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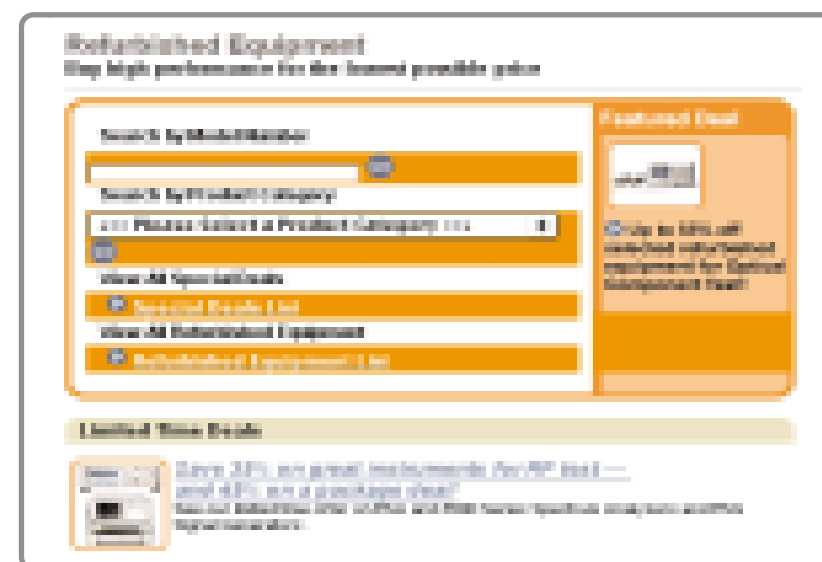
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Instruments, information and insight



## General Purpose Test Instruments Catalogue

### 2002

Coping with next-generation wireless transceivers: advice from engineers who've been there



DMEP2464203

DMEP2464203

## 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 to 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, though, 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 doesn't interfere too much with other nearby

transmitters. 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, and vendors and developers have to characterize and verify those attributes.

In our work with engineers creating many types of wireless devices, we've gathered a few insights that may help you deal with some of the challenges you're facing today with the next generation of transmitters, receivers and components. Here are some samples.

### 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 doesn't meet spec, 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 multichannel 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's 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 analyze 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.

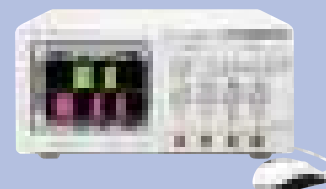
## NEW AGILENT TEST SOLUTIONS



**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 analyzers.



**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 will the interference that mobile stations (MS) must overcome to ensure successful transmission and reception. A few telltale 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. A too-large 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 desensitizing 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.

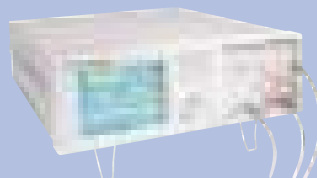
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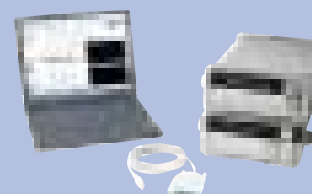
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**Page 32.** View 18 time-aligned channels (2 analogue and 16 digital) simultaneously with bandwidths up to 500 MHz in the new 54640 series scopes equipped with MegaZoom deep memory.



**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.

Dear Colleague:

Welcome to the new edition of the *General Purpose Test Instruments Catalogue*, your best source for staying up to date on the latest test and measurement solutions from Agilent Technologies Canada Inc.

With instruments, information and insight, we're working to provide you with the specialized measurement expertise that today's leading-edge designs demand. A key part of this effort is the many application notes, tutorials, webcasts and other resources available online and the numerous measurement tips you'll find throughout this catalogue.

**I realize many of you are facing restricted equipment budgets as we all try to manage our way through the current economy. To help you stretch your budget, we've created a special promotion that lets you save thousands of dollars on multi-instrument purchases. The more instruments you select, the more you save, so it's a great opportunity to get the latest measurement technologies that will help reduce your design times. Visit [www.agilent.com/find/measure](http://www.agilent.com/find/measure) for all the details.**

Across the range of RF, digital and general purpose instruments, you'll see a number of exciting new products that will help you tackle some of today's toughest measurement challenges. The catalogue provides a top-level overview, and you can continue your research online with in-depth product information, product and application notes, and other technical resources. We continue to streamline the Web site as well, making it easier to find the information you need. As always, call us at **1-877-894-4414** to speak with a measurement specialist.

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Ned Barnholt  
President and CEO, Agilent Technologies

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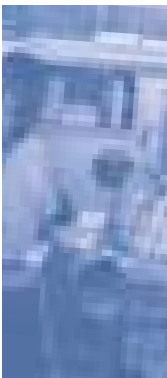
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<b>Test code optimization</b>	Optimizing test plans and code for wireless appliance functional test
<b>Test data management</b>	Organizing and storing test data for further analysis and reporting
<b>Test plan development</b>	Assisting and advising on test strategy and definition
<b>NFA measurement characterization</b>	Making accurate noise figure and gain measurements with noise figure analyzers
<b>Understanding VNA time-domain analysis</b>	Using VNAs for impedance measurements and fault location in time or distance
<b>Waveforms for ESG signal generators</b>	Creating automated custom signal and waveform applications



### Support solutions

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

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

*Transmitters & Receivers*, *Understanding Optical Passive Device Characterization*, *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*.

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- **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 that'll 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 per 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 sample, see the wireless LAN measurement tip on the following page and others throughout the catalogue.

- **Back to Basics.** Whether you'd 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

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All of this information is available at [www.agilent.com/find/measure](http://www.agilent.com/find/measure).

Be sure to sign up for automated email notification, too. You can select application information in a variety of technical specialties, and the privacy and personalization features ensure that you get only the information you request (see page 3 for details).



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Whether you're looking for a simple accessory or a complete measurement solution, Agilent call center 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 technical consultation. Either way, we'll 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.

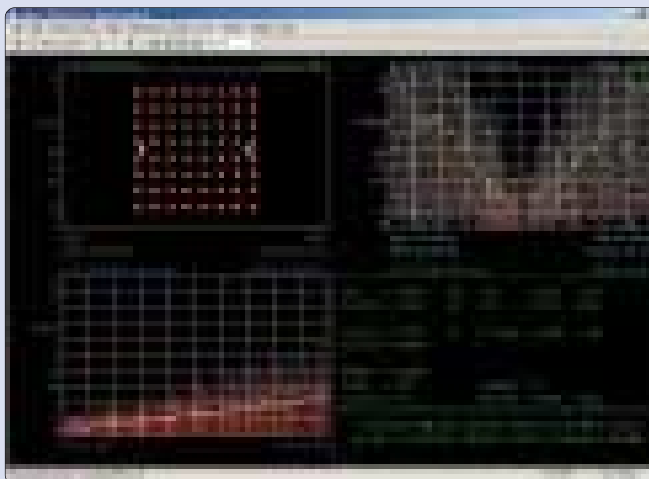
Certification happens late in the race to market, but the roots of interoperability reach back to the earlier stages of product design and development. In the early stages, each manufacturer optimizes its designs differently—a useful practice that can translate into different (but in-spec) behavior in 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 nonlinear 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**

Those 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 signaling 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're 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 nonlinear distortion and spurious errors.

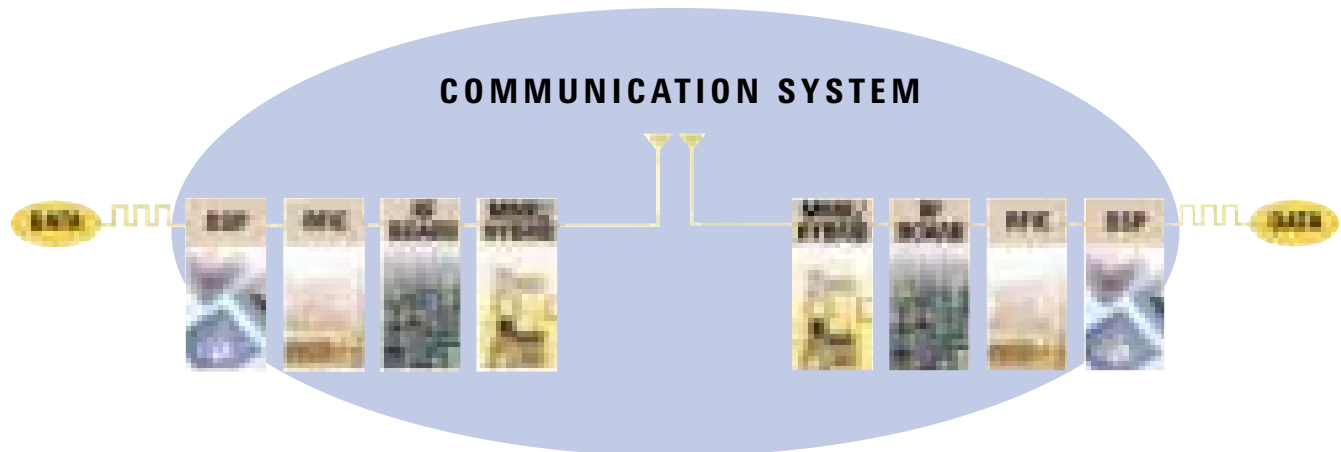
#### **Getting the rest of the story**

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've 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/measure](http://www.agilent.com/find/measure)**, where you can request the free CD-ROM Bluetooth™ & Wireless LAN Test Products, Systems, and Services.

## Speeding optimized 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 analyzers 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 minimizes the need for data or design transfer, and ADS works with other EDA frameworks for full compatibility within your overall design process.

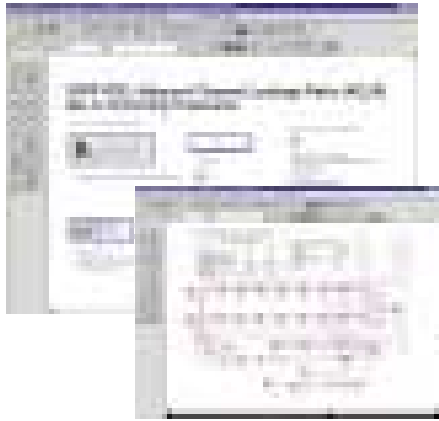
Use ADS and its highly integrated links and support as a basis for your design verification solution. ADS can be used for virtual prototyping, debugging, or as an aid in manufacturing test.

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

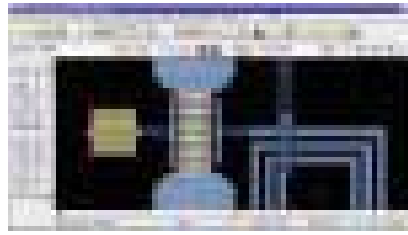
extensible: you can customize ADS by adding design suites focused on your particular application needs (see page 9). All suites share a common database, user interface and display. ADS and the six design suites run on PCs and workstations, with complete file compatibility between platforms and across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

### **Optimize 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 analog/RF track. You can build the physical design for the RF portions in ADS, then choose to integrate with other third-party EDA frameworks.



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**

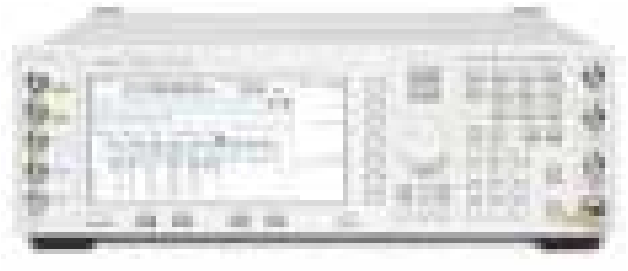
Customize ADS for demanding applications and design flows from RF chips and boards to

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
<p><b>Communication System Designer</b> Provides a unified environment from system concept to implementation.</p>	Validates RF system designs. RF simulator and linear/nonlinear 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.
<p><b>DSP Designer</b> The ability to verify DSP algorithms in conjunction with mixed systems helps you isolate and avoid RF/analogue/DSP integration problems.</p>	Uses the Agilent Ptolemy fixed-point simulator and libraries for system-level DSP algorithm development.	Integrates the analysis and simulation of RF, DSP and analog systems to determine RF/DSP design tradeoffs. Expandable floating- and fixed-point capabilities.	Helps analyze interaction between DSP content and the rest of the communications system. Co-simulate and generate HDL codes for analysis, and validate more levels of system abstraction.
<p><b>RFIC Designer</b> Realize the most demanding RFIC designs through leading-edge simulation and optimization. RFIC Designer links to third-party EDA solutions and libraries and is supported by major silicon foundries around the world.</p>	N/A	Provides an integrated time-, frequency- and modulation-domain simulation environment for schematics containing a combination of models for devices, behavioral blocks, layout parasitics, and off-chip components.	Adds user-defined element modeling, statistical design, RF system models and convolution simulation.
<p><b>RF Board Designer</b> Confidently design RF boards to specification by accurately predicting, optimizing and rendering PCB designs for manufacturing. The results are fewer board turns, lower development costs and shorter time-to-market.</p>	Base simulator capability for linear circuits. Includes accurate models, libraries and unique Agilent EEsot tools.	Provides an integrated environment for design and verification of RF board components. Designers and design teams benefit from leading-edge simulator technology, advanced modeling, a physical design environment and yield-optimization tools.	Adds RF system models and Circuit Envelope for analysis of complex modulated signals. Provides end-to-end architecture, design and implementation capabilities.
<p><b>Microwave Circuit Designer</b> A complete solution for developing high-frequency designs, including MMICs and hybrids, with optimized performance and manufacturing yield.</p>	Combines high-frequency simulation and optimization with accurate models, libraries and physical design tools.	A powerful solution for microwave component designers. Adds an integrated physical design environment and yield-optimization and maximization 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.
	<b>Precision Modeling System</b>	<b>RF Modeling System</b>	<b>Pulsed Modeling System</b>
<p><b>Precision, RF and Pulsed Modeling Systems</b> Complete, single-source systems configured for specific frequency ranges and applications to accurately measure nonlinear devices.</p>	A complete measurement system for high-frequency active devices. Includes an Agilent 8510C network analyzer for ac measurements up to 20 GHz (optionally 26.5 GHz or 50 GHz).	Designed for modeling at frequencies below 3 GHz (optionally to 6 GHz) using the Agilent 8753 or PNA network analyzers.	Improves device characterization and modeling 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 millimeter-wave satellite systems.

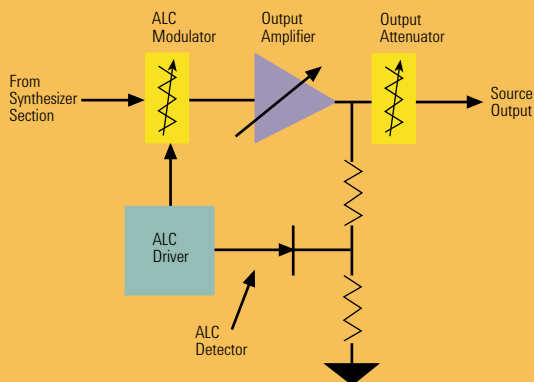
Agilent's RF signal generators are designed for testing of analog and digital communications systems. Flexible options meet the requirements of most current and proposed air interface standards, letting you simulate the performance of a communication system.

Spectral purity and switching speed are critical measures of an RF signal generator. That's 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 synthesized signal generators provide excellent frequency resolution, level control, signal purity, and modulation.

### MEASUREMENT TIP: OPTIMIZING SIGNALS FOR CDMA TESTS



Agilent ESG signal generators let you manually select output amplifier and attenuator settings to optimize 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 optimized to deliver the necessary signal quality. Specifically, select a combination of output amplifier and output attenuator settings that keeps the signal generator's noise level below the noise level you're 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 optimizes 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 isn't compatible with the CDMA test specification, while the second will.

**Agilent RF Signal Generators**

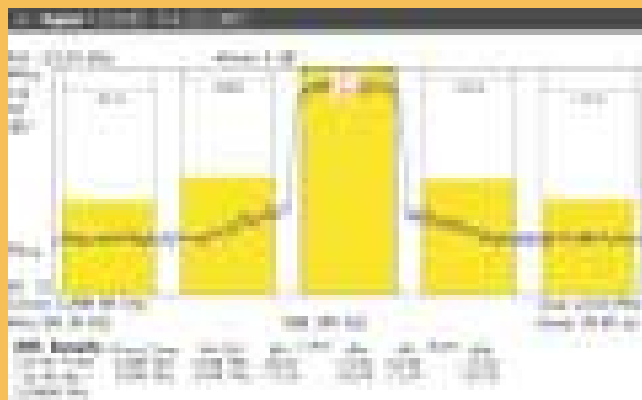
	<b>Frequency range</b>	<b>Key features and applications</b>
ESG Vector Signal Generator <b>E4438C</b> (see page 12)	250 kHz to 6 GHz	Same as ESG-D series plus: up to 160 MB waveform memory; 6 GB hard drive; 100 MHz sample clock; up to 160 MHz modulation BW; adjustable carrier-to-noise ratio (Eb/No); differential I/Q outputs; fast frequency switching; high-speed BER; and LAN connectivity.
ESG-D/DP series <b>E4430-37B</b> (see page 12)	250 kHz to 4 GHz	Analogue and digital modulation. Optional modulation formats for W-CDMA, cdma2000, EDGE, GSM, <i>Bluetooth</i> , WLAN and others. Custom formats also available.
ESG-A/AP series <b>E4400B, E4420-26B</b> (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.
<b>8648A/B/C/D</b> (www.agilent.com/find/measure)	9 kHz to 4 GHz	Low-cost synthesized signal generator series for manufacturing and service applications.
<b>8644B</b> (www.agilent.com/find/measure)	252 kHz to 2.06 GHz	Very low SSB phase noise and spurious. A performance signal generator for RF design and manufacturing.
<b>8664A</b> (www.agilent.com/find/measure)	100 kHz to 6 GHz	Low nonharmonic 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**

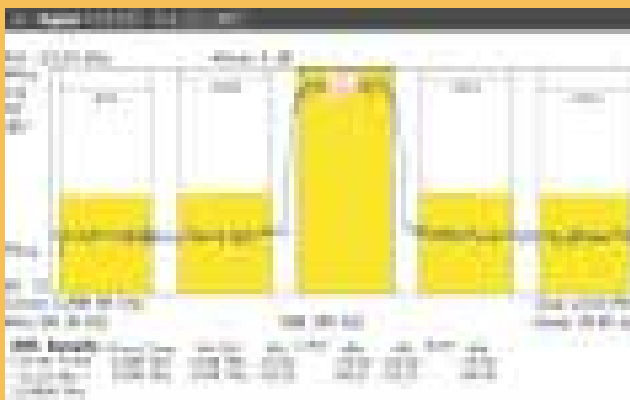
	<b>Frequency range</b>	<b>Key features and applications</b>
PSG-A series <b>E8251A, E8254A</b> (see page 14)	250 kHz to 40 GHz	Optimized for analogue modulation applications that need high output power and low phase noise.
PSG-L series <b>E8241A, E8244A</b> (see page 14)	250 kHz to 40 GHz	Optimized for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

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[www.agilent.com/find/measure](http://www.agilent.com/find/measure)

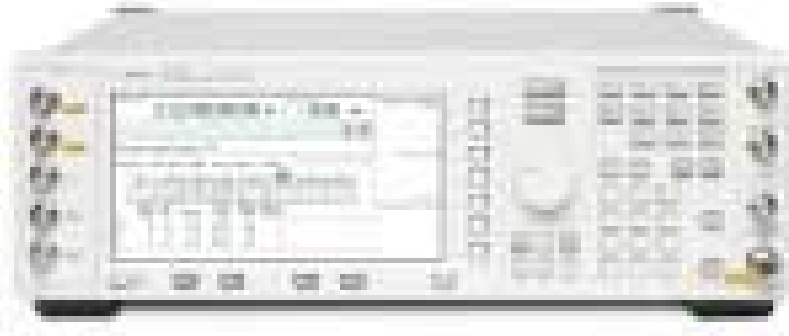


Normal W-CDMA Test Model 1 with 64 DPCH. The +15/-20 dBm combination of amplifier/attenuator settings produces a signal with higher sideband noise for the ACLR test because the amplifier is set at a high level.



The -5/0 dBm combination, in contrast, produces a low-noise signal optimized 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



- **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 customize 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 and spectral purity, and our



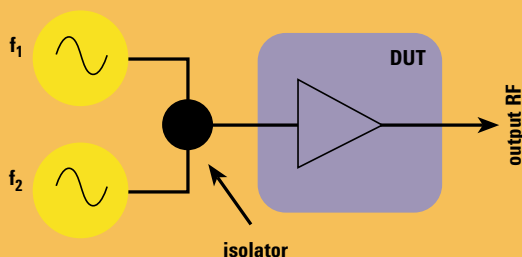
The fully channel-coded W-CDMA personality offers independent data channels, 16 OCNS, compressed mode and adjustable carrier-to-noise ratio in a single instrument.

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 customizable modulation formats. With frequency ranges up to 4 GHz, they're ideal for testing receivers, local oscillators, and 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 nonlinearities of an amplifier will produce upper and lower third-order mixing products:

$$f_L = 2f_1 - f_2$$

$$f_U = 2f_2 - f_1$$

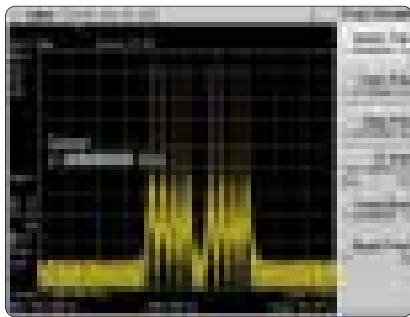
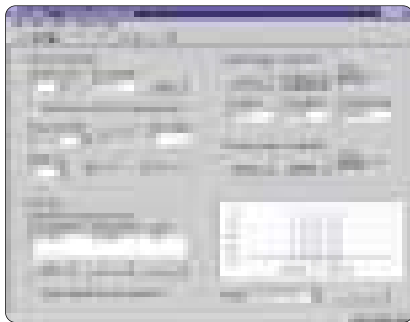
where  $f_1$  and  $f_2$  are the output frequencies of the two sources.

Spurious signals from the CW sources can corrupt the measurement. When selecting a source, check the nonharmonic 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 and 802.11a, and enhanced multitone.



Download a free evaluation copy of Signal Studio at [www.agilent.com/find/measure](http://www.agilent.com/find/measure).

**Agilent E4438C ESG Series Signal Generator** (digital models<sup>(1)</sup>)

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

**Ordering information**

E4438C ESG Vector Signal Generator (must order frequency option)	\$ 0.00
Frequency options	
Opt. 501 250 kHz to 1 GHz frequency range	27,147.00
Opt. 502 250 kHz to 2 GHz frequency range	30,064.00
Opt. 503 250 kHz to 3 GHz frequency range	32,981.00
Opt. 504 250 kHz to 4 GHz frequency range	35,899.00
Opt. 506 250 kHz to 6 GHz frequency range (requires Option UNJ)	40,761.00
Hardware options	
Opt. UNB High output power with mechanical attenuator (mechanical attenuator included with Option 506)	1,621.00
Opt. UNJ Enhanced phase noise performance (includes high-stability timebase, Option 1E5)	8,104.00
Opt. UN7 Internal bit-error-rate analyzer	5,154.00
Opt. 001 Internal baseband generator with 8 MSa memory	12,966.00
Opt. 002 Internal baseband generator with 32 MSa memory	18,638.00
Opt. 005 6 GB hard drive (Option 001 or 002 required)	1,621.00
Opt. 1E5 High-stability timebase	1,621.00
Signal generation personalities	
Opt. 400 3GPP W-CDMA-FDD personalities	4,862.00
Opt. 401 cdma2000 and IS-95A personalities	4,862.00
Opt. 402 TDMA personalities (includes GSM, EDGE, NADC, others)	3,241.00
Opt. 403 Calibrated noise personality	8,104.00
Software personalities	
Opt. 404 cdma2000-1xEV-DO Signal Studio software	4,862.00
Opt. 405 Wireless LAN (802.11b) Signal Studio software	2,431.00
Opt. 406 <i>Bluetooth</i> Signal Studio software	3,241.00
Opt. 408 Enhanced multitone utility	8,104.00
Opt. 410 Wireless LAN (802.11a) Signal Studio software	4,052.00

<sup>(1)</sup> 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 nonlinearities 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 analyzers 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/measure](http://www.agilent.com/find/measure).

## 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 millimeter 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 optimized 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 optimized for LO needs at industry-leading price and performance. The PSG-A series excels at analog 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 synthesized for rates below 10 kHz, providing stable, low-noise FM in narrow-band 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, ODU and radios.

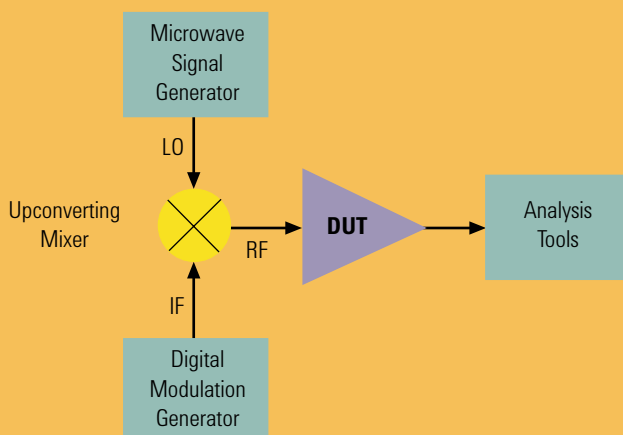
### Digital sweeps of frequency and level

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 synthesized, 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

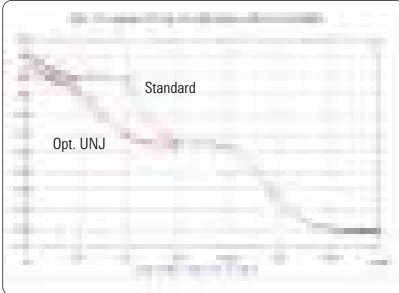
The PSG series replaces the Agilent 836xx and 837xx series of microwave synthesizers. In automated test systems, the PSG series instruments are SCPI-compatible with the previous products.

## 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		
<b>Output power</b>			
20 GHz models	<b>Standard</b>	<b>Option 1EA</b>	
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	<b>Standard</b>	<b>Option 1EA</b>	
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	
<b>CW level accuracy (dB)</b>			
	<b>Output power</b>		
	<b>&gt;+10 dBm</b>	<b>+10 dBm to -10 dBm</b>	<b>-10 dBm to -20 dBm</b>
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
<b>SSB phase noise (CW)</b>			
	<b>Offset from carrier</b>		
	<b>20 kHz (standard)</b>	<b>1 kHz (Opt. UNJ)</b>	
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**

<b>PSG-A Series</b>		
E8251A	250 kHz to 20 GHz	\$45,380.00
E8254A	250 kHz to 40 GHz	67,908.00
<b>PSG-L Series</b>		
E8241A	250 kHz to 20 GHz	32,252.00
E8244A	250 kHz to 40 GHz	50,080.00
	Option UNJ Enhanced phase-noise performance (includes high-stability timebase, Opt. 1E5)	9,238.00
(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:

- **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're 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'll 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.

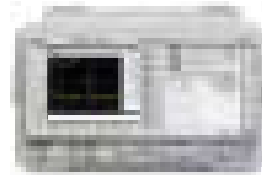
## A full spectrum of signal analysis solutions

- **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**

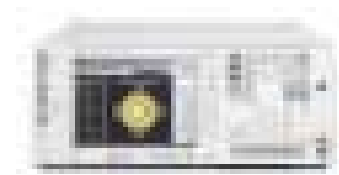
RF and microwave signals are becoming more complex, carrying ever-more information at higher frequencies and in narrower channels. Agilent offers several spectrum analyzer families that address measurement needs in the lab, on the production line and even in the field.

### Cover the basics

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



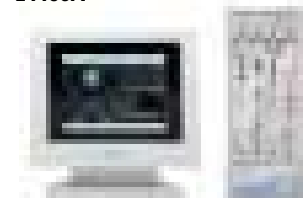
E4402B



E4406A



E4440A



89640A

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 analyzer. Optional measurement personalities let you customize your analyzer 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 analyzers (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's relatively easy to cut test times on the manufacturing line without cutting corners on the quality or thoroughness of your tests. Here's a selection of time-saving ideas developed for spectrum analyzers specifically but applicable to nearly all bus-connected instruments. Some are more obvious than others, but they're 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.

- Minimize DUT connections and reconnections. A high-level look at test programs can reveal possibilities to group tests under a single connection.
- Minimize the number of GPIB transactions by grouping commands together whenever possible.

### Individual features and functions

- Disable analyzer 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 optimized 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.
- Minimize use of the reset (\*RST) command. It gets the instrument back to a known state, but usually

**Agilent Spectrum Analyzer Application Recommendations**

Optional application-specific solutions <sup>11</sup>	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 <sup>12</sup>	
GSM/DCS1800/PCS1900		x	x
GPRS		x	
Modulation analysis		x	
NADC			x
PDC			x
Phase noise		x	x
W-CDMA			x

<sup>11</sup> Generally available as a combination of optional hardware and measurement personalities <sup>12</sup> Available in Agilent E7400 series

**Agilent Vector Signal Analyzer 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 <sup>11</sup>	x <sup>12</sup>	x	x	x <sup>13</sup>
Information bandwidth	narrow/wide <sup>14</sup>	narrow	wide	narrow
Standards-based production and design verification	x			x
Nonstandard signal analysis		x	x	
Software simulation, integration and analysis			x <sup>15</sup>	
Base/mobile station test	x			x

<sup>11</sup> "Flexible modulation analysis" refers to an analyzer's ability to demodulate nonstandard and custom-made signals

<sup>12</sup> Through 89601A software <sup>13</sup> Through a link to Agilent Advanced Design System EDA software (pages 8–9) <sup>14</sup> 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're 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'll often need to explore several

measurement possibilities to understand the tradeoffs, but the effort can pay off in markedly reduced test times.

- Don't use markers in the analyzer to retrieve multiple measurement points from a single trace. It's 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're using the latest version of the instrument firmware to take advantage of the latest speed improvements.

Learn more about a wide variety of analyzer topics, free online at [www.agilent.com/find/measure](http://www.agilent.com/find/measure).

## Verify your designs practically anywhere: bench, line or field

- **Fast sweeps and measurements**
- **Continuously phase-locked synthesizer**
- **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 analyzers offer a flexible range of solutions for R&D, manufacturing and field service. For basic spectrum analysis, the ESA-L series spectrum analyzers 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 color display and a wider range of functions, including optional one-button measurement personalities for specialized 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 synthesized analyzers 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 analyzers 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 customize the ESA-E to meet specific testing requirements. Measurement personalities, downloaded into the analyzer'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

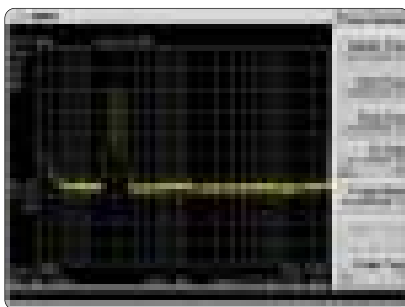
EMC and device test applications, the new log sweep function in the ESA-E series makes it easy to correlate compliance data in the industry-standard log frequency format. (If you already own an ESA analyzer, you can download a free firmware update from [www.agilent.com/find/measure](http://www.agilent.com/find/measure).)

- A new software link utility lets you combine ESA-E analyzers 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 analyzer 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.

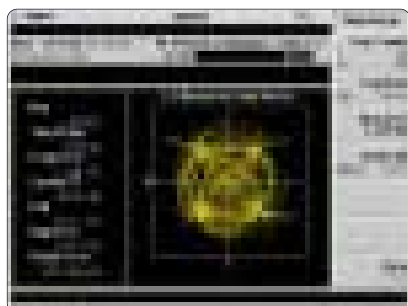




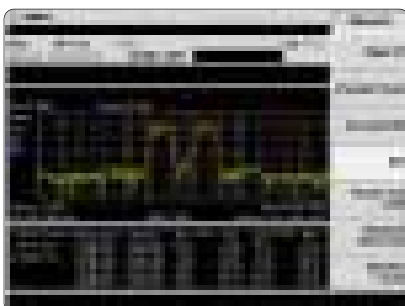
Measure multiple signals in minimal time: get the frequency and amplitude of up to 10 signals in just milliseconds.



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 analyzers 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 analyzer, 9 kHz to 1.5 GHz**  
Starting at \$22,852.00
- **E7402A EMC analyzer, 30 Hz to 3.0 GHz**  
Starting at \$31,847.00
- **E7403A EMC analyzer, 30 Hz to 6.7 GHz**  
Starting at \$41,733.00
- **E7404A EMC analyzer, 30 Hz to 13.2 GHz**  
Starting at \$49,043.00
- **E7405A EMC analyzer, 30 Hz to 26.5 GHz**  
Starting at \$56,401.00

**Agilent ESA Series Spectrum Analyzers**

	<b>ESA-L series E4411/03/08B</b>	<b>ESA-E series E4401/02/04/05/07B</b>
<b>Frequency range</b> standard	9 kHz to 1.5, 3.0 or 26.5 GHz	30 Hz <sup>(1)</sup> to 1.5, 3.0, 6.7, 13.2 or 26.5 GHz <sup>(2)</sup>
<b>Resolution BW range</b>	1 kHz to 5 MHz	1 Hz <sup>(1)</sup> to 5 MHz
<b>Dynamic range</b> (maximum third-order)	83 dB/83 dB/82 dB	109 dB/108 dB/108 dB/108 dB/108 dB <sup>(1)</sup>
<b>Sensitivity</b> Displayed average noise level (DANL)	-117 dBm	-150 dBm <sup>(1,4)</sup> or -166 dBm <sup>(1,3,4)</sup>
<b>Phase noise at 1 GHz</b> at 10 kHz offset at 10 MHz offset	-90 dBc/Hz	-90 dBc/Hz -137 dBc/Hz <sup>(1)</sup>
<b>Accuracy</b> 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)
<b>Speed</b> Minimum RF sweep Minimum zero-span sweep Local measurement rate	4 ms 4 ms ≥28 meas/second <sup>(4)</sup>	1 ms 25 ns <sup>(1)</sup> ≥40 meas/second <sup>(4)</sup>
<b>Price</b>	E4411B starting at \$12,155.00 E4403B starting at 18,800.00 E4408B starting at 38,573.00	E4401B starting at \$19,286.00 E4402B starting at 23,549.00 E4404B starting at 33,549.00 E4405B starting at 41,976.00 E4407B starting at 47,325.00

<sup>(1)</sup> Optional

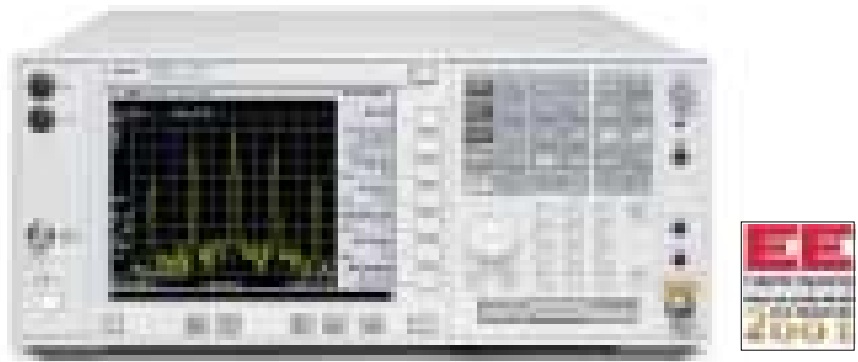
<sup>(2)</sup> To 325 GHz with external mixing

<sup>(3)</sup> With optional built-in preamp

<sup>(4)</sup> 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

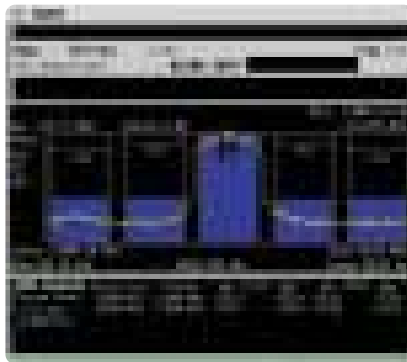
control for advanced customization. Phase noise optimization, 160 resolution bandwidth settings, a 2 dB step attenuator, a full detector suite, and swept and FFT modes are standard in every PSA spectrum analyzer.

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

Characterize 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 Analyzers

**NEW**

	<b>E4443A/E4445A/E4440A</b>	<b>E4446A/E4448A</b>
<b>Frequency range</b>	3 Hz to 6.7, 13.2 or 26.5 GHz	3 Hz to 44 or 50 GHz
<b>Dynamic range</b> (maximum third order) W-CDMA ACPR	113 dB (<3 GHz) 78 dB <sup>(1)</sup> (<3 GHz)	Visit <a href="http://www.agilent.com/find/measure">www.agilent.com/find/measure</a> for details
<b>Sensitivity</b> Displayed average noise level (DANL)	-153 dBm/-166 dBm <sup>(2)</sup> (10 MHz to 3 GHz)	-151 dBm/-164 dBm <sup>(2)</sup> (10 MHz to 3 GHz)
<b>Phase noise at 1 GHz</b> 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
<b>Accuracy</b> Overall amplitude accuracy Span accuracy	±0.65 dB/±0.24 dB <sup>(3)</sup> (<3 GHz) ±0.2% of span	±0.65 dB/±0.24 dB <sup>(3)</sup> (<3 GHz) ±0.2% of span
<b>Speed</b> Minimum RF sweep Minimum zero-span sweep Local measurement rate	1 ms 1 μs ≥50/second	1 ms 1 μs ≥50/second
<b>Resolution BW range</b> (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
<b>Price</b>	E4440A starting at \$77,146.00 E4443A starting at \$67,422.00 E4445A starting at \$70,663.00	E4446A starting at \$109,900.00 E4448A starting at \$130,310.00

<sup>(1)</sup> Typical with noise correction

<sup>(2)</sup> With optional built-in preamplifier

<sup>(3)</sup> 95% confidence

## Uncover RF and DSP problems throughout your block diagram



- **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 analyzers (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. Analyze 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 analyzers. 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 analyzer, as well as the 54800 series Infiniium oscilloscopes.

### **89400 series VSA, dc to 2.65 GHz**

Offering flexible demodulation for design troubleshooting, 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's also compatible with the 89601A VSA software for additional troubleshooting measurements and flexible vector modulation analysis.

Agilent Vector Signal Analyzers			
	89400 VSA series	89600 VSA series	E4406A VSA
<b>Frequency range</b>	<b>89410A:</b> dc to 10 MHz <b>89441A:</b> dc to 2.65 GHz <b>89441V:</b> VSB/QAM	<b>89641A:</b> dc to 6.0 GHz <b>89640A:</b> dc to 2.7 GHz <b>89610A:</b> dc to 40 MHz <b>89611A:</b> 70 MHz IF	7 MHz to 4 GHz
<b>Sensitivity at 1 GHz</b>	-160 dBm/Hz	-159 dBm/Hz	-106 dBm (1 kHz RBW)
<b>Phase noise</b>	-116 dBc/Hz (10 kHz offset)	-99 dBc/Hz (20 kHz offset)	-99 dBc/Hz (10 kHz offset)
<b>Amplitude accuracy</b>	±1.0 dB	±2.0 dB	±0.6 dB
<b>Information bandwidth</b>	8 MHz	36 MHz	8 MHz
<b>Resolution BW range</b>	<1 Hz to 3 MHz	<1 Hz to 10 MHz	10 Hz to 7.5 MHz
<b>Price</b>	Starting at \$51,458.00	Starting at \$56,725.00	\$46,839.00

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## Tackle the most demanding active and passive devices



- **Excellent measurement accuracy**
- **Fast, precise, integrated synthesized 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 analyzers 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.

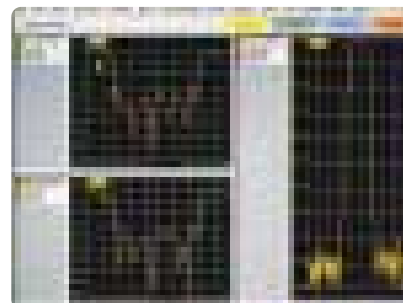
On the production line, advanced productivity features such as automated pass/fail testing and segmented sweeps help accelerate test throughput. Built-in sequencing, programming and connectivity capabilities increase the flexibility of your test systems, and can decrease the cost of test.

### Agilent Network Analyzers

	<b>E8356/7/8A E8362/3/4A E8801/2/3A N3381/2/3A</b> (page 23)	<b>E5070A E5071A</b> (page 24)	<b>8753ES/ET</b> (page 25)	<b>8719ES/ET 8720ES/ET 8722ES/ET</b> (page 26)	<b>8712ES/ET 8714ES/ET</b> (page 27)
<b>Frequency range</b>	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
<b>System dynamic range at test port</b>	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
<b># of ports</b>	2 or 3	2, 3 or 4	2	2	2
<b>Power range</b>	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
<b>Key advantages</b>	Up to 50 GHz frequency coverage  Exceptional dynamic range for high-rejection measurements  TRL and mixed-connector calibration  Advanced automation	Multipoint 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 noncoaxial 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 analyzers 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 analyzers offer performance that is similar to the E8356/7/8A. A host of optional capabilities lets you custom-fit an analyzer 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 programs can execute in the analyzer or an external PC; you can program easily using COM/DCOM or use SCPI commands.

### Agilent PNA Series Network Analyzers

	<b>E8362/3/4A</b>	<b>E8356/7/8A</b>	<b>E8801/2/3A</b>	<b>N3381/2/3A</b>
<b>Frequency range</b>	45 MHz to 20/40/50 GHz	300 kHz to 3/6/9 GHz		
<b>Number of ports</b>	2	2	2	3
<b>System dynamic range at test port</b>	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		
<b>Power range</b>	-25 dBm to +5 dBm*	-85 dBm to +10 dBm		
<b>Trace noise (typical)</b>	<0.010 dB rms to 500 MHz <0.006 dB rms to 50 GHz (1 kHz BW)	<0.002 dB rms (1 kHz BW)		
<b>Price</b>	Starting at \$121,500.00	Starting at \$69,691.00	Starting at \$58,346.00	Starting at \$66,449.00

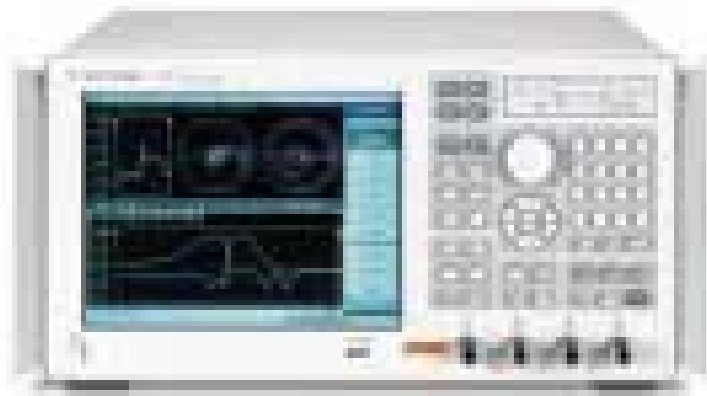
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## Ready for new generation, multiport RF devices

- **2, 3 or 4 built-in test ports with full port calibration**
- **Multiport measurements as fast as 9.6  $\mu$ s/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 analyzers 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 minimizes 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 Analyzers

	<b>E5070A</b>	<b>E5071A</b>
<b>Frequency range</b>	300 kHz to 3 GHz	300 kHz to 8.5 GHz
<b>Number of ports</b>	2, 3 or 4	2, 3 or 4
<b>System dynamic range at test port</b>	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
<b>Power at test port</b>	-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
<b>Trace noise, 3 kHz BW</b>	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
<b>Price</b>	2 port \$45,380.00 3 port 61,587.00 4 port 74,553.00	2 port \$56,725.00 3 port 73,932.00 4 port 82,656.00

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## 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 analyzers 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  $\Omega$  or 75  $\Omega$ ). The more economical 8753ET performs forward measurements with its built-in transmission/reflection test set (50  $\Omega$ ).

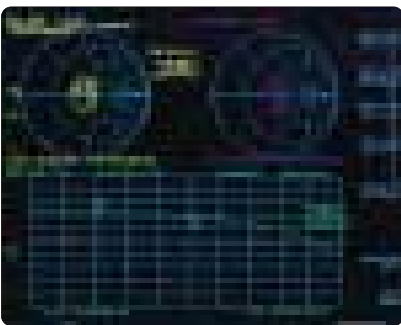
Both models provide a full range of magnitude and phase measurements up to 3 GHz or 6 GHz.

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 characterize active and passive networks, devices, components and subsystems. Swept-list-frequency mode optimizes 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 characterizes the nonlinear 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 Analyzers

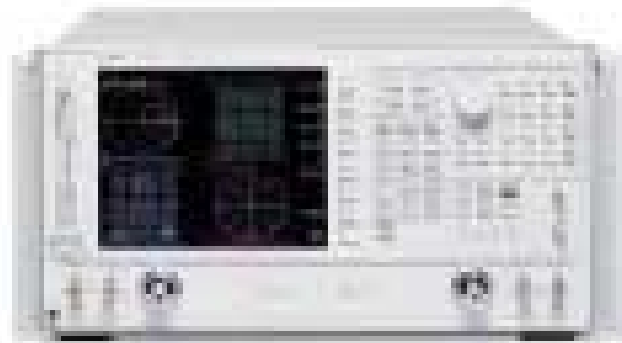
	<b>8753ES</b>	<b>8753ET</b>
<b>Frequency range</b>	Standard: 30 kHz to 3 GHz Optional: 30 kHz to 6 GHz	Standard: 300 kHz to 3 GHz Optional: 300 kHz to 6 GHz
<b>Number of ports</b>	2	2
<b>System dynamic range at test port</b>	100–110 dB, 300 kHz to 3 GHz 105 dB, 3 GHz to 6 GHz	110 dB, 300 kHz to 3 GHz 105 dB, 3 GHz to 6 GHz
<b>Power at test port</b>	–85 dBm to +10 dBm	–20 dBm to +5 dBm
<b>Trace noise (typical), 3 kHz BW</b>	<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
<b>Price</b>	starting at \$58,346.00	starting at \$45,542.00

Call Agilent Technologies at 1-877-894-4414

[www.agilent.com/find/measure](http://www.agilent.com/find/measure)

## Boost the design and production of microwave components

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



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

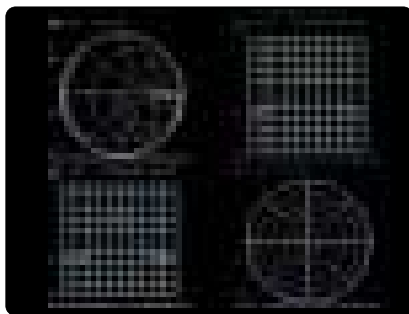
a synthesized source with an integrated test set, covering frequencies from 50 MHz to 13.5, 20 or 40 GHz.

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 noncoaxial 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 analyzer'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 Analyzers

	<b>8719ES, 8720ES, 8722ES</b>	<b>8719ET, 8720ET, 8722ET</b>
<b>Frequency range</b>	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
<b>Number of ports</b>	2	2
<b>System dynamic range at test port</b>	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
<b>Power at test port</b>	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
<b>Trace noise (typical), 3 kHz BW</b>	<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
<b>Price</b>	8719ES starting at \$ 75,987.00 8719ET starting at 61,644.00 8720ES starting at 96,870.00 8720ET starting at 76,741.00 8722ES starting at 132,266.00 8722ET starting at 108,612.00	

## Thorough component testing at mass-production prices



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're 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'll get fast sweeps with a 1 Hz resolution source. All models provide broadband detection for scalar characterization 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 analyzers 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.

- **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**

### Agilent 8712E Series Network Analyzers

<b>8712ET</b>	300 kHz to 1.3 GHz, T/R test set	\$16,296.00
<b>8712ES</b>	300 kHz to 1.3 GHz, S-parameter test set	26,361.00
<b>8714ET</b>	300 kHz to 3.0 GHz, T/R test set	27,204.00
<b>8714ES</b>	300 kHz to 3.0 GHz, S-parameter test set	37,268.00

## MEASUREMENT TIP: CHARACTERIZING 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, characterize, 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 characterize 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/measure](http://www.agilent.com/find/measure).*

## 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**
- **Analyzer 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  $\pm 0.02$  dB ( $\pm 0.5\%$ ), 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
<b>Frequency Range</b> <sup>(1)</sup>	9 kHz to 110 GHz			
<b>Power Range</b> <sup>(1)</sup> 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
<b>Measurement speed</b> 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
<b>Standard interfaces</b>	GPIB, RS-232 and RS-422			
<b>Price</b>	\$6,167.00	\$9,692.00	\$4,886.00	\$8,379.00

### Agilent E-Series Power Sensors

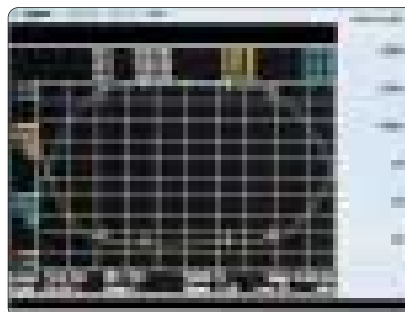
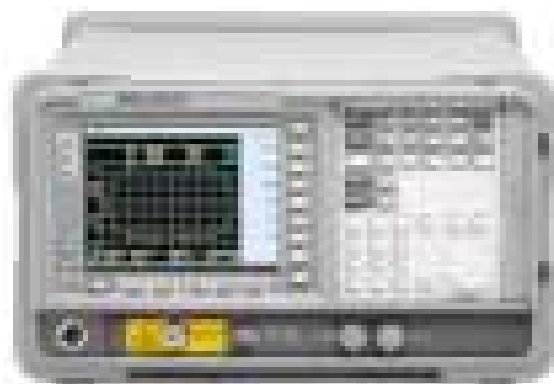
	Sensor Type	Frequency Range	Video BW	Power Range	Connector	Price
<b>E4412A</b>	CW power	10 MHz to 18 GHz	N/A	-70 dBm to +20 dBm	N (m)	\$2,261.00
<b>E4413A</b>	CW power	50 MHz to 26.5 GHz	N/A	-70 dBm to +20 dBm	APC-3.5 mm (m)	3,039.00
<b>E9301A</b>	Average power	10 MHz to 6 GHz <sup>(2)</sup>	N/A	-60 dBm to +20 dBm	N (m)	2,261.00
<b>E9301B</b>	Average power	10 MHz to 6 GHz <sup>(2)</sup>	N/A	-30 dBm to +44 dBm	N (m)	3,857.00
<b>E9301H</b>	Average power	10 MHz to 6 GHz <sup>(2)</sup>	N/A	-50 dBm to +30 dBm	N (m)	2,585.00
<b>E9304A</b>	Average power	9 kHz to 6 GHz	N/A	-60 dBm to +20 dBm	N (m)	2,569.00
<b>E9321A</b> <sup>(3)</sup>	Peak/average power	50 MHz to 6 GHz <sup>(2)</sup>	300 kHz	-65 dBm to +20 dBm	N (m)	2,431.00
<b>E9322A</b> <sup>(3)</sup>	Peak/average power	50 MHz to 6 GHz <sup>(2)</sup>	1.5 MHz	-60 dBm to +20 dBm	N (m)	3,241.00
<b>E9323A</b> <sup>(3)</sup>	Peak/average power	50 MHz to 6 GHz <sup>(2)</sup>	5 MHz	-60 dBm to +20 dBm	N (m)	4,457.00

<sup>(1)</sup> Sensor-dependent

<sup>(2)</sup> 18 GHz models available. Contact Agilent Technologies for more information.

<sup>(3)</sup> For use with Agilent E9288A sensor cable

## Give your designs an edge by optimizing 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 analyzers 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 characterization**

NFA series noise figure analyzers 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 onscreen 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 analyzer, ENR data is stored electronically inside the noise source and downloads automatically when you connect the source to the analyzer. 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 <sup>[1]</sup>	Measurement range	-20 dB to +40 dB		
	Instrument uncertainty	±<0.17 dB		

Agilent NFA Series Measurement Speed <sup>[2]</sup> (nominal)				
	Frequency range	8 averages	64 averages	Price
N8972A	(10 MHz to 1.5 GHz)	<100 ms/measurement	<80 ms/measurement	\$28,119.00
N8973A	(10 MHz to 3.0 GHz)	<50 ms/measurement	<42 ms/measurement	38,168.00
N8974A	(10 MHz to 3.0 GHz)	<50 ms/measurement	<42 ms/measurement	54,699.00
	(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	80,630.00
	(3.0 GHz to 26.5 GHz)	<70 ms/measurement	<50 ms/measurement	

<sup>[1]</sup> 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.

<sup>[2]</sup> 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 analyze circuit behaviour. 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 minimize 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	Price	Page	
<b>54621A</b>	60 MHz	200 MSa/s	2	4 MB	High-definition display, serial triggering standard (SPI, CAN, USB, I <sup>2</sup> C) 	\$ 3,963.00	32	
<b>54621D</b>	60 MHz	200 MSa/s	2 analogue, 16 digital	4 MB		6,394.00	32	
<b>54622A</b>	100 MHz	200 MSa/s	2	4 MB		5,259.00	32	
<b>54622D</b>	100 MHz	200 MSa/s	2 analogue, 16 digital	4 MB		8,014.00	32	
<b>54624A</b>	100 MHz	200 MSa/s	4	4 MB		8,014.00	32	
<b>NEW 54641A</b>	350 MHz	2 GSa/s	2	8 MB		High-definition display, serial triggering standard (SPI, CAN, USB, I <sup>2</sup> C) 	10,527.00	32
<b>NEW 54641D</b>	350 MHz	2 GSa/s	2 analogue, 16 digital	8 MB			15,875.00	32
<b>NEW 54642A</b>	500 MHz	2 GSa/s	2	8 MB			14,254.00	32
<b>NEW 54642D</b>	500 MHz	2 GSa/s	2 analogue, 16 digital	8 MB	20,251.00		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	Price	Page
<b>NEW 54830B</b>	600 MHz	4 GSa/s	2	4 MB standard 16 MB optional	Lowest-cost Infiniium with deep memory 	\$20,980.00	31
<b>NEW 54831B</b>	600 MHz	4 GSa/s	4		Lowest-cost 4 channel Infiniium with deep memory 	29,084.00	31
<b>NEW 54832B</b>	1 GHz	4 GSa/s	4		High bandwidth with deep-memory Infiniium 	33,946.00	31
<b>54845B</b>	1.5 GHz	8 GSa/s	4	64 kB	Wide bandwidth with fastest sample rate	49,343.00	31
<b>54846B</b>	2.25 GHz	8 GSa/s	4		Highest-performance Infiniium oscilloscope	55,015.00	31

 Quick Ship is available for most of the products listed here. Call Agilent Technologies for more information.

## 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**

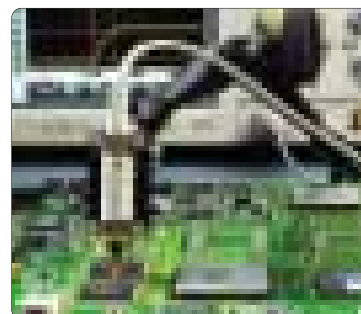
Agilent Infiniium 54800 series oscilloscopes combine the high performance of digital technology with the simple look and feel of analogue scopes.

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
<b>Bandwidth</b>	600 MHz	600 MHz	1 GHz	1.5 GHz	2.25 GHz
<b>Channels</b>	2	4	4	4	4
<b>Max sample rate</b>	4 GSa/s	4 GSa/s	4 GSa/s	8 GSa/s	8 GSa/s
<b>Memory depth</b>	up to 4 MB (2 MB/ch) standard up to 16 MB optional			32 kB on all channels, 64 kB on 2 channels	
<b>Trigger mode</b>	Edge, glitch, pattern, delay by time/events, setup/hold violation, pulse width, rise/fall time violation, video, line				
<b>Storage</b>	5.0 GB hard drive, 3.5" 1.44 MB/120 MB Super Disk, CD-ROM drive				
<b>Interfaces</b>	GPIB, RS-232, Centronics, 10/100 Mb/s LAN, USB, VGA, PS/2 mouse and keyboard				
<b>Price</b>	\$20,290.00	\$29,084.00	\$33,946.00	\$49,343.00	\$55,015.00
4 MB/ch memory	+\$3,160.00	+\$6,402.00	+\$6,402.00	N/A	N/A
8 MB/ch memory	+\$5,591.00	+\$11,264.00	+\$11,264.00	N/A	N/A



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

Call Agilent Technologies at 1-877-894-4414

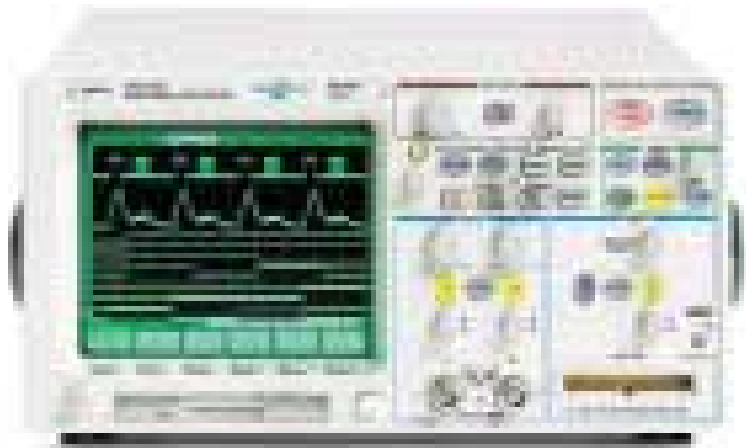
[www.agilent.com/find/measure](http://www.agilent.com/find/measure)



## 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 won't show you**
- **Standard serial trigger including I<sup>2</sup>C, 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's like opening a new window to see inside your circuits.

You'll see subtle details you couldn't see before, from narrow transients to distorted edges to intermittent defects, with greater fidelity than you've probably ever seen 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 I<sup>2</sup>C, 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/measure](http://www.agilent.com/find/measure).

### Finding hidden component problems at IBM using deep-memory scopes

Every engineer knows the feeling: The CPU is doing everything it's supposed to do and everything else is in order, but the system still doesn't 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 start-up sequence on these cards with a logic analyzer (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, of course, the lower the resolution, which meant the expected chip select activity could have actually been taking place in between samples.

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

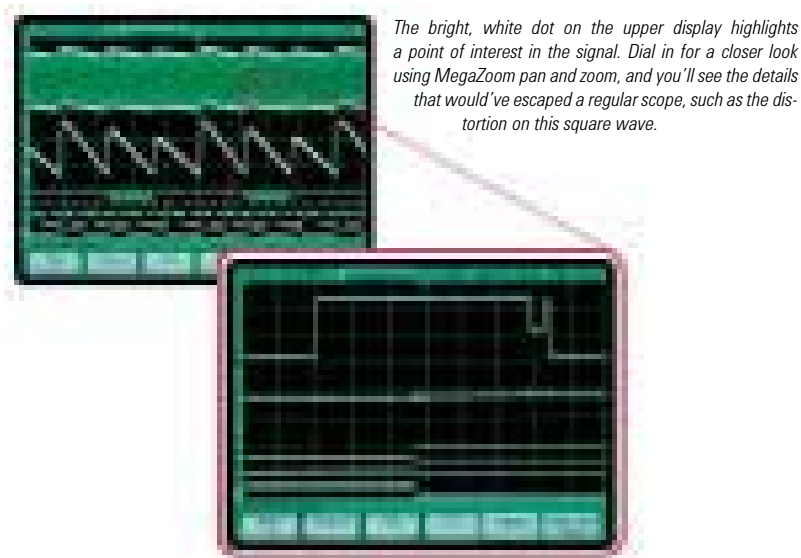


Figure 1: The flash memory module was receiving the correct control signals after the reset signal (RP\_N, top trace) went inactive but its outputs were still tristated and expected chip select activity (in the area outlined by the display markers) was nowhere to be seen.

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

Agilent 54600 Series Oscilloscopes									
	54621A	54621D	54622A	54622D	54624A	54641A	54641D	54642A	54642D
<b>Bandwidth</b>	60 MHz	60 MHz	100 MHz	100 MHz	100 MHz	350 MHz	350 MHz	500 MHz	500 MHz
<b>Channels</b>	2	2 + 16 digital	2	2 + 16 digital	4	2	2 + 16 digital	2	2 + 16 digital
<b>Maximum sample rate</b>	200 MSa/s					2 GSa/s			
<b>Maximum memory depth</b>	4 MB					8 MB			
<b>Trigger modes</b>	Edge, pulse width, pattern, TV, sequence, duration, enhanced I <sup>2</sup> C, SPI, CAN frame, USB frame trigger								
<b>Price</b>	\$3,963.00	\$6,394.00	\$5,259.00	\$8,014.00	\$8,014.00	\$10,527.00	\$15,875.00	\$14,254.00	\$20,251.00

 Quick Ship is available for all the products listed here. Call Agilent Technologies for more information.



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'll see the details that would've escaped a regular scope, such as the distortion on this square wave.



With serial communication trigger mode, verifying handshaking is easier than ever.

Call Agilent Technologies at 1-877-894-4414

[www.agilent.com/find/measure](http://www.agilent.com/find/measure)

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 wasn't the memory responding?

Because deep memory captured much more data than was actually shown onscreen initially, 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

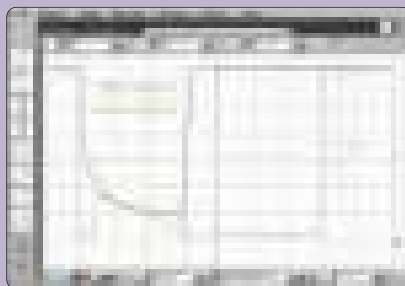


Figure 2: A high-resolution deep-memory waveform capture uncovered chip select activity (CS\_N) shortly after the chip reset signal (RP\_N) went inactive high.

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 been

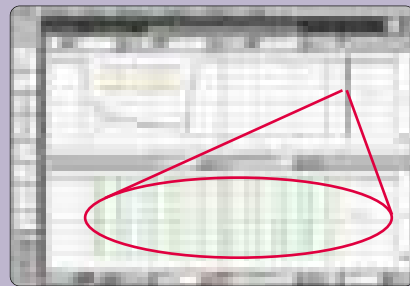


Figure 3: Zooming in on the captured data with 5000X magnification revealed nearly two dozen individual chip select commands.

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



LogicWave

Your digital design challenges certainly aren't 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 analyzers offer intuitive, single-window operation. A variety of new trigger capabilities lets you trigger the way you think during troubleshooting.
- The unique Agilent LogicWave E9340A PC-hosted logic analyzer 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 analyzers and emulation probes.

### Selecting a Logic Analysis Solution

	<b>16700B, 16702B Modular Logic Analysis Systems</b> <small>(page 35)</small>	<b>1680, 1690 Series Benchtop Logic Analyzers</b> <small>(pages 42–43)</small>	<b>E9340A LogicWave PC-Hosted Logic Analyzer</b> <small>(www.agilent.com/find/measure)</small>	<b>54620 and 54640 Series Mixed-Signal Oscilloscopes</b> <small>(pages 32–33)</small>	<b>Trace Port Analyzers</b> <small>(page 40)</small>	<b>Run Control Emulation Probes</b> <small>(page 40)</small>
<b>State analysis</b>	100 MHz to 1.5 Gb/s	200 MHz	100 MHz	N/A	Processor-dependent	N/A
<b>Timing analysis</b>	Up to 4 GHz	Up to 800 MHz	250 MHz	Up to 1 GSa/s	N/A	N/A
<b>Transitional timing</b>	Most modules	200 MHz	N/A	N/A	N/A	N/A
<b>2 GHz timing zoom</b>	Most modules	N/A	N/A	N/A	N/A	N/A
<b>Logic channels</b>	Up to 8,160	Up to 136	32	16	Processor-dependent	N/A
<b>Inverse assembly</b>	Broad coverage	Select coverage	N/A	N/A	N/A	N/A
<b>Optional analysis toolsets</b>	See page 39	N/A	N/A	N/A	N/A	N/A
<b>Emulation</b>	See page 40	N/A	N/A	N/A	See page 40	See page 40
<b>Advantages</b>	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 benchtop or cost-saving PC-hosted model		Integrated oscilloscope channels		
	Touch screen	Single-screen operation				
	Multiple bus analysis	Offline analysis				
	Deepest memory					

 Quick Ship is available for the E9340A. Call Agilent Technologies at 1-877-894-4414 for more information.

## 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're ready for today's ultrafast systems. To simplify signal capture, analysis probes provide customized 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.

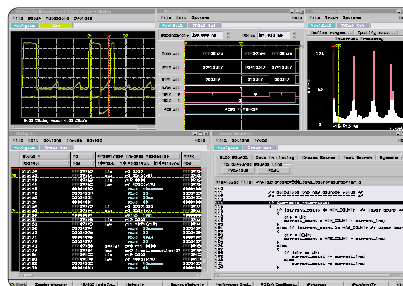
### The power to handle today's digital systems

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

<b>16700B mainframe</b>	Five measurement module slots, one emulation module slot
<b>16702B mainframe</b>	Five measurement module slots, one emulation module slot
<b>16701B expansion mainframe</b>	Five measurement module slots, two emulation module slots
<b>Memory depth</b>	8 K to 64 M (depending on module selection)
<b>Ordering information</b>	
16700B mainframe	\$17,423.00
16702B mainframe	19,351.00
16701B expansion mainframe	9,060.00
Option 008 18 GB external data drive	3,241.00
Option 012 multiframe (connect up to 8 mainframes and expanders)	8,104.00



Get a complete, simultaneous view of your system, from analogue signals to source code, along with extensive performance analysis and run-control tools.

Call Agilent Technologies at 1-877-894-4414

[www.agilent.com/find/measure](http://www.agilent.com/find/measure)

## 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 and memory depth to isolate and analyze pipelined architectures and split transactions.

Agilent 16740A, 16741A, 16742A, 16750B, 16751B and 16752B 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're using differential signaling 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 don't 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	16750B/51B/52B	16760A
<b>Maximum state clock</b>	100 MHz	167 MHz	167 MHz	333 MHz	200 MHz	400 MHz	1.5 Gb/s
<b>Maximum timing sampling rate</b> (half/full channels)	500/250 MHz	667/333 MHz	667/333 MHz	667/333 MHz	800/400 MHz	800/400 MHz	800 MHz
<b>2 GHz timing zoom</b>	No	No	Yes	Yes	Yes	Yes	No
<b>Transitional timing</b>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<b>Eye finder</b>	No	Yes	Yes	Yes	Yes	Yes	Yes
<b>Memory depth</b> (half/full channels) <sup>(1)</sup>	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	16750B: 8/4 M 16751B: 32/16 M 16752B: 64/32 M	128/64 M <sup>(4)</sup>
<b>Setup/hold time</b>							
Window	4.0 ns <sup>(2)</sup>	2.5 ns	2.5 ns	2.5 ns	2.5 ns <sup>(3)</sup>	2.5 ns <sup>(3)</sup>	1 ns
With eye finder	N/A	1.25 ns	1.25 ns	1.25 ns	1.25 ns	1.25 ns	500 ps
Adjustment resolution	500 ps	100 ps	100 ps	100 ps	100 ps	100 ps	10 ps
<b>Channels per module</b>	102	68	68	68	68	68	34
<b>Maximum channels</b> on a single timebase and trigger	204	340	340	340	340	340	170
<b>Price</b>	16710A: \$12,617.00 16711A: \$15,859.00 16712A: \$20,235.00	\$26,717.00	\$23,476.00	\$32,228.00	16740A: \$22,666.00 16741A: \$29,148.00 16742A: \$40,493.00	16750B: \$37,252.00 16751B: \$45,356.00 16752B: \$58,321.00	\$46,976.00

<sup>(1)</sup> Increased memory depth in half-channel timing mode only

<sup>(2)</sup> 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.

<sup>(3)</sup> Minimum setup/hold specified for single-clock, single-edge acquisition. For multiclock or multi-edge acquisition, setup/hold window is 3 ns.

<sup>(4)</sup> 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 analyzer 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.

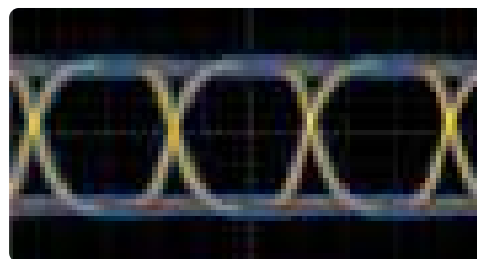
**Flexible analysis tools**

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 optimize displays and to balance statistical richness versus overall test time.

**Identify InfiniBand system problems at the protocol view**

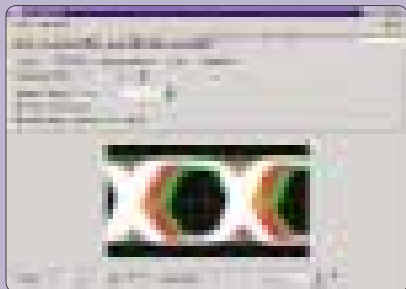
Get new insights into tough system problems caused by the increasing use of protocol on higher- and higher-speed inter-chip interconnects. InfiniBand (IB) protocol analysis tools for the 16700 series logic analysis system and highly tuned IB analysis and IB data generation in the E2950 series provide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

For more information, please visit [www.agilent.com/find/measure](http://www.agilent.com/find/measure).



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 noncompliant 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.

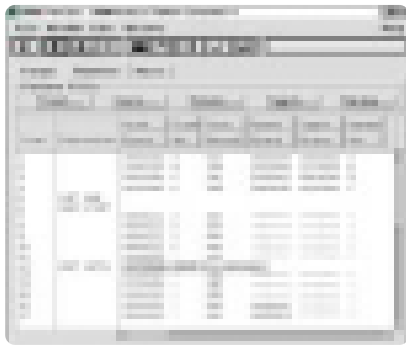
You may also want to vary power supply voltage or temperature while monitoring signal integrity using eye scan.

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'll 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/measure](http://www.agilent.com/find/measure).

**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**

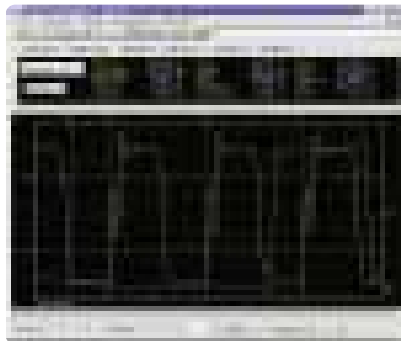
	Half channels	Full channels
<b>Maximum clock speed</b>	300 MHz	180 MHz
<b>Memory depth</b>	16 M vectors	8 M vectors
<b>Channels per card</b>	24	48
<b>Channels per timebase</b>	120	240
<b>Stimulus commands</b>	Initialize, block, repeat, and break macros	
<b>Logic levels supported</b>	5 V TTL, 3 state 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	
<b>Price</b>	\$17,787 + data and clock pods	

**Pod options for 16720A**

	Price
Option 011 TTL clock pod & lead set	\$316.00
Option 013 3 state TTL/CMOS data pod & lead set	316.00
Option 014 TTL data pod & lead set	316.00
Option 015 2.5 V clock pod & lead set	316.00
Option 016 2.5 V 3 state data pod & lead set	316.00
Option 017 3.3 V clock pod & lead set	316.00
Option 018 3.3 V 3 state data pod & lead set	316.00
Option 021 ECL clock pod & lead set	316.00
Option 022 ECL (terminated) data pod & lead set	316.00
Option 023 ECL (unterminated) data pod & lead set	608.00
Option 031 5 V PECL clock pod & lead set	316.00
Option 032 5 V PECL data pod & lead set	316.00
Option 033 3.3 V LVPECL clock pod & lead set	316.00
Option 034 3.3 V LVPECL data pod & lead set	316.00
Option 041 1.8 V clock pod & lead set	316.00
Option 042 1.8 V 3 state data pod & lead set	316.00
Option 051 LVDS clock pod & lead set	316.00
Option 052 LVDS data pod & lead set	316.00

**High-performance digitizing oscilloscope**

The Agilent 16534A digitizing oscilloscope module offers the advantages of a full-featured, deep-memory, colour scope integrated into your logic analyzer. 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 Digitizing Oscilloscope Module**

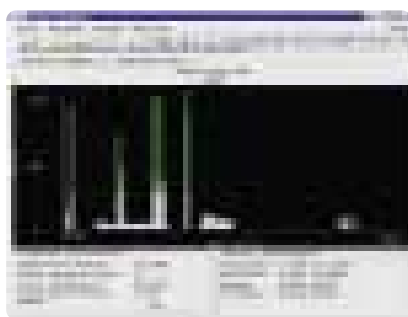
<b>Bandwidth</b>	500 MHz
<b>Maximum sampling rate</b>	2 GSa/s
<b>Memory depth</b>	32 K
<b>Channels per card</b>	2
<b>Maximum number of channels on a single trigger and timebase</b>	8
<b>Price</b>	\$14,894.00



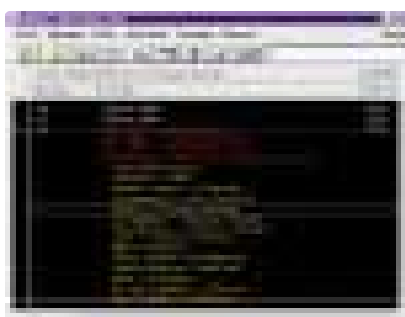
## Find root causes faster and boost system performance

Check out these optional postprocessing tools for the 16700 series.

Application	Agilent Tool
<b>Debug parallel data communications buses</b> Display logic analyzer 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
<b>Debug the new storage area network technology</b> 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
<b>Extend your view of Gigabit Ethernet IP systems</b> 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
<b>Debug and validate MPEG-2 based systems</b> Display trace information at a protocol level. Powerful trigger macros allow triggering on standard or custom protocol fields. Also analyze transport stream, program stream and packetized elementary stream directly.	B4645B MPEG-2 protocol analysis tool
<b>Debug your real-time code at the source level</b> Correlate a logic analyzer trace with the high-level source code that produced it. Set up the logic analyzer trace by simply pointing and clicking on a line of source code.	B4620B source correlation tool
<b>Optimize your target system's performance</b> Profile your target system's performance to identify system bottlenecks and to identify areas needing optimization.	B4600B system performance analysis tool
<b>Solve your serial communications problems</b> 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
<b>Customize your trace for greater insight</b> Create custom tools using the C programming language. Custom tools can analyze captured data and present it in a form that makes sense to you.	B4605B tool development kit
<b>Measure GigaBit protocol with RapidIO</b> Display RapidIO packets for 8 and 16 bit LP-LVDS interconnects.	N4215A RapidIO protocol analysis tool
<b>Protocol decode for OC-192, POS-PHY L4, SPI4-2</b> 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're 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.

Call Agilent Technologies at 1-877-894-4414

[www.agilent.com/find/measure](http://www.agilent.com/find/measure)

## Customized processor support and powerful emulation

Agilent and Third-Party Processor Support						
Device manufacturer or architecture and name	Run control emulation probes	Emulation modules	Trace port analyzers	Inverse assembly/probing support		
	Link to the processor's debug port for a convenient way to download code, modify memory and registers, and control program execution.	Add the same emulation capability of an emulation probe as part of an integrated solution built around your 16700 series logic analyzer.	Provide emulation and real-time execution trace information; can be integrated with the 16700 series for coordinated system analysis.	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				EPMS192-P		
AMD				29xxx, 186CC 186/188 EM/ES		
Analog Devices				ADSP 21xx		
ARM®7/9TDMI	E5900B #300 \$5,664.00	E5901B #300 \$6,151.00		ARM7, ARM7-Thumb, ARM9, ARM9-Thumb		
ARM7/9-ETM			E5904B #300 \$12,966.00			
GTE				65816		
IBM PPC 4xx	E5900B #060 \$5,664.00	E5901B #060 \$6,151.00	E5904B #060 \$12,966.00	PowerPC 403/405/601/603/740/750/750Cxe		
IBM PPC 6xx	E5900B #060 \$5,664.00	E5901B #060 \$6,151.00				
IBM PPC 7xx	E5900B #070 \$5,664.00	E5901B #070 \$6,151.00				
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	E5900B #060 \$5,664.00	E5901B #060 \$6,151.00		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		
Motorola PPC 7xx	E5900B #070 \$5,664.00	E5901B #070 \$6,151.00				
Motorola MPC 8xx	E5900B #080 \$5,664.00	E5901B #080 \$6,151.00				
Motorola MPC 74xx	E5900B #110 \$5,664.00	E5901B #110 \$6,151.00				
Motorola MPC 82xx	E5900B #100 \$5,664.00	E5901B #100 \$6,151.00				
Motorola M CORE	E5900B #090 \$5,664.00	E5901B #090 \$6,151.00				
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, R4000, R4400PC	E5900A #800* \$5,664.00	E5901A #800* \$5,664.00	E5903A #800* \$4,854.00	R3900, R4000/4400PC		
Toshiba TMPR 3927	E5900A #810* \$5,664.00		E5903A #810* \$5,664.00			
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)	GPIO, HPIB (IEEE488)	HyperTransport	I <sup>2</sup> C	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			



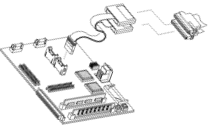
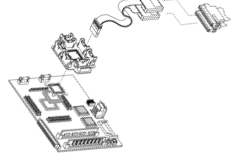
For more information, refer to *Processor and Bus Support for Agilent Technologies Logic Analyzers* at [www.agilent.com/find/measure](http://www.agilent.com/find/measure) or call 1-877-894-4414. ARM is a registered trademark of ARM Limited. Intel and Pentium are U.S. registered trademarks and Celeron 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's an overview of the four major

approaches to probing; you can find complete information about all these accessories at [www.agilent.com/find/measure](http://www.agilent.com/find/measure).

Approach	Advantages	Limitations	Key accessories
 <p><b>Connecting to individual test points with flying leads</b></p>	<p>Most flexible method</p> <p>Flying lead probes are included with all Agilent logic analyzer modules (except 16760A)</p>	<p>Can be time-consuming when measuring multiple channels</p> <p>Least space-efficient method</p>	<p>Lead sets</p> <p>IC clips</p> <p>SMD clips</p> <p>Wedge probe adapters</p>
 <p><b>Connecting to all pins on a quad flat-pack (QFP) package</b></p>	<p>Rapid access to all pins on QFP packages</p> <p>Very reliable connections</p>	<p>Adapter requires a small amount of clearance around the chip</p>	<p>Elastomeric probe adapters</p> <p>¼ flexible adapters</p>
 <p><b>Designing connectors into the target system</b></p>	<p>Very reliable connections</p> <p>Saves time when making multiple connections</p>	<p>Requires planning in the design stage</p> <p>Requires small amount of dedicated board space</p> <p>Slight incremental cost</p>	<p>High-density probe adapters</p> <p>Moderate-density probe adapters</p> <p>16760A-specific probes</p>
 <p><b>Using a processor- or bus-specific analysis probe</b></p>	<p>Easiest and fastest connection to supported processors and buses</p>	<p>Moderate to significant incremental cost</p> <p>Usable only for the supported processor or bus</p> <p>Might require a small amount of clearance around the chip</p>	<p>Analysis probes <i>(see page 40 for list of supported processors and buses)</i></p>

For more information on specific solutions, refer to *Probing Solutions for Agilent Logic Analysis Systems* at [www.agilent.com/find/measure](http://www.agilent.com/find/measure) or call 1-877-894-4414.

### 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 analyzer 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 analyzer, sometimes even more than the probe itself.

For instance, here's 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 Analyzer Probing*. Call Agilent Technologies for a free copy or download it at [www.agilent.com/find/measure](http://www.agilent.com/find/measure).

## 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 analyzers 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 customize 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 analyzers.

Plus, you can make the most efficient use of your time and equipment. While your analyzer 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.

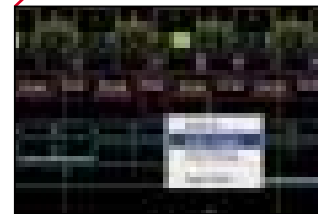
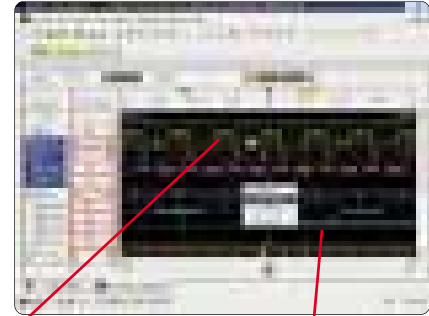
### **Protect your 1670G series investment**

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.

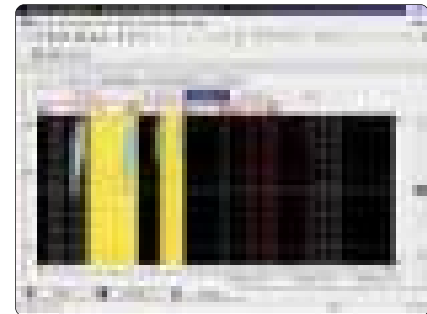
### **Take a test drive**

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

Agilent 1680 and 1690 Series Logic Analyzers				
<b>Benchtop models</b>	<b>1680A, 1680AD</b>	<b>1681A, 1681AD</b>	<b>1682A, 1682AD</b>	<b>1683A, 1683AD</b>
<b>PC-hosted models</b>	<b>1690A, 1690AD</b>	<b>1691A, 1691AD</b>	<b>1692A, 1692AD</b>	<b>1693A, 1693AD</b>
<b>Channels</b>	136	102	68	34
<b>State speed</b>	200 MHz on all channels			
<b>Timing speed</b>	400/800 MHz (full/half channels)			
<b>Transitional timing speed</b>	200 MHz on all channels			
<b>Memory depth</b>	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			
<b>1680 series I/O and storage</b>	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			
<b>Ordering information</b>				
<b>Channels</b>	136	102	68	34
<b>Benchtop with standard memory</b>	<b>1680A</b>	<b>1681A</b>	<b>1682A</b>	<b>1683A</b>
<b>Price</b>	\$34,035.00	\$28,362.00	\$22,690.00	\$17,017.00
<b>Benchtop with deep memory</b>	<b>1680AD</b>	<b>1681AD</b>	<b>1682AD</b>	<b>1683AD</b>
<b>Price</b>	\$43,759.00	\$35,656.00	\$27,552.00	\$19,449.00
<b>PC-hosted with standard memory</b>	<b>1690A</b>	<b>1691A</b>	<b>1692A</b>	<b>1693A</b>
<b>Price</b>	\$24,311.00	\$18,638.00	\$13,776.00	\$8,095.00
<b>PC-hosted with deep memory</b>	<b>1690AD</b>	<b>1691AD</b>	<b>1692AD</b>	<b>1693AD</b>
<b>Price</b>	\$32,414.00	\$24,716.00	\$17,828.00	\$10,940.00



See something you didn't 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 analyze system failure when there are no live signals to trigger on? The classic approach is to capture only 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 you can figure out a way to catch it.

Here's an easy way around the problem:

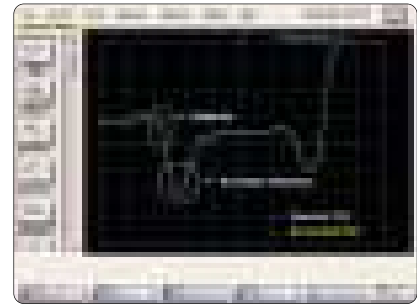
1. Find a predictable "heartbeat" somewhere in the system, such as an address strobe or a periodic interrupt. Doesn't matter what it is, as long as it's consistent.
2. Measure the time interval of this signal so you know when to expect it.
3. Use a timer in your trigger routine to check for each occurrence; reset the timer with each new beat.

4. If the heartbeat doesn't show up within the expected interval, you know the system has crashed and it's 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 Analyzer, available free online at [www.agilent.com/find/measure](http://www.agilent.com/find/measure).

## Complex data transmission measurements made fast and simple



TDR normalization 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 Analyzer (DCA) and its family of plug-in modules. The 86100B delivers the accurate eye-diagram analysis essential for characterizing 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 characterize InfiniBand transmission lines quickly and easily. With TDR step overshoot

less than 5%, step rise time a nominal 35 ps and normalization, you'll 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 don't 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.

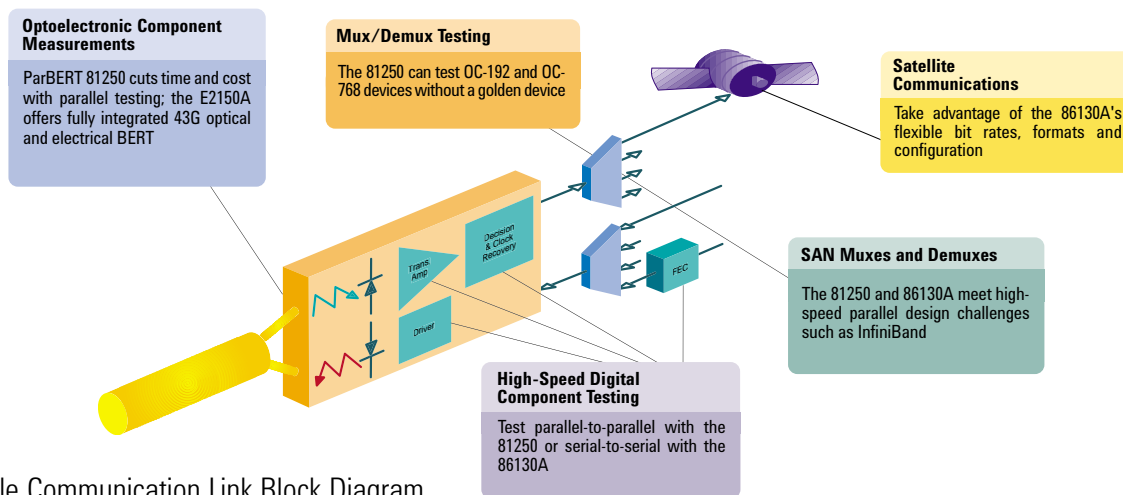
### **High-speed waveform test**

Make standard waveform compliance tests quickly and accurately with a suite of standards-based eye-diagram masks. If you're measuring a protocol that's 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.

## Application-focused solutions for computer interconnects and digital transmission testing



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 characterizing, verifying and testing optoelectronic optical transmitters and receivers and high-speed digital components, multiplexers and demultiplexers 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 optimized for specific application areas eliminate the need to adapt general purpose instruments.

### Agilent BER test solutions for your unique needs

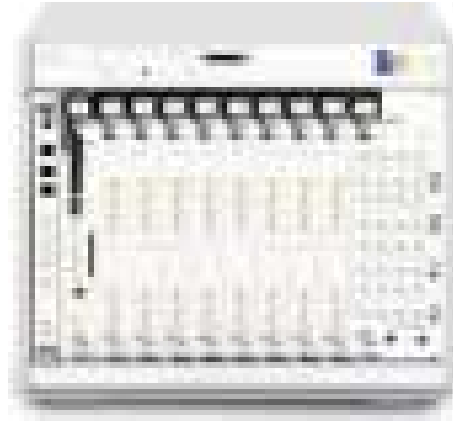
<b>ParBERT 81250</b>	A modular parallel bit error ratio solution for testing at rates up to 10.8 Gb/s. Thoroughly characterizes your device by going beyond BER measurements, providing test features such as propagation delay and setup and hold time. Optical and electrical solutions are available for OC-768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

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/demultiplexer 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 analyze 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  $2^{31}-1$ . Analyze bit error ratios with

user-defined data, PRBS or mixed data from parallel ports.

### Take advantage of powerful flexibility

Mix and match analyzer 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.

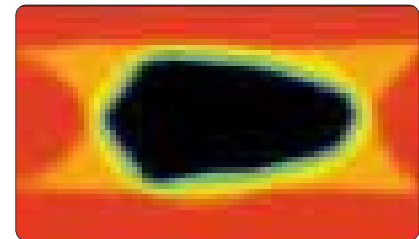
### Integrated electrical/optical BERT to 43G

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.

<b>Mainframe</b>			
81250A 149 13 slot VXI mainframe	\$	9,157.00	
81250A 020 Rack		4,392.00	
81250A 150 MXI 1st expander frame		22,901.00	
81250A 151 MXI 2nd expander frame		16,612.00	
81250A 152 IEEE 1394 expander frame		12,496.00	
<b>Data modules</b>			
E4832A 675 MHz data module		11,426.00	
E4861A 2.7 Gb/s data module		11,377.00	
E4861B 3.3 Gb/s data module		16,693.00	
E4866A 10.8 Gb/s generator		69,691.00	
E4867A 10.8 GSa/s analyzer		84,925.00	
E4868B 43.2 Gb/s multiplexer		340,349.00	
E4869B 43.2 Gb/s demultiplexer		340,349.00	
<b>Front ends</b>			
E4835A 675 MSa differential analyzer (2)		8,460.00	
E4838A 675 MHz differential generator		2,026.00	
E4862A 2.7 Gb/s generator		8,509.00	
E4862B 3.3 Gb/s generator		12,479.00	
E4863A 2.7 Gb/s analyzer		11,377.00	
E4863B 3.3 Gb/s analyzer	\$	16,693.00	
E4864A 1.65 Gb/s generator		5,510.00	
E4865A 1.65 Gb/s analyzer		7,455.00	
<b>Clock modules</b>			
E4805B 675 MHz central clock		13,257.00	
E4808A high-performance central clock		24,635.00	
<b>Controller</b>			
81250A 013 IEEE 1394 PC link to VXI		3,987.00	
81250A 014 external PC		4,554.00	
E4803A 2 slot VXI PC controller		17,406.00	
<b>Software</b>			
E4875A ParBERT user software		31,798.00	
<b>Preconfigured bundles</b>			
E4894A 43.2 Gb/s pattern generator		520,734.00	
E4895A 43.2 Gb/s error detector		560,118.00	
<b>E2150B 43G bundles</b>			
Option 011 for C Band optical		2,119,500.00	
Option 012 for L Band optical		2,119,500.00	
Option 013 for C+L Band optical		2,198,000.00	



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 analyzer with error analysis provides insight into root causes**
- **Agilent Infiniium-like user interface simplifies setup tasks and provides faster access to both basic and advanced features**
- **Precise waveform shapes ensure that you're driving your device with the best possible stimulus signals**

### **Simplifying BER test and analysis with a familiar graphical approach**

The Agilent 86130A BitAnalyzer 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 more revealing ways. To set up test patterns, for instance, simply select an

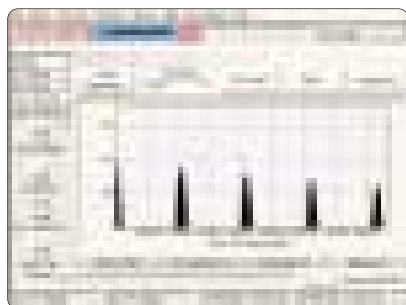
industry-standard pattern from the built-in library or edit it as needed using simple cut and paste commands.

### **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 analyze 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 maximize 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 BitAnalyzer**

#### **Ordering information**

86130A BitAnalyzer	\$176,657.00
Option 100 2-D error mapping	11,775.00
Option 200 error correction coding analysis	11,775.00
Option 300 4 GHz synthesized signal source	14,130.00

Call Agilent Technologies at 1-877-894-4414

[www.agilent.com/find/measure](http://www.agilent.com/find/measure)

## 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 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 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 ultrawide-band microwave input that covers the entire RF and microwave spectrum, from intermediate frequencies of 50 MHz up to millimeter 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 optimize speed and precision.

### Agilent Universal and RF Counters

(representative specifications at selected settings; see [www.agilent.com/find/measure](http://www.agilent.com/find/measure) for complete specifications)

	53131A	53132A	53181A
<b>Measurements</b>	Frequency, frequency ratio, time interval, period, rise/fall time, positive/negative pulse width, duty cycle, phase, totalize, peak voltage, time interval average, time interval delay		Frequency, frequency ratio (with optional ch 2), period, peak voltage
<b>Analysis</b>	Automatic limit testing, math (scale and offset), statistics (minimum, maximum, mean, standard deviation)		
<b>Frequency range</b> (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)
<b>Resolution</b> (frequency, time interval)	10 digits/s, 500 ps	12 digits/s, 150 ps	10 digits/s, N/A
<b>Ordering information</b>			
53131A universal counter			\$2,893.00
53132A universal counter			4,497.00
53181A RF counter			2,520.00

### Agilent Microwave Counters

(representative specifications at selected settings; see [www.agilent.com/find/measure](http://www.agilent.com/find/measure) for complete specifications)

	53150A	53151A	53152A
<b>Frequency range</b> 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
<b>Sensitivity</b> 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
<b>Power measurement accuracy</b> 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)
<b>Math functions</b>	Offset, averaging, cable loss compensation		
<b>Ordering information</b>			
53150A 20 GHz counter			\$10,089.00
53151A 26.5 GHz counter			12,026.00
53152A 46 GHz counter			20,178.00

Quick Ship is available for many of the products listed here. Call Agilent Technologies at 1-877-894-4414 for more information.

## 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/measure](http://www.agilent.com/find/measure) for complete specifications)

<b>dc voltage accuracy</b> (1 year, 10 V range)	±(0.0035% of reading + 0.0005% of range)
<b>True rms ac voltage accuracy</b> (1 year, 1 V to 750 V ranges, 10 Hz to 20 kHz)	±(0.06% of reading + 0.03% of range)
<b>Resistance</b> (100 kΩ range)	±(0.010% of reading + 0.001% of range) with 10 μA current source
<b>Math functions</b>	Null, min/max/avg, dBm, dB, limit test
<b>Price</b>	\$1,605.00

### Agilent 3458A Highlights

(representative specifications at selected settings; see [www.agilent.com/find/measure](http://www.agilent.com/find/measure) for complete specifications)

<b>Maximum reading rates</b> 4½ digits 8½ digits	100,000 readings/second 6 readings/second
<b>dc voltage accuracy</b> (1 year, 10 V range)	±(8/4 <sup>(1)</sup> ppm of reading + 0.05 ppm of range)
<b>True rms ac voltage accuracy</b> (1 year, 10 V range)	±(0.007% of reading + 0.002% of range)
<b>Resistance</b> (1 year, 4 wire Ω, 100 kΩ range)	±(10 ppm of reading + 0.5 ppm of range) with 50 μA current source
<b>Math functions</b>	Null, scale, offset, rms filter, single pole filter, thermistor linearization, dB, dBm, % error, limit test, statistics
<b>Price</b>	\$11,909.00 + \$1,932.00 high stability Option 002

### Agilent 34420A Highlights

(representative specifications at selected settings; see [www.agilent.com/find/measure](http://www.agilent.com/find/measure) for complete specifications)

<b>dc voltage accuracy</b> (24 hour, 1 mV range)	±(0.0025% of reading + .0020% of range)
<b>Resistance accuracy</b> (1 year, 4 wire Ω, 100 Ω range)	±(0.0015% of reading + .0002% of range) with 10 mA current source
<b>Math functions</b>	Null, chart null, scale, statistics, low-pass filter, moving average filter
<b>Temperature readings</b>	SPRT, RTD, thermistor, thermocouple
<b>Price</b>	\$5,467.00

<sup>(1)</sup> With high-stability Option 002

Quick Ship is available for the 34401A. Call Agilent Technologies at 1-877-894-4414 for more information.

### 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 setup changes per second. If precision is the priority, select 8½ digit resolution with 0.1 ppm transfer accuracy. Twenty-four-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 optimized 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/measure](http://www.agilent.com/find/measure)

## 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've 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, and will 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're looking for new power supplies. We'll help you select the right solutions for your application and your budget, including customized solutions for unique applications.

### **Choose a focused solution for your power needs**

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

## Simplify system design with clean power you can count on

### Agilent 6600 Series Single-Output dc Power Supplies

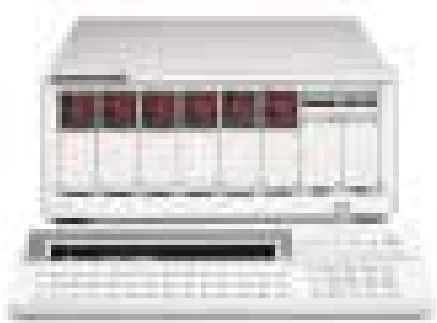
	Total W	Max V	Max I	GPIOB	Price		Total W	Max V	Max I	GPIOB	Price		Total W	Max V	Max I	GPIOB	Price
6611C	40	8	5	•	\$2,350.00	6644A	200	60	3.5	•	\$4,086.00	6572A	2 K	20	100		\$ 5,379.00
6612C	40	20	2	•	2,350.00	6545A	200	120	1.5		2,579.00	6672A	2 K	20	100	•	7,206.00
6613C	50	50	1	•	2,350.00	6645A	200	120	1.5	•	4,086.00	6573A	2 K	35	60		5,379.00
6614C	50	100	0.5	•	2,350.00	6551A	500	8	50		3,394.00	6673A	2 K	35	60	•	7,206.00
6631B	80	8	10	•	3,047.00	6651A	500	8	50	•	5,023.00	6574A	2 K	60	35		5,379.00
6632B	100	20	5	•	3,045.00	6552A	500	20	25		3,394.00	6674A	2 K	60	35	•	7,206.00
6633B	100	50	2	•	3,047.00	6652A	500	20	25	•	5,023.00	6575A	2 K	120	18		5,379.00
6634B	100	100	1	•	3,047.00	6553A	500	35	15		3,394.00	6675A	2 K	120	18	•	7,206.00
6541A	200	8	20		2,579.00	6653A	500	35	15	•	5,023.00	E4356A	2 K	80	30	•	7,206.00
6641A	200	8	20	•	4,086.00	6554A	500	60	9		3,394.00	6680A	5 K	5	875	•	9,928.00
6542A	200	20	10		2,579.00	6654A	500	60	9	•	5,023.00	6681A	5 K	8	580	•	9,928.00
6642A	200	20	10	•	4,086.00	6555A	480	120	4		3,394.00	6682A	5 K	21	240	•	9,928.00
6543A	200	35	6		2,579.00	6655A	480	120	4	•	5,023.00	6683A	5 K	32	160	•	9,928.00
6643A	200	35	6	•	4,086.00	6571A	2 K	8	220		5,379.00	6690A	6.6 K	15	440	•	10,901.00
6544A	200	60	3.5		2,579.00	6671A	2 K	8	220	•	7,206.00	6691A	6.6 K	30	220	•	10,901.00
												6692A	6.6 K	60	110	•	10,901.00

### 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	Price
<b>Output ratings</b> 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	
		<b>Output combinations</b>						
6621A	2					2		\$ 7,478.00
6622A	2						2	7,478.00
6623A	3			1	1	1		8,371.00
6624A	4			2	2			9,256.00
6627A	4				4			9,256.00
6625A	2	1	1					9,256.00
6626A	4	2	2					14,902.00
6628A	2		2					9,256.00
6629A	4		4					14,902.00

### 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	Price
66101A	8	16	\$3,065.00
66102A	20	7.5	3,065.00
66103A	35	4.5	3,065.00
66104A	60	2.5	3,065.00
66105A	120	1.25	3,065.00
66106A	200	0.75	3,065.00
66000A	Mainframe		3,337.00
66001A	Keyboard		1,595.00

## 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

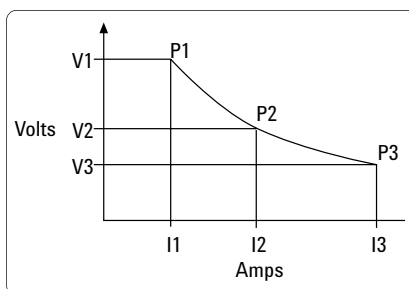
	Total W	Max V	Max I	# of Outputs	Dual Ranges	GPIB/RS-232	Remote Sensing	Protection <sup>(1)</sup>	Price
E3640A	30	20	3	1	•	•	•	V	\$ 940.00
E3641A	30	60	0.8	1	•	•	•	V	940.00
E3642A	50	20	5	1	•	•	•	V	1,102.00
E3643A	50	60	1.4	1	•	•	•	V	1,102.00
E3644A	80	20	8	1	•	•	•	V	1,345.00
E3645A	80	60	2.2	1	•	•	•	V	1,345.00
E3646A	60	20	3	2	•	•	•	V	1,256.00
E3647A	60	60	0.8	2	•	•	•	V	1,256.00
E3648A	100	20	5	2	•	•	•	V	1,742.00
E3649A	100	60	1.4	2	•	•	•	V	1,742.00
E3610A	30	15	3	1	•				504.00
E3611A	30	35	1.5	1	•				504.00
E3612A	30	120	0.5	1	•				504.00
E3614A	48	8	6	1			•	V	859.00
E3615A	60	20	3	1			•	V	859.00
E3616A	60	35	1.7	1			•	V	859.00
E3617A	60	60	1	1			•	V	859.00
E3620A	50	25	1	2					859.00
E3630A	35	20	2.5	3					859.00
E3631A	80	25	5	3		•			1,742.00
E3632A	120	30	7	1	•	•	•	V, I	1,596.00
E3633A	200	20	20	1	•	•	•	V, I	1,929.00
E3634A	200	50	7	1	•	•	•	V, I	1,929.00

<sup>(1)</sup> V = overvoltage protection, I = overcurrent protection

Quick Ship is available for many of the products listed here. Call Agilent Technologies at 1-877-894-4414 for more information.

### 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 subassembly 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	Price
6033A	240	20	30	•	\$5,600.00
6038A	240	60	10	•	5,600.00
6030A	1200	200	17	•	7,463.00
6010A	1200	200	17		6,702.00
6031A	1072	20	120	•	7,463.00
6011A	1072	20	120		6,702.00
6032A	1200	60	50	•	7,463.00
6012B	1200	60	50		6,702.00
6035A	1050	500	5	•	8,220.00
6015A	1050	500	5		7,494.00



## 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*



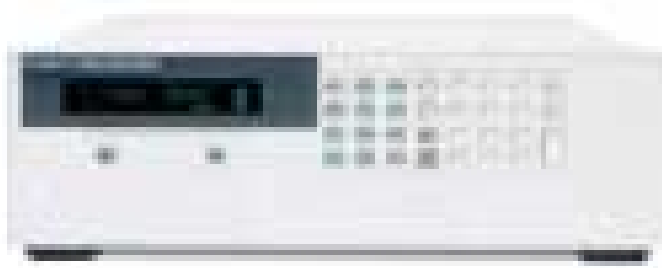
**Agilent N3300 Series Electronic Loads**

	Max W	Max V	Max I	(# slots) Width	Price
<b>N3302A</b>	150	60	30	1	\$2,357.00
<b>N3303A</b>	250	240	10	1	3,356.00
<b>N3304A</b>	300	60	60	1	2,914.00
<b>N3305A</b>	500	150	60	2	4,305.00
<b>N3306A</b>	600	60	120	2	4,141.00
<b>N3300A</b> 6 slot mainframe					3,381.00
<b>N3301A</b> 2 slot mainframe					2,874.00

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

**6800 series ac power source/analyzers:  
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/analyzer makes both static and dynamic measurements*
- *Analyze harmonic distortion to the 50th harmonic*
- *Easy-to-use software GUI also available*
- *Optional dual power analyzer for UPS testing and efficiency measurements*
- *Programmable dc output*
- *Programmable output impedance*



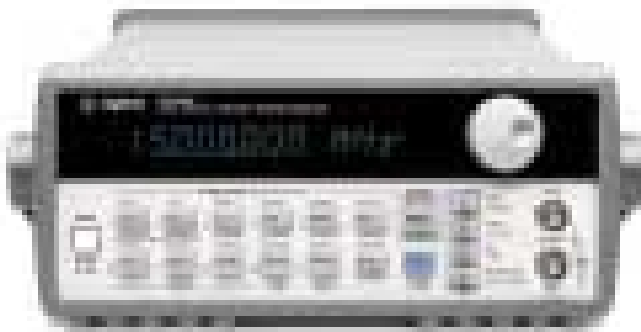
**Agilent 6800 Series ac Source/Analyzers**

	Max output power (VA)	Max output voltage	Max rms current	Max repetitive peak current	Max dc power (watts)	Price
<b>6811B</b>	375	300	3.25	40	285	\$ 9,337.00
<b>6812B</b>	750	300	6.5	40	575	11,969.00
<b>6813B</b>	1750	300	13	80	1350	16,512.00

Call Agilent Technologies at 1-877-894-4414

[www.agilent.com/find/measure](http://www.agilent.com/find/measure)

## 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  $\pm 0.1$  dB**

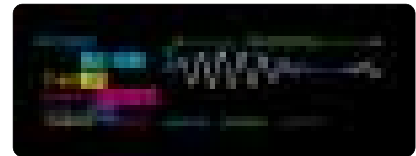
The Agilent 33120A and 33250A function/arbitrary waveform generators give you the tools to put your products through their paces, quickly and thoroughly. Not only do you get a full complement of standard functions, you also get versatile arbitrary waveforms, with 12-bit resolution and a sample rate of 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 in 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.



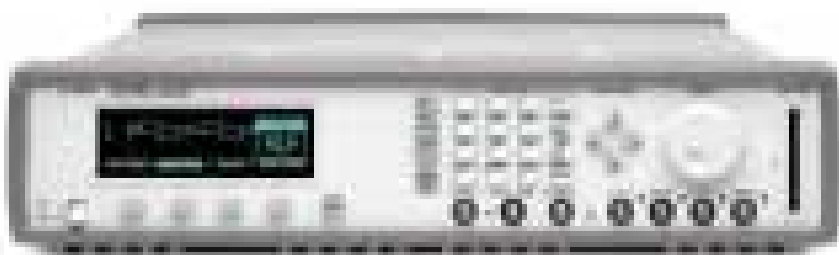
The 33250A's graphical mode simplifies waveform creation.

### Agilent Function/Arbitrary Waveform Generators

	<b>33120A</b>	<b>33250A</b>
<b>Frequency range (sine, square)</b>	15 MHz	80 MHz
<b>Standard waveforms</b>	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
<b>Arbitrary waveforms</b>	8 to 16,000 points	1 to 64 K points
<b>Sample rate</b>	40 MSa/s	200 MSa/s
<b>Modulation</b>	AM (int/ext), FM (int), FSK (int/ext), burst (int/ext)	AM, FM, FSK, burst (all internal/external)
<b>Sweep</b>	Linear or logarithmic; up or down	Linear or logarithmic; up or down
<b>External clock reference</b>	Optional External lock range: 10 MHz $\pm 50$ Hz Internal frequency: 10 MHz	Standard External lock range: 10 MHz $\pm 35$ kHz Internal frequency: 10 MHz
<b>Warranty</b>	3 years	3 years
<b>Ordering information</b>		
Agilent 33120A 15 MHz function/arbitrary waveform generator		\$2,893.00
Opt. 001 external clock reference for 33120A		648.00
Agilent 33250A 80 MHz function/arbitrary waveform generator		6,872.00

Quick Ship is available for the 33120A. Call Agilent Technologies at 1-877-894-4414 for more information.

## Generate the unique signals needed to test innovative digital designs



Variable transition times, from 5 ns to 200 ns, 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 the unique signals to characterize 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 optimized 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 <sup>(1)</sup>		81130A		8133A	81133A	81134A
Channel model	N/A	N/A	81105A	81111A	81112A	81131A	81132A	<sup>(5)</sup>	N/A	
Number of channels	1 single ended	1 single ended	1 or 2 single ended	1 or 2		1 or 2		1 or 2 differential	1	2
				single ended	differential	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 $\mu$ s		<sup>(5)</sup>	-5 ns to 230 ns	
Period RMS-jitter	0.03% + 25 ps <sup>(2)</sup>	0.01% + 15 ps <sup>(3)</sup>	0.01% + 15 ps <sup>(3)</sup>	0.01% + 15 ps <sup>(3)</sup>		0.001% + 15 ps		<5 ps (<1 ps typ.)	<2 ps	
Amplitude range	1.00 V to 100 V <sup>(1)</sup>	100 mV to 20.0 V <sup>(1)</sup>	100 mV to 20.0 V <sup>(1)</sup>	100 mV to 20.0 V <sup>(1)</sup>	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	
Price	\$18,509.00	\$9,935.00	\$8,282.00	\$12,561.00		\$18,411.00		\$59,107.00	\$72,848.00	\$90,432.00
			\$5,818.00	\$7,536.00	\$7,536.00	\$5,024.00	\$6,694.00			

<sup>(1)</sup> Depends on selected source impedance (all other values apply for 50  $\Omega$  source impedance into 50  $\Omega$  load) <sup>(2)</sup> 0.05% + 25 ps in the 50 ns to 100 ns range <sup>(3)</sup> 0.001% + 15 ps with internal PLL as clock source <sup>(4)</sup> Also available as VXI Pulse/Pattern Generators E8311A and E8312A <sup>(5)</sup> 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

## Customize a switching solution that meets your exact needs

- **“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 exact 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 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're 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

Ordering information			
<b>Mainframes</b>	3499B	2 slot switch/control mainframe	\$2,084.00
	3499A	5 slot switch/control mainframe	3,399.00
	3499C	9–14 slot switch/control mainframe	5,495.00
<b>General purpose relays</b>	N2261A	40 channel general purpose relay	2,245.00
	N2267A	8 channel 8 A general purpose relay	1,609.00
	44471A	10 channel general purpose relay	1,040.00
	44471D	20 channel general purpose relay	1,601.00
	44477A	7 channel Form-C relay	1,092.00
<b>Relay multiplexers</b>	N2260A	40 channel multiplexer	2,245.00
	N2266A	40 channel high-speed multiplexer	2,253.00
	N2270A	10 channel 1,000 V multiplexer	1,851.00
	44470A	10 channel relay multiplexer	1,040.00
	44470D	20 channel relay multiplexer	1,601.00
<b>RF multiplexers</b>	N2268A	Dual 1 x 4 RF (3.5 GHz) multiplexer (50 Ω)	3,702.00
	N2272A	1 x 9 RF (1 GHz) multiplexer (50 Ω)	2,011.00
	44472A	Dual 1 x 4 VHF (300 MHz) multiplexer (50 Ω)	1,530.00
	44478A	Dual 1 x 4 RF (1.3 GHz) multiplexer (50 Ω)	1,955.00
	44478B	Dual 1 x 4 RF (1.3 GHz) multiplexer (75 Ω)	2,110.00
<b>Matrix modules</b>	N2262A	4 x 8 matrix	1,601.00
	44473A	4 x 4 matrix switch	1,254.00
<b>Microwave modules</b>	N2276A	Dual 1 x 6 (20 GHz) multiplexer	7,966.00
	N2276B	Relay driver (supports 2 microwave switches)	1,368.00
	44476A	Triple 1 x 2 (20 GHz) multiplexer (50 Ω)	4,979.00
	44476B	Microwave relay driver	1,092.00
<b>Optical multiplexers</b>	N2280A	Quad optical 1 x 2 multiplexer, SC/APC	12,071.00
	N2281A	Dual optical 1 x 4 multiplexer, SC/APC	12,071.00
	N2282A	Optical 1 x 8 multiplexer, SC/APC	12,071.00
<b>Other modules</b>	N2263A	32 bit digital I/O	1,601.00
	N2264A	12 + 3 GP + 16 bit digital I/O	2,084.00
	44474A	16 bit digital I/O	1,040.00

View the complete list of modules and connectors at [www.agilent.com/find/measure](http://www.agilent.com/find/measure).

## 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 nonvolatile memory, real-time clock, standard GPIB, RS-232 and SCPI

#### Module highlights

Module	Speed (ch/sec)	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 analog 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*	\$2,083.00	34905A dual 4 ch RF mux, 50 Ω	\$ 799.00
34970A without DMM*	1,284.00	34906A dual 4 ch RF mux, 75 Ω	799.00
34901A 20 ch general-purpose mux	637.00	34907A multifunction module	476.00
34902A 16 ch high-speed mux	637.00	34908A 40 ch single-ended mux	637.00
34903A 20 ch actuator/GP switch	476.00	E2050A LAN-to-GPIB gateway	1,717.00
34904A 4 x 8 matrix switch	637.00		

\* Mainframe only—modules are required to operate

Quick Ship is available for the 34970A. Call Agilent Technologies for more information.

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'd 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's easy to specify measurement functions channel by channel—put 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.

Call Agilent Technologies at 1-877-894-4414

[www.agilent.com/find/measure](http://www.agilent.com/find/measure)

## Make sure all your components meet your demanding standards

- **Impedance analyzers offer a variety of inductance, capacitance, resistance and phase measurements**
- **LCR meters offer a lower-cost alternative to analyzers with fast results and high accuracy**
- **Combination analyzers offer the convenience of integrated network, spectrum and impedance analysis**
- **Specialty resistance meters offer ultralow or ultrahigh resistance measurements**



Comparing impedance measurement solutions

Product highlights	Impedance analyzers	LCR meters	Combination analyzers
<b>Frequency sweep capability</b>	Continuous	Spot	Continuous
<b>Display</b>	Graphical	Numeric	Graphical
<b>Productivity functions</b>	Equivalent circuit analysis built in	Handler interfaces	Equivalent circuit analysis built in, multiple functions in one instrument
<b>Key advantages</b>	Frequency characteristics and resonant analysis, circuit modeling	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's 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  $\Omega$ . With this measurement technique, impedance values are derived from reflection coefficients.

### Impedance analyzers

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

The Agilent 4294A precision impedance analyzer 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 semiconductors, as well as material evaluations on PC boards, toroidal cores and other parts. Take advantage of  $\pm 0.08\%$  basic accuracy to evaluate extremely small variations in component characteristics. Perform in-circuit or grounded measurements with the 42941A impedance probe. Standard measurements include  $|Z|$ ,  $|Y|$ ,  $\theta$ , R, X, G, B, C, L, D and Q.

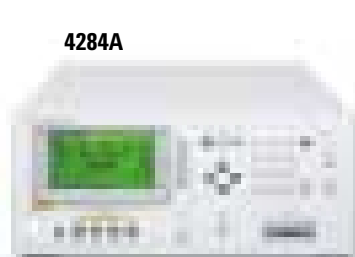
### LCR meters

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  $|Z|$ ,  $|Y|$ ,  $\theta$ , R, X, G, B, C, L, D and Q.

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

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

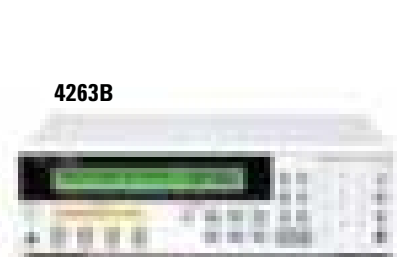
The Agilent 4263B LCR meter delivers low-cost component evaluation in a compact, easy-to-use meter. Offers spot frequency testing at 100 Hz, 120 Hz, 1 kHz, 10 kHz and 100 kHz (optional 20 kHz). Option 001 and the 16060A provide the transformer parameter measurement function.



**4284A**



**4395A**



**4263B**

**Combination analyzers**

Save time, money and rack space with integrated component evaluation tools. These analyzers offer the same advanced impedance measurements as our dedicated impedance analyzers, along with precision network and spectrum analysis. Standard measurements include  $|Z|$ ,  $|Y|$ ,  $|Γ|$ ,  $θ$ , R, X, G, B, C, L, D and Q. The Agilent 4396B network/spectrum/impedance analyzer (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 analyzer (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 milliohm meter offers ultralow resistance measurements over  $10\ μΩ$  to  $100\ kΩ$ . The 4339B high-resistance meter provides ultrahigh resistance measurements up to  $1.6 \times 10^{16}\ Ω$ . 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 <sup>(1)</sup>	Measurement Technique	Primary Applications	Price
<b>Impedance analyzer</b>	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	\$71,960.00
	High performance, multifunction	4294A	40 Hz to 110 MHz (frequency sweep)	0.08%	25 mΩ to 40 MΩ	Autobalancing bridge	LCR components, materials, semiconductors	55,266.00
<b>LCR meter</b>	High performance, multifunction	4285A	75 kHz to 30 MHz (spot frequency)	0.1%	10 mΩ to 10 MΩ	Autobalancing bridge	LCR components, materials, semiconductors	27,325.00
	High performance, multifunction	4284A	20 Hz to 1 MHz (spot frequency)	0.05%	10 mΩ to 100 MΩ	Autobalancing bridge	LCR components, materials, semiconductors	19,740.00
	Low cost, multifunction	4263B	100 Hz to 100 kHz (spot frequency)	0.1%	1 mΩ to 100 MΩ	Autobalancing bridge	LCR components, transformers	6,758.00
<b>Combination analyzer</b>	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	50,031.00
	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	43,322.00
<b>Specialty resistance meter</b>	Milliohm	4338B	1 kHz only	0.4%	10 μΩ to 100 kΩ	(other)	Connectors, resistors, switches, batteries	7,196.00
	High resistance	4339B	DC only	0.6%	10 kΩ to $1.6 \times 10^{16}\ Ω$	(other)	Transformers, capacitors	8,168.00

<sup>(1)</sup> 10% accuracy range

Call Agilent Technologies at 1-877-894-4414

[www.agilent.com/find/measure](http://www.agilent.com/find/measure)

## Simplify test setup with the new Connectivity Suite

- **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 characterization, 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's more than likely 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**

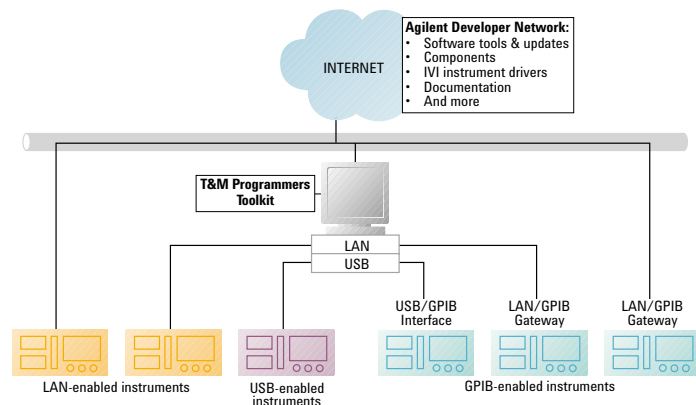
The T&M Programmers Toolkit at the heart of the Connectivity Suite is ideal for the continual changes in prototype testing and design validation. It's easy to set up a system, add more test

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.

Microsoft and Visual Studio .NET are registered trademarks of Microsoft Corporation in the U.S and/or other countries.



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





*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 lowers 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/measure](http://www.agilent.com/find/measure) 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,

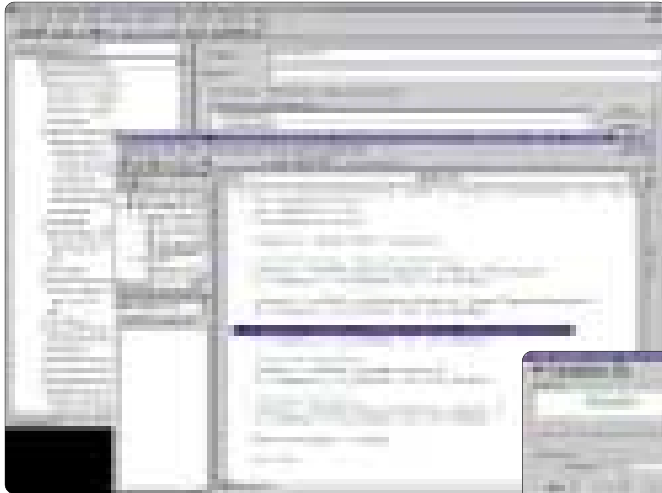
global project communication and remote access to instruments.

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

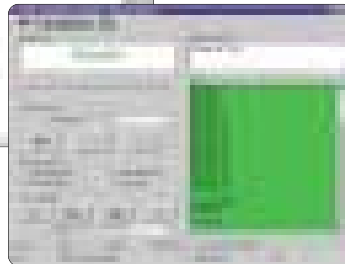
*All these elements are available individually or as part of easy-to-order, money-saving bundles. Learn more about the time-saving benefits of the Connectivity Suite at [www.agilent.com/find/measure](http://www.agilent.com/find/measure).*

<b>Agilent Connectivity Products</b>	
<b>Software</b>	
W1130A T&M Programmers Toolkit developer annual license to use, unlimited distribution of runtime, updates, released upgrades and support for license duration (12 months)	\$1,091.00
W1131A T&M Programmers Toolkit perpetual license to use. Includes developer license to use, unlimited distribution of runtime	1,405.00
<b>Hardware</b>	
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	797.00
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	797.00
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	1,719.00
<b>Bundle discounts</b>	
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**



Give test engineers a head start with TestExec SL's fully customizable operator interface, open architecture for multiple instrument integration, flexible test sequencing and easy debugging tools. Seamlessly develop and debug re-usable Visual Basic routines for your test sequences.

As part of Agilent's Intelligent Test open software architecture, Agilent TestExec SL offers a unique way to control test operations and automate test-engineering tasks. Use it to boost productivity

through test sequencing, limit checking, data logging and exporting, and ready-made user interfaces. Its modular architecture enables measurement libraries for easy code use and

re-use. Powerful development tools include a test profiler to evaluate test performance and a switch manager to simplify switching. Plus, you can add or remove debug code without recompiling, a major time-saver during system integration.

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

Visit [www.agilent.com/find/measure](http://www.agilent.com/find/measure) to download the evaluation version.

### Agilent TestExec SL

E2011FA TestExec SL perpetual developer's license	\$5,835.00
E2011FD TestExec SL perpetual runtime license	924.00
E2011FS TestExec SL monthly phone + update support contract (for E2011FA)	122.00
E2011FC TestExec SL 12 month limited-term developer's license (including support)	2,431.00
E2011FE TestExec SL 12 month, limited-term runtime license	373.00
E2011FB TestExec SL one-time upgrade to latest perpetual developer's license	3,501.00

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### **Agilent IntuiLink: intrinsic connectivity, instinctive control**

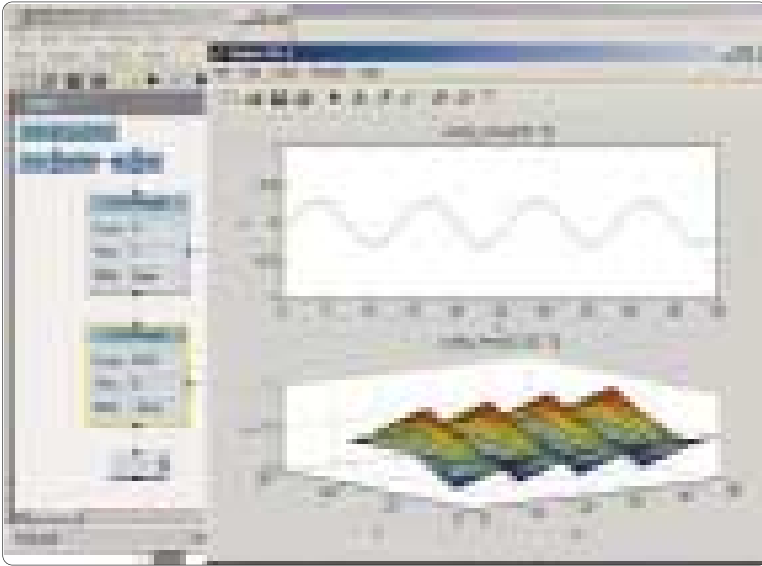
IntuiLink removes the barrier between instruments and PCs, giving you instant, easy access to measurement results, whenever and wherever you need them—in design verification, manu-

facturing test, process control and data acquisition. Instrument data and graphics are just a few mouse clicks away, so instrument programming happens quickly from familiar PC applications. With immediate access to your valuable measurement data, you can easily analyze it, display

it, and use it to gain insights, solve problems and engineer better products faster.

Look for free IntuiLink support on a wide variety of Agilent oscilloscopes, generators, analyzers, multimeters and counters.

## VEE OneLab: more power, less pain



Build tests quickly using fewer high-level objects. This same procedure can take more than two dozen icons in other packages.

If your research and design work demands fast test creation with a mix of GPIB and PC card instruments, Agilent VEE OneLab simplifies the task at half the price of other programming

packages. Using fewer programming icons, you'll create powerful test programs that take advantage of embedded MATLAB Script with world-class numerical analysis, graphics and signal processing.

- **Develop tests faster using fewer high-level objects**
- **Save time with extensive built-in measurement and analysis capabilities**
- **Get started quickly with dynamic addressing, automatic debugging of I/O and instrument verification**

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.

And if you or your manufacturing colleagues need to apply the power of VEE programming to larger test systems, VEE Pro adds speed profiling, Web enabling, unlimited run-time copies, extensive programmatic links and other productivity enhancements.

Visit [www.agilent.com/find/measure](http://www.agilent.com/find/measure) to download the evaluation version and tutorials.

### Agilent VEE

E2123A VEE OneLab for Windows 98/NT/2000/XP	\$ 1,332.00
E2120A VEE Pro for Windows 98/NT/2000/XP	2,190.00
W1139A Connectivity kit for VEE	1,562.00
H2327A Option WNT VEE Pro Windows faculty version	2,190.00
E2120AL VEE Pro for Windows annual license to use	1,405.00

### Selecting a software development solution

Product	Description	Fit to development cycle	Major features
<b>T&amp;M Programmers Toolkit</b> (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
<b>VEE</b> (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
<b>IntuiLink</b> (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
<b>TestExec SL</b> (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



Complete your measurement solution with reliable connectors, cables and other accessories. And take advantage of our extensive online library covering a wide range of application areas.

### **Accessories for a complete test and measurement solution**

Whether you're designing a complex RF or digital system or simply need a new lead set for

your multimeter, Agilent accessories ensure a quality signal path that won't compromise your measurements.

**RF accessories:** If your designs depend on reliable, repeatable RF measurements, make sure your accessories aren't degrading overall measurement quality. Agilent attenuators, switches, adapters, noise sources and power sensors deliver dependable results at competitive prices.

**Digital design and test accessories:** Agilent logic analysis probes and connectors are up to the challenge of today's fast components and complex chip packages. Choose from lead sets, SMD clips, and unique probing solutions for high-density PQFP and TQFP packages.

**Basic instrument accessories:** We offer a complete line of scope probes and DMM accessories and quality cables for dependable test connections.

Our accessories search engine lets you browse by category or search by specific model number.



### **Extensive application information for improved measurement results**

Visit [www.agilent.com/find/measure](http://www.agilent.com/find/measure) for a wide range of quick tips, tutorials and in-depth application notes, all designed to help you make better measurements in less time:

- **Application Central:** This library of application notes, training courses, FAQs and tutorials covers more than two dozen application categories, from measurement fundamentals to leading-edge applications.
- **Education and Services:** Browse a complete listing of education and training offerings, test and measurement engineering services, and our free Back to Basics seminars.
- **Measurement Tips:** Quick tips and techniques you can apply on the job today, from power measurements to high-speed digital probing.

## 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 to 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, though, 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 doesn't interfere too much with other nearby

transmitters. 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, and vendors and developers have to characterize and verify those attributes.

In our work with engineers creating many types of wireless devices, we've gathered a few insights that may help you deal with some of the challenges you're facing today with the next generation of transmitters, receivers and components. Here are some samples.

### 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 doesn't meet spec, 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 multichannel 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's 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 analyze 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.

## Ordering information

### Ordering

#### Where and when to call

Call 1-800-276-8661 any weekday between 8:30 A.M. and 5 P.M. EST. You can also fax your order to 1-800-746-4866. (For technical information, call 1-877-894-4414.)

Have ready when you call:

- Your company's purchase order number so we may reference it on your order.
- Your VISA®, MasterCard™ or American Express® card and expiration date for credit card orders.
- Your Agilent account number.

### Shipping

#### Free surface delivery

Our prices include regular surface freight delivery by a carrier of our choosing.

#### Special delivery and handling

Charges for any special types of delivery will appear separately on your invoice.

#### Quick Ship

The Quick Ship symbol, used in the ordering information, indicates specific products are available for quick delivery. To order Quick Ship items, call 1-800-276-8661.

### Payment

#### To open an account

It's easy. Just give us your company billing and shipping addresses and a purchase order number. We'll give you an account number in minutes.

#### Taxes

We are required to collect all GST, provincial and/or any additional applicable taxes unless we have a tax exempt certificate on file. When you phone in your order, we can tell you the simple steps to follow to ensure your order ships promptly.

#### Credit cards

We accept VISA®, MasterCard™ and American Express®.



### Terms

Net 30 days from invoice date for Agilent account customers. Open account terms are subject to credit approval.

### Pricing

#### Effective date

Prices are effective May 1, 2002 and are subject to change.

Only Agilent Corporate Price List prices, as listed at the time your credit-approved order is placed, are applicable.

### Discounts

We honor all Agilent quantity and corporate discounts.

### Catalogue errors

Agilent reserves the right to correct printing errors.

### Problem Solving

#### Billing questions

If you ordered via Agilent Technologies and have a question regarding your billing, please call 1-800-276-8661 and ask for the collections department. This number is for billing questions only.

#### Shipping damages

Returns are simple—just call 1-800-276-8661 for return instructions. Our Agilent Customer Care Representatives will ensure your problem is resolved promptly.

Please provide us with the Agilent sales order number found on your packing slip, the product number, and the quantity damaged.

Some limitations apply to returns.

### Agilent Support, Services, and Assistance

Agilent Technologies aims to maximize the value you receive and minimize your risk and problems. We can help you choose the right products and apply them successfully. Our customer care specialists will quickly assess your needs and either handle your request or connect you with a test and measurement engineer for

technical consultation. Every instrument/system we sell has a global warranty and is supported at least five years beyond its production life. Two concepts underlie the Agilent support policy: "Our Promise" and "Your Advantage."

**Our Promise** means your Agilent test and measurement equipment will meet its advertised performance and functionality. We can verify that it works properly, help with product operation, and provide basic measurement assistance for specified capabilities, at no extra cost. Many self-help tools are available.

**Your Advantage** means that Agilent offers additional expert test and measurement services at extra cost. Solve problems efficiently by contracting with us for calibrations, extra-cost upgrades, out-of-warranty repairs, on-site training, professional engineering services, and more.

### Agilent sales office phone numbers

To get the telephone number of your local Agilent sales office, call 1-877-4AGILENT (1-877-424-4536).

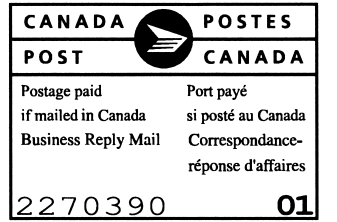
### Warranty

As an expression of confidence that our products will continue to meet the high standards of reliability and performance that our customers expect, Agilent products carry the following limited warranty:

Agilent Technologies products are warranted against defects in materials and workmanship. If Agilent Technologies receives notice of such defects during the warranty period, Agilent Technologies shall, at its option, either repair or replace hardware products that prove to be defective.

All instruments in this catalogue are manufactured at sites that have been ISO-9002 certified and are CFC-free.

To provide the best service for you now and in the future, your call may be recorded.



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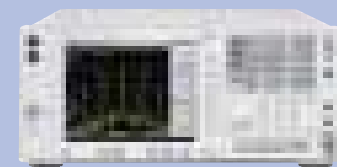
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## NEW AGILENT TEST SOLUTIONS



**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 analyzers.



**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.