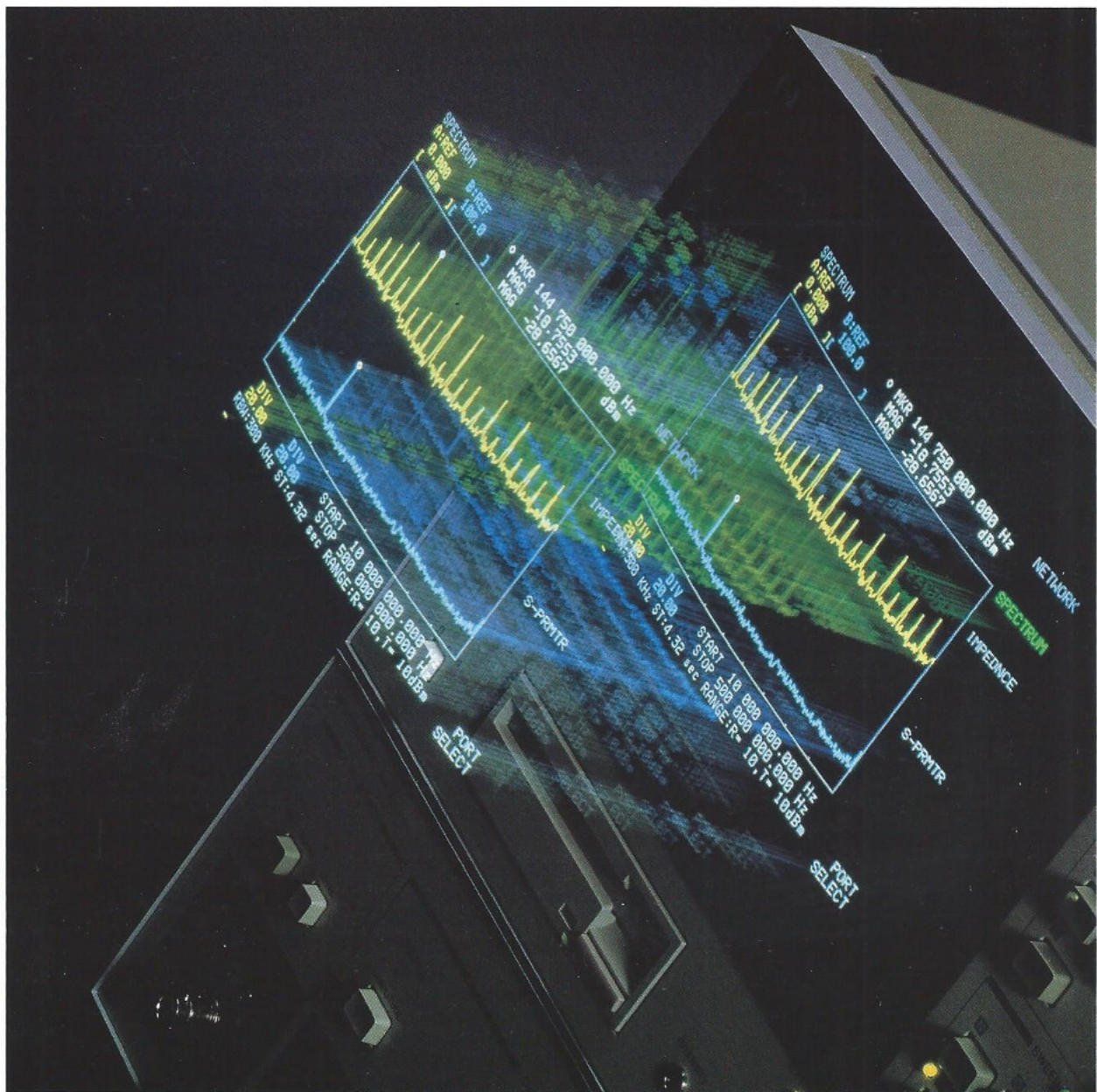


TEST & MEASUREMENT

N E W S

HEWLETT-PACKARD

NOVEMBER/DECEMBER 1987



HP 4195A
Network/Spectrum Analyzer

 HEWLETT
PACKARD

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GENERAL-PURPOSE INSTRUMENTS

New single-mode optical attenuator offers extremely high return loss

The new HP 8157A Optical Attenuator's extremely high return loss, 0.01-dB attenuation steps, and high linearity make it an excellent choice for making bit error rate tests (BERT) in R&D and production. It is also well-suited for applications using fast laser diodes, such as distributed feedback lasers.

Its main specifications and features:

- 36-dB return loss
- Wavelength range of 1200 nm to 1650 nm
- ± 0.20 -dB (typically ± 0.05 -dB) linearity for 0-dB to 60-dB attenuation
- 0.01-dB resolution
- ± 0.04 -dB repeatability
- Exchangeable connector interfaces for Diamond® HMS-10 R/HP, FC/PC, DIN 47256, and ST connections.

Each optical attenuator is individually calibrated at 1300 nm and 1550 nm over the whole attenuation range of 60 dB. The wavelength characteristics for the metallic filter coatings are stored in an EEPROM.

The optical system is sealed, and all optical surfaces have special antireflection coatings for low wavelength dependency and polarization sensitivity.

The HP 8157A can be programmed either remotely over the HP-IB (IEEE 488/IEC 625) or manually and it is fully software compatible with the HP 8158B Optical Attenuator.

The HP 8157A is priced at \$8,300. The connector interfaces, each consisting of two connectors, are \$580.

For more information, check **A** on the HP Reply Card.

Diamond® is a registered trademark of Diamond SA.



The HP 8157A Optical Attenuator provides more than 36-dB return loss.

Highly stable laser sources for 1300-nm, 1550-nm wavelengths

Whether you're evaluating the insertion or splice loss of connectors or the attenuation of long-distance cables, the new HP 8155A Option 002 (1300 nm) and 003 (1550 nm) Laser Diode Sources provide the required power-level stability.

Specifications include:

- ± 0.003 -dB short-term stability over 15 minutes at a constant temperature
- ± 0.03 -dB long-term stability over 12 hours and an environmental temperature change of $\pm 2^\circ\text{C}$
- Optical output power: -4 dBm $< P_{\text{out}} < -3$ dBm
- External modulation in the 1-kHz to 850-MHz range
- Internal modulation at 270 Hz, derived from a quartz oscillator (chopped light).

The new laser sources accept external modulation up to 850 MHz and have excellent pulse performance. These features make them well-suited for testing fast receivers in telecommunication systems up to data rates of 565 Mbits/s.

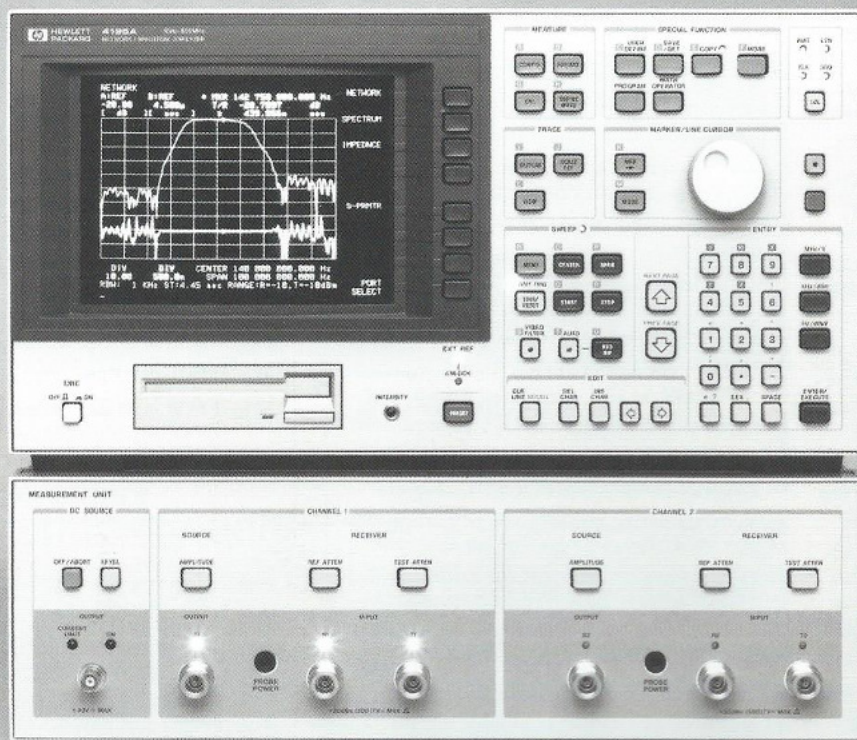
The sources are thermoelectrically cooled and controlled. They fully comply with the IEC 825 and VDE 0837 international standards, with incorporated laser safety circuitry. And the sources are available with four different optical connector interfaces, which can be exchanged easily: Diamond® HMS-10/HP, FC/PC, DIN 47256, and ST.

The HP 8155A Option 002 is \$8,900 and Option 003 is \$10,600. The HP 8155A Laser Source mainframe is \$2,500. The connector interfaces, each of which consists of two connectors, are \$290.

For more information, check **B** on the HP Reply Card.

Diamond® is a registered trademark of Diamond SA.

GENERAL-PURPOSE INSTRUMENTS



The HP 4195A Network/Spectrum Analyzer offers flexible analysis capability for testing and evaluating analog devices.

Network/spectrum analyzer tests analog devices

The HP 4195A Network/Spectrum Analyzer (10 Hz to 500 MHz) is the first instrument from Hewlett-Packard to provide both vector network and spectrum measurements in one unit. Designed for engineers developing and testing analog circuits and components, the new analyzer effectively delivers the performance of two instruments for the price of one.

Exceptional performance

The HP 4195A has an amplitude/phase accuracy of ± 0.5 dB/ ± 0.3 degrees for network measurements and greater than 70 dB dynamic range for spectrum measurements. Direct impedance measurements can also be performed, using an optional impedance test set. HP 4195A Opt. 001, a high-stability reference oscillator, is also available.

Easy operation and customization

An easy-to-understand, unified network and spectrum command structure offers fast measurement and analysis operation. The analyzer features a color-graphic CRT and provides rectangular, tabular, Smith, and polar display formats for viewing data.

The user program capability allows you to create a BASIC-like internal program to automate measurement and data analysis. Examples of user programs are carrier-to-noise (C/N) measurements and automatic parameter extraction of amplifiers, mixers, and filters.

Flexible measurement configurations

Its measurement port configuration makes the HP 4195A useful in a wide range of linear and nonlinear device measurement applications. The analyzer has two channels, each consisting of one output and two input ports.

For network measurements, standard HP accessories or customer-selected reflection/transmission test sets can be used to perform gain, phase, group-delay, and reflection-coefficient measurements. Forward and reverse s-parameter measurements (S_{11} , S_{21} , S_{22} , S_{12}) can be performed by using two reflection/transmission test sets.

The HP 4195A also performs multi-channel spectrum measurements. The analyzer's four input ports allow for multiple connections to a device without moving a test probe.

The HP 4195A Network/Spectrum Analyzer is priced at \$23,000. Option 001 is \$850.

For more information, check **C** on the HP Reply Card.

GENERAL-PURPOSE INSTRUMENTS

PC-based software reduces DACQ program-development time

HP's new general-purpose data-acquisition manager can reduce your program-development time by as much as a factor of 10. Designed for the HP Vectra Personal Computer, and usable with virtually any HP-IB instrument, the HP DACQ/PC (HP 44459A) software contains subroutines that can be added to an HP BASIC program. The software saves you time by eliminating much of the software writing required to manipulate and display data.

Initialization and debugging routines are built into HP DACQ/PC. By writing a 100-line program and calling HP DACQ/PC subroutines, you can do the job of a 10,000-line program with little effort.

Customized data management

HP DACQ/PC subroutines are used to set up a database, as well as retrieve, store, analyze, display, print, plot, and transmit data. These routines can be inserted anywhere in an HP BASIC program. A scheduler routine assists with timing and putting these subroutines into order.

HP BASIC language-processor card

HP DACQ/PC tools are optimized for maximum performance on the HP BASIC language-processor card for the HP Vectra PC. Using compiled Pascal and Assembly subroutines, the software keeps the program running at top speed.

The HP BASIC language processor card turns the HP Vectra PC into a powerful instrument controller. HP BASIC, part of the HP 9000 Series 200/300 engineering workstations, is one of the industry's most powerful and easy-to-use programming environments for instrument control.

The HP 44459A DACQ/PC is \$1,480. For more information, check **D** on the HP Reply Card.

New TV/video-sync pod is versatile and self contained

The new HP 1133A TV/Video-Sync Pod lets you add composite-video-signal triggering to analog and digitizing oscilloscopes, spectrum analyzers, and other signal monitoring devices. This versatile accessory has clamped and unclamped video outputs and variable gain for measuring small signals. It is compatible with most standard video-broadcast systems.

The HP 1133A simplifies timing and amplitude measurements when used with a

digitizing oscilloscope. The pod allows you to easily view frames and fields, horizontal and vertical intervals, and vertical-interval test signals. It has its own power supply.

The pod has a high-impedance (1-M Ω) pickoff that drives its circuits without affecting the 75 Ω composite video signal being fed through. By looping your test signal through the HP 1133A, you can route the signal to a video monitor or other 75 Ω device.

The HP 1133A is \$275.

For more information, check **E** on the HP Reply Card.

Instrument Notes

New standard for modular instrumentation.

HP and four other companies announced endorsement of a new standard for modular instrumentation called the VMEbus Extensions for Instrumentation (VXIbus). The other companies are Colorado Data Systems, Racal Dana Instruments, Tektronix, and Wavetek Corporation. VXIbus is an open architecture for modular instruments that allows modules from different manufacturers to operate within the same card chassis. The new standard has been submitted to two national committees with the recommendation that these groups incorporate it into their standardization efforts. It will be considered by the IEEE P1155 working group as a commercial standard and by the MATE Instrument-on-a-Card subcommittee as an Air Force standard.

Logic analyzers. "Feeling Comfortable with Logic Analyzers" gives you a quick course in the basics of logic state and timing analysis. This 32-page booklet compares logic analyzers with oscilloscopes and explains which is the right tool for various applications. Other topics include sampling, triggering, and disassembly. Check **F**.

Digitizing oscilloscopes. "Feeling Comfortable with Digitizing Oscilloscopes" covers the basics of digitizing oscilloscope technology in 42 pages. Contents include di-

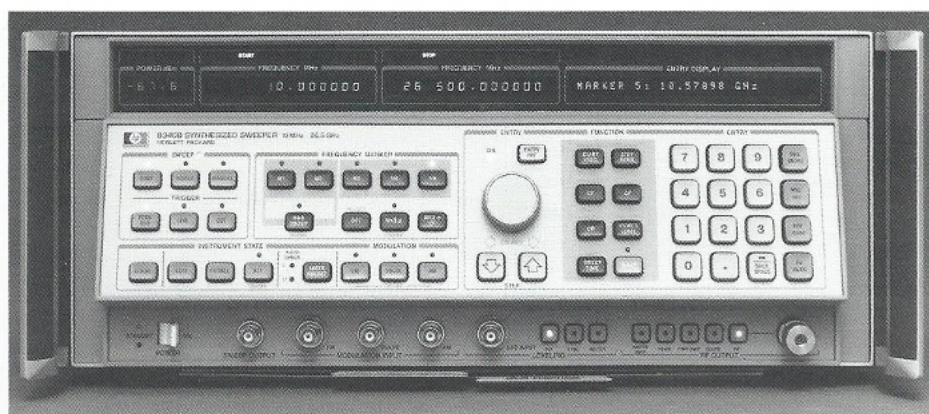
gitizing concepts, sampling techniques, analog-to-digital conversion, and interpreting specifications. Check **G**.

HP 9480 Analog LSI Test System enhancements. We're already shipping an enhanced HP 9480 for analog and mixed signal device testing. New hardware features include a spot-frequency generator that covers the LF range, an 18-bit (1-MHz) arbitrary-waveform generator, voltage-force/current compare and current-force/voltage compare capability per pin, and an increase in the number of samplers and digitizers. Software enhancements include an upgrade to the HP 9000 Model 350 Computer, X Window capability, and array processing for 64k arrays. Call your HP Sales Representative.

ASIC prototype verification. A new product note describes how design and test engineers can achieve fast and accurate test results with the HP 81810S IC Design Verification System. Check **H**.

Arbitrary waveform generation. Another new product note describes applications based on the arbitrary waveform generator option for the HP 8175A Digital Signal Generator. Option 002 provides two arbitrary channels in addition to the full capabilities of the HP 8175A. The examples are presented for complex analog signals and for standard functions. All waveforms are also available on a disc, the Arbitrary Waveform Library. Call your local sales office for more information on the library. For a copy of the product note, check **I**.

RF & MICROWAVE



Synthesized frequency coverage from 10 MHz to 26.5 GHz is now an even greater value.

High-performance synthesis, sweep versatility at a lower cost

Good news for those of you with applications that require synthesized 10 MHz to 26.5 GHz frequency coverage from an analog sweeper.

The price of the standard HP 8340B Synthesized Sweeper, whose performance characteristics include 1-Hz frequency resolution, excellent phase noise, and flexible modulation capabilities, has been significantly reduced. And a new option (Option 008) on the HP 8340B provides 1 kHz of frequency resolution at an equally significant reduction in price.

Option 008 is especially useful for applications that only require 1 kHz of frequency

resolution and 100-kHz minimum sweep widths. And you still have the versatile power control, outstanding phase noise and excellent pulse, AM, FM, and simultaneous modulation capabilities.

Choose the synthesizer to meet your needs

The excellent frequency accuracy and stability of the synthesizers translate to precision magnitude, phase, and group delay measurements. And the broadband frequency coverage provides excellent resolution in time-domain measurements. The recommended source for use with the HP 8510 Vector Network Analyzer is the HP 8340B Option 005. In network analysis applications where reduced frequency resolution is sufficient, the HP 8340B Option 005/008 deletes the attenuator, provides 1 kHz of frequency resolution, and offers the convenience of a rear-panel RF output.

The price of the standard HP 8340B is now \$57,500. Option 005 Rear-Panel RF Output without Attenuator is less \$1,800, and Option 008 1-kHz Frequency Resolution is less \$8,000.

For more information, check **J** on the HP Reply Card.

Test low-loss devices with new scalar detector

Use the new HP 85025E Scalar Detector with the HP 8757A Scalar Network Analyzer to make better transmission and absolute power measurements from 10 MHz to 26.5 GHz. The detector offers excellent return loss performance (better than 25 dB from 100 MHz to 25 GHz) so that mismatch uncertainty is reduced substantially. With its 3.5-mm male test-port connector, the scalar detector is well-suited for making measurements on devices with SMA connectors. Measurements can be made using either ac or dc detection.

Table 1 shows the improvement in transmission-measurement accuracy when using

Table 1.
Transmission Measurement Accuracy

	Typical Detector	Padded Detector	HP 85025E
Match	1.33 SWR (17 dB)	1.28 SWR (18 dB)	1.12 SWR (25 dB)
Calibration error	±0.22 dB	±0.19 dB	±0.09 dB
Measurement error	±0.27 dB	±0.26 dB	±0.20 dB
Total error	±0.49 dB	±0.45 dB	±0.29 dB

the HP 85025E detector relative to a typical detector and a typical detector isolated with a 10-dB pad. The device under test is a 10-dB attenuator, at 18 GHz, with a return loss of 20 dB (1.22 SWR) at both the input and output ports. The source match is 15 dB (1.43 SWR). With the HP 85025E, a substantial

reduction of measurement uncertainty is gained.

The scalar detector's low reflection coefficient is beneficial when testing low-loss devices (filter passbands, switches, and isolators, for example). In the case of filter passband ripple measurements, the filter's passband generally has little attenuation. Any reflections caused by the detector can be re-reflected by the source, causing significant ripple on the insertion-loss trace. With the HP 85025E detector, reflections are minimized so that the passband ripple can be characterized more accurately.

The HP 85025E is \$1,200. The HP 8757A is \$11,000.

For more information, check **K** on the HP Reply Card.

RF & MICROWAVE

Instrument combination provides complex signal simulation

Testing technology for modern radar/EW receivers involves scenarios that predict extremely crowded signal environments. Signal simulators are required to replicate multiple signals and complex parameters such as antenna scans, multiple-lobing, jittered and staggered pulse trains, and more.

Benchmark simulation that can approach some of that complex modulation can be provided by an HP 8780A Vector Signal Generator (10 to 3000 MHz) that is modulated by two HP 8770S Signal Simulator Systems, one for in-phase and the other for

quadrature phase. This combination provides complete control of the carrier's phase plane. For example, a 100-MHz-wide chirp pulse with 4- μ s sweep time and a Gaussian envelope is easy. Figure 1 shows the instrument setup.

Application Note 314-4, "Exceptionally Complex Signal Simulation for Multi-Signal Environments in Radar/EW Test," discusses the procedure in more detail.

For a free copy of Application Note 314-4, check **L** on the HP Reply Card.

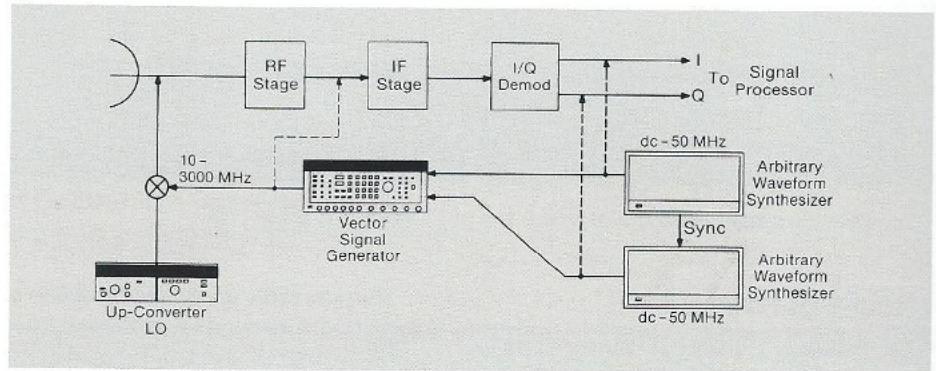


Figure 1. Two HP 8770A Arbitrary Waveform Synthesizers driving the I and Q scalar inputs of an HP 8780A Vector Signal Generator create exceptionally complex signals.

Make low-level power measurements with exceptional accuracy

With Option 050 Increased Power Measurement Accuracy, the HP 8902A Measuring Receiver makes power measurements over a dynamic range of 120 dB with accuracy second only to that of a primary standard. Option 050 specifies tuned RF level on the HP 8902A with a cumulative accuracy



The performance of attenuators and signal generators can now be verified to the most stringent specifications.

of 0.005 dB per 10-dB step. This accuracy increases your measurement margin.

To test the accuracy of the HP 8902A, Hewlett-Packard uses the Techtest Model 310 Piston Attenuator, a primary standard traceable to both the National Physics Laboratory in England and the National Bureau of Standards (NBS) in the United States.

Option 050 provides a Certificate of Calibration. This certifies that your HP 8902A has been calibrated in compliance with MIL-STD-45662 and that the calibration standards are traceable to the U.S. NBS.

The HP 8902A is \$22,950, and Option 050 is \$3,500.

For more information, check **M** on the HP Reply Card.

Signal monitoring software available for modular, portable spectrum analyzers

With the HP 85865B Signal Monitoring Software and an HP 9000 Computer, a high-performance HP spectrum analyzer can become an automated receiver system and perform many of the measurement tasks required in spectrum monitoring and broadband surveillance. A new revision of this

signal monitoring software (HP 85865B Revision A.01.00) is now available for the HP 71000 Series Modular Spectrum Analyzers and the HP 8562A Portable Spectrum Analyzers. The software runs on the HP 9000 Model 330 and 350 Computers and supports the HP 70700A Digitizers.

The A.01.00 release is also fully backward-compatible with the HP 9000 Series 200 and 300 Computers (3M bytes of RAM are required) and the software supports all other previously supported hardware, including the HP 8566B, 8568B, and 8567A Spectrum Analyzers. However, spectrum analyzer CRT graphics, a feature of HP

8566B/68B/67A systems, is not available with the HP 71000 Series or the HP 8562A.

In addition to hardware compatibility, the software also provides these enhancements:

- Band/signal setup and definition from the manual mode
- Alpha TIMEGRAM summary
- User interface enhancements—including softkeys and band/signal definition screens
- Remote graphics (over RS-232-C link).

The HP 85865B A.01.00 software is priced at \$5,100.

For more information, check **N** on the HP Reply Card.

RF & MICROWAVE

RF/Microwave Notes

Components. We now have a way to modify our HP 33323 Series Step Attenuators to combine switching and attenuation in the same component. Application Note 332-1, "Novel Combinations of Microwave Switches and Step Attenuators for Programming Applications," gives details on custom variations ranging from SP5T to dual transfer switches to 70-dB step ranges with one SPDT switch on each end. Check **O**.

If you use coaxial switches, we have a new technical data sheet describing the HP 33311/12/13 series of coaxial switches for use up to 26.5 GHz. It includes SPDT, 4-Port, and 5-Port types. Internal design changes keep improving the reliability of this series of switches. Check **P**.

Signal generators. When you're looking for the lowest phase noise on a carrier to 1280 MHz, the HP 8662/3 Signal Generators are about the only game in town. But to get even better phase noise close to the carrier, you can make about a 10-dB improvement by using an external cesium beam standard such as the HP 5061A Option 004. This works best for offset frequencies below about 2 Hz.

Signal analyzers. You can buy a special option of our HP 11970W Harmonic Mixer (Option E87) to work all the way to 170 GHz. Conversion loss runs to 60-70 dB. HP mixers do not require bias adjustment.

For environmental test engineers who haven't been able to get to our training seminar on EMI measurements, now you can get a videotape of the proceedings, including the seminar handbook. The four-hour program is recorded on two VHS (NTSC-format) tapes and can be ordered under HP part number 5958-6633.

Owners of the HP 70000 Modular Spectrum Analyzer systems now have the HP 11990A System Performance Test software package available to run an on-site verification test. Naturally, you may have to roll up some external instruments such as power meters and counters for certain tests. The

software is modular and instrument specific, so any system configuration can be tested with ease.

Some multisite systems for signal monitoring use the HP 85865B Signal Monitoring Software to tie together a number of systems to a master control station (HUB). HP now has recommended hardware configurations for the HUB and SLAVE sites.

Noise figure. Any owner or intended owner of the new HP 8970B/S Microwave Noise Figure System (18 GHz) needs a copy of our latest Product Note 8970B/S-2, "Applications and Operation of the HP 8970B Noise Figure Meter and HP 8970S MW Noise Figure Measurement System." This 70-page note gives step-by-step procedures for several operating modes including the brand new single-sideband method allowed by the YIG-tuned tracking preselector. It summarizes the features and references the three pullout cards on the instrument. Check **Q**.

Network analyzers. Application Note 345-2, "Mixer Measurements Using the Scalar Network Analyzer," tells how to measure mixer return loss, conversion loss, and compression with scalar instruments. Uncertainty effects of LO and RF feedthrough, IF harmonics, and detector flatness are examined. Check **R**.

Attention crystal, SAW, and dielectric resonator engineers! There's new measurement software for use with the HP 8753A and 8510 Vector Network Analyzers. The HP 85165A Dielectric Resonator Measurement Software fully characterizes such devices for resonant frequency, Q, series resistance, and other parameters. It is based on an emerging EIA Standard 512, which uses s-Parameters. It runs on BASIC 3.0 and HP 9000 Series 200/300 technical computers.

If you've ever looked inside a modern military airframe, you know that it's a confused array of hydraulic lines interweaved with solid conductor coax, just waiting for inadvertent damage at bulkheads. For easier maintenance of those cables, the USAF recently ordered a number of slightly customized HP 8328A Cable Fault Carts. With some novel mathematical manipulation of the swept reflection data taken from a scalar network analyzer, the operator can detect the offending mechanical imperfections without removing the cable run. The basic HP 8328A is on the GSA schedule and has a National Stock Number of 6625-01-232-3292.

MORE PRODUCTS

Digital data tester offers complete T1, DDS testing



The new HP 3787B offers a single-unit solution to T1 and DDS/dataport test needs in the areas of production, installation, commissioning, and maintenance.

The new HP 3787B Digital Data Test Set offers in-service and out-of-service bit error ratio measurements on a wide variety of North American digital transmission hierarchies. It tests T1 leased and digital data system (DDS) services as well as 56 kbit/s switched and packet-switched services and equipment—a job that normally calls for several test instruments.

The new tester interfaces at any convenient point in the T1 or DDS network (that is, DSX-1C, DSX-1, DSX-0B, DSX-0A, or the logic near/far TTL interface). It can multiplex between these interfaces to test not only transmission paths and multiplexing equipment, but customer circuits (2.4, 4.8, 9.6, 56, and 64 kbit/s) as well, all while interfacing at either DS1C or DS1.

In addition, the HP 3787B features:

- Result logging on the built-in printer
- Comprehensive error measurement and analysis
- DS1 jitter measurement
- DS1C and DS1 peak-voltage measurement
- HP-IB and RS-232-C remote interfaces
- Protocol-analyzer interface.

The HP 3787B Digital Data Test Set is \$8,000.

For more information, check **S** on the HP Reply Card.

MORE PRODUCTS

Screen telecom devices before costly final testing

With the new HP Telecomtest software, the HP 3065AT Combinational Board Test System can fully screen demanding telecommunications devices and lower the cost of final specification testing.

Digital signal processing

HP Telecomtest software provides digital signal processing (DSP) capability to analyze complex, nondeterministic digital waveforms. Programming utilities automatically turn serial signals into ready-to-use test vectors.

The software breaks the testing barriers posed by codecs, serial devices, and new ICs for integrated services digital networks (ISDN). There are no workarounds and no compromises.

Serial-frame generator

To ease the serial-programming burden, serial frame generator utilities produce popular telecom signals, frame them according to standard protocols, and convert them to test patterns. A complete ISDN device set forms part of a new telecom library.

Serial-response capture

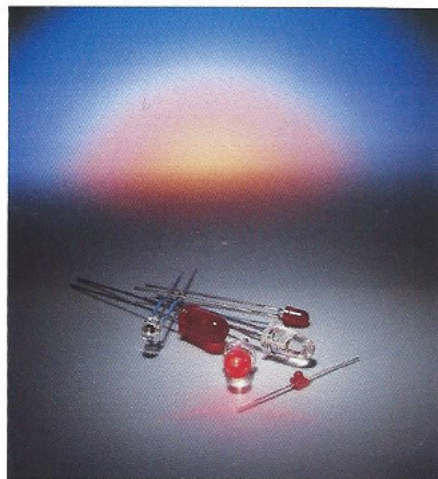
HP Telecomtest software includes commands to capture, store, and later retrieve up to 64K bits of serial output at a time. Arrays receive the formatted serial bits for DSP or other analysis techniques.

HP 3065AT hardware provides high-precision analog and VLSI functional testing, analog/digital synchronization important to mixed-signal testing, and long digital streams that maintain device-under-test synchronization important to serial-device testing. The standard HP 3065AT software eases the VLSI/ISDN test programming task and automatically generates standard analog and digital in-circuit tests.

Telecomtest software is included with HP 3065AT system configurations. Tests from the ISDN device library are \$7,500 for one, and \$15,000 for two to four.

For more information, check **T** on the HP Reply Card.

New AlGaAs LED lamps, displays



The new LEDs are especially useful for outdoor lighting applications, such as moving message panels and traffic lights.

Double-heterostructure aluminum gallium arsenide (AlGaAs) is HP's newest process for producing LED components. Twelve lamps and four series of seven-segment displays using the new technology are now available.

The AlGaAs material is a super-efficient semiconductor that yields three to four times the light output of conventional LEDs. This

allows applications in bright sunlight and operation at very low currents.

The LED lamps may be driven either at 1 mA for low-current operation or at higher currents for other purposes. Driven at 20-mA forward current, these devices provide outstanding brightness.

AlGaAs displays are specified at only 1-mA forward current per segment for use in battery-powered equipment or in instances where they are driven directly off CMOS ICs. The high-intensity red lamps include two T-1 $\frac{3}{4}$ lamps (HLMP-D101/D105), two T-1 lamps (HLMP-K101/K105), and one subminiature (HLMP-Q101). The very high intensity lamps are T-1 $\frac{3}{4}$ biconics (HLMP-4100/4101). The low-current LEDs are the HLMP-D150/D155 (T-1 $\frac{3}{4}$), the HLMP-K150/K155 (T-1), and the HLMP-Q150 (subminiature).

The low-current display families are the HDSP-A101 series (0.3-inch character height), the HDSP-E100 series (0.43-inch), the HDSP-H101 series (0.56-inch), and the HDSP-N100 series (0.80-inch).

In quantities of 10,000, the HLMP-D101/D105/D155/K101/K105/K155/Q101/Q150 are \$0.34 each. The HLMP-4100 is \$0.48 each and the HLMP-4101 is \$0.72 each. In quantities of 1,000, the HDSP-A101/E100/H101 are \$2.42 each and the HDSP-N100 is \$3.06 each.

For more information, check **U** on the HP Reply Card.

Fast-switching beam lead PIN diode now available

Fast switching and low capacitance make the new HPND-4018 beam lead PIN diode excellent in phased-array radar applications. Lower capacitance yields improved isolation at higher frequencies, and the HPND-4018 guarantees a low-capacitance window from a minimum of 0.015 picofarads (pf) to a maximum of 0.025 pf. Consistent perfor-

mance is the result when using the HPND-4018 in applications of phase shifting and switching.

The low resistance of 4.6 Ω at a forward current of 10 mA and a frequency of 100 MHz translates into low power consumption. Operating temperatures are from -65°C to +150°C.

The HPND-4018 can be ordered in 10-piece increments. In quantities of 100, the HPND-4018 is \$11.69 each.

For more information, check **V** on the HP Reply Card.