

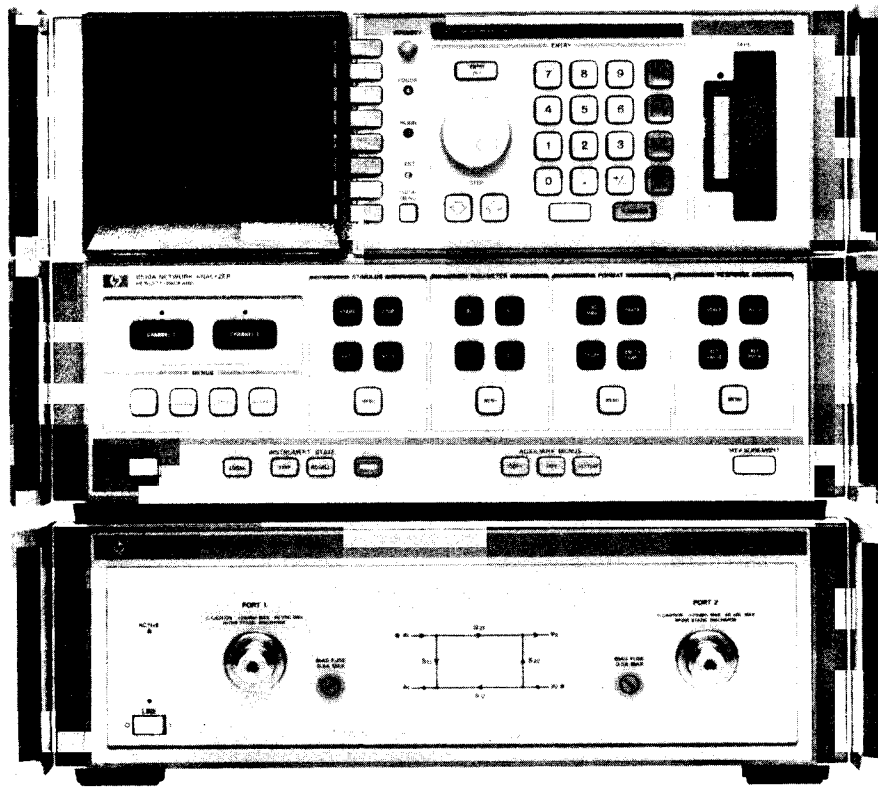


NETWORK ANALYZERS

Microwave Network Analyzers, 45 MHz to 26.5 GHz

8510 Series

- 45 MHz to 26.5 GHz frequency range
- "Real Time" error-corrected measurements
- 50 dB effective directivity, 40 dB effective source and load match
- 80 dB to 100 dB dynamic range
- 0.001 dB, 0.01 degree, 0.01 nanosecond measurement resolution
- Time domain analysis



HP 8510A



Description

The HP 8510 series microwave vector network analyzers provide a complete solution for characterizing the linear behavior of either active or passive networks over the 45 MHz to 26.5 GHz frequency range. A complete system comprises the HP 8510A network analyzer, one of four HP 851XA broadband test sets, and a compatible RF source.

The test sets are offered in one of two measurement test setup configurations. The reflection/transmission test sets provide the capability to simultaneously measure the complex reflection and transmission characteristics of a test device. The S-parameter test sets offer a single test setup solution for complete characterization of two-port devices. Each measurement presented on the CRT display consists of 51, 101, 201, or 401 discrete points of data, and when the system source is a synthesizer, the frequency of each data point is synthesized.

Measurement results can be displayed on one of two completely independent, yet identical, channels. The channels may be displayed individually, or simultaneously, with results presented in either logarithmic/linear magnitude, phase, or group delay format on rectangular or polar coordinates. Direct measurement of normalized impedance is possible with the Smith chart format. The value and frequency of any one data point can be read with one of five independent markers. The entire measurement trace can be copied directly to a plotter, such as the HP 7470A, 7475A, or 7550A without the need of an external computer. Also, a list of the trace values can be sent to a printer such as the HP 9876A or 2225A.

Powerful measurement enhancement functions are also available. Data averaging can be employed to effectively narrow the receiver IF

bandwidth, extending dynamic range and reducing signal-to-noise ratio. Trace smoothing aids in the interpretation of measurement results and is used to control the aperture of group delay measurements. The equivalent of an electronic line stretcher is available via the electrical delay function.

Built-in storage provides the capability to save and recall up to eight different front panel states, eight separate measurement calibrations, and four separate measurements in nonvolatile memory. Extension of the internal storage capacity is practically limitless via the built-in tape cassette unit.

All the functions of the HP 8510 system are completely programmable from an external computer through the Hewlett-Packard Interface Bus. Also, measurements can be transferred to a computer in one of four data transfer formats. CRT graphics, such as limit lines, can be written to the HP 8510 to aid in test procedures. The built-in tape drive can, as well, be used to provide permanent storage of CRT graphics.

High Performance

Along with the capability to completely characterize a microwave network with a single connection over the extremely broad 45 MHz to 26.5 GHz frequency range, the HP 8510 system offers wide dynamic range. Depending on the test set used, 80 dB to 100 dB of dynamic range is available. The precision IF processing and detection system contributes as little as ± 0.05 dB and ± 0.5 degree measurement uncertainty at a level of 50 dB below the reference. Meaningful resolutions of 0.001 dB, 0.01 degree, and 0.01 nanosecond are easily achievable.

"Real Time" Error Correction

The fundamental accuracy limitations in most microwave measurements are due primarily to uncertainties associated with systematic errors in the microwave hardware (directivity, mismatch, frequency response, etc.). The HP 8510A's built-in, high speed computer provides the capability to characterize and effectively remove the impact of systematic errors through accuracy enhancement techniques. Effective directivity is improved to 50 dB, and effective source and load match to better than 40 dB. The data processing speed of the system is such that a fully error-corrected, 401 point trace of data is updated in under one second. This virtual "real time" display of error-corrected data means that you can easily adjust your test device while it's being measured, with the assurance that you are viewing the data at the highest possible accuracy.

Hewlett-Packard supplies kits of measurement calibration standards for precision 7 mm, precision 3.5 mm, and Type N connector interfaces. The HP 8510 system, also, provides the capability to measure devices in other coaxial interfaces, and waveguide, given the proper calibration standards.

Time Domain Analysis

The HP 8510 (with option 010) has the capability of displaying the time domain response of a network, obtained by computing the Inverse Fourier Transform of the frequency domain response. The time domain response displays the reflection coefficient of the network versus time, which displays the magnitude and location of each individual discontinuity, or else the transmission coefficient versus time, which displays each individual transmission path.

The HP 8510 offers two time domain modes. The Low Pass mode provides the traditional Time Domain Reflectometer (TDR) measurement capability and gives the response of the network to a (mathematically simulated) step or impulse stimulus. This mode gives information of the type of impedance (R, L, or C) present at a discontinuity. The Band Pass time domain mode, which has only the impulse stimulus, may be used over any frequency range to give the time domain response of frequency-selective devices (such as waveguide).

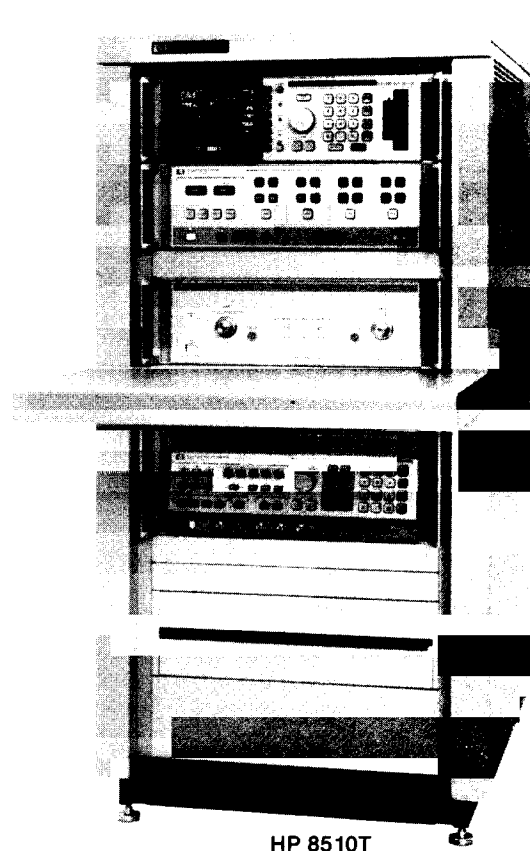
Gating is another powerful time domain feature that may be used to selectively isolate a single response in time and then convert just that response back to the frequency domain. For reflection measurements, this provides the capability to view the return loss of individual portions of a microwave component without disturbing the actual circuit. For transmission measurements, one can view the frequency and time domain responses of individual transmission paths.

The HP 8510A time domain capability can give great insight into the design of microwave components. Another useful application is cable fault location. Gating can be used in a variety of applications such as removing fixturing residuals or removing the effects of multipath and ground clutter in antenna measurements.

Compatible Sources

The HP 8340A and 8341A synthesized sweepers with the HP 8510 provide the best, most accurate measurements, regardless of the parameter selected. They combine a high resolution synthesizer with a broadband sweeper to cover the full frequency range of the HP 8510. With the HP 8340A you obtain 4 Hz resolution at 26.5 GHz for CW frequencies, phase locked narrowband (<5 MHz) sweeps, and fully synthesized start frequencies for broadband sweeps.

The HP 8350B sweep oscillator family is also fully compatible with the HP 8510. Coupled with this versatile sweeper mainframe, you can choose from a wide variety of RF plug-ins.



HP 8510T

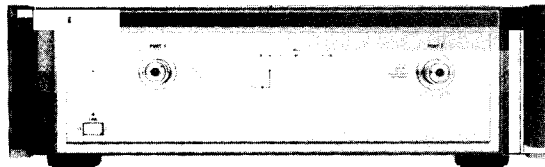
HP 8510T Network Analyzer System

The HP 8510T is the highest performance system in the HP 8510 series. It provides, under one model number, everything needed to make precision measurements in the 45 MHz to 26.5 GHz frequency range. The system includes the HP 8510A with option 010, the 8515A S-Parameter Test Set, and an HP 8340A Synthesized Sweeper with options 005, 006, and 007. A comprehensive array of test and measurement accessories including the HP 85050A 7 mm Calibration Kit, HP 85051A 7 mm Verification Kit, HP 85052A 3.5 mm Calibration Kit, along with RF return cables and adapters, are supplied. The instruments are installed in the portable HP 85043A system rack.

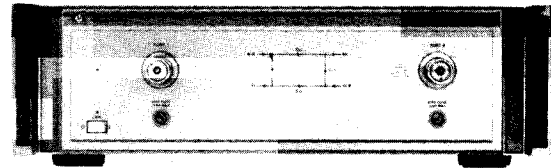
When you purchase HP 8510T you not only obtain a high performance network measurement system, you are also provided with the total solution. Included with the HP 8510T are an impressive array of support products including on-site maintenance for one year, installation, and calibration at no extra charge.

HP 85043A System Rack

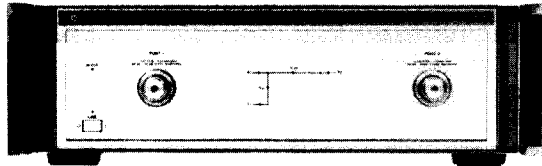
The HP 85043A System Rack is a rack standing only 123.7 cm (48.7") high with a width of 60.0 cm (23.6") and a depth of 80.0 cm (31.5"). Complete with support rails and ac power distribution (suitable for 50 to 60 Hz, 100-240 Vac), it includes rack mounting hardware for all instruments. Thermal design is such that no rack fan is needed.



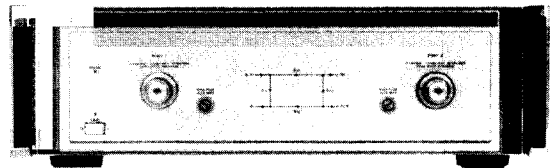
HP 8512A



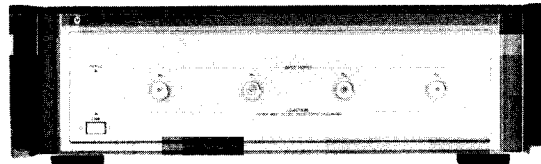
HP 8514A



HP 8513A



HP 8515A



HP 8511A

HP 8512A Reflection/Transmission Test Set

The HP 8512A Reflection/Transmission Test Set provides the capability to simultaneously measure the complex reflection and transmission characteristics of a test device from 45 MHz to 18 GHz in transmission and 500 MHz to 18 GHz in reflection. Reflection measurements to 45 MHz is achievable with some loss (about 30dB) in dynamic range. An HP 8512A-based system offers very broad dynamic range with the highest accuracy available. The test ports have rugged precision 7-mm connectors and may be adapted to other interfaces with the appropriate precision adapters. The test set includes an integrated three-channel frequency converter.

HP 8513A Reflection/Transmission Test Set

The HP 8513A Reflection/Transmission Test Set provides the capability to simultaneously measure the complex reflection and transmission characteristics of a test device over the 45 MHz to 26.5 GHz frequency range. An HP 8513A-based system offers the capability to measure a network over an extremely wide frequency range with just one connection, over a wide dynamic range with high accuracy. The test ports are a special, ruggedized, version of the precision 3.5-mm connector interface that is completely compatible with any connector in the 3.5 mm family. The test set includes an integrated three-channel frequency converter.

HP 8514A S-Parameter Test Set

The HP 8514A S-Parameter Test Set provides the capability to measure all four S-parameters of a two port device with a single connection over the 500 MHz to 18 GHz frequency range. Measurements to 45 MHz are achievable with some loss (about 30 dB) in dynamic range. The S-parameter test set architecture is ideal for measuring two-port devices where it is not convenient to physically reverse the device to measure the reverse parameters, or for networks that need to be adjusted while being measured with full error-correction employed. The test ports have rugged precision 7-mm connectors

and may be adapted to other connector interfaces with the appropriate precision adapters. Along with an integrated, four-channel frequency converter, the test set includes two 90-dB step attenuators for changing the incident power level at the test port and two bias networks for applying dc bias to the test port center conductor in active device test applications.

HP 8515A S-Parameter Test Set

The HP 8515A S-Parameter Test Set provides the capability to measure all four S-parameters of a two-port device with a single connection over the 45 MHz to 26.5 GHz frequency range. The S-parameter test set architecture is ideal for measuring two port devices where it is not convenient to reverse the device to measure the reverse parameters, or for networks that need to be adjusted while being measured with full error-correction employed. The test ports are a special, ruggedized, version of the precision 3.5 mm interface that is completely compatible with any connector in the 3.5 mm family. Along with an integrated, four-channel frequency converter, the test set includes two 90-dB step attenuators for changing the incident power level at the test port and two bias networks for applying dc bias to the test port center conductor in active device test applications.

HP 8511A Frequency Converter

The HP 8511A is a four-channel frequency converter covering the 45 MHz to 26.5 GHz frequency range. An HP 8510A/8511A combination results in a system that can be customized to unique test requirements with the addition of customer-supplied test setup hardware. Examples include multi-port device measurements and antenna characterization. Each of the four inputs operates over the full dynamic range of the system, from 85 dB to 100 dB. Isolation between channels is typically greater than 100 dB. Dynamic accuracy is better than ± 0.05 dB and ± 0.2 degree at a test channel level of -50 dBm.

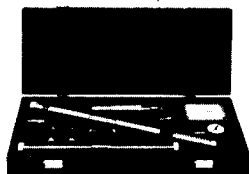


NETWORK ANALYZERS

Accessories



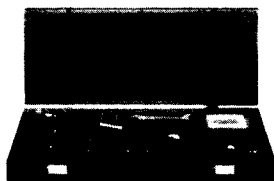
Models 85050A, 85051A, 85052A, 85053A, 85054A, 85130A, 85131A/B, 85132A/B



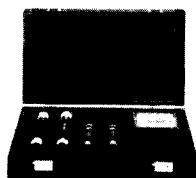
HP 85050A



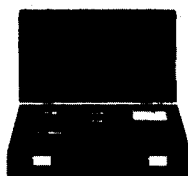
HP 85052A



HP 85054A



HP 85051A



HP 85053A



HP 85130A



HP 85131A/B



HP 85132A/B

Calibration Kits

Error-correction procedures require that the systematic errors in the measurement system be characterized by measuring known devices (standards) on the system over the frequency range of interest. The calibration kits in the HP 8510 family contain precision standard devices to characterize the systematic errors of the HP 8510 system. Hewlett-Packard offers several calibration kits in various connector interfaces that are compatible with the HP 8510.

HP 85050A 7 mm Calibration Kit

The HP 85050A 7 mm Calibration Kit contains a set of precision calibration standards used to calibrate the HP 8510 system for measurements of devices with precision 7-mm connectors. The calibration standards include open and short circuits, and fixed and sliding terminations. Also included are a precision 7-mm connector gage and tools for verifying and maintaining the connector interfaces.

Option 010: Adds a precision 30-cm beadless airline that is useful in time domain applications.

Option 020: Deletes precision 7-mm connector gage and tools.

HP 85052A 3.5 mm Calibration Kit

The HP 85052A 3.5 mm Calibration Kit contains a set of precision calibration standards used to calibrate the HP 8510 system for measurements of devices with 3.5-mm connectors (precision 3.5 mm or SMA). The calibration standards include open and short circuits, and fixed and sliding terminations. Also included are precision 7-mm to 3.5-mm adapters. Connector gages are supplied for verifying critical mechanical tolerances of the 3.5-mm connector interface.

Option 010: Adds precision 15-cm beadless airline that is useful in time domain applications.

Option 020: Deletes precision 3.5-mm connector gages.

HP 85054A Type N Calibration Kit

The HP 85054A Type N Calibration Kit contains a set of precision calibration standards used to calibrate the HP 8510 system for measurements of devices with Type N connectors. The calibration standards include open and short circuits, and fixed and sliding terminations. Also included are precision 7-mm to Type N adapters.

Verification Kits

Measuring known devices, other than the calibration standards, is a straightforward way of verifying that the HP 8510 system is operating properly. Hewlett-Packard offers verification kits that include standard devices, with data, for verifying the error-corrected measurement performance of the HP 8510 system.

HP 85051A 7 mm Verification Kit

The HP 85051A 7 mm Verification Kit contains a set of precision devices, with data, used to verify the error-corrected performance of the HP 8510 system. The devices have precision 7-mm connectors and include 20-dB and 50-dB attenuators, a 10-cm beadless airline, and a 10-cm beadless stepped impedance airline (25 ohms nominal).

HP 85053A 3.5 mm Verification Kit

The HP 85053A 3.5 mm Verification Kit contains a set of precision devices, with data, used to verify the error-corrected performance of the HP 8510 system. The devices have precision 3.5-mm connectors and include 20-dB and 40-dB attenuators, a 7.5-cm beadless airline, and a 7.5-cm beadless stepped impedance airline (25 ohms nominal).

Test Port Return Cables

Hewlett-Packard offers a variety of high quality RF cables that are used to return the transmitted signal to the test set when measuring two-port devices.

HP 85131A 3.5 mm Test Port Return Cable

The HP 85131A is a single test port return cable for use with either the HP 8513A or 8515A test sets (when connecting the device directly to Port 1).

Frequency Range: dc to 26.5 GHz

Length: 91 cm (36 in.)

VSWR: 1.22:1, typical

Connectors: Special 3.5 mm, and precision 3.5 mm (female)

HP 85131B 3.5 mm Test Port Return Cable Set

The HP 85131B is a pair of test port return cables for use with the HP 8515A test set. The device is connected between the cables during measurement.

Frequency Range: dc to 26.5 GHz

Length: 66 cm (24 in.) each

VSWR: 1.22:1, typical

Connectors: Special 3.5 mm, and precision 3.5 mm (one male, or female)

HP 85132A 7 mm Test Port Return Cable

The HP 85132A is a single test port return cable for use with either HP 8512A or 8414A test sets (when connecting the device directly to Port 1). When used with the HP 85130A adapter set, the HP 85132A can also be used with the HP 8513A and HP 8515A test sets when measuring devices with precision 7-mm connectors.

Frequency Range: dc to 18 GHz

Length: 91 cm (86 in.)

VSWR: 1.2:1, typical

Connectors: Precision 7 mm

HP 85132B Test Port Return Cable Set

The HP 85132B is a pair of test port return cables for use with the HP 8514A test set. The device is connected between the cables during measurement. When used with the HP 85130A adapter set, the HP 85132A set can also be used with the HP 8515A set when measuring devices with precision 7-mm connectors.

Frequency Range: dc to 18 GHz

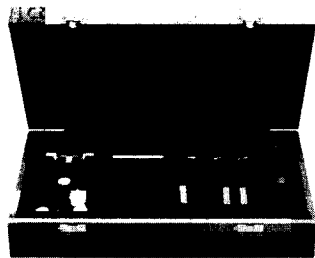
Length: 66 cm (24 in.) each

VSWR: 1.2:1, typical

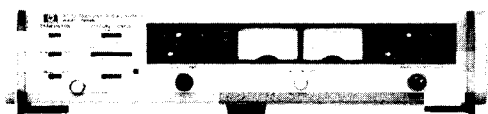
Connectors: Precision 7 mm

HP 85130A Special 3.5 mm to 7 mm Adapter Set

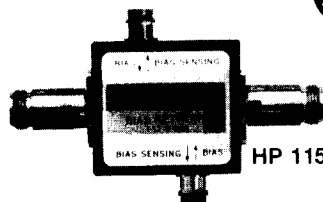
The HP 85130A kit contains a set of precision special 3.5-mm to 7-mm adapters used for converting the test ports of the HP 8513A and 8515A test sets to a precision 7-mm interface. The HP 85132A or 85132B cables are used as the test port return cables when the HP 85130A adapters are connected to the test set.



HP 85041A



HP 8717B



HP 11590B



HP 11612A



HP 11635A

Active Device Test

Hewlett-Packard offers an extensive array of accessories designed for the needs of active device test and measurement, including fixtures, bias supplies, bias networks, and application software.

HP 85041A Transistor Test Fixture Kit

The HP 85041A Transistor Test Fixture (TTF) kit is a comprehensive measurement system for testing and characterizing stripline packaged microwave transistors. When used with the HP 85014A Active Device Measurement software, fully error-corrected, deembedded measurements can be made.

Frequency Range: dc to 18 GHz

Transistor Package Inserts: 70 mil and 100 mil

Verification Devices: Short and through circuits

Connectors: precision 7 mm

Accessories Supplied: fixture stand, torque tool, tweezers, and lid opening tool

HP 8717B Transistor Bias Supply

The HP 8717B transistor bias supply provides manual or automatic biasing for transistor testing. This supply 8717B has two meters for independently monitoring current and voltage. Bias connections are conveniently selected for all transistor configurations with a front panel switch.

Voltage Ranges: 1,3,10,30,100 V

Current Ranges: 0.1,0.3,1,3,10,30,100,300,1000 mA

Accuracy: 4% of full scale for both current and voltage

Option 001: programmable D/A converter

Option 011: programming cable for HP Series 200 computers

HP 11590B Bias Network

The HP 11590B is a rugged, broadband bias network. This bias network provides dc bias to the center conductor of a coaxial line which can be connected to the device under test while blocking DC bias from the RF circuit.

Frequency Range: 1.0 to 12.4 GHz (Option 001, 1.0 to 18.0 GHz)

Maximum insertion loss: 1.0 dB, 0.1 - 1.0 GHz

0.8 dB, 1.0 - 12.4 GHz

1.2 dB, 12.4 - 18.0 GHz (Option 001)

Minimum return loss: 16 dB, 0.1 - 1.0 GHz

19 dB, 1.0 - 12.4 GHz

14 dB, 12.4 - 18.0 GHz (Option 001)

Maximum Bias Current: 0.5 A, each bias port

Maximum Bias Voltage: 100 V

Connectors: BNC for dc bias; type N female for RF (Option 001, precision 7 mm)

HP 11612A Bias Network

The HP 11612A is an insertable, extremely broadband bias network with excellent port match and low insertion loss. This bias network provides dc bias to the center conductor of a coaxial line which can be connected to the device under test while blocking DC bias from the RF circuit.

Frequency Range: 45 MHz to 26.5 GHz

Insertion loss: 0.8 dB, 45 MHz - 12.4 GHz

(max) 1.3 dB, 12.4 - 26.5 GHz

Minimum return loss: 20 dB, 45 MHz - 8.0 GHz

18 dB, 8.0 - 18.0 GHz

14 dB, 18.0 - 26.5 GHz

Maximum Bias Current: 0.5 A

Maximum Bias Voltage: 40 V

Connectors: SMB snap-on for dc bias; precision 3.5 mm for RF

HP 11635A Bias Decoupling Network

The HP 11635A bias decoupling network is a recommended accessory for prevention of bias oscillations when biasing microwave bipolar transistors with any HP bias network or s-parameter test set. Installing the HP 11635A between the bias supply and the base bias network prevents low frequency oscillations.

Application Software

Hewlett-Packard offers several application software packages that compliment the HP 8510 system providing automated calibration and measurement capability. Software is available for HP 200 Series desktop computers with either BASIC 2.0 or 3.0 operating systems on both 3 1/2" and 5 1/4" disc media.

HP 85014A Active Device Measurement Application Pac

The HP 85014A software pac provides the capability to the HP 8510 system for measurement of RF and microwave transistors. Features include automated device biasing with the HP 8717B bias supply, system calibration, and de-embedding of s-parameters when using the HP 85041A transistor test fixture. It is also usable with other HP transistor fixtures as well as user-designed fixtures. Plotted and listed output of device S, H, Y, and Z parameters, as well as the device Amplifier Summary and Termination Summary are provided. Also available is the capability to store and retrieve s-parameter data in formats suitable for computer aided design applications.

HP 85013A Basic Measurements Application Pac

The HP 85013A software pac provides the capability to automate the HP 8510 system for applications where the system is required to emulate the user interface of the HP 8409 series automatic network analyzers. All the features of the HP 8409 series operating system are provided for including the capability to measure up to 401 related (Start/Stop/Step) or unrelated (individual CW) frequency points.



Support Products

Hewlett-Packard offers a complete group of support products specifically tailored to achieve maximum HP 8510 productivity. Several of these products are described below.

HP 8510A + 24D Basic Measurements Using the HP 8510 Network Analyzer System

With two enrollments included in the purchase price of the HP 8510A, this three day, lab intensive training course introduces students to the operation of the HP 8510 system including error-correction and time domain fundamentals. The training course provides the opportunity for users to accelerate on the basic operation learning curve, allowing maximum utilization of the system to be achieved in a shorter time.

HP 8510T + 23N On-Site System Installation (where available)

The HP 8510T+23N provides for complete installation of the HP 8510 system in either table top or racked configurations. Included are pre-installation inspection, on-site installation, and verification. Also included is a retrofit of one customer owned HP 8350 series sweep oscillator for HP 8510 compatibility.

HP 8510T + 23A Basic System Maintenance and Calibration (where available)

The HP 8510T+23A provides complete on-site maintenance and calibration support for an HP 8510 system. Included are next-day on-site response when repairs are needed, preventive maintenance, and on-site calibration performed twice a year with NBS (or other standard agency) traceable devices.

Ordering Information

| | Price |
|--|-------------|
| Analyzer | |
| HP 8510A Network Analyzer | \$33,500 |
| Option 010 Time Domain Capability | add \$9,500 |
| Test Sets (choose at least one) | |
| HP 8512A R/T Test Set (0.5 to 18.0 GHz) | \$17,300 |
| HP 8513A R/T Test Set (45 MHz to 26.5 GHz) | \$25,000 |
| HP 8514A S-Parameter Test Set (0.5 to 18.0 GHz) | \$28,000 |
| HP 8515A S-Parameter Test Set (45 MHz to 26.5 GHz) | \$37,200 |
| HP 8511A Frequency Converter (45 MHz to 26.5 GHz) | \$17,300 |
| Sources (choose either the HP 8340A/8341A or the HP 8350B with an RF Plug-in) | |
| HP 8340A 0.01 to 26.5 GHz Synthesized Sweeper (with options 005, 006, 007) | \$59,800 |
| HP 8341A 0.01 to 20.0 GHz Synthesized Sweeper (with option 005) | \$44,200 |
| HP 8350B Sweep Oscillator (choose one of these recommended plug-ins) | \$ 4,565 |
| HP 83592A 0.01 to 20.0 GHz (with option 004) | \$23,770 |
| HP 83595A 0.01 to 26.5 GHz (with option 004) | \$29,285 |

Calibration Kits (choose one for each connector type to be used)

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|----------------------------------|-------------|
| HP 85050A 7 mm Calibration Kit | \$3,000 |
| Opt. 010 30 cm beadless airline | add \$1,100 |
| Opt. 020 delete connector tools | less \$750 |
| HP 85052A 3.5 mm Calibration Kit | \$4,850 |
| Opt. 010 15 cm beadless airline | add \$1,100 |
| Opt. 020 delete connector tools | less \$750 |
| HP 85054A Type N Calibration Kit | \$1,950 |

Verification Kits

| | |
|-----------------------------------|---------|
| HP 85051A 7 mm Verification Kit | \$2,400 |
| HP 85053A 3.5 mm Verification Kit | \$2,600 |

Test Port Return Cables (choose at least one)

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|--|---------|
| HP 85131A 3.5 mm Test Port Return Cable | \$850 |
| HP 85131B 3.5 mm Test Port Return Cable Set | \$1,600 |
| HP 85132A 7 mm Test Port Return Cable | \$700 |
| HP 85132B 7 mm Test Port Return Cable Set | \$1,350 |
| HP 85130A Special 3.5 mm to 7 mm Adapter Kit | \$575 |

Transistor Test Accessories

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|--|-----------|
| HP 85041A Transistor Test Fixture Kit | \$5,000 |
| HP 8717B Transistor Bias Supply | \$4,415 |
| (when used with HP 85014A software must order) | |
| Opt. 001 Programming Capability | add \$670 |
| Opt. 011 Programming Cable | add \$250 |
| HP 98622A GPIO Interface | \$355 |
| HP 11590B Bias Network | \$775 |
| HP 11612A Bias Network | \$700 |
| HP 11635A Bias Decoupling Network | \$275 |

System Rack

| | |
|-----------------------|---------|
| HP 85043A System Rack | \$2,300 |
|-----------------------|---------|

Software (choose one option)

| | |
|--|---------|
| HP 85013A Basic Measurements Application Pac | \$950 |
| Opt. 630 3 1/2" disc | N/C |
| Opt. 655 5 1/4" disc | N/C |
| HP 85014A Active Device Measurements Application Pac | \$3,000 |
| Opt. 630 3 1/2" disc | N/C |
| Opt. 655 5 1/4" disc | N/C |

Support Products

| | |
|---|-----------------|
| HP 8510A + 24D User Course | \$1,100/student |
| HP 8510T + 23N On-site Installation (where available) | \$600 |
| HP 8510T + 23A On-site Service (where available) | |

Systems

| | |
|----------------------------------|-----------|
| HP 8510T Network Analyzer System | \$162,000 |
|----------------------------------|-----------|