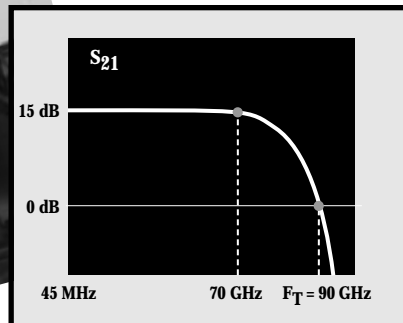
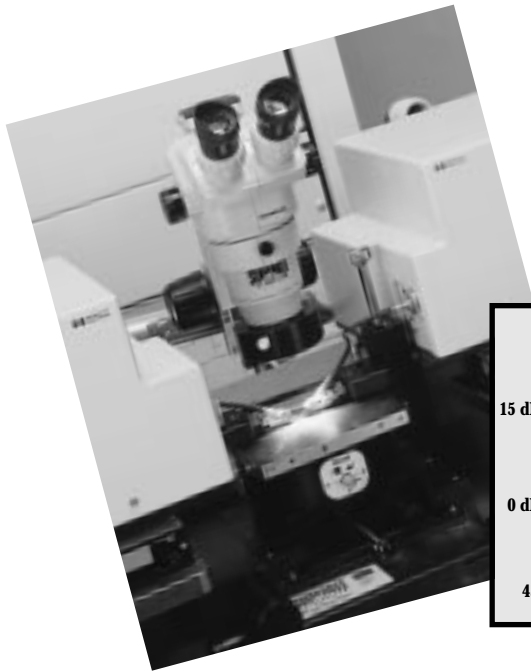


HP 8510 NEWS 8720

February 1998
Volume 9—Number 1

The newsletter for users
of HP 8510 and 8720
network analyzers



New network analyzer systems provide single-sweep measurements to 110 GHz with a single coaxial connection

Traditional vector network analyzers (VNAs) are available with broad frequency coverage using coaxial connectors, but typically cover a range of 45 MHz to 26.5 GHz (with SMA connectors) or 45 MHz to 50 GHz (with 2.4 mm connectors). Also available are VNAs that sweep a single band of waveguide frequencies and use a waveguide flange for the final output connector. For example, an HP V85104A millimeter-wave test set for the HP 8510 VNA uses WR-15 waveguide on the test port to provide frequency coverage from 50 to 75 GHz. Additional waveguide bands that are covered include 33 to 50 GHz, 40 to 60 GHz, and 75 to 110 GHz. Selecting the correct VNA and test set(s) for a set of test requirements is highly dependent upon the measurement application.

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As applications for wireless systems continue to explode and fill the airwaves with signals, VNAs with limited bandwidths or single-waveguide-band coverage may not reveal enough information about a device under test (DUT) to be useful. An instrument that is capable of extending far below and well above the frequency of interest can provide useful information on harmonic, subharmonic, and spurious-signal characteristics, as well as process-related trends in wireless systems development.

Until the recent development of broadband couplers, it was not possible to configure a broadband VNA for measurements up to 110 GHz. Such a VNA can serve as the main measurement tool for multiple projects without changing the analyzer's test set or test configuration, or performing an additional calibration routine. The alternative is either to have dedicated systems or to switch among several test sets during broadband measurements.

HP 8510XF (broadband VNA) systems

HP is now introducing the HP 8510XF series of VNA systems, the latest addition to the HP 8510C family, providing measurements from 45 MHz to 110 GHz in a single sweep with a single, 1.0 mm coaxial connection. System configuration includes an HP 8510C receiver, a broadband test set and two synthesizers (one for the RF signal and the other for the LO signal). The broadband test set consists of a millimeter-wave controller and two test heads (one for each test port). This modular test set design was chosen for convenient connection of the test system to wafer-probing equipment. Figure 1 is a block diagram of the HP 8510XF.

1.0 mm components

With the advent of the 1.0 mm coaxial connector, it is now possible to manufacture a broadband coupler that can operate from DC to 110 GHz. By placing this 1.0 mm coaxial coupler directly on the test port, excellent raw directivity and test port match from 45 MHz to 110 GHz can be achieved to significantly improve broadband S-parameter measurement accuracy.

In addition to the 1.0 mm coaxial coupler, HP has developed 1.0 mm coaxial signal combiners that combine multiple signals to yield output signals from 45 MHz to 110 GHz. Unlike other VNAs, the signal combiners used in the HP 8510XF are positioned before the signal-separation couplers, greatly reducing the effect of insertion loss on the calibrated performance. Port power and dynamic range are enhanced by controlling insertion losses and balancing system power levels (see Figure 1).

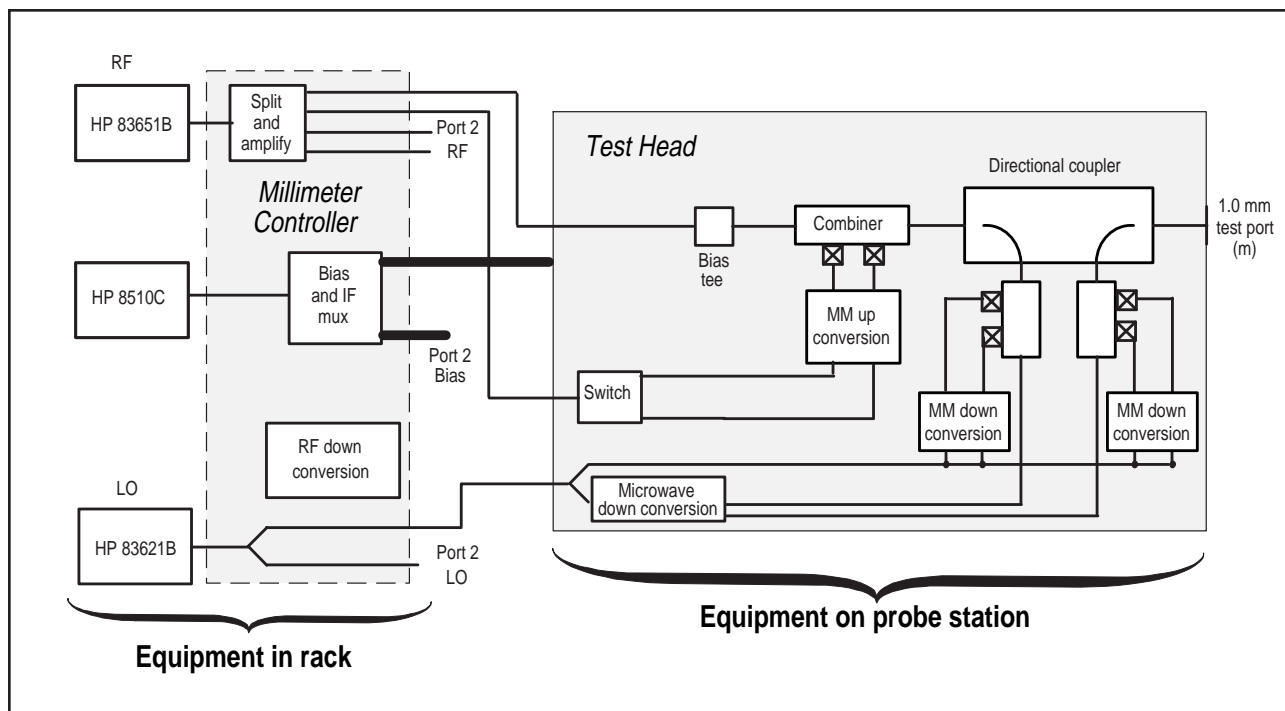


Figure 1. A block diagram of the new HP 8510XF broadband VNA.

Convenient high-performance on-wafer measurements

The HP 8510XF systems are designed for convenient on-wafer measurements. The new test heads are designed especially for mounting on top of the probe positioners in a wafer probe configuration. This configuration allows the test heads to move with the probe tips so there is no relative movement between the two, improving calibration stability. With the test heads placed closer to the probe tips, RF cable insertion loss is minimized, which results in excellent performance at the probe tips up to 110 GHz. Figure 2 illustrates a typical on-wafer configuration using a Cascade Microtech probe station with an HP 8510XF system.

Port power leveling

When performing on-wafer measurements, it is important to control the amount of power delivered to the wafer-under-test to avoid damaging it with excessive input power. Without leveling, power at the test port can vary up to 25 dB over the full range, subjecting the wafer-under-test to different RF power levels at different frequencies. With leveling in the HP 8510XF, test port power variation is typically less than 1 dB over the full frequency sweep. Power levels can also be controlled with an accuracy of ± 0.2 dB, with a leveling range of at least 20 dB at 110 GHz. This leveling range can be increased if a smaller portion of the frequency span is used. Figure 3 shows a comparison between leveled and unleveled port power.

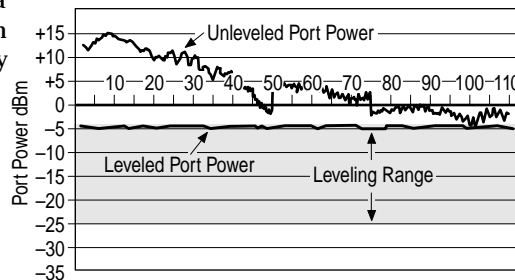


Figure 3. Leveled and unleveled port power.

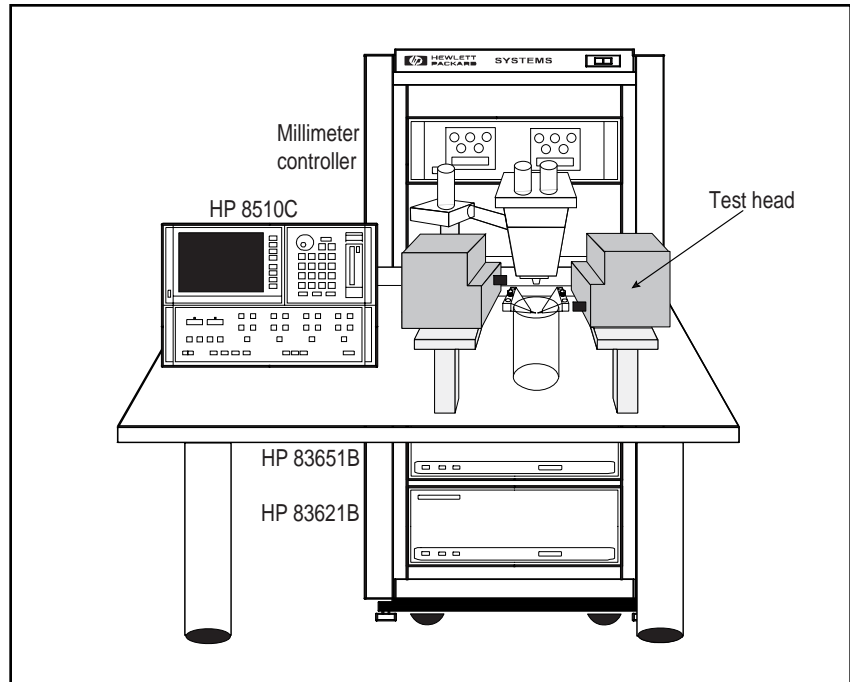


Figure 2. System configuration for wafer probing to 110 GHz using a Cascade Microtech wafer probing station and ACP 110 probes.

Fully-calibrated measurements to 110 GHz with a single connection

With the HP 8510XF system and 1.0 mm calibration kits, a single calibration can be performed from 45 MHz to 110 GHz, allowing fully error-corrected, single-sweep measurements to 110 GHz in 1.0 mm coax with one 1.0 mm connection. This broadband calibration can be applied to either broadband or narrowband device measurements.

Product News

The 1.0 mm connection: your key to precision millimeter-wave measurements

Hewlett-Packard introduced its first 1.0 mm coaxial connector accessories in 1993, and the first 1.0 mm coaxial calibration kit (for operation from 50 GHz to 110 GHz) in 1995. Today, HP is introducing a wide range of 1.0 mm accessories along with the introduction of the HP 8510XF series of vector network analyzer (VNA) systems.

The 1.0 mm connector is an IEEE industry standard connector with a cutoff frequency well above 120 GHz. Figure 1 shows the dimensions of the 1.0 mm connector interface. The connector utilizes an air dielectric interface for highest accuracy and repeatability. The coupling diameter and thread size were chosen to maximize strength, increase durability, and provide highly repeatable interconnects.

Electrical advantages

- Cutoff frequency above 120 GHz
- Connector repeatability of about 40 dB
- Connector insertion loss of less than 1 dB
- Coaxial calibration can be performed using the HP 85059A calibration/verification kit

Mechanical advantages

- Well-defined precision interface
- Male pin is precision machined
- Female contact is precision machined and electrically compensated to 50 ohms
- Reference plane is specified for flatness and finish
- Pin depth is well-defined
- Concentricity is well-controlled (specification is 0.025 mm radial maximum)
- Connector is rugged despite its small size
- The outer conductors align before the center conductors engage, guaranteeing a damage-free connection (see Figure 2).

1.0 mm accessories

Since the 1.0 mm connector is designed for the highest accuracy and repeatability, HP continues to broaden its offering of 1.0 mm coaxial accessories to meet new challenges. Accessories available today include the HP 85059A, 11500I, 11500J, V281C, V281D, W281C and W281D (see Figure 3).

The HP 85059A is a 1.0 mm calibration/verification kit designed for vector network analyzer systems operating over the frequency range of 45 MHz to 110 GHz. The opens, shorts and loads in this kit were optimized to provide accurate calibrations over the specified frequency range. For best results, the calibration techniques recommended are the open-short-load-thru (OSLT) calibration from 45 MHz to 50 GHz, and the offset-shorts calibration from 50 GHz to 110 GHz.

The HP 11500I and 11500J are flexible 1.0 mm coaxial cables available for connecting between the test ports and devices, fixtures or probe tips with 1.0 mm connectors for frequency coverage from 45 MHz to 110 GHz. The HP 11500I is an 8.8 cm length cable with female connectors on both ends. The HP 11500J is a 16.0 cm length cable with a female connector on one end and a male connector on the other end. These cables have a typical insertion loss of 0.1 dB per cm at 110 GHz.

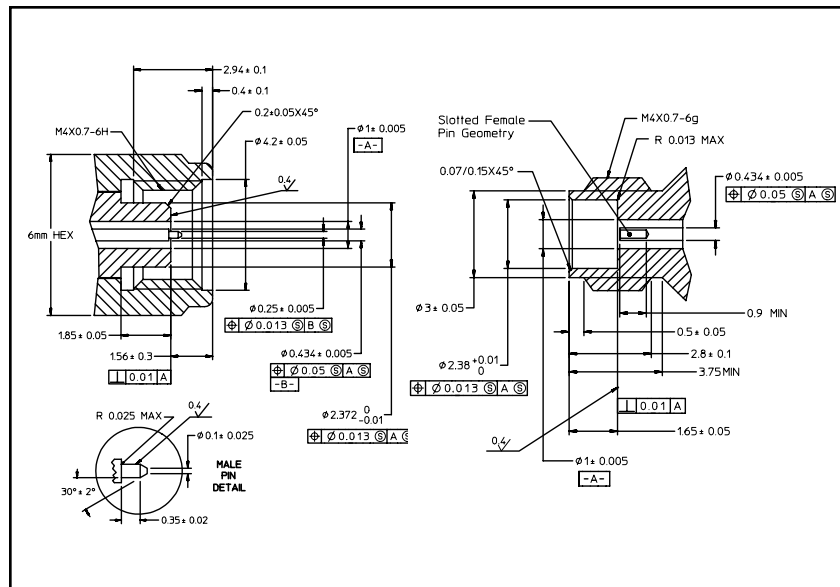


Figure 1. 1.0 mm connector interface dimensions per the IEEE standard: (a) male connector (b) female connector

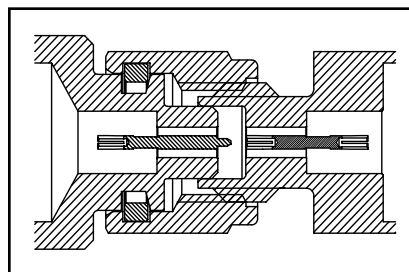


Figure 2. Alignment of 1.0 mm connectors. Outer conductors align before center conductors engage.



Figure 3.
1.0 mm
accessories
include
in-series
adapters,
1.0 mm-to-V-
or W-band
adapters,
cables, opens
and shorts.

The HP V281C and V281D are V-band waveguide-to-1.0 mm adapters with female and male connectors, respectively. Similarly, the HP W281C and W281D are W-band waveguide-to-1.0 mm adapters with female and male connectors, respectively. These waveguide-to-coaxial adapters are designed for connecting devices, fixtures or probe tips with a waveguide connection to a coaxial measurement system, and vice versa.

Since 1.0 mm connection is the key to precision millimeter-wave measurements, HP will continue to offer the highest accuracy and repeatability available in 1.0 mm accessories. Other accessories being developed include 1.0 mm-to-1.85 mm and 1.0 mm-to-2.4 mm between-families adapters, and 1.0 mm launches for fixture applications.

The new HP 8753E: a fast and powerful RF network analyzer

For increased test throughput and reduced design time, the world's most popular network analyzer now measures RF components up to seven times faster than its predecessor, the HP 8753D. A firmware upgrade (expected to be available in June 1998 on diskette or via the HP Web site) increases tuning speed by providing simultaneous display of all four S-parameters. New flash memory allows quick and easy upgrades from diskette and reduces support efforts.

The increased speed of the HP 8753E has an effect on virtually every aspect of the instrument's performance. Measurement time, pass-fail testing, and test sequence execution are significantly faster, and the time is dramatically reduced for even the most complex measurements.

New features increase productivity and accuracy

Smaller and lighter, the HP 8753E retains compatibility with rack-mount systems. The VGA output lets you add a large, external monitor for enhanced viewing. Use the adapter-removal calibration technique for improved measurement accuracy of non-insertable devices. Reduce measurement time by selecting swept list mode, and choose frequency ranges with independent IF bandwidths and power levels. Code compatibility with the HP 8753D offers an easy transition.



**Up to seven
times faster,
the HP 8753E
also offers
more calibration
techniques and
four-parameter
display.**

And the HP 8753E is compatible with HP's electronic calibration products, which reduce calibration errors, connector damage, and maintenance.

An unbeatable solution

The high-performance HP 8753E brings together an unbeatable combination of speed, performance and ease-of-use features. With an integrated S-parameter test set that covers 30 kHz to 3 or 6 GHz, up to 110 dB of dynamic range and both frequency and power sweeps, the HP 8753E accurately and quickly characterizes the linear and non-linear behavior of active and passive components.

Multiple configurations

The HP 8753E offers a comprehensive package of options including 6-GHz operation, time-domain for location and resolution of discontinuities, harmonic measurement capability for display of swept second- and third-harmonic levels down to -40 dBc, and deletion of the front-panel display.

Huge savings through trade-in program

A trade-in program for all previous HP 8753 analyzers, with credit from 40% to 100% applied to the purchase of an HP 8753E, will run through June 30, 1998.

T

otal Solutions Partner

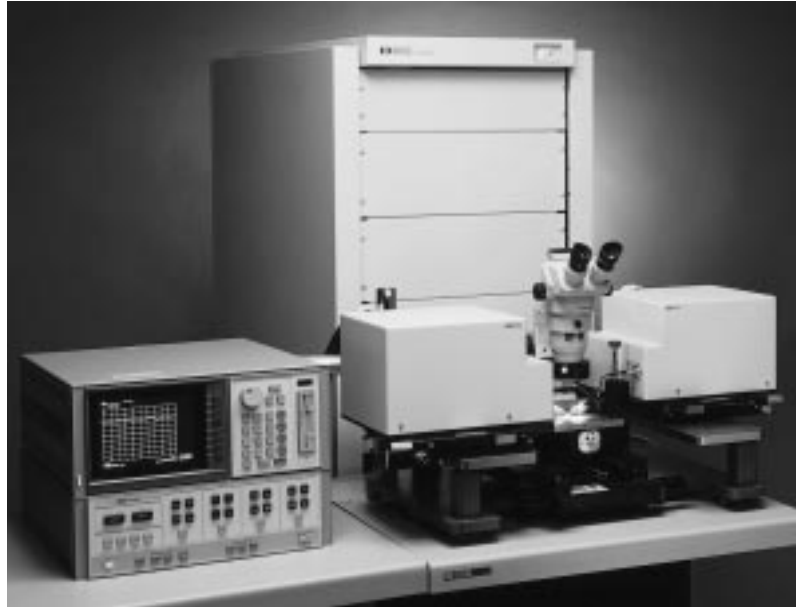
Complete on-wafer measurement solutions to 110 GHz

Cascade Microtech has been working closely with Hewlett-Packard for over a decade to bring you the highest quality, wafer-level S-parameter measurement capabilities. Starting in 1983 with 18 GHz coplanar probes, the Cascade product line has expanded to include millimeter-wave probes, probe stations, autoprobers, calibration standards, measurement software and application support for all Hewlett-Packard vector network analyzers. Combining Cascade Microtech probe products with Hewlett-Packard analyzers provides all the tools needed for complete RF probing solutions through 110 GHz.

A complete on-wafer, S-parameter test system configured for 45 MHz to 110 GHz consists of the new HP 8510XF coupled directly to wafer probe micropositioners on a Cascade Microtech prober. Wafer probes and calibration standards to match the test devices specified by the customer round out the equipment accessories. Customer-selected calibration kits or software complete the requirements for accurately corrected S-parameter measurements.

Micropositioners

Specially designed X-Y-Z micropositioners conveniently hold the HP 8510XF test heads, HP 11500J minimum-length cables and ACP110 wafer probes, providing micron motion control without measurement-degrading cable strain and losses. A 5-micron misplacement of probes would result in 0.75 pH error in measured inductance, which



**HP 8510XF VNA
with Cascade
Microtech prober.**

is significant at millimeter-wave frequencies. Cable flexure normally degrades S-parameter repeatability to less than 1% (-40dB). Mounting the test heads onto the X-Y-Z micropositioners allows for 1-micron placement accuracy and completely eliminates errors caused by cable flexure. This solution provides better than -60dB connection repeatability up to 110 GHz.

Probers

A full range of Cascade RF probers is offered to fit all customer needs. All RF probers are designed specifically for thin wafer usage with easy loading stages and offer patented auxiliary chucks that handle the calibration standards. For general characterization work, choose the Summit 9101. The Summit 9101 chuck is designed to hold a wide range of wafer sizes, from single dies as small as 500 microns to 150 mm wafers. Fine-pitch lead screws allow for a manual placement repeatability under 5 mm on a test device.

For metrology-grade semi-automated RF measurements, choose the Summit 12101-6. Full wafers can be autoprobed with 1-micron repeatability. Fully automatic VNA calibrations repeat to under 0.03 vector magnitude, assuring data integrity.

For extensive temperature-dependent characterization, choose the Summit 12651-6. The Summit 12651-6 with patented MicroChamber yields fast, frost-free measurements from -65°C to +200°C in a light- and EMI/RFI-tight enclosure. Using the system stability monitoring and automatic calibration features of Cascade's WinCal software assures that over-temperature measurements are made with the same precision as room-ambient S-parameters.

For exhaustive characterization, process monitoring or production device testing, choose the PS21 RF Autoprober. The PS21 offers 75 mm to 200 mm wafer cassette handling, MicroChambers with double-wall EMI/RFI shielding, and a full range

of built-in temperature options from -55°C to $+200^{\circ}\text{C}$. The PS21 RF handles wafers thinned to 100 microns or less without breakage, assuring proper heat sinking of temperature-sensitive devices.

Wafer probes and calibration standards

The ACP110 series wafer probes combine the HP-developed 1.0 mm connector with Cascade's patented air dielectric coplanar waveguide technology to cover the dc to 110 GHz range. The ACP110 series offers Ground-Signal-Ground standard tips with pitches ranging from 50 microns to 150 microns to cover all specific test needs. The ACP110-L, with insertion loss <1.0 dB, is designed specifically for S-parameter, noise parameter and load pull disciplines while the ACP110-C is used for thermal characterization from -65°C to $+200^{\circ}\text{C}$.

Cascade offers two mode-free impedance standard substrates (ISSs) for full 2-port ACP110 calibration support. Each ISS offers multiple sets of standards, verified to compare favorably to the rigorous NIST multi-line TRL calibration methodology. Calibration reproducibility between ISSs is better than -50 dB vector due to the uniformity of thin film standards. W-band ISS p/n 104-783 covers ACP110 with 75-micron to 150-micron pitches, while the p/n 104-909 ISS is used for 50-micron pitch probes. The companion diskette (p/n 101-338) provides downloadable HP 8510 cal kits supporting SOLT, LRM and TRL calibrations.

Computer-aided calibration and system support

Cascade's WinCal PC software utilities enhance your HP 8510XF on-wafer system performance. WinCal provides tools that can automatically verify each calibration, monitor total system drift and check the performance of each probe. Windows[®] OLE links WinCal to Microsoft[®] Excel, HP EEsof or HP VEE as an S-parameter test manager. Linked to the Summit 12651-6 or PS21 RF, WinCal provides fully automatic calibrations shown to repeat better than -56 dB vector using the NIST VERIFY program — extremely useful for over-temperature S-parameters.

Cascade probe upgrade paths

Like HP, you can enhance your existing Cascade RF probe investments. Depending on your current measurement setup, you may need a standard preconfigured upgrade or a customized upgrade. The following matrix gives standard system configurations. Please consult with a Cascade Microtech factory representative for customized system solutions.

For more information contact:

Cascade Microtech, Inc.
14255 SW Brigadoon Ct.
Beaverton, OR 97005
(503) 626-8245
www.cmico.com



**PS21 RF
Autoprober
with the
HP 8510XF for
wafer testing.**

Cascade RF Probers

Model	Style	HP 8510XF Application	ACP110-L	ACP110-C	East Positioner	West Positioner	WinCal Software
Summit 9101	Manual	General Purpose	•	•	112-960	112-970	VNACAL-WIN-M
Summit 10101	Semi-auto	Modeling	•	•	112-960	112-970	VNACAL-WIN
Summit 11101	Manual	General Purpose	•	•	113-120	113-130	VNACAL-WIN-M
Summit 11651	Manual	G.P. Thermal		•	113-120	113-130	VNACAL-WIN
Summit 12101	Semi-auto	Characterization		•	113-120	113-130	VNACAL-WIN
Summit 12651	Semi-auto	Thermal Modeling		•	113-120	113-130	VNACAL-WIN
PS21 RF	Automatic	Production		•	SQ-113-120-01	SQ-113-130-01	SP-VNACAL-WIN-01

Tips & Techniques

Q. *How can I obtain the HP 8510 system specifications from the performance and verification software?*

A. If you have a copy of the HP 8510 performance and verification software (P/N 08510-10033) and have HP BASIC installed on your computer, you can obtain the specs for your system's configuration. After you complete the Hardware Configuration without error, select the Sys Spec softkey (F2) from the Main Menu. You will be prompted to select tables in which you can find the specs for each band. If you want a hard copy, select Print.

Q. *What are the sources that are compatible with the HP 8510A/B/C?*

- A.** 1. HP 8350B sweeper (firmware rev. >6.0) with HP 8359X RF plug-ins (firmware rev. >7.0).
2. HP 8340/41 A/B synthesized sweeper.
3. HP 83621A/B, 83631A/B, and 83651A/B.

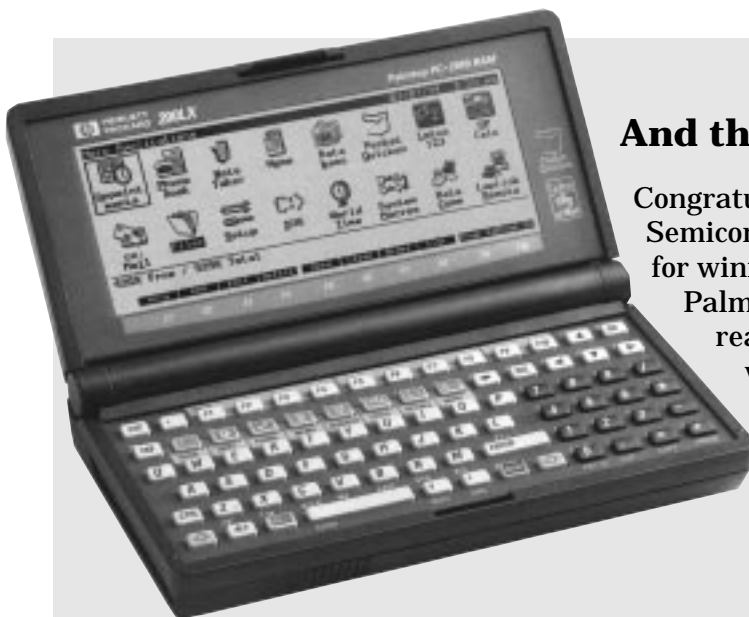
Contact HP for other sources.

Q. *Is the HP 8510C operating system specific to a system?*

A. No, the HP 8510C operating system works with any HP 8510C system, unlike the HP 8510A/B operating systems. However, the HP 8510C operating system's security key IC must be installed before it can be loaded. The HP 11575J upgrade kit upgrades any revision of the HP 8510C operating system to the current version.

Q. *How can I make gain compression measurements with the HP 8510?*

A. The HP 8510 has the capability to make both swept-frequency and swept-power gain compression measurements. The swept-frequency measurement locates the frequency at which the 1 dB gain compression first occurs. A swept-power measurement shows the reduction in gain at a single frequency as a power ramp is applied to the AUT. Product Note 8510-18, Testing Amplifiers and Active Devices with the HP 8510C Network Analyzer, gives step-by-step procedures for making both of these gain compression tests. You can obtain a copy of this Product Note by contacting your HP sales representative.



And the winner is...

Congratulations to Jan Sholten of Philips Semiconductors B.V. in the Netherlands for winning our drawing for an HP 200LX Palmtop PC. Jan was one of the many readers who responded to the survey we mailed out last summer. Your responses will help us make HP 8510/8720 News even more useful.

For Your Files

New Web site information

You'll find extensive, up-to-date information about the HP 8510C family of products on the HP Web site at:

http://www.tmo.hp.com/tmo/datasheets/English/HP8510C_Family.html.

Also available on-line is a PDF version of the last issue (June 1997) of HP 8510/8720 News. You can locate this issue by using the "go station" at http://www.hp.com/go/component_test.

Test & Measurement
Product Information

HP 8510C Network Analyzer Family,
45 MHz to 110 GHz

Summary Features Specifications Key Literature Ordering Assistance Related Info

The HP 8510C vector network analyzer continues to provide the best performance to meet your new design and test challenges. With unmatched accuracy and convenience, the HP 8510C vector network analyzer makes broadband measurements from 45 MHz to 50 GHz in 2.4 mm coax, from 45 MHz to 110 GHz in 1.0 mm coax and from 33 GHz to 110 GHz in waveguide bands.

The HP 8510C network analyzer measures the magnitude, phase, and group delay of two-port networks to characterize their linear behavior. Optionally, the HP 8510C network analyzer is also capable of displaying a network's time domain response to an impulse or a step waveform by computing the inverse Fourier transform of the frequency domain response.

This product family includes

- HP 8510E Microwave Network Analyzer, 45 MHz to 20 GHz
- HP 8510SX Microwave Network Analyzer, 45 MHz to 26.5 GHz
- HP 8510XF Single Connection, Single Sweep, Network Analyzer System, 0.045 to 85 GHz
- HP 8510XF Single Connection, Single Sweep, Network Analyzer System, 0.045 to 110 GHz
- HP 85107B Microwave Network Analyzer, 45 MHz to 50 GHz
- HP 85106D Millimeter-Wave Network Analyzer, 33 GHz to 110 GHz
- HP 85108A Pulsed-RF Network Analyzer System, 2 to 20 GHz
- HP 85108L Pulsed-RF Network Analyzer System, 45 MHz to 2 GHz

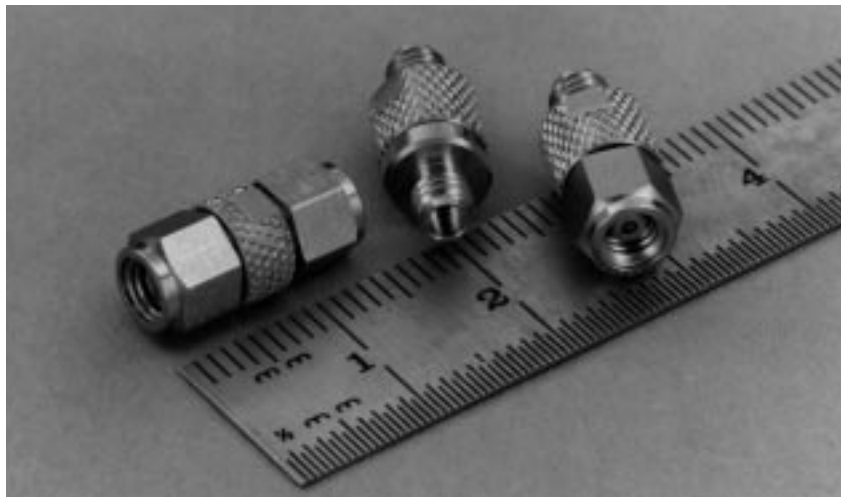
Summary Features Specifications Key Literature Ordering Assistance Related Info

- 45 MHz to 110 GHz frequency range
- Real-time error-corrected measurements
- 60 dB effective directivity and source match
- Up to 100 dB dynamic range

1.0 mm accessories

A series of 1.0 mm accessories is available for use with the HP 8510XF systems. The following accessories are available today:

HP 85059A 1.0 mm calibration/verification kit
 HP 11500I 1.0 mm cable (8.8 cm and f-f)
 HP 11500J 1.0 mm cable (16.0 cm and m-f)
 HP V281C 1.0 mm (f) to V-band waveguide adapter
 HP V281D 1.0 mm (m) to V-band waveguide adapter
 HP W281C 1.0 mm (f) to W-band waveguide adapter
 HP W281D 1.0 mm (m) to W-band waveguide adapter



1.0 mm accessories.

Other 1.0 mm accessories are being developed and will be available later in the year. These accessories include 1.0 mm-to-1.85 mm and 1.0 mm-to-2.4 mm between-family adapters, and 1.0 mm launches for fixture applications.

HP 8510XF system configurations

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

HP 8510 upgrade paths

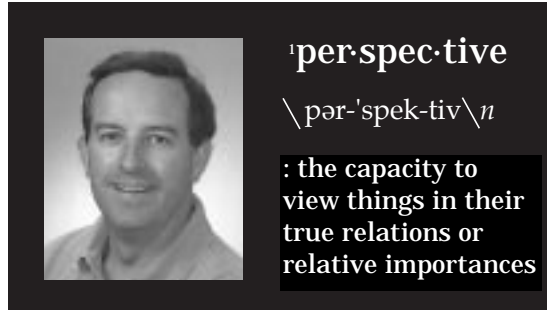
Any existing HP 8510-based system can be upgraded to an HP 8510XF. Preconfigured upgrades are available for standard HP 8510 systems to either an 85 GHz or 110 GHz HP 8510XF system. These systems include HP 85107B, 85106C/D and 85109C (with Option 002). All upgrade packages include hardware and firmware upgrades and on-site installation. Customized upgrades are available for other system configurations.

Related literature

Additional information can be found in the following publications:

5965-9888E	HP 8510XF Product Overview
5965-8837E	HP 8510 System Solutions Color Brochure
5091-8967E	HP 8510C Family Network Analyzer Configuration Guide
5091-8484E	HP 8510C Family Network Analyzer Technical Specifications

Information can also be found on the HP Web site at the following location:
http://www.tmo.hp.com/tmo/datasheets/English/HP8510XF_Family.html



A popular theme in the technology press in the late 1980s was the impending demise of high-frequency test and measurement. The future was said to be exclusively digital; powerful microprocessors and inexpensive memory were to supersede analog technologies and measurements. The use of CAE tools that allowed the creation of perfect designs “the first time every time” (or so the stories went) would allow engineers to do their work on the desktop without measurement tools. The combination of inexpensive digital technologies, advanced CAE tools and software was expected to marginalize analog technologies and measurements.

Well, a funny thing happened on the way to the future. Digital technology has allowed the rapid advancement of technologies and products that touch all of our lives (e.g., cell phones, laptops and voice-mail). CAE tools have brought incredible power and insight into the hands of engineers around the world, and many working designs are finished and tested completely in software. However, digital technology and tools have not eliminated the need for high-quality microwave designs and measurements. Rather, they have had almost the reverse effect: moving the appropriate parts of new designs into the digital realm has freed the microwave engineer to push the capability of analog technology further and faster than was previously possible. 60 GHz wireless LAN for the office market and collision warning radar for the automotive industry are examples of advanced applications that demand the latest in measurement innovation and performance.

As we approach the millennium, all the engineering disciplines are confronted with fast-moving technology and business issues that challenge the creativity of analog, digital and software engineers — as well as engineering management. At Hewlett-Packard, we are energized by these trends and the exciting opportunities to contribute to the business success of our customers. Our future together has never looked so bright!

Dave Myers
Marketing Manager
Santa Rosa Systems Division



The *HP 8510/8720 News* is published regularly by the Santa Rosa Systems Division of Hewlett-Packard. Please send queries, submissions and comments to:

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P.O. Box 4026
Englewood, CO 80155-4026
1 800 452 4844

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