channels), 1 M transitional timing			
1680 series I/O and storage	2 IEEE 1394 ports, 10/100 Base-T, parallel port, 20 GB hard drive, 1.44 MB flexible disk drive, 24X CD-ROM drive, DIN mouse and keyboard ports, external SVGA display port, Trigger In and Trigger Out BNCs			
Ordering information				
Channels	136	102	68	34
Benchtop with standard memory	**1680A**	**1681A**	**1682A**	**1683A**
Benchtop with deep memory	**1680AD**	**1681AD**	**1682AD**	**1683AD**
PC-hosted with standard memory	**1690A**	**1691A**	**1692A**	**1693A**
PC-hosted with deep memory	**1690AD**	**1691AD**	**1692AD**	**1693AD**
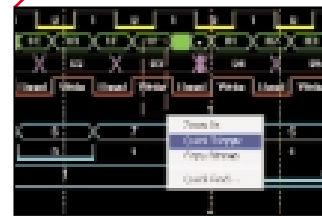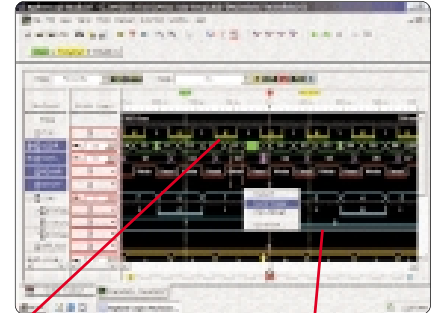
See something you did not expect? Simply draw a box around the questionable event and Quick Trigger will set the trigger to see if the event re-occurs.
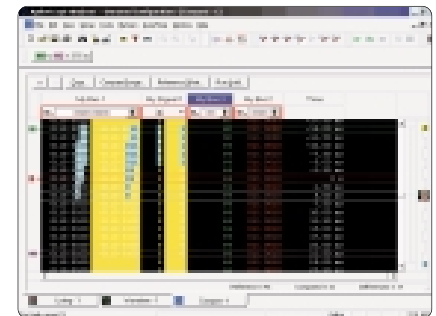
Quickly verify changes in system operation by comparing the current acquisition to a previous trace.

MEASUREMENT TIP: HOW TO TRIGGER ON NOTHING

How can you analyse system failure when there are no live signals to trigger on? The classic approach is to only capture data of interest while the system is running, then stop the measurement manually when the system crashes. A great idea, but it works only if you already know what you need to capture and can figure out a way to catch it.

Here is an easy way around the problem:

1. Find a predictable "heartbeat" somewhere in the system, such as an address strobe or a periodic interrupt. It does not matter what it is, as long as it is consistent.

2. Measure the time interval of this signal so you know when to expect it.

3. Use a timer in your trigger routine to check for each occurrence; reset the timer with each new beat.

4. If the heartbeat does not show up within the expected interval, you know the system has crashed and it is time to trigger a measurement.

You can also cross-trigger to an internal or external scope to see what happens to key signals right before and right after the heartbeat disappears.

For more tips like this, check out 8 Hints for Solving Common Debugging Problems with Your Logic Analyser, *available free online at* **www.agilent.com/find/measurements**.

Complex data transmission measurements made fast and simple
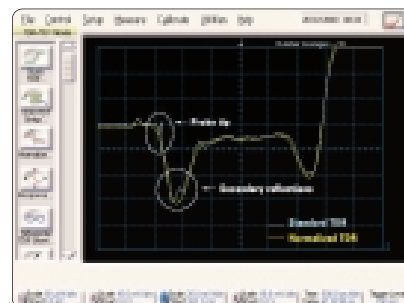
TDR normalisation sets the reference plane at the probe tip and eliminates test fixture errors.

- **High-performance time-domain reflectometer (TDR) to help you create ultrafast physical layer designs**

- **63 GHz oscilloscope to measure electrical and optical signals with extremely low jitter**

- **Reference receiver for performing high bit-rate compliance mask testing for optical transceivers**

Solve demanding signal integrity problems in high-speed systems with the Agilent Infiniium 86100B Digital Communications Analyser (DCA) and its family of plug-in modules. The 86100B delivers the accurate eye-diagram analysis essential for characterising the quality of transmitters from 100 Mb/s to 40 Gb/s and beyond. Choose from a diverse and expanding selection of modules that offer optical and electrical measurements as well as clock recovery functions.

TDR measurements made easy
Use the 86100B with the 54754A differential TDR plug-in to characterise InfiniBand transmission lines quickly and easily. With TDR step overshoot less than 5%, step rise time a nominal 35 ps and normalisation, you will get accurate measurements with great resolution. The Quick TDR Wizard can help you set up a TDR measurement quickly and with confidence.

Wide-bandwidth oscilloscope
With a wide choice of input plug-ins, get up to 63 GHz of electrical bandwidth or 53 GHz optical bandwidth. Each optical module includes an accurate optical power meter so you do not have to route signals through couplers or switches for average power measurements. The new high-bandwidth plug-in modules offer superior time-domain response with minimal overshoot and undershoot.

High-speed waveform test
Make standard waveform compliance tests quickly and accurately with a suite of standards-based eye-diagram masks. If you are measuring a protocol that is not included in the extensive suite, edit an existing mask or create a custom mask quickly to meet your needs. You also get extinction ratio measurements and eye measurements.
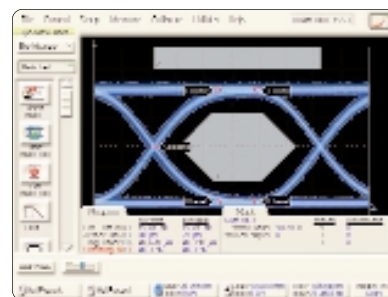
Filters can be switched in or out for compliance testing or wide-bandwidth analysis.

www.agilent.com/find/measurements   Please contact your nearest Agilent office.

Application-focused solutions for computer interconnects and digital transmission testing

Optoelectronic Component Measurements

ParBERT 81250 cuts time and cost with parallel testing; the E2150A offers fully integrated 43G optical and electrical BERT

Mux/Demux Testing

The 81250 can test OC-192 and OC-768 devices without a golden device

Satellite Communications

Take advantage of the 86130A's flexible bit rates, formats and configuration

SAN Muxes and Demuxes

The 81250 and 86130A meet high-speed parallel design challenges such as InfiniBand

Trans Amp

Decision & Clock recovery

Driver

FEC

High-Speed Digital Component Testing

Test parallel-to-parallel with the 81250 or serial-to-serial with the 86130A

Example Communication Link Block Diagram

New protocols, relentless speed increases, shrinking error margins – the demands on digital transmission designers continue to pile up. Moreover, the task of characterising, verifying and testing optoelectronic optical transmitters and receivers and high-speed digital components, multiplexers and de-multiplexers has grown beyond the capabilities of general purpose instrumentation.

Thanks to Agilent's expanded portfolio of bit error ratio test solutions, you can choose a solution designed for your specific component types and data rates. These test platforms can be configured for your unique test needs today, while preparing you for the future as technology advances.

Agilent's BER platforms help reduce cost-per-test and keep your options open for the future. Solutions optimised for specific application areas eliminate the need to adapt general purpose instruments.

Agilent BER test solutions for your unique needs	
ParBERT 81250	A modular parallel bit error ratio solution for testing at rates up to 10.8 Gb/s. Thoroughly characterises your device by going beyond BER measurements, providing test features such as propagation delay and setup and hold time. Optical and electrical solutions are available for OC-768 devices. *(Page 46)*
E2150B new 43G electrical/optical BERT	Offers the first fully integrated solution for optical and electrical BER testing up to 43G. *(Page 46)*
86130A BitAlyzer®	The first BER test solution with the unique Agilent Infiniium look and feel, offering general-purpose serial BER testing up to 3.6 Gb/s with the power of error analysis from SyntheSys Research. *(Page 47)*
86100B Infiniium DCA	Use it as an oscilloscope to characterise signal parameters, as a digital communications analyser for eye-diagram and pulse measurements or as a time-domain reflectometer. *(Page 44)*
71612C 12.5 Gb/s error performance analyser	Accurately characterise systems, devices and components. Wide performance range covers lightwave components and subassemblies, advanced computer technology and high-capacity communication systems. *(Information available online)*
71501D jitter analysis system	Provides advanced jitter analysis of high-speed digital communication waveforms and the components that generate them. *(Information available online)*

BitAlyzer® is a U.S. registered trademark of SyntheSys Research, Inc.

Decrease time-to-market and time-to-volume with BER testing up to 43G

New
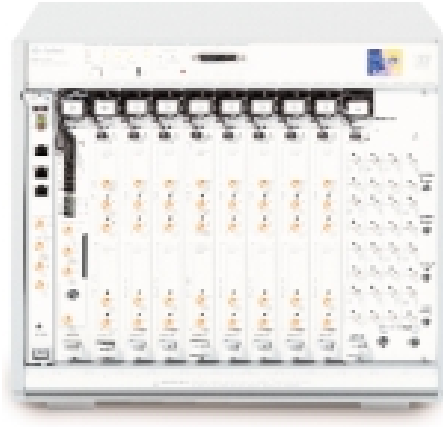
- *A flexible solution for testing up to OC-768 devices*
- *Parallel input and output channels at rates up to 10.8 Gb/s*
- *Modular design lets you create custom solutions for unique applications*
- *New E2150B and E4894/95A bundles test electrical and optical devices up to 43G*

The Agilent ParBERT 81250 provides the world's fastest parallel BER testing for multiplexer/de-multiplexer ICs and modules (including those with Xaui interfaces), forward error correction devices, O/E E/O devices and storage area network ICs. Key measurements include setup and hold times, propagation delay and BER versus temperature. The 81250 provides chip control signals and divided or multiple clock signals, plus you can analyse single-ended, low voltage and true differential signals to accommodate a variety of logic families, including LVDS. Generate pseudo-random word sequences (PRWS) and standard PRBS up to $2^{31}-1$. Analyse bit error ratios with user-defined data, PRBS or mixed data from parallel ports.

Take advantage of powerful flexibility
Mix and match analyser channels, generator channels and speed classes (675 MHz, 1.65 Gb/s, 2.7 Gb/s, 3.35 Gb/s and 10.8 Gb/s) to create a system that matches your unique needs. Add a 17th channel to meet the emerging SFI-5 specification. The new 43.2 Gb/s mux and demux modules offer a solution for OC-768 device testing.

High-speed pass/fail testing
New measurements included in ParBERT's standard software make it even easier to do production BER testing. With the fast eye mask measurement, simply set the threshold levels and let ParBERT tell you the result up to 10 times faster than with previous test methods. ParBERT can deliver direct numerical results for certain complex tests so you can compare results to specifications without additional calculations.

Integrated electrical/optical BERT to 43G
Built on the proven 81250 module platform, the new E2150B 43G electrical/optical BERT test system offers the first fully integrated, turnkey solution for optical and electrical BER testing up to 43G. The computer software and all electrical and optical instrumentation and cables are supplied fully tested and ready to run.

Agilent ParBERT 81250

Configure a system to your specific needs by adding modules and front ends to a mainframe, clock and software.

Mainframe	E4863B 3.3 Gb/s analyser
81250A 149 13 slot VXI mainframe	E4864A 1.65 Gb/s generator
81250A 020 Rack	E4865A 1.65 Gb/s analyser
81250A 150 MXI 1st expander frame	**Clock modules**
81250A 151 MXI 2nd expander frame	E4805B 675 MHz central clock
81250A 152 IEEE 1394 expander frame	E4808A high-performance central clock
Data modules	**Controller**
E4832A 675 MHz data module	81250A 013 IEEE 1394 PC link to VXI
E4861A 2.7 Gb/s data module	81250A 014 external PC
E4861B 3.3 Gb/s data module	E4803A 2 slot VXI PC controller
E4866A 10.8 Gb/s generator	**Software**
E4867A 10.8 GSa/s analyser	E4875A ParBERT user software
E4868B 43.2 Gb/s multiplexer	**Preconfigured bundles**
E4869B 43.2 Gb/s demultiplexer	E4894A 43.2 Gb/s pattern generator
Front ends	E4895A 43.2 Gb/s error detector
E4835A 675 MSa differential analyser (2)	**E2150B 43G bundles**
E4838A 675 MHz differential generator	Option 011 for C Band optical
E4862A 2.7 Gb/s generator	Option 012 for L Band optical
E4862B 3.3 Gb/s generator	Option 013 for C+L Band optical
E4863A 2.7 Gb/s analyser	
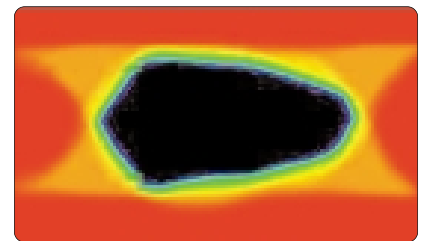
See trends clearly with the eye-opening measurement.

Find and fix bit errors faster with built-in error analysis
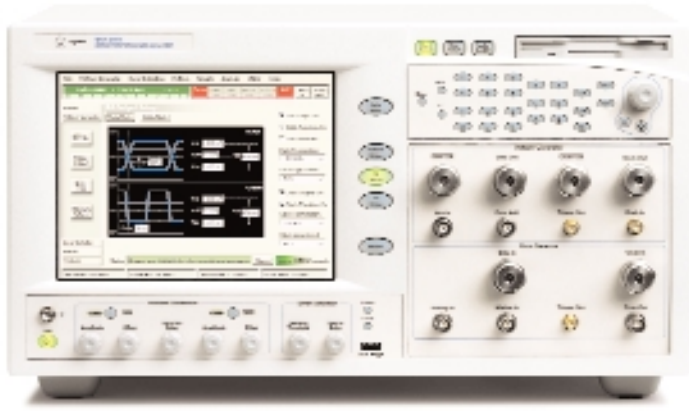
- *3.6 Gb/s error performance analyser with error analysis provides insight into root causes*

- *Agilent Infiniium-like user interface simplifies set-up tasks and provides faster access to both basic and advanced features*

- *Precise waveform shapes ensure that you are driving your device with the best possible stimulus signals*

Simplifying BER test and analysis with a familiar graphical approach

The Agilent 86130A BitAlyzer provides a unique combination of simplicity and analysis power to help you quickly test and troubleshoot forward error correction (FEC) devices, high-speed digital components and systems, optoelectronic devices and a variety of other semiconductor components.

Leveraging the look and feel of the popular Agilent Infiniium oscilloscopes, the 86130A helps new users set up accurate measurements in less time and view them in a clearer way. To set up test patterns, for instance, simply select an industry-standard pattern from the built-in library or edit it as necessary using simple cut and paste commands.

Unique analysis tools boost design productivity

The 86130A uses patented error-analysis technology from SyntheSys Research to help uncover the clues behind device behaviour. The 86130A analysis tools help you analyse burst errors, pattern sensitivity, error-free intervals, errored blocks, error correction coding and error correlation. Optional 2-D error mapping provides additional insights into system behaviour. Use optional error correction coding analysis to experiment with different interleave depths and maximise throughput rates in error correction circuits.

For even more analysis power, team up the 86130A with the Agilent 86100B Infiniium DCA (page 44) to measure impedance discontinuities and crosstalk, or verify standards compliance using eye diagram analysis.
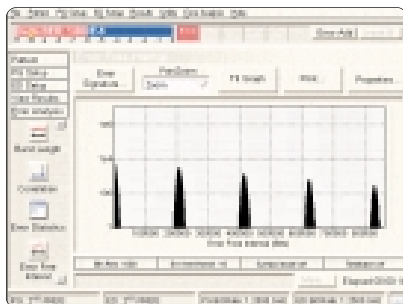
Uncover the relationships between error events with powerful analysis tools.

Agilent 86130A BitAlyzer

Ordering information
86130A BitAlyzer
Option 100 2-D error mapping
Option 200 error correction coding analysis
Option 300 4 GHz synthesised signal source

Please contact your nearest Agilent office.

www.agilent.com/find/measurements

Count on precision, speed and versatility

- *Choice of universal counters, economy RF and precision microwave counters*
- *Pipelined architecture for higher measurement throughput (universal and RF counters)*
- *Frequency ranges up to 46 GHz in a variety of channel configurations*
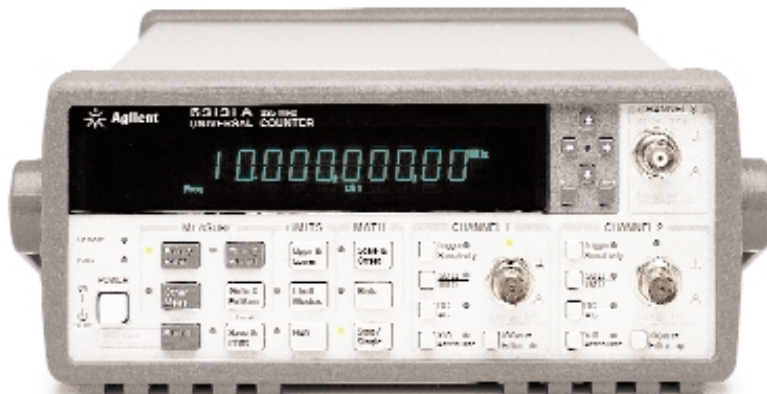
Fast, versatile universal counters

The Agilent 53131A/32A universal counters perform a wide variety of time and frequency measurements at speeds of up to 200 measurements per second via GPIB. Automated limit tests and extensive analysis features help you find detailed answers quickly. The 53131A offers 10 digits/second frequency resolution and 500 ps time interval resolution up to 225 MHz on two channels (with an optional 3, 5 or 12.4 GHz on a third channel). The 53132A offers the same measurement set and frequency coverage options with up to 12 digits/second frequency resolution and 150 ps time interval resolution.

Economical RF counter

The value-priced Agilent 53181A RF counter provides 10 digits/second frequency resolution up to 225 MHz on one channel with an optional 1.5, 3, 5 or 12.4 GHz second channel.

Precision microwave counters with power measurement capability

The Agilent 53150 series features an ultra-wide-band microwave input that covers the entire RF and microwave spectrum, from intermediate frequencies of 50 MHz up to millimetre waves. An advanced sampler measures both frequency and power through a single connection, and you have full control over resolution and sample rate in order to optimise speed and precision.

Agilent Universal and RF Counters

(representative specifications at selected settings; see **www.agilent.com/find/measurements** for complete specifications)

|	53131A	53132A	53181A
Measurements	Frequency, frequency ratio, time interval, period, rise/fall time, positive/negative pulse width, duty cycle, phase, totalise, peak voltage, time interval average, time interval delay		Frequency, frequency ratio (with optional ch 2), period, peak voltage
Analysis	Automatic limit testing, math (scale and offset), statistics (minimum, maximum, mean, standard deviation)		
Frequency range (optional)	dc to 225 MHz (3, 5 or 12.4 GHz)	dc to 225 MHz (3, 5 or 12.4 GHz)	dc to 225 MHz (1.5, 3, 5 or 12.4 GHz)
Resolution (frequency, time interval)	10 digits/s, 500 ps	12 digits/s, 150 ps	10 digits/s, N/A

Ordering information
53131A universal counter
53132A universal counter
53181A RF counter

Agilent Microwave Counters

(representative specifications at selected settings; see **www.agilent.com/find/measurements** for complete specifications)

	53150A	53151A	53152A
Frequency range Channel 1 (normal mode) Channel 2	10 Hz to 125 MHz 50 MHz to 20 GHz	10 Hz to 125 MHz 50 MHz to 26.5 GHz	10 Hz to 125 MHz 50 MHz to 46 GHz
Sensitivity Channel 1 (30 Hz to 125 MHz) Channel 2 (0.3 GHz to 12.4 GHz) (12.4 GHz to 18 GHz) (20 GHz to 26.5 GHz) (26.5 GHz to 40 GHz)	25 mVrms –33 dBm –33 dBm N/A N/A	25 mVrms –33 dBm –33 dBm –25 dBm N/A	25 mVrms –33 dBm –30 dBm –27 dBm –23 dBm
Power measurement accuracy Channel 1 Channel 2 (0 dBm to –20 dBm)	N/A ±1.5 dB	N/A ±1.5 dB (0.05 GHz to 20 GHz) ±2.0 dB (20 GHz to 26.5 GHz)	N/A ±1.0 dB (0.05 GHz to 12.4 GHz) ±1.5 dB (12.4 GHz to 26.5 GHz) ±2.0 dB (26.5 GHz to 46 GHz)
Math functions	Offset, averaging, cable loss compensation		

Ordering information
53150A 20 GHz counter
53151A 26.5 GHz counter
53152A 46 GHz counter

Multifunction flexibility with dependable precision

- *34401A: 6½ digits of resolution at a 5½ digit price*

- *3458A: up to 8½ digits of resolution, up to 100,000 readings per second*

- *34420A: nanovolt sensitivity with 7½ digit precision*

Agilent 34401A Highlights

(representative specifications at selected settings; see **www.agilent.com/find/measurements** for complete specifications)

dc voltage accuracy (1 year, 10 V range)	±(0.0035% of reading + 0.0005% of range)
True rms ac voltage accuracy (1 year, 1 V to 750 V ranges, 10 Hz to 20 kHz)	±(0.06% of reading + 0.03% of range)
Resistance (100 kΩ range)	±(0.010% of reading + 0.001% of range) with 10 µA current source
Math functions	Null, min/max/avg, dBm, dB, limit test

Agilent 3458A Highlights

(representative specifications at selected settings; see **www.agilent.com/find/measurements** for complete specifications)

Maximum reading rates 4½ digits 8½ digits	100,000 readings/second 6 readings/second
dc voltage accuracy (1 year, 10 V range)	±(8/4 [1] ppm of reading + 0.05 ppm of range)
True rms ac voltage accuracy (1 year, 10 V range)	±(0.007% of reading + 0.002% of range)
Resistance (1 year, 4 wire Ω, 100 kΩ range)	±(10 ppm of reading + 0.5 ppm of range) with 50 µA current source
Math functions	Null, scale, offset, rms filter, single pole filter, thermistor linearization, dB, dBm, % error, limit test, statistics

Agilent 34420A Highlights

(representative specifications at selected settings; see **www.agilent.com/find/measurements** for complete specifications)

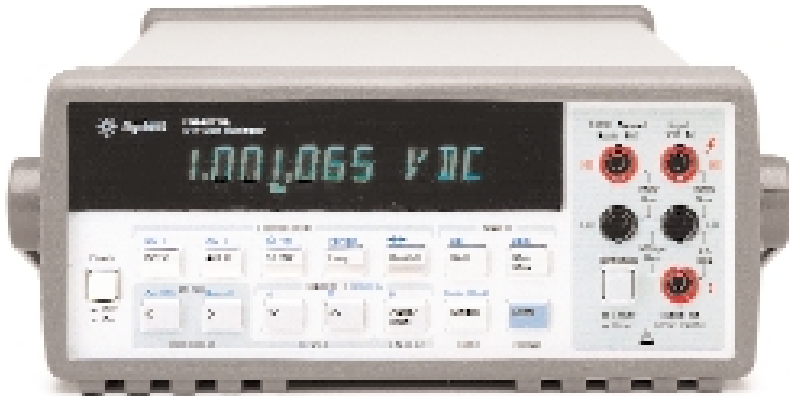|	
dc voltage accuracy (24 hour, 1 mV range)	±(0.0025% of reading + .0020% of range)
Resistance accuracy (1 year, 4 wire Ω, 100 Ω range)	±(0.0015% of reading + .0002% of range) with 10 mA current source
Math functions	Null, chart null, scale, statistics, low-pass filter, moving average filter
Temperature readings	SPRT, RTD, thermistor, thermocouple

[1] With high-stability Option 002

34401A digital multimeter, 6½ digit

Thousands of engineers worldwide count on the Agilent 34401A for fast, dependable results, knowing the last measurement of the day will be as accurate as the first: 24-hour accuracy is 0.0015% for dc volts and 0.06% for ac volts. One or two button presses give you a wide array of functions, from dc volts to frequency to dB and dBm. Advanced tests include limit checks, min/max/avg readouts and dc voltage ratios.

3458A digital multimeter, 8½ digit

When your tests demand speed and accuracy without compromise, the Agilent 3458A offers rates up to 100,000 readings, 110 autoranges and more than 340 set-up changes per second. If precision is the priority, select 8½ digit resolution with 0.1 ppm transfer accuracy. 24-hour accuracy is 0.6 ppm for dc volts, 2.2 ppm for resistance and 100 ppm for mid-band ac volts. You can also use the extensive set of math and filtering functions to improve your measurement accuracy.

34420A nanovoltmeter, 7½ digit

The Agilent 34420A nanovolt/micro-ohm meter is optimised for precision low-level measurements, with 7½ digit resolution and 1.3 nVrms/8 nVp-p noise performance. Two input channels let you make voltage measurements independently, or mathematically combine them for difference and ratio measurements. Direct SPRT, RTD, thermistor and thermocouple measurements let you tackle a wide range of temperature sensors.

www.agilent.com/find/measurements

From basic power supplies to complete power solutions

Cost, space and performance benefits of the integrated source/measurement solution
The central theme in all our power products is one-box integration, giving you a complete solution for the price of a single instrument. With specifications guaranteed for the entire solution, you know that you can count on your test results.

Power you can count on year after year
We have been a leader in the power products business for more than three decades because engineers like you know that they can count on Agilent performance and reliability. Our average MTBF of more than 100,000 hours leads the industry.

The right dc or ac power supply for your present and future needs
Our diverse product line will provide the power you need now, as well as help you design the flexible test platforms that will continue to serve you far into the future.

The expertise to help you address your ac and dc power challenges
Agilent engineers can save you both time and money when you are looking for new power supplies. We will help you select the right solutions for your application and your budget, including customised solutions for unique applications.

Choose a focused solution for your power needs

Product Family	Test Advantages	Highlights
6600 series single-output dc power supplies	Get clean, stable power from 40 W to 6.6 kW while lowering system integration costs and overall test times.	Page 51
6620 series multiple-output dc power supplies	Multiple dc signals in minimal rack space, available in standard and high-accuracy models.	Page 51
66000 modular power systems	Make the most of limited rack space by packing up to 8 supplies into just 18 cm (7 in) of rack space.	Page 51
E3600 series basic power supplies	Low cost, linear regulation with programmable single, double and triple-output supplies. High value, solid performance.	Page 52
6030 series autoranging power supplies	Flexible power solutions to test military, aerospace and other equipment across a wide range of operating points.	Page 52
N3300 series electronic loads	Increase test throughput in high-volume manufacturing of dc power supplies and chargers.	Page 53
6800 series ac source/analysers	Reduce design and test times for both 50/60 and 400 Hz components and systems. Simulate all ac line conditions and analyse harmonic distortion.	Page 53
Application-specific solutions	Focused solutions such as: The 66300 series mobile communications dc sources test expected battery life for cell-phones, Bluetooth appliances, and other battery-operated devices. The E4350B solar array simulator simulates the dc output of a satellite's solar panels. The E4370A multicell charger/discharger is the perfect power solution for manufacturers of lithium-ion and lithium-polymer batteries.	**www.agilent.com/find/ measurements**

www.agilent.com/find/measurements   Please contact your nearest Agilent office.

Simplify system design with clean power you can count on

Agilent 6600 Series Single-Output dc Power Supplies

	Total W	Max V	Max I	GPIB		Total W	Max V	Max I	GPIB		Total W	Max V	Max I	GPIB
6611C	40	8	5	•	**6644A**	200	60	3.5	•	**6572A**	2 K	20	100	
6612C	40	20	2	•	**6545A**	200	120	1.5		**6672A**	2 K	20	100	•
6613C	50	50	1	•	**6645A**	200	120	1.5	•	**6573A**	2 K	35	60	
6614C	50	100	0.5	•	**6551A**	500	8	50		**6673A**	2 K	35	60	•
6631B	80	8	10	•	**6651A**	500	8	50	•	**6574A**	2 K	60	35	
6632B	100	20	5	•	**6552A**	500	20	25		**6674A**	2 K	60	35	•
6633B	100	50	2	•	**6652A**	500	20	25	•	**6575A**	2 K	120	18	
6634B	100	100	1	•	**6553A**	500	35	15		**6675A**	2 K	120	18	•
6541A	200	8	20		**6653A**	500	35	15	•	**E4356A**	2 K	80	30	•
6641A	200	8	20	•	**6554A**	500	60	9		**6680A**	5 K	5	875	•
6542A	200	20	10		**6654A**	500	60	9	•	**6681A**	5 K	8	580	•
6642A	200	20	10	•	**6555A**	480	120	4		**6682A**	5 K	21	240	•
6543A	200	35	6		**6655A**	480	120	4	•	**6683A**	5 K	32	160	•
6643A	200	35	6	•	**6571A**	2 K	8	220		**6690A**	6.6 K	15	440	•
6544A	200	60	3.5		**6671A**	2 K	8	220	•	**6691A**	6.6 K	30	220	•
										6692A	6.6 K	60	110	•

Agilent 6620 Series Multiple-Output dc Power Supplies

	Total number of outputs	25 W precision output	50 W precision output	40 W output	40 W output	80 W output	80 W output
Output ratings Low range: Max V, Max I High range: Max V, Max I		7 V, 15 mA 50 V, 1 A or 16 V, 2 A	16 V, 200 mA 50 V, 1 A or 16 V, 2 A	7 V, 5 A 20 V, 2 A	20 V, 2 A 50 V, 0.8 A	7 V, 10 A 20 V, 4 A	20 V, 4 A 50 V, 2 A
			Output combinations				
6621A	2					2	
6622A	2						2
6623A	3			1	1	1	
6624A	4			2	2		
6627A	4				4		
6625A	2	1	1				
6626A	4	2	2				
6628A	2		2				
6629A	4		4				

Get more done in less space with the flexible Modular Power System

- *High density; up to 1200 W in 7 inches*
- *Up to 8 isolated dc outputs*
- *Low noise; stable dc power*
- *Output sequencing and triggering*
- *Output reversal/disconnect relays*
- *Extensive protection features*
- *Easy future reconfigurability*

Agilent 66000 Modular Power Systems

Model	Max V	Max I
66101A	8	16
66102A	20	7.5
66103A	35	4.5
66104A	60	2.5
66105A	120	1.25
66106A	200	0.75
66000A	Mainframe	
66001A	Keyboard	

Exceptional economic value with Agilent quality

E3600 series basic system and bench dc power supplies

- *Clean power and low price no longer an either/or question*

- *23 models with single, dual and triple outputs*

- *GPIB and RS-232 standard for programmable models*

Agilent E3600 Series Basic Power Supplies

	Total W	Max V	Max I	# of Outputs	Dual ranges	GPIB/ RS-232	Remote Sensing	Protection [1]
E3640A	30	20	3	1	•	•	•	V
E3641A	30	60	0.8	1	•	•	•	V
E3642A	50	20	5	1	•	•	•	V
E3643A	50	60	1.4	1	•	•	•	V
E3644A	80	20	8	1	•	•	•	V
E3645A	80	60	2.2	1	•	•	•	V
E3646A	60	20	3	2	•	•	•	V
E3647A	60	60	0.8	2	•	•	•	V
E3648A	100	20	5	2	•	•	•	V
E3649A	100	60	1.4	2	•	•	•	V
E3610A	30	15	3	1	•			
E3611A	30	35	1.5	1	•			
E3612A	30	120	0.5	1	•			
E3614A	48	8	6	1			•	
E3615A	60	20	3	1			•	
E3616A	60	35	1.7	1			•	
E3617A	60	60	1	1			•	
E3620A	50	25	1	2				
E3630A	35	20	2.5	3				
E3631A	80	25	5	3				
E3632A	120	30	7	1	•	•	•	V, I
E3633A	200	20	20	1	•	•	•	V, I
E3634A	200	50	7	1	•	•	•	V, I

[1] V = overvoltage protection, I = overcurrent protection

6030 series autoranging power supplies: Test at a wide range of V & I combinations with a single 200 W or 1,000 W power supply

- *Flexibility for sub-assembly test*

- *Optimal for military and aerospace applications*

- *Safeguard your valuable DUT with extensive protection features*

- *Integrated V & I measurement capabilities*
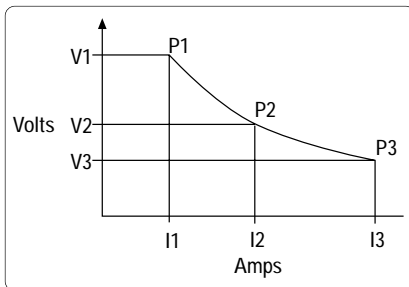
A wide range of voltage and current combinations are available at the maximum power level.

Agilent 6030 Series Autoranging Power Supplies

	Max W	Max V	Max I	GPIB
6033A	240	20	30	•
6038A	240	60	10	•
6030A	1200	200	17	•
6010A	1200	200	17	
6031A	1072	20	120	•
6011A	1072	20	120	
6032A	1200	60	50	•
6012B	1200	60	50	
6035A	1050	500	5	•
6015A	1050	500	5	

Precision control plus comprehensive test capability

**N3300 series fast electronic loads
simplify power supply test**

- *Increase system throughput*

- *Measure V & I quickly and accurately*

- *Built-in digitizer*

- *Programmable sequencing for
  multiple-output power supply test*

- *Operate down to 0 volts**

- *GPIB and RS-232 standard*

- *Optional ATE dc connectors (Opt. UJ1)
  for reliable test system configurations*

- *Stand-alone loads also available*

Agilent N3300 Series Electronic Loads

	Max W	Max V	Max I	(# slots) Width
N3302A	150	60	30	1
N3303A	250	240	10	1
N3304A	300	60	60	1
N3305A	500	150	60	2
N3306A	600	60	120	2
N3300A 6 slot mainframe				
N3301A 2 slot mainframe				

* Below 3 volts, maximum current and slew rate limitations apply.

**6800 series ac power source/analysers:
A fully integrated ac power test system
at the cost of a single instrument**

- *The fast, easy way to generate both clean
  and distorted ac power for product testing*

- *High-performance 16 bit power
  meter/analyser makes both static and
  dynamic measurements*

- *Analyse harmonic distortion to the 50th
  harmonic*

- *Easy-to-use software GUI also available*

- *Optional dual power analyser for UPS
  testing and efficiency measurements*

- *Programmable dc output*

- *Programmable output impedance*

Agilent 6800 Series ac Source/Analysers

	Max output power (VA)	Max output power	Max rms current	Max repetitive peak current	Max dc power (watts)
6811B	375	300	3.25	40	285
6812B	750	300	6.5	40	575
6813B	1750	300	13	80	1350

Please contact your nearest Agilent office.   **www.agilent.com/find/measurements**

# Are your products ready for the real world?

- *10 standard waveforms, with sine and square to 15 MHz or 80 MHz*

- *Arbitrary waveforms with 40 MSa/s or 200 MSa/s*

- *THD less than 0.04% and flatness as low as ±0.1 dB*

The Agilent 33120A and 33250A function/ arbitrary waveform generators give you the tools to put your products through their paces, quickly and thoroughly. Not only do you get a full complement of standard functions, you also get versatile arbitrary waveforms, with 12-bit resolution and a sample rate of 40 MSa/s (33120A) or 200 MSa/s (33250A). In addition, the 33250A can generate pulse waveforms up to 50 MHz with variable edge time.

Start with the signals a product is supposed to see, then add noise, harmonics, spurs and other extraneous signals to see how well it responds. By testing with realistic signals, you can make sure your products can handle the signals they are likely to encounter before your customers put them into service.

Built-in modulation capabilities and both linear and log sweeps further expand your test possibilities without requiring additional generators. Plus, the external clock reference timebase increases the frequency stability while letting you generate precise phase-offset signals, phase-lock to another 33120A or 33250A, or to a 10 MHz frequency standard.
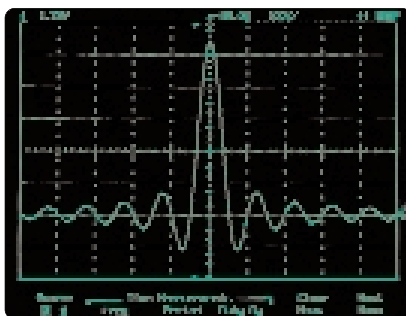
Store up to four arbitrary waveforms.
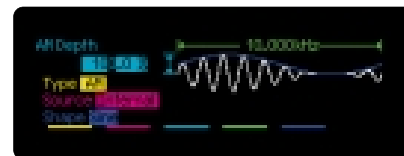
The 33250A's graphical mode simplifies waveform creation.

Agilent Function/Arbitrary Waveform Generators

	33120A	33250A
Frequency range (sine, square)	15 MHz	80 MHz
Standard waveforms	Sine, square, triangle, ramp, noise, sin(x)/x, exponential rise and fall, cardiac, dc volts	Sine, square, pulse, triangle, ramp, noise, sin(x)/x, exponential rise and fall, cardiac, dc volts
Arbitrary waveforms	8 to 16,000 points	1 to 64 K points
Sample rate	40 MSa/s	200 MSa/s
Modulation	AM (int/ext), FM (int), FSK (int/ext), burst (int/ext)	AM, FM, FSK, burst (all internal/external)
Sweep	Linear or logarithmic; up or down	Linear or logarithmic; up or down
External clock reference	Optional External lock range: 10 MHz ±50 Hz Internal frequency: 10 MHz	Standard External lock range: 10 MHz ±35 kHz Internal frequency: 10 MHz
Warranty	3 years	3 years

Ordering information
   Agilent 33120A 15 MHz function/arbitrary waveform generator
   Opt. 001 external clock reference for 33120A
   Agilent 33250A 80 MHz function/arbitrary waveform generator

Generate the unique signals needed to test innovative digital designs
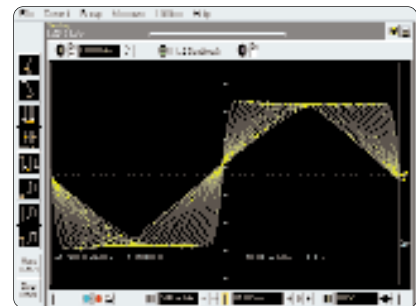
Variable transition times, from 5 ns to 200 ms, help you test circuits for sensitivity, synchronization and other critical performance factors.

- *Programmable pulse/pattern generators for testing today's digital designs*

- *Eight unique models with frequency ranges from 1 MHz to 3.3 GHz*

- *Dropout and glitch-free timing changing for reliable tests*

- *Versatile serial patterns and PRBS*

- *LVDS levels*

- *Jitter modulation on clock and data signals*

From functional verification to memory testing, the Agilent 81100 family of pulse/pattern generators lets you create unique signals to characterise innovative designs. With extensive control over transition time, amplitude and duty cycle, you can tailor unique signals for the requirements of each application. Create complex serial data streams, including PRBS data, to test data networks. Plus, you can choose a frequency optimised for your specific needs.

For testing on a tight budget, the Agilent 81101A offers 50 MHz pulse generation with the same degree of flexibility and signal shaping as the higher-end models. When timing is critical, the new Agilent 81134A provides the high resolution, low jitter and very fast transitions needed. High-performance and the capability to add jitter to your clock and data signals make the 81134A ideal for stressed eye-diagram measurements.

The graphical display, built-in help, store/recall and standard SCPI programming simplify both manual and automated tests.

Agilent 81100 Family of Pulse/Pattern Generators								*NEW*	
Mainframes	**8114A**	**81101A**	**81104A**	**81110A**[4]		**81130A**		**8133A**	**81133A**	**81134A**
Channel model	N/A	N/A	81105A	81111A	81112A	81131A	81132A	[5]	N/A	
Number of channels	1 single ended	1 single ended	1 or 2 single ended	1 or 2 single ended	differential	1 or 2 differential		1 or 2 differential	1	2 differential
Frequency range	1 Hz to 15 MHz	1 mHz to 50 MHz	1 mHz to 80 MHz	1 mHz to 165 MHz	1 mHz to 330 MHz	1 kHz to 400 MHz	1 kHz to 660 MHz	33 MHz to 3 GHz	20.8 MHz to 3.3 GHz	
Variable delay range	0.00 ns to 999 ms	0.00 ns to 999.5 s	0.00 ns to 999.5 s	0.00 ns to 999.5 s		0.00 ns to 3.00 µs		[5]	−5 ns to 230 ns	
Period RMS-jitter	0.03% + 25 ps[2]	0.01% + 15 ps[3]	0.01% + 15 ps[3]	0.01% + 15 ps[3]		0.001% + 15 ps		<5 ps (<1 ps typ.)	<2 ps	
Amplitude range	1.00 V to 100 V[1]	100 mV to 20.0 V[1]	100 mV to 20.0 V[1]	100 mV to 20.0 V[1]	100 mV to 3.8 V	100 mV to 3.8 V	100 mV to 2.5 V	300 mV to 3.00 V	50 mV – 2.0 V	
Transition time range (10/90)	<7 ns fixed	5.00 ns to 200 ms	3.00 ns to 200 ms	2.00 ns to 200 ms	800 ps or 1.6 ns selectable	800 ps or 1.6 ns selectable	500 ps typ. fixed	<100 ps fixed (<60 ps typ.)	<80 ps	

[1] Depends on selected source impedance (all other values apply for 50 Ω source impedance into 50 Ω load)   [2] 0.05% + 25 ps in the 50 ns to 100 ns range   [3] 0.001% + 15 ps with internal PLL as clock source
[4] Also available as VXI Pulse/Pattern Generators E8311A and E8312A   [5] Please refer to detailed product information for specifications regarding the available options #001 delay channel 1, #002 pulse/data channel 2, #003 pulse channel 2

Please contact your nearest Agilent office.   www.agilent.com/find/measurements

Customize a switching solution that meets your exact needs

New

- *"Perfect fit" switching solution with no extraneous costs*

- *Scalable and flexible configurations with three mainframe choices*

- *Wide selection of plug-in modules for dc, RF, microwave and optical signals*

With three mainframes and thirty modules to choose from, you can be sure the Agilent 3499 family meets your very needs. Build the system you need today and add more modules later as your needs change, always maintaining the right switching configuration at the lowest cost.

The Agilent 3499 family provides versatile, needs-driven switching at rates of up to 350 channels per second, with mainframes that accommodate a range of configurations:

- 3499B 2 slots, up to 80 channels

- 3499A 5 slots, up to 200 channels

- 3499C 9/14 slots, up to 360 channels

The electronic switching and multifunction modules can switch signals from dc to 26 GHz at amplitude levels up to 1,000 V and up to 8 A. The optical modules can switch signals from 1,270 nm to 1,670 nm. Unique, built-in relay cycle counters help you plan maintenance and avoid end-of-life failures.

To help configure and reconfigure tests quickly, you can choose optional removable-screw terminal blocks, crimp-and-insert terminal blocks or DIN96-to-D25/D50 cables. Instead of completely rewiring when you swap out a relay module, simply plug your wired terminal block into the new module and you are ready to go.

Your past investments are protected, too. Agilent 3499 systems are both hardware and software compatible with the Agilent 3488A.

Agilent 3499 Switch/Control Family

Ordering information

Mainframes	3499B	2 slot switch/control mainframe
	3499A	5 slot switch/control mainframe
	3499C	9–14 slot switch/control mainframe
General purpose relays	N2261A	40 channel general purpose relay
	N2267A	8 channel 8 A general purpose relay
	44471A	10 channel general purpose relay
	44471D	20 channel general purpose relay
	44477A	7 channel Form-C relay
Relay multiplexers	N2260A	40 channel multiplexer
	N2266A	40 channel high-speed multiplexer
	N2270A	10 channel 1,000 V multiplexer
	44470A	10 channel relay multiplexer
	44470D	20 channel relay multiplexer
RF multiplexers	N2268A	Dual 1 x 4 RF (3.5 GHz) multiplexer (50 Ω)
	N2272A	1 x 9 RF (1 GHz) multiplexer (50 Ω)
	44472A	Dual 1 x 4 VHF (300 MHz) multiplexer (50 Ω)
	44478A	Dual 1 x 4 RF (1.3 GHz) multiplexer (50 Ω)
	44478B	Dual 1 x 4 RF (1.3 GHz) multiplexer (75 Ω)
Matrix modules	N2262A	4 x 8 matrix
	44473A	4 x 4 matrix switch
Microwave modules	N2276A	Dual 1 x 6 (20 GHz) multiplexer
	N2276B	Relay driver (supports 2 microwave switches)
	44476A	Triple 1 x 2 (20 GHz) multiplexer (50 Ω)
	44476B	Microwave relay driver
Optical multiplexers	N2280A	Quad optical 1 x 2 multiplexer, SC/APC
	N2281A	Dual optical 1 x 4 multiplexer, SC/APC
	N2282A	Optical 1 x 8 multiplexer, SC/APC
Other modules	N2263A	32 bit digital I/O
	N2264A	12 + 3 GP + 16 bit digital I/O
	44474A	16 bit digital I/O

Dedicated data acquisition performance at PC plug-in prices

- *6½ digits (22 bits) of resolution*

- *11 built-in measurements*

- *Scan rates of up to 250 channels/second*

- *Includes BenchLink DataLogger software to configure and control tests, display results and move data for further analysis*

Agilent 34970A Data Acquisition/Switch Unit

DMM highlights

dc voltage accuracy (1 year, 10 V range)	0.0035% of reading + 0.0005% of range
ac voltage accuracy (1 year, 10 Hz to 20 kHz)	0.06% of reading + 0.04% of range
Thermocouple accuracy (–210° C to +1,820° C)	Probe + 1.0° C
Thermistor accuracy (–80° C to +150° C)	Probe + 0.08° C
Resistance accuracy (1 kΩ to 1 MΩ)	0.010% of reading + 0.001% of range

Other measurements and features: ac and dc current, frequency and period, 50,000 reading non-volatile memory, real-time clock, standard GPIB, RS-232 and SCPI

Module highlights

Module (ch/sec)	Speed	Max V	Max I	Key features
34901A 20 ch mux	60	300 V	1 A	2 current channels (22 ch total)
34902A 16 ch mux	250	300 V	50 mA	2/4 wire
34903A 20 ch actuator	120	300 V	1 A	Form C (SPDT) switches
34904A 4 x 8 matrix	120	300 V	1 A	2 wire, full cross point
34905A 50 Ω dual 1:4 RF mux	60	42 V	0.7 A	2 GHz
34906A 75 Ω dual 1:4 RF mux	60	42 V	0.7 A	2 GHz
34907A multifunction module Two 8 bit digital I/O ports 26 bit, 100 kHz counter Two 16 bit analogue outputs		42 V 42 V ±12 V	400 mA 10 mA	Open drain Gated; selectable input threshold Earth referenced; calibrated
34908A 40 ch mux	60	300 V	1 A	Common low, no 4 wire measurement

Ordering information

34970A data acquisition/switch unit*	34905A dual 4 ch RF mux, 50 Ω
34970A without DMM*	34906A dual 4 ch RF mux, 75 Ω
34901A 20 ch general-purpose mux	34907A multifunction module
34902A 16 ch high-speed mux	34908A 40 ch single-ended mux
34903A 20 ch actuator/GP switch	E2050A LAN-to-GPIB gateway
34904A 4 x 8 matrix switch	

*Mainframe only – modules are required to operate

The modular Agilent 34970A data acquisition and switching system combines the performance of a dedicated data acquisition system with the simplicity of a data logger, at a price you would expect to pay for PC plug-in card solutions.

The system consists of a three-slot mainframe with a built-in 6½ digit DMM. Choose from eight optional plug-in modules to create a compact data logger, full-featured data acquisition system or low-cost switching unit. On-module screw terminal connections eliminate the need for terminal blocks and a unique relay maintenance feature counts every closure on every switch for easy, predictable relay maintenance. Universal inputs let you measure 11 different functions without the added cost or hassle of signal-conditioning accessories.

It is easy to specify measurement functions channel by channel by putting a dc volts channel next to a temperature channel next to an ac volts channel. Plus, each input has user-definable units, Mx+B scaling and alarm limits.

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Make sure all your components meet your demanding standards

- *Impedance analysers offer a variety of inductance, capacitance, resistance and phase measurements*

- *LCR meters offer a lower-cost alternative to analysers with fast results and high accuracy*

- *Combination analysers offer the convenience of integrated network, spectrum and impedance analysis*

- *Specialty resistance meters offer ultra-low or ultra-high resistance measurements*

E4991A

4294A

Comparing impedance measurement solutions

Product highlights	Impedance analysers	LCR meters	Combination analysers
Frequency sweep capability	Continuous	Spot	Continuous
Display	Graphical	Numeric	Graphical
Productivity functions	Equivalent circuit analysis built in	Handler interfaces	Equivalent circuit analysis built in, multiple functions in one instrument
Key advantages	Frequency characteristics and resonant analysis, circuit modelling	Lower-cost, ease of use, high speed	Cost-effective, time-saving, compact size

Choosing a component test solution

To choose the best solution, consider frequency range, device type, special features such as device handler interfaces and accuracy requirements. Because frequency, accuracy and other key parameters are determined by the measurement technique used, it is important to understand the four major impedance techniques. (The table on the following page indicates the techniques used by each Agilent instrument.)

- The autobalancing bridge offers the widest impedance measurement range with typical frequency range of 20 Hz to 110 MHz. Best for low-frequency, general-purpose testing.

- Designed for accuracy and high-frequency performance, the RF I-V technique is excellent for RF component analysis, especially for small inductance and capacitance values.

- Network analysis offers the highest frequency coverage, but works best when the measurement range is close to 50 Ω. With this measurement technique, impedance values are derived from reflection co-efficients.

Impedance analysers

The Agilent E4991A RF impedance/material analyser measures impedance from 1 MHz to 3 GHz with accuracy of ±0.8% and 1 mHz resolution, and an optional material-test function measures permittivity and permeability. Standard measurement parameters include $|Z|$, $|Y|$, θ, R, X, G, B, C, L, D and Q, and options let you measure material characteristics including $|\varepsilon r|$, $\varepsilon r'$, $\varepsilon r''$, $|\mu r|$, $\mu r'$ and $\mu r''$.

The Agilent 4294A precision impedance analyser offers high-accuracy, 4-terminal-pair impedance measurements from 40 Hz to 110 MHz. The 4294A is designed for the most demanding measurements on capacitors, inductors, resonators and semi-conductors, as well as material evaluations on PC boards, toroidal cores and other parts. Take advantage of ±0.08% basic accuracy to evaluate extremely small variations in component characteristics. Perform in-circuit or grounded measurements with the 42941A impedance probe. Standard measurements include $|Z|$, $|Y|$, θ, R, X, G, B, C, L, D and Q.

LCR meters

Agilent LCR meters bring measurement precision and operational simplicity to both R&D and production applications. Ideal for lower-cost, general-purpose testing of leaded and surface-mount components, materials and more. Measurements include $|Z|$, $|Y|$, θ, R, X, G, B, C, L, D and Q.

The Agilent 4284A precision LCR meter offers extreme accuracy (±0.05%) at frequencies up to 1 MHz. Add Option 001 for ±40 V internal dc bias voltage.

The Agilent 4285A precision LCR meter offers a balance of accuracy and frequency coverage, with ±0.1% basic accuracy from 75 kHz to 30 MHz. Option 001 adds ±40 V dc bias voltage.

The Agilent 4263B LCR meter delivers low-cost component evaluation in a compact, easy-to-use meter. Offers spot frequency testing at 100 Hz, 120 Hz, 1 kHz, 10 kHz and 100 kHz (optional 20 kHz). Option 001 and the 16060A provide the transformer parameter measurement function.

4284A

4395A

4263B

Combination analysers

Save time, money and rack space with integrated component evaluation tools. These analysers offer the same advanced impedance measurements as our dedicated impedance analysers, along with precision network and spectrum analysis. Standard measurements include $|Z|$, $|Y|$, $|\Gamma|$, θ, R, X, G, B, C, L, D and Q. The Agilent 4396B network/spectrum/impedance analyser (with 43961A RF impedance test kit

and 4396B Option 010) provides 1.8 GHz frequency range with such advanced features as time-gated spectrum analysis for pulsed signal analysis and digital resolution bandwidth for faster sweeps. The 4395A network/spectrum/ impedance analyser (with 43961A RF impedance test kit and 4395A Option 010) offers a similar set of tools and capabilities in the 500 MHz frequency range.

Specialty resistance meters

The 4338B milliohmmeter offers ultra-low resistance measurements over 10 µΩ to 100 kΩ. The 4339B high-resistance meter provides ultra-high resistance measurements up to 1.6 x 10^{16} Ω. Its 34 ms (4338B) or 10 ms (4339B) measurement speed helps boost production-line throughput.

Product Type	Purpose	Model	Frequency Range	Basic Z Accuracy	Z range[1]	Measurement Technique	Primary Applications
Impedance analyser	High performance, multifunction	E4991A	1 MHz to 3 GHz (frequency sweep)	0.8%	150 mΩ to 20 kΩ	RF I-V	LCR components, materials, semiconductors
	High performance, multifunction	4294A	40 Hz to 110 MHz (frequency sweep)	0.08%	25 mΩ to 40 MΩ	Autobalancing bridge	LCR components, materials, semiconductors
LCR meter	High performance, multifunction	4285A	75 kHz to 30 MHz (spot frequency)	0.1%	10 mΩ to 10 MΩ	Autobalancing bridge	LCR components, materials, semiconductors
	High performance, multifunction	4284A	20 Hz to 1 MHz (spot frequency)	0.05%	10 mΩ to 100 MΩ	Autobalancing bridge	LCR components, materials, semiconductors
	Low cost, multifunction	4263B	100 Hz to 100 kHz (spot frequency)	0.1%	1 mΩ to 100 MΩ	Autobalancing bridge	LCR components, transformers
Combination analyser	Network/spectrum/ impedance measurements	4396B (with Opt. 010 and 43961A)	100 kHz to 1.8 GHz (frequency sweep)	3%	2 Ω to 5 kΩ	RF I-V	LCR components, other passive components, active components, circuit analysis
	Network/spectrum/ impedance measurements	4395A (with Opt. 010 and 43961A)	100 kHz to 500 MHz (frequency sweep)	3%	2 Ω to 5 kΩ	RF I-V	LCR components, other passive components, active components, circuit analysis
Specialty resistance meter	Milliohm	4338B	1 kHz only	0.4%	10 µΩ to 100 kΩ	(other)	Connectors, resistors, switches, batteries
	High resistance	4339B	DC only	0.6%	10 kΩ to 1.6 x 10^{16} Ω	(other)	Transformers, capacitors

[1] 10% accuracy range

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Simplify test set-up with the new Connectivity Suite

New

- *Simplified connectivity for test and measurement instruments, over GPIB, USB and LAN*

- *New T&M Programmers Toolkit features development tools based on Microsoft's powerful new Visual Studio .NET® environment*

- *Quick access to drivers, documentation, updates and more as part of the new Agilent Developer Network*

- *New connectivity standards for future Agilent instruments ensure easy automation using PC standards and tools*

Tired of struggling to connect instruments to your PC and develop ad hoc programs for design characterisation, validation or test?

Don't want to learn a new language or get trapped in a proprietary programming environment?

The Agilent Connectivity Suite takes a fresh look at the instrument connectivity challenge and provides a simple solution to complex connectivity requirements.

Created for the unique demands of instrument connection and control

The Agilent Connectivity Suite is a set of tools and components created specifically for engineers who need to develop tests quickly, without the time investment typically associated with connecting to instruments and writing test code from scratch in a language or environment that lacks a T&M focus.

Program less, engineer more

As Microsoft® revolutionizes programming with Visual Studio .NET, Agilent is bringing that power to design and test engineers. By taking advantage of Visual Studio .NET code portability, enormous built-in functionality and wide user community, you can cut the time required to program instruments and display data by as much as 50%.

Whatever programming language you use now, it is more than likely to be among the 26 languages supported by Visual Studio .NET and the Connectivity Suite.

In other words, you can get back to your engineering responsibilities and avoid becoming a full-time programmer or connectivity expert.
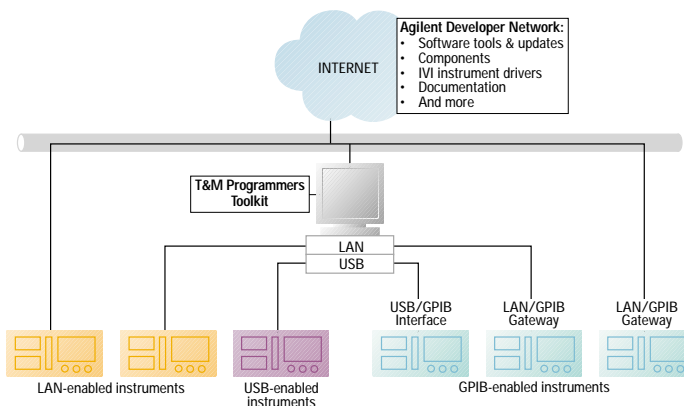
Modify tests quickly and easily

The T&M Programmers Toolkit at the heart of the Connectivity Suite is ideal for the continual changes in prototype testing and design validation. It is easy to set up a system, add more test equipment, try out new tests and perform simple data visualization and analysis.

Easy connection to test and measurement instruments

The Connectivity Suite can save you time and frustration whenever you need to move beyond the front panel and automate tests or retrieve data. The Connectivity Suite offers easy connection to T&M instruments with your choice of I/O: USB/GPIB, LAN/GPIB, or GPIB interfaces.

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Agilent Developer Network:
- Software tools & updates
- Components
- IVI instrument drivers
- Documentation
- And more

INTERNET

T&M Programmers Toolkit

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USB/GPIB Interface

LAN/GPIB Gateway

LAN/GPIB Gateway

LAN-enabled instruments

USB-enabled instruments

GPIB-enabled instruments

The Agilent Connectivity Suite takes the work out of communicating with virtually any instrument with the programming language and I/O of your choice.

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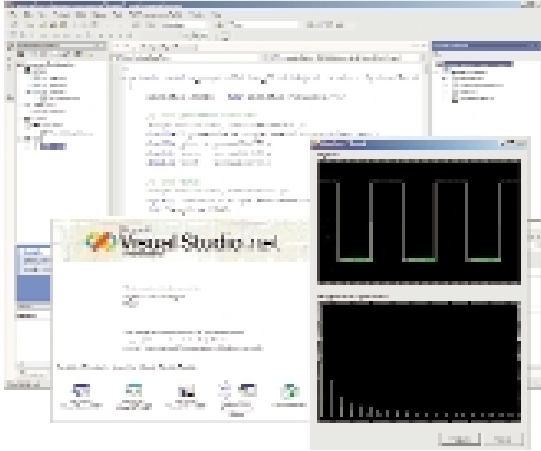
The T&M Toolkit, as part of Agilent's Connectivity Suite, lets you quickly assemble an instrument control program

The advantages of Visual Studio .NET

As an extension of the powerful built-in functionality in the Visual Studio .NET environment, the T&M Programmers Toolkit greatly simplifies programmatic access to your instruments and speeds your programming job. Thanks to Visual Studio .NET's language independence, you can write in virtually any programming language without worrying about integration issues. Best of all, Visual Studio .NET is an industry-standard development environment, so your T&M Programmers Toolkit programming expertise will be valuable in any work environment.

Elements of the Agilent Connectivity Suite

T&M Programmers Toolkit: Development tools and components that bring the power and ease of the Microsoft Visual Studio .NET environment to the test and measurement world. Project Wizards provide instrument and system control program building blocks. The Instrument Explorer automatically finds all instruments connected to the customer's PC and makes it easy to manage multiple instruments and drivers. The Instrument Explorer also lets you simply drag and drop each instrument onto your work window to generate code to connect to the instrument. And a fully integrated, online help system reduces your programming learning curve.

Agilent Developer Network: Agilent's web-based community providing test and measurement software tools, components, instrument drivers, I/O, documentation and other connectivity information. ADN helps you connect with resources that help you get your job done. Register at **www.agilent.com/find/measurements** to benefit from this dynamic, growing community.

USB/GPIB interface: Simplified connections between any vendor's GPIB test equipment and the standard interface on your PC without opening or reconfiguring your PC.

LAN/GPIB gateway: Network connections for your GPIB instruments, enabling resource sharing, global project communication and remote access to instruments.

IVI-COM drivers: A new class of language-independent drivers optimised for the PC programming environment. They are more consistent than current drivers, with better error handling and higher performance. Plus, they also let you simulate unavailable instruments.

All these elements are available individually or as part of easy-to-order, money-saving bundles. Learn more about the time-saving benefits of the Connectivity Suite at **www.agilent.com/find/measurements**.

Agilent Connectivity Products

Software

W1130A T&M Programmers Toolkit developer annual license to use, unlimited distribution of run-time, updates, released upgrades and support for license duration (12 months)
W1131A T&M Programmers Toolkit perpetual license to use. Includes developer license to use, unlimited distribution of run-time

Hardware

| |
| --- |
| 82357A USB/GPIB Interface for Windows, IEEE 488.2 compatible with transfer rates of 750 KBytes/sec for large block transfers; includes I/O Libraries software for Windows 98 (SE)/Me/2000/XP |
| 82350A High-speed PCI GPIB card with built-in buffering for speed; transfer rates of 750 KBytes/sec; includes I/O Libraries software for Windows 95/98/Me/NT/2000/XP |
| E5810A LAN to GPIB gateway to control GPIB instruments over local or wide area networks; includes I/O Libraries software for Windows 98/Me/NT/2000/XP |

Bundle discounts

With the W1138A Connectivity Suite, purchase one software and one hardware product together and receive a 10% discount off each component

Create powerful automated tests in less time
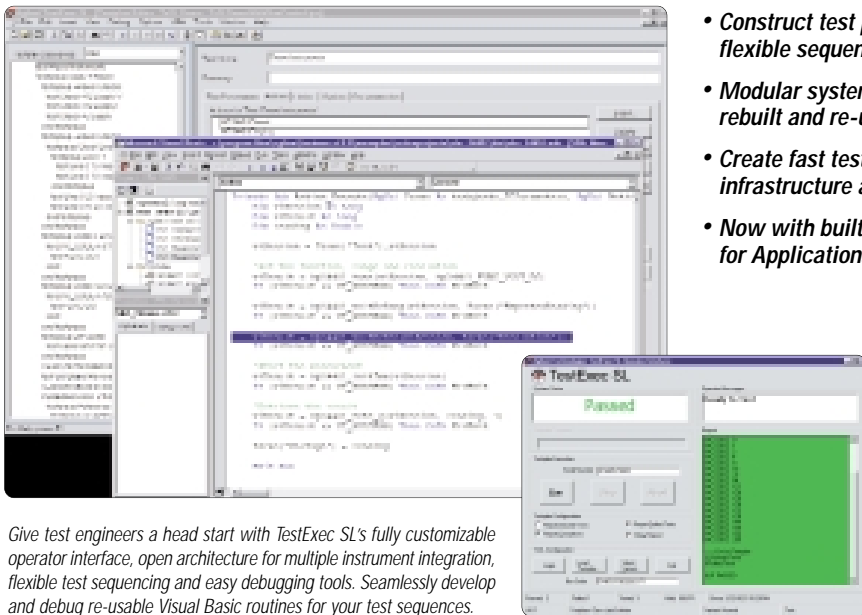
- *Construct test plans quickly with flexible sequencing*

- *Modular systems can be rapidly rebuilt and re-used*

- *Create fast tests with performance-tuned infrastructure and optimization tools*

- *Now with built-in Microsoft Visual Basic® for Applications*

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TestExec SL supports Microsoft Visual Basic for Applications, Microsoft Visual Studio® (C, C++ and Visual Basic), Agilent VEE and National Instruments LabVIEW.

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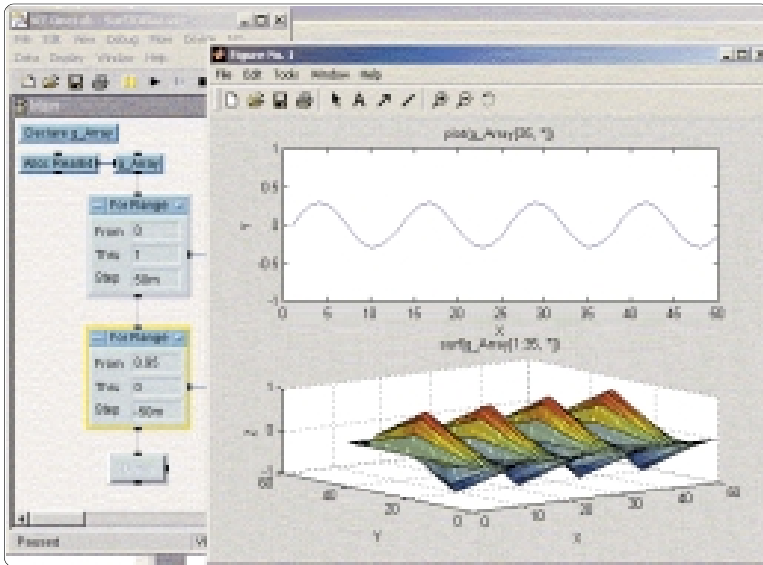
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Full support of ActiveX means you can customize programs within VEE and automate reporting or spreadsheets with Microsoft Word or Excel. Multimedia tutorials and example programs help you get up to speed quickly. The products include a variety of site licenses, upgrades, GPIB bundles and educational packages.

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Selecting a software development solution

Product	Description	Fit to development cycle	Major features
T&M Programmers Toolkit (page 60)	Components and class libraries in the open environment of Microsoft's Visual Studio .NET for instrument control programs	Design, design characterization and validation and prototype testing; ramp to manufacturing; manufacturing	Tools for instrument ID, control, debugging, connection, visualization and analysis Available in annual subscription that includes support and updates
VEE (page 63)	Graphical instrument programming environment	Design, data acquisition and manufacturing	Graphical metaphor for rapid prototyping and construction Built-in MATLAB capability for analysis and visualization Full support of ActiveX controls and ActiveX automation
IntuiLink (page 62)	Toolbar add-ins for MS Word and Excel	Design and design validation	Easy connection to instruments Simple no-programming connection for data transfer to MS Excel and Word with a single mouse click
TestExec SL (page 62)	Application platform for development, debug and execution of automated tests	Manufacturing or design validation functional test; global site deployment	One-click access to built-in Visual Basic development and debug environment Enables easy software re-use Robust and flexible instrument integration

Quality accessories, timely information
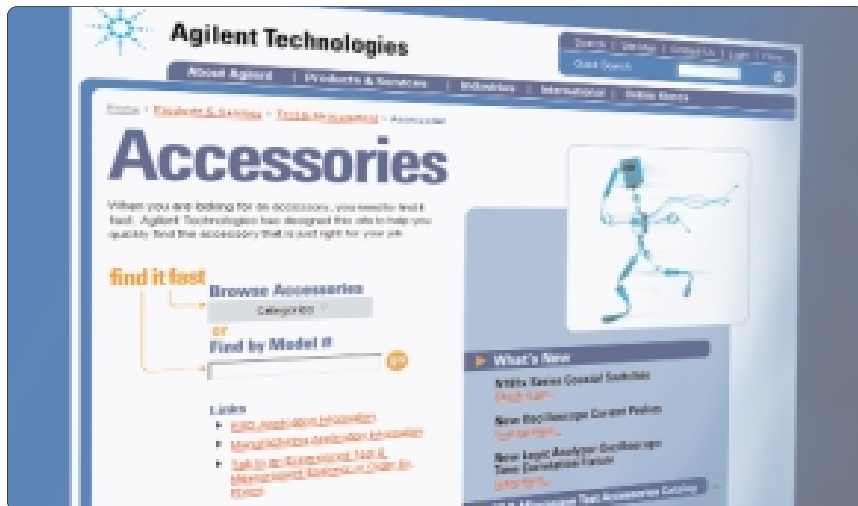
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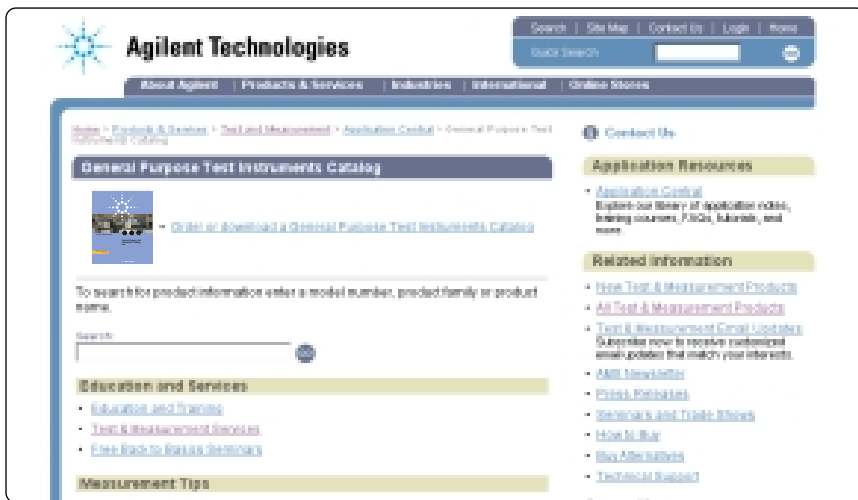
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64

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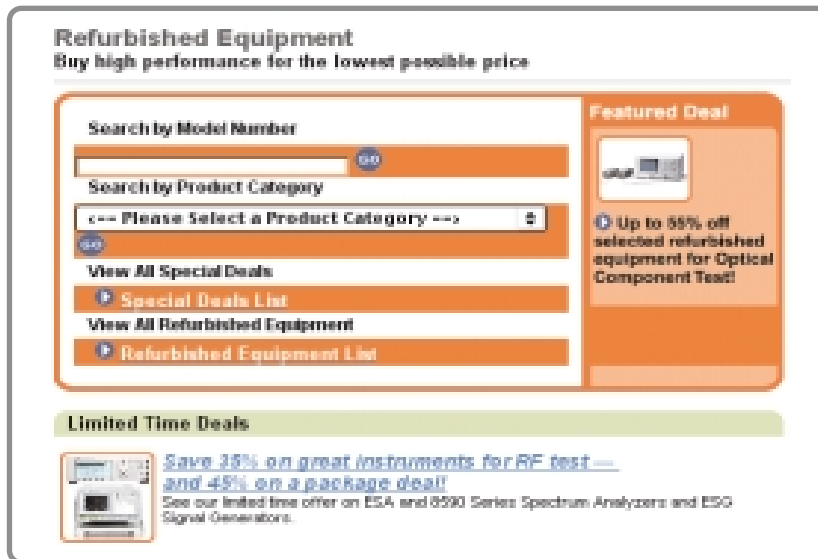Tel: +966 1 462 42 66
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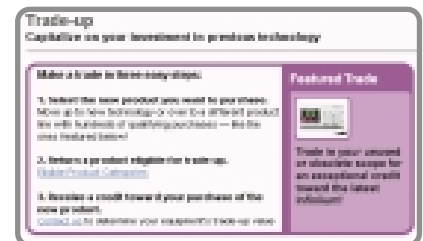
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