



**New Electronics for**

- Measurement**
- Analysis**
- Computation**

**Autumn 1968**

**HEWLETT**  **PACKARD**

## About this booklet . . .

This booklet provides summary descriptions of our newest products being introduced in the autumn of 1968. *Please retain it as a supplement to the Hewlett-Packard annual general catalog.*

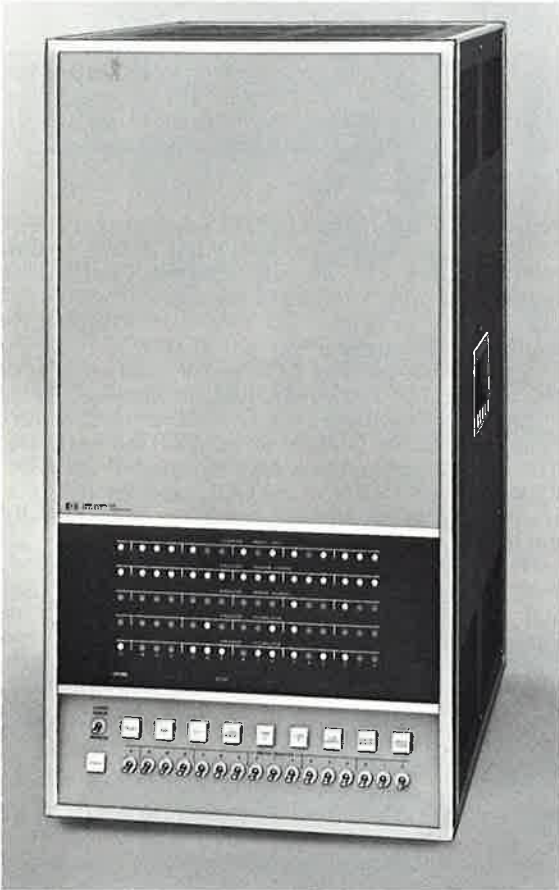
For prices in your country, please contact your Hewlett-Packard representative (listed at rear of this booklet). He will be happy to offer you applications engineering assistance, in addition to detailed ordering and delivery information.

Most of our products are designed for 115/230 V, 50-60 Hz operation, via a selector switch. More complex changes which involve motors, transformers, etc., may incur a nominal additional charge.



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## A more powerful computer for your money: 16-bit word length, 16k memory, easily expandable



You get greatly increased computational power at lower cost, thanks to new core stacks which double the memory size in HP's 2116-series computers. A 16k memory can now be contained entirely within the main frame of new Model **2116B**, at a price significantly below that of the earlier Model 2116A (which required an external extender for 16k).

The new 16-bit-word 2116B general-purpose computer has tremendous flexibility for hardware interfacing via 16 pre-wired circuit card slots which can be used *at any time*, a feature unique to HP computers. Interface cards and software already exist for CPU options like direct memory access, hardware multiply-divide, parity check and memory protect. Other standard plug-in cards interface the computer to all traditional peripherals — teleprinters, magnetic tape units, card readers, scope displays, Dataphones, etc. Interface cards and software are also available for a wide variety of instruments such

as DVM's, quartz thermometers, nuclear scalers and gas chromatographs.

Well-proven software includes an assembler, FORTRAN and ALGOL compilers, and easy-to-use Conversational BASIC. Modular software drivers for peripherals permit programming very nearly independent of the input/output devices used.

The 2116B has a 1.6  $\mu$ sec cycle time and a 3.2  $\mu$ sec add time, two addressable accumulators, 70 basic instructions (including micro-programmable register reference instructions), and 23 assembly-directing pseudo instructions. In its basic configuration, it has an 8192-word memory and sells for \$24,000; with a 16k memory, \$34,000.

## Let this desk-top calculator free you for more productive thinking!



Use magnetic cards to program repetitive calculations

Here's a new stand-alone problem-solver that is easily accessible for solving intricate scientific and engineering equations. Or, team it with your large computer or time-share facility — doing many jobs faster and easier than either — for less money.

Log functions, trig and hyperbolic functions — all available in milliseconds at a key-depression with the Hewlett-Packard **9100A** Calculator. Forward and inverse polar/rectangular coordinate transformation in all four quadrants. Floating decimal point calculations for 10 significant digits of accuracy over the range,  $10^{-98}$  to  $10^{99}$ . Fastest cycle times in the calculator field, with 10-place trig operations under 300 milliseconds. There are 19 magnetic core registers available for display and storage.

Program up to 196 steps with the keyboard or handy magnetic cards. And, all keys are in algebraic or English notation; no language to learn! Use conditional qualifiers to program looping and branching decisions. Couple the Calculator to other peripherals, including forthcoming optional silent printer and X-Y plotter. Model 9100A is priced at \$4900.

## Analyze audio frequency spectra ... quickly and in real time



8054A Real-Time Audio Spectrum Analyzer with 15109B 1-inch Condenser Microphone

In only a few seconds, you can now make audio frequency spectrum measurements which formerly often took hours or even days. The new **8054A** Real-Time Audio Spectrum Analyzer *simultaneously* looks at twenty-four  $\frac{1}{3}$ -octave frequency bands (whose center frequencies range from 50 Hz to 10 kHz)—and writes out a spectrum on the CRT in less than 30 msec, at rates up to 35 spectra/sec.

You can evaluate design changes or adjustments which affect the input signal, without delay, thanks to the analyzer's immediate response. And one-shot phenomena can be captured by using the storage feature.

Overall amplitude measurement range is 140 dB (1  $\mu$ V–10 V) with readout in dB above 1  $\mu$ V, or in dB of sound pressure by using an appropriate microphone. Either the peak or rms value is measured in all 24 channels, and displayed on the CRT. A built-in DVM reads the level in any selected channel to a resolution of 0.1 dB.

In addition to the visual displays, there are analog outputs for external monitoring or recording—plus BCD digital outputs! This latter capability, when paired with the remote programmability of all major analyzer functions, means unprecedented flexibility and speed in automatically processing data. Analyzer price: \$8950; preamps for vibration work, or microphones: \$140–275. Extended 2 Hz–16 kHz coverage available on special order.

## This low-cost A-to-D converter is easily interfaced with computers



New **5610A** Analog-to-Digital Converter consists of a 10 bit (including sign) converter, a sample-and-hold amplifier with 50 nsec aperture time, and a multiplexer with 16-channel capacity. Standard input is  $\pm 1$  V fs (with  $\pm 2.5$  V or  $\pm 10$  V optionally available). Throughput rate is 100 kHz.

This general-purpose ADC can be used easily with any of the HP computers, and an interface kit is available—including an interface card, interconnecting cable, a BCS driver and test software. The BCS driver makes it easy to program the ADC by using FORTRAN or ALGOL, and the test software provides an efficient means to automatically check out unit performance.

The ADC can operate in internal-sequenced, external-sequenced and random access modes. Digital outputs include the 10 data bits, 4 bits of channel identification, a data ready or "flag" bit, and one line with clock pulses from an internal 8 MHz clock. Price (for 8 channels,  $\pm 1$  V input): \$2500.

## Precision microphones for accurate acoustic measurements

Two new omnidirectional HP condenser microphone assemblies provide you with precision tools for making critical acoustic measurements—yet are rugged enough for general-purpose sound use. The assemblies (cartridge and preamplifier, with 10-ft. cable) are ideal input devices for the HP Loudness Analyzer, Real-Time Audio Spectrum Analyzer and Impulse Sound Level Meters.

The  $\frac{1}{2}$ -inch-diameter assembly (**15119A**, \$275) has a flat  $\pm 1$  dB response from 20 Hz to 20 kHz, and a sensitivity of 1.58 mV/ $\mu$ bar ( $-56$  dB re 1V/ $\mu$ bar). Its small size insures virtually negligible sound field disturbance. The 1-inch assembly (**15109B**, \$270) is fully 10 dB more sensitive than the 15119A but otherwise has similar characteristics.

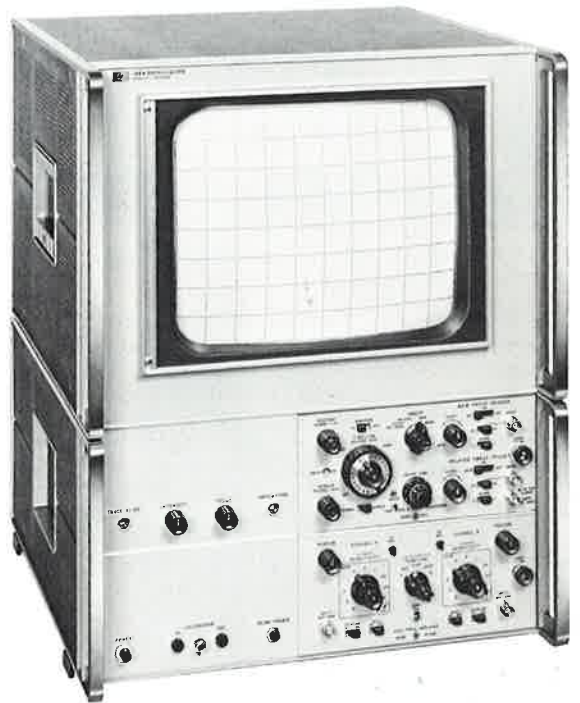
Both assemblies use reliable solid-state preamplifiers, housed in connecting cases the same small diameter as the cartridges. By using an included adapter instead of a cartridge, you can easily apply electrical signals such as from vibration transducers directly to the preamp (preamps also available separately, without cartridges).

## New nuclear modules for fast pulse timing: dual timing pickoff, fast coincidence units

Where time is a parameter of interest in nuclear work, two HP Nuclear Instrument Modules (NIM) in the AEC-compatible configuration offer pulse timing right down to the nanosecond. The **5584A** Dual Timing Pickoff (\$900) gives you your choice of leading edge or zero crossing pickoffs in each of two independent channels. Outputs can be delayed from 100 nsec to 11  $\mu$ sec in two switch-selected ranges, and you can sweep the delay in one channel. The **5585A** Fast Coincidence (\$900) offers meaningful resolving times down to 1 nsec. Three switchable coincidence inputs, one anticoincidence input; also ten-turn precision pot for setting the resolving time.



Stand back . . . take a good look with this new big-screen oscilloscope!



## Dual-preset scaler and timer in Nuclear Instrument Module



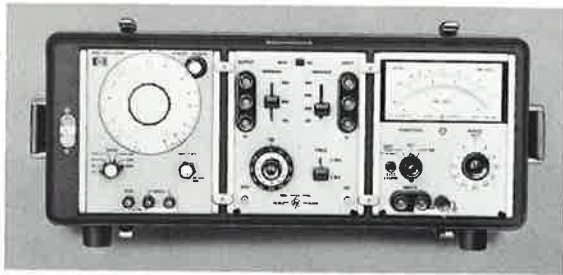
This Nuclear Instrument Module (NIM) scaler and timer can be preset for *either or both* count and time, and it presents results in a lighted display you can read from across the laboratory. In one compact package, Model **5590A** combines scaling and timing (two separate registers); dual preset automatic operation; integral discrimination; in-line display; 8421 BCD printer output including format and paper advance. Command with pushbuttons; program with lever switches; preset with thumbwheels. It is an easy-to-use key to nuclear measurement systems of maximum capability. HP 5590A with 6 digit readout, \$1675 (add \$50 for 7 digits).

You can readily see the display from a distance or examine fine detail on a trace when you use the new Model **143A** general-purpose oscilloscope. For its bright CRT has a big 8-inch by 10-inch screen (with parallax-free internal graticule especially valuable for viewing by large groups) which provides higher resolution displays with the same accuracy and linearity normally associated with 5-inch scopes.

What's more, all 19 existing plug-ins for the 140/141-series oscilloscopes can be used in this new unit — for big-screen dual-channel real time measurements to 15 MHz and sampling measurements to 12.4 GHz. Choose deflection factors to 10  $\mu$ V/inch, calibrated dc offset, high common mode rejection; or, special purpose plug-ins such as a Time Domain Reflectometer or a Swept Frequency Indicator. Also, you can get a large-screen 1 kHz–110 MHz frequency domain oscilloscope by using the new HP spectrum analyzer plug-ins.

143A, \$1400 (plus plug-ins from \$225 and up).

## New extended-range oscillator now included in transmission test set

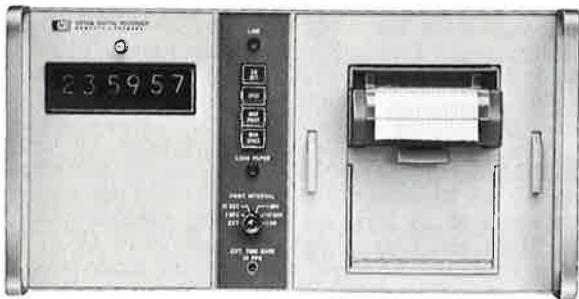


3550B Portable Test Set with splash-proof cover removed

The HP portable test set widely used by the communications industry for aligning multichannel systems and telephone circuits is now available with extended capabilities, at *no* increase in price. For the oscillator now included is the recently-announced Model 204C—which has a wider frequency range (5 Hz–1.2 MHz), lower distortion (<0.1 dB), flatter output ( $\pm 0.5\%$  over 30 Hz–300 kHz) and lower hum and noise (<0.01%).

New Model **3550B** retains all other patch panel and voltmeter features found on the original model. Price: \$1150.

## Clock annotates recorded digital data to 0.1 sec . . . also programs sampling



5050B digital recorder, with Option 55 clock

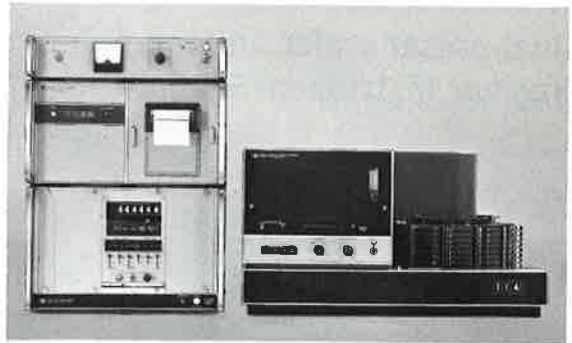
Your measurement data printed by either HP 5050A or 5050B Digital Recorders can now include time-of-day information to the nearest 0.1 second, thanks

to a new clock option available for those recorders. Time information can be easily positioned anywhere within the printed format (up to 18 columns total).

The clock can also serve as an automatic measuring/recording system programmer by initiating printing at preselected intervals of 1, 10 or 60 sec, or 10 or 60 min. And digital display tubes visually indicate to 23 hrs, 59 min, and 59 sec. Transistors and IC's perform all timing and logic functions, and column boards needed for driving the recorder are built right into this compact clock.

A factory-installed clock adds \$950 to the price of the 5050B Digital Recorder (\$1900, plus \$70 for each 2 columns printed), and is known as the **5050B Option 55**. A kit for field installation of the clock (in 5050A's and 5050B's) will soon be available.

## Automatic systems for nuclear counting

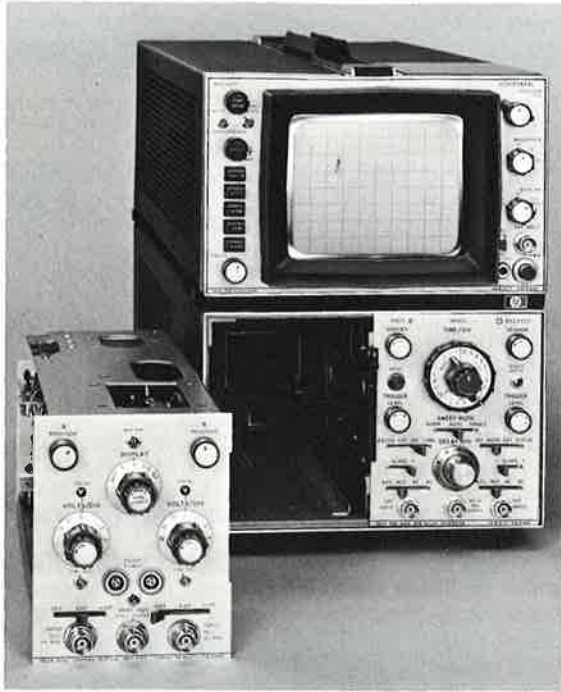


5563A gas-flow nuclear counting system, with automatic sample changer at right

The lowest background available (0.1 count per minute) is the beta counting capability of this automatic nuclear counting system, equipped with a 0.5-inch gas-flow detector. The **5560**-series of modular systems, built up from Hewlett-Packard research-grade nuclear instruments, can be arranged and rearranged to meet your counting needs for alpha, beta, gamma—or even beta-gamma or gamma-gamma coincidence.

Load 120 samples into the drum . . . return next morning . . . and you'll have for each sample a print-out of sample number, count *and* time. You can interrupt an automatic run any time to hand-load one sample. These systems offer preset time *and* count, digital output (you may want to add a computer later), and true ease of use. Prices, according to your selection of detector size and system configuration, are approximately \$10,000–\$12,000.

## New 100 MHz oscilloscope plug-in ... better high-frequency accuracy



High-frequency circuit loading and risetime degradation can virtually be forgotten when you make measurements with the new **1802A** Dual Channel Vertical Amplifier plugged into any HP 180A or 181A scope. A 50-ohm transmission-line type input system is used which provides virtually no input capacitance.

Both channels have identical dc-100 MHz response, and the bandwidth is the same on *all* deflection factor settings, which range from 10 mV/cm to 1 V/cm (to 2.5 V/cm using the vernier). For more sensitivity, the two channels can be cascaded to provide 1 mV/cm up to 75 MHz.

For high-impedance probing with maximum sensitivity, there's a new optional **1123A** Active Probe—100 k $\Omega$ , and 3.5 pF (less than any other high-impedance active probe). Overall probe-scope system frequency response is >100 MHz, and overall risetime is 3.5 nsec. Temperature-insensitive circuits hold drift to <100  $\mu$ V/ $^{\circ}$ C change at probe tip.

Faster triggering capability to keep pace with the new 100 MHz amplifier plug-in is available in two new time base plug-ins: Model **1820B** triggers to 150 MHz, has 5 nsec/cm sweep speed and variable trigger hold-off; Model **1822A** is identical, but also includes delayed and mixed sweep.

Prices: 1802A amplifier, \$1200; 1123A probe, \$325; 1820B time base, \$525; 1822A time base, \$900. (180A scope mainframe, \$825; 181A, which also includes variable persistence and storage, \$1850.)

## Wideband magnetic tape recording ... dc-400 kHz FM and 2 MHz direct



The proven Model **3950-series** Magnetic Tape Recording Systems now have extended dc-400 kHz FM capabilities, thanks to a new modular plug-in FM amplifier. In addition to being available on new systems (approximate price for complete 7-track record/reproduce system with new FM amplifier: \$16,200), the amplifier is available separately for use in all existing HP 3950-series systems.

Also, 3950-series systems are now available with an optional 2 MHz (instead of standard 1.5 MHz) direct recording capability. Typical price for a 7-track record/reproduce 2 MHz system: \$17,200—and as with the FM amplifier above, existing 3950-series systems can be easily converted for 2 MHz recording.

## Digital multi-function meter for up to 12 different measuring tasks!



Astounding measuring capability at a most reasonable price is yours with the new **3450A** Multi-Function Meter!

For \$3150, you get the basic instrument—a 5-digit (+1 digit for 20% overrange) integrating and guarded digital voltmeter able to measure *V<sub>dc</sub>* ( $\pm 100$  mV to  $\pm 1000$  V ranges, 1  $\mu$ V sensitivity on lowest range, 30 day accuracy of  $\pm [0.008\%$  of reading + 0.002% of range]) at up to 15 readings/sec, and *V<sub>dc</sub> ratio*. An isolated **4-terminal-technique** is used for all ratio measurements.

The compact 3½-inch-high (88,2 mm) instrument accepts optional modules which you can plug in at any time for additional measurement modes: **true rms Vac** (45 Hz–1 MHz,  $\pm 0.05\%$  mid-band accuracy) and *Vac ratio*, +\$1250; *ohms* (100 $\Omega$  to 10 M $\Omega$  ranges, 1 m $\Omega$  sensitivity) and *ohms ratio*, +\$400; **HI-GO-LO limit tests** for any of the six previously mentioned modes, +\$350.

Also, the multi-function meter has other options which fit inside the compact case, ideally suiting it for systems use: *remote control* (function, range, trigger rate, integration interval), +\$225; *digital recorder output*, +\$175; and *rear terminals*, +\$50. Integrated circuits are used extensively, and no cooling fan is required.

## Precision X-Y display, dc–600 kHz



Whenever you need accurate high-speed X-Y plotting, use the new all-solid-state **1208A** Display. It has identical X and Y amplifiers with 600 kHz bandwidth, well matched for minimum phase shift. Each amplifier is floating, permitting differential inputs—but either terminal may be grounded for single-ended operation. Gain is continuously adjustable from 100 mV/cm to 1 V/cm. Markers or other intensity-modulated information can be direct-coupled via the 1.75 MHz Z-axis input.

Display size is 8 by 10 cm on the internal graticule CRT. Other features usually associated with more expensive scopes include a beam finder for locating the trace regardless of control settings, and a calibrator output for conveniently determining deflection factor settings. Price is \$540 for either the cabinet version or for the 5¼-inch-high rack mount version shown.

## Fast 20 Hz–620 kHz wave analysis ... automatic >85 dB dynamic range



3590A Wave Analyzer with 3594A Sweeping Local Oscillator plug-in

You can now analyze and record spectra of complex signals between 20 Hz and 620 kHz with amazing ease—for the new 3590A Wave Analyzer has automatic sensitivity ranging (over a *wide* >85 dB dynamic range) and built-in electronic sweeping capabilities!

Connect a general-purpose X-Y recorder to this versatile analyzer and you get plots displayed in terms most meaningful to your application. For example, amplitude (Y-axis) can be recorded as linear volts or linear dB (0–90 dB range!)—and frequency (X-axis) can be portrayed in a linear or logarithmic fashion. Direct Bode plots of amplifier and filter frequency response are especially convenient, for there's a constant-level BFO output which tracks analyzer tuning and can be used as the test stimulus in many such applications.

Other features include AFC and restored-frequency outputs, choice of 4 bandwidths from 10 Hz to 3.1 kHz, AM and SSB detectors; plus automatic lights showing proper meter scale, sensitivity, range, overload, unlocked AFC, or too fast a sweep rate. **3590A** analyzer main frame (\$3200) needs a tuning plug-in for operation: **3593A** (\$1100) has a 3-digit frequency readout, while similar plug-in **3594A** (\$1600) has a 5-digit readout; auxiliary plug-in **3592A** (\$80) has no readout, is used when the analyzer is slaved to another instrument. (Special analyzer **3591A** with balanced inputs and selectable input impedances for communications use is available, \$3350.)



## New \$975 AC calibrator gives you voltage, current at 0.25% accuracy



Here's an excellent low-cost ac instrument for your use in calibrating moving-coil meters and similar reactive-load devices that require power during calibration. The desired voltage or current output is easily set (to 0.25% accuracy) with the digital front panel knobs.

There are four voltage ranges (1.4, 14, 140 and 280 V), with a maximum output of 280 V rms. And there are five current ranges (1.4, 14 and 140mA; 1.4 and 5 A), with a maximum output of 5 A rms. Although you'll need an external oscillator to utilize the full 50 Hz–2 kHz frequency range of the 6921A AC Calibrator, standard frequencies of 60 Hz, 400 Hz and 1 kHz are provided internally.

## Special noise generator for cross-correlation experiments



Pseudo-random noise techniques continue to find increasing acceptance for testing all sorts of "systems" in a way that simulates actual operating conditions. For example, *impulse response* is a uniquely complete description and an important parameter for characterizing linear systems.

The new **HO1-3722A** Noise Generator is ideally suited for cross-correlation techniques which lead to impulse response approximation. The pseudo-random binary sequence input to a system and its resulting output are cross-correlated against one another via a continuous multiplication and product averaging process, for various delays between input and output signals. For this purpose the HO1-3722A has a built-in second binary output which can be delayed by a selectable number of clock periods with respect to the main binary output.

Please see the September 1967 *Hewlett-Packard Journal* for additional information on this increasingly important "statistical" test technique. Send for details on the HO1-3722A (\$2950) via the enclosed card.

## New computerized data acquisition



Fast data acquisition and expedited test results (via on-line computation and data reduction) are yours with three new **2018** Computing Data Acquisition Systems. All functions are computer-controlled, and can be based on test results if required. The straightforward Data Acquisition Executive Program is easy to learn and use, and gives you teleprinter access to scanning, measuring, recording and comparison functions, and to computing constants.

You can tailor a system to exactly match your needs, based on a broad selection of capabilities and prices. Plug-ins expand system use with many computer-controlled peripherals and I/O devices. Similarly, plug-ins expand the system's dc measuring device (Model 2402A Integrating DVM) to include ac, frequency and resistance measurements. And you have a choice of HP computers, with memory size and I/O capacity best suited to your application. System prices begin at \$37,300.

## Power your vacuum-tube circuits with this solid-state supply

### Test digital logic modules automatically at 10,000 tests/sec

Testing complex logic modules or circuit cards can create a real bottleneck in your production, incoming inspection or quality assurance areas—especially if you're using slow manual or electromechanical techniques. Now, the new **2060A** Digital Logic Module Test System can eliminate that bottleneck by performing up to 10,000 logic function tests/second!

The system operates by comparing modules of unknown quality against a reference module known to be acceptable. Modules of all common IC logic forms, discrete components, or mixes of these can be tested without special system adaptation. Interchangeable plug-in adapters and simple program reloading make conversions simple and rapid.

Heart of the system is the versatile HP 2116B Computer, complemented with general-purpose system components configured to perform specific functions. System-controlling software is fully proven and documented—and simple, English-language programming permits easy program changes and fast startup times.

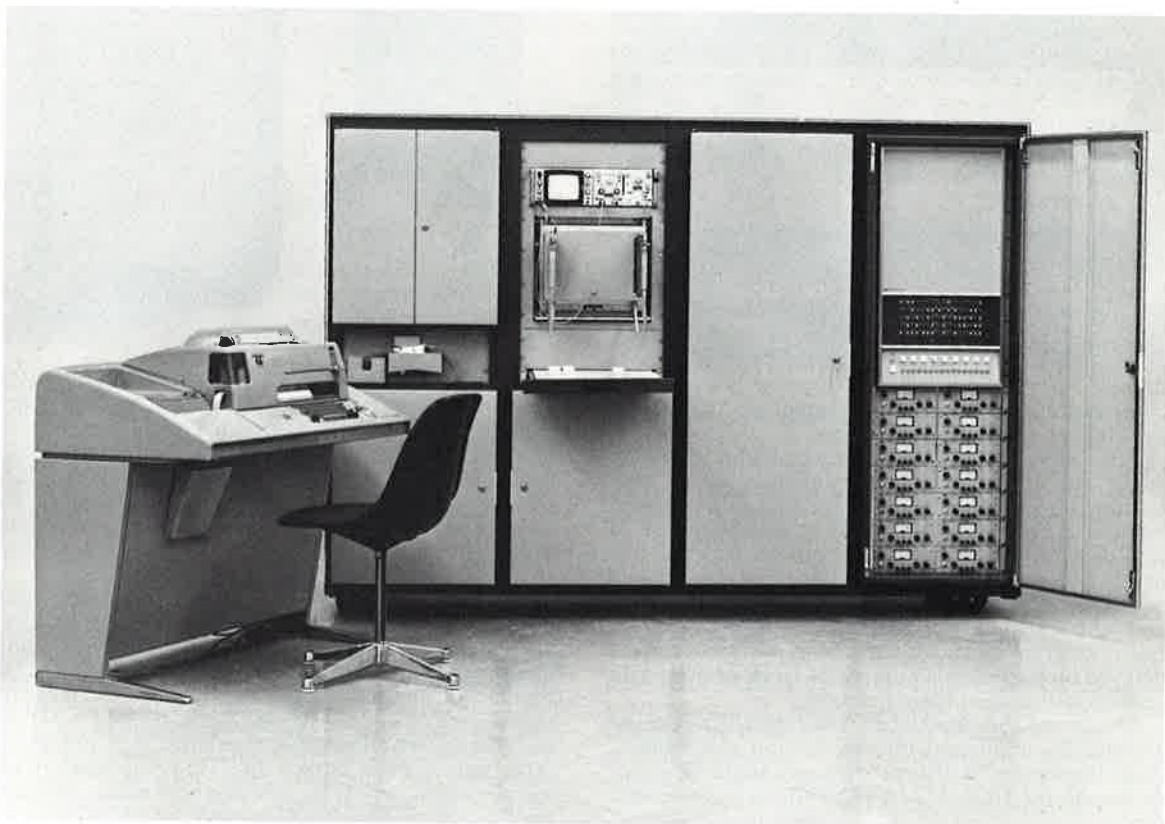
The 2060A system (priced from \$60,000) is straightforward to operate and designed for production situations. Tests performed, however, can be as complex and thorough as required—and recorded test results can be as detailed or as simple as necessary for your application.



Wherever you need to power vacuum-tube circuits, oscillators, small transmitters, and even certain small klystrons—in the lab or on the production line—use the reliable new **712C** Power Supply. In addition to providing a variable main output of 0–500 Vdc (200 mA max), it also has a fixed –300 Vdc (50 mA max) output, a variable bias output of 0 to –150 Vdc (5 mA max), and a 6.3 Vac (10 A max) center-tapped filament output.

Changing from no load to full load changes the output voltage of this well-regulated supply  $<0.01\%$  + 5 mV. And recovery time to transients is fast, returning the output to within 25 mV of selected voltage within 50  $\mu$ sec. Ripple is  $<500 \mu$ V or 15 mV p-p.

External and internal circuitry is protected from accidental overloads, via current-limit control. This not only eliminates the inconvenience of fuse changing, it also lets you set the protection limit at less than maximum current levels. Supply price: \$490.



## New 135 MHz counters ... accept 18 GHz frequency and 10 nsec time interval plug-ins



5248M electronic counter, with 5267A time interval plug-in

Direct counting to 135 MHz, waveform period measurement with 10 nsec resolution, and time interval measurement with 10 nsec resolution (using the new 5267A plug-in mentioned nearby) are yours with two new additions to the highly-popular series of HP plug-in counters. For not only do they possess the reliability you've come to expect from HP, the versatile new **5248L** and **5248M** (which accept the industry's widest choice of plug-in accessories) do just about anything counters can do!

Without plug-ins they measure: frequency, frequency ratio, period, multiple periods, multiple ratios, and will scale frequencies and totalize. Front panel plug-ins: extend frequency to 18 GHz, permit dc voltage measurements, give increased sensitivity, and allow preset counting and data normalizing. The time base aging rates are: 5248L,  $<3 \times 10^{-9}$ /day; 5248M,  $<5 \times 10^{-10}$ /day (and also features rapid warm-up). Prices, without plug-ins: 5248L, \$2900; 5248M, \$3300.

## 10 nsec time interval resolution with new HP counter plug-in

Practically every feature available in precision time interval measurements is built into a plug-in accessory for the new HP 5248L/M Counters: 10 nsec resolution for measurements up to 1 sec, 100 nsec resolution to  $10^6$  sec; 1 M $\Omega$ /35 pF input impedance on all ranges (high enough for measurement in a very wide range of circuits); marker outputs to identify measured waveform intervals on external oscilloscope; 100 mV rms input sensitivity; ac or dc coupling; dual input channels with individual trigger controls for amplitude, slope and polarity; "steering" to allow measuring time interval between successive like or unlike polarity pulses on a single or dual input. The new **5267A** Time Interval plug-in (\$400) also works with HP 5245 and 5246 Counters, giving all of the above features except that best resolution becomes 100 nsec.

## Portable atomic clock and frequency standard is economical



Get new economy and convenience in this portable, atomic (rubidium vapor cell) frequency and time standard. It will transport time from one location to another with accuracy in microseconds, display time on a 24-hour clock, and furnish a precision 1 ppsec clock pulse with  $<20$  nsec jitter. Auto synchronization to external pulses is provided, and thumbwheel switches allow shifting the internal-external pulse relationship in 1  $\mu$ sec steps up to 1 sec. There's a built-in frequency synthesizer for time scale changes.

As a frequency standard, its most sought characteristic is its excellent short term stability:  $<7 \times 10^{-12}$  rms (1 sec averaging);  $<7 \times 10^{-13}$  rms (100 sec averaging) — the best short term stability yet offered in a rubidium frequency standard. Long term stability is better than  $\pm 2 \times 10^{-11}$ /month. **E21-5065A**, \$12,300 (which includes versatile power supply with 8-hr sealed NiCad standby battery, rechargeable from 6/12 Vdc or from 115/220 Vac (50-400 Hz).

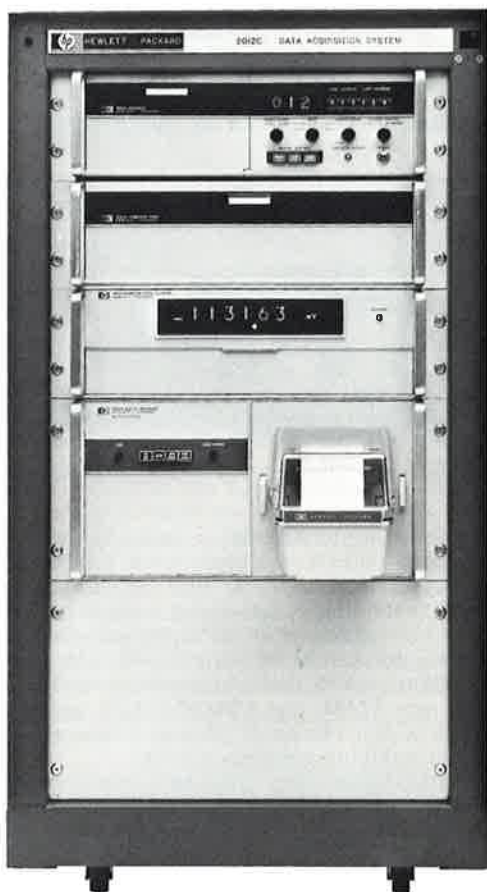
## Fast data acquisition systems have low-level accuracy, noise immunity

Get long-term analog or bar graph trend records . . . of up to 4 parameters



You can now reliably record up to 4 slowly changing variables with a compact, direct writing instrument designed for long-term, unattended operation. Using electrosensitive paper, the **7825A** Trend Recorder has a single time-shared pen which produces either a standard analog trace or a bar graph for each activated channel — taking a maximum of 30 sec to cycle through all 4 channels. Each channel has independent on/off, analog/bar graph, position and sensitivity controls for maximum operational flexibility. Maximum sensitivity is full scale deflection (12 cm) for  $\pm 2.5$  Vdc input.

Standard chart speed is 1 cm/hr (others optional), which means a single 50-ft roll of paper can provide slightly over 2 months of continuous recording! Not only does the paper carry hourly marks along one edge for your convenience during later analysis, it also is well-suited for mounting (a 24-hour record fits nicely on a standard letter-sized sheet for filing, etc.) and is clearly reproducible. Recorder price: \$925.



Here's relief from the classical problem of making fast, useful measurements in noisy environments—now solved by two new HP data acquisition systems which scan, measure and record multiple inputs at rates to 40 channels/second.

Input to both systems is via the new Model 2912A Reed Scanner, which switches up to 40 (optionally to 1,000) guarded 3-wire input channels. Those channels selected are measured by the systems' new Model 2402A Integrating DVM which achieves 110 dB common mode rejection and low-level sensitivity without the use of preamplifiers — assuring accurate readings of millivolt signals at full system speed. In addition to Vdc, the voltmeter can also measure Vac, frequency and resistance via optional plug-in circuit cards. A “universal” output coupler, using plug-in cards, provides easy interface between the voltmeter and virtually every type of output device — and can optionally provide time-of-day and manual data entry.

Price for typical **2012C** system (including scanner, DVM and HP 5050A Digital Printer output), \$11,320. Prices for **2012D** systems depend on output device, up to \$17,125 (for magnetic tape).

## New decade capacitor with 0.25% accuracy, 40 pF–1.2 $\mu$ F



Easy to use and read, the compact **4440B** Decade Capacitor is an ideal aid for circuit design, ac bridge measurements or any application requiring high accuracy. It covers 40 pF to 1.2  $\mu$ F. Decade switching, starting from 100 pF, uses silvered mica capacitors for low dissipation factor and good temperature coefficient. And an air capacitor vernier provides continuous adjustment from 40 to 140 pF, with a resolution of 1 pF. Direct reading accuracy for three-terminal connection is  $\pm(0.25\% + 3 \text{ pF})$  at 1 kHz, increasing by less than 1 pF for two-terminal connection. Typical resonant frequencies are: 450 kHz at 1  $\mu$ F, 4 MHz at 0.01  $\mu$ F and 40 MHz at 100 pF. Maximum voltage is 500 V peak. Price: \$260.

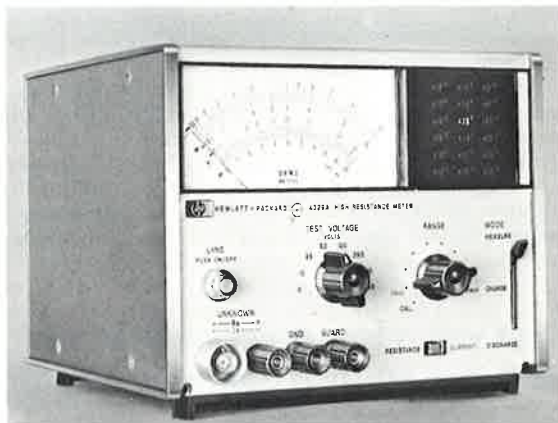
## FM signal generator for testing L, S-band telemetry receivers



Here, in one compact unit, is a precision signal generator covering *both* the "L" and "S" FM telemetry bands. The 1430–1540 and 2150–2310 MHz rf output frequencies are variable from  $-10$  to  $-127$  dBm, and can be leveled so that there is a maximum excursion of 1.5 dB p-p across each band. A built-in modulation oscillator provides any of 21 standard IRIG telemetry subcarrier frequencies, at the flip of a switch.

FM deviation (variable from 0 to  $\pm 3$  MHz, in 5 ranges) is accurately indicated on the internal meter (which requires no external instrumentation for calibration). FM nonlinearity is  $<1.0\%$  at  $\pm 1.0$  MHz deviation. Price of the completely-solid-state Model **3205A** is \$5750.

## Measure insulation, other high resistances up to $2 \times 10^{16} \Omega$



4329A high resistance meter

Whenever you need to measure the very high resistances associated with synthetic resins, rubber, porcelain, or insulating oils—use the new **4329A** High Resistance Meter. Use it, too, for measuring the resistances of capacitors, transformers, switches and cables.

In addition to resistance ( $5 \times 10^5 \Omega$  to  $2 \times 10^{16} \Omega$ ), the meter also measures current (0.05 pA to 20  $\mu$ A). You get rapid and error-free measurements in both modes, for the proper meter scale is automatically indicated by an illuminated marker and the multiplying factor is also automatically illuminated. Seven fully regulated test voltages (10–1000 Vdc) are provided by the meter. Both grounded and ungrounded samples are easily measured, and the instrument case remains at ground potential for all test conditions. 4329A (including low noise test leads), \$750.

### Resistivity cell for sheet insulation materials.

In those instances where you wish to measure the surface and volume resistivity of sheet insulation materials, use the new **16008A** Resistivity Cell with your 4329A. The cell can accommodate samples up to 125 x 125 x 7 mm. It measures volume resistivity up to approx.  $4 \times 10^{18} \Omega \text{ cm}$  on samples 0.1 cm thick and surface resistivity up to approx.  $4 \times 10^{17} \Omega$ . Test voltages up to 1000 Vdc may be used. 16008A, \$200.

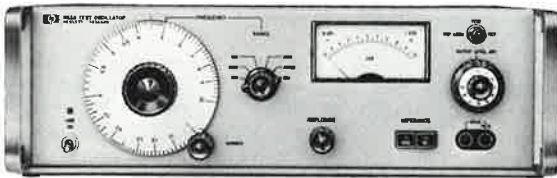
## Monochrome 14-inch picture monitor has high resolution, linearity

Use the new **6947A** Picture Monitor for any application where you need a high-quality display of a picture signal output from TV studios/tape machines/transmitters, from video switching systems, or from alphanumeric systems. A precise measuring and display instrument, this solid-state monochromatic monitor has a 14-inch CRT and comes ready to mount in a standard 19-inch-wide rack.

The quality, high-resolution display results from unity interlace, small ( $<0.007$  inch) spot size, constant black-level (to 1%), video amplifier bandwidth to 18 MHz, and low geometric raster distortion ( $<1\%$  over center 80% of display area,  $<1.5\%$  over entire display area).

Among included controls are a display reduction switch (to 80% normal size for examination of raster edges, without affecting linearity), a pulse cross display switch, and a 50/60 Hz field rate switch for standard 625 or 525 display lines. Couple this monitor (\$900) with the HP 191A TV oscilloscope and you'll have the complete TV quality monitoring system.

## Test video transmission systems with this 10 Hz–10 MHz oscillator



The new **653A** Test Oscillator is ideally suited for use in measuring and adjusting video transmission systems—and by itself replaces 4 separate test equipment items formerly required. In addition, it can be used for checking broadband amplifiers, TV camera circuits, transmitters, and other broadband components.

Output is via either  $124\Omega$  balanced or  $75\Omega$  unbalanced standard Western Electric connectors, and is calibrated in dBV ( $0\text{ dB}=1\text{ V p-p}$ ). For comparison measurements, there's a built-in 300 kHz reference oscillator (amplitude  $\pm 0.1\text{ dB}$  for 90 days) whose output can be conveniently alternated with the output of the variable test oscillator.

Test oscillator is flat (within  $\pm 0.05\text{ dB}$  with respect to the reference) over the range, 50 Hz–10 MHz. A precision attenuator, accurate to  $\pm 0.15\text{ dB}$ , adjusts output level from  $+10\text{ dBV}$  ( $3.2\text{ V p-p}$ ) to  $-90\text{ dBV}$  ( $30\ \mu\text{V}$ ) in 1 and 10 dB steps. Protective front and rear panel covers are included for \$990.

## Phase, amplitude network analysis over swept 10 kHz–32 MHz range



675A (top)/676A network analyzer

The new **676A** Phase/Amplitude Tracking Detector, when combined with the **675A** Sweeping Signal Generator, gives you the first sophisticated network analyzer of its kind—providing phase (full  $360^\circ$ ) and amplitude (80 dB dynamic range!) information over the 10 kHz to 32 MHz range.

You can sweep the entire frequency range or only a small portion of it to measure such things as dynamic input and output impedances, return loss, open and closed loop response, transfer characteristics, and system flatness. And you can plot impedances or analyze small signals. The analyzer's low spurious and noise ( $-85\text{ dB}$ ) and low residual FM ( $<70\text{ Hz}$  peak) enable you to make accurate measurement on devices having ultra-steep responses.

The analyzer's dual channel operation make it convenient to compare a device under test against a "standard"—and the scope outputs of phase (A–B) and amplitude (A–B) differences are especially useful and time-saving in production work. High impedance probes ( $100\text{ k}\Omega$ ,  $3.5\text{ pF}$ ) are available where circuit loading is a consideration. **676A**, \$1275; **675A**, \$2250.

## Economical square wave generator

You can buy the laboratory-quality **221A** Square Wave Generator, which operates at 1 Hz–10 MHz repetition frequencies, for only \$195. Yet, look at what it does: Square-wave output rise and fall times  $<15\text{ nsec}$ ; source impedance of  $50\Omega$  preserves clean wave shape by absorbing reflections from impedance mismatches; positive-going amplitude controllable 0 to  $+5\text{ V}$  peak into  $50\Omega$  load. Frequency is selected by vernier control within any of 7 decade ranges; can also be controlled throughout any range by external  $-1.2$  to  $-13\text{ V}$ . External voltages between 0 and  $-1\text{ V}$  suppress square wave generation, so you can also use a VCO input to gate generator's output. Compact, weighs only  $3\frac{1}{2}$  lbs.

## X-band hot carrier detector

HP's new **X-band Hot Carrier Detector** diode is a 10 GHz video detector emphasizing low noise and high sensitivity, with video bandwidths as low as 400 kHz. It is available in two package styles: miniature glass (\$50, 1-9 quantities) and symmetrical pill (\$16, 1-9 quantities).

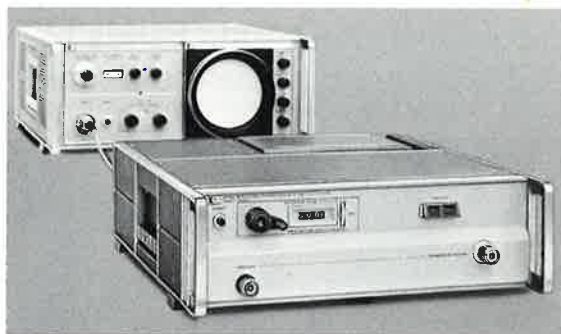
## This dc-40 GHz frequency measuring system uses standard HP instruments



You get a real bonus with the new **E40-5245L** system for measuring frequency from dc to 40 GHz! For it not only gives superior performance and easier operation than some special-purpose microwave frequency measuring instruments — it is made up primarily of standard HP instruments, each of which can be used separately for other tasks when not needed in the system. These include: 5245L Counter with 5257A Transfer Oscillator plug-in, 8690A Sweep Oscillator, 8709A Synchronizer, and 11517A Mixer.

The overall system has a wide (0.1%) phase lock range, sensitivity typically better than  $-30$  dBm over entire dc-40 GHz range, and accuracy better than  $\pm 2 \times 10^{-7}$ . Complete E40-5245L system approximately \$10,500, depending upon hardware and cabinet requirements.

## Measure reflection, transmission with single 2-12.4 GHz test unit



8743A reflection/transmission test unit, used with 8410A network analyzer (background)

The new **8743A** Reflection/Transmission Test Unit (\$2450) combines a precision reflectometer and transmission test system into a single instrument covering 2.0 to 12.4 GHz. Used with the HP 8410A Network Analyzer to measure these basic parameters in vector form, it allows you to completely characterize two-port networks. SWR of the test ports is  $< 1.25$  and system directivity is better than 30 dB. The calibrated Reference Plane Extension is adjustable from 0 to 15 cm for "reflection" and from 0 to 30 cm for "transmission"—and either measurement function is selected by front-panel push-buttons.

This test unit can accommodate unknown coaxial networks of virtually any configuration, through the use of HP 11588A Coaxial Rotary Joints (below) and sections of precision coax air line.

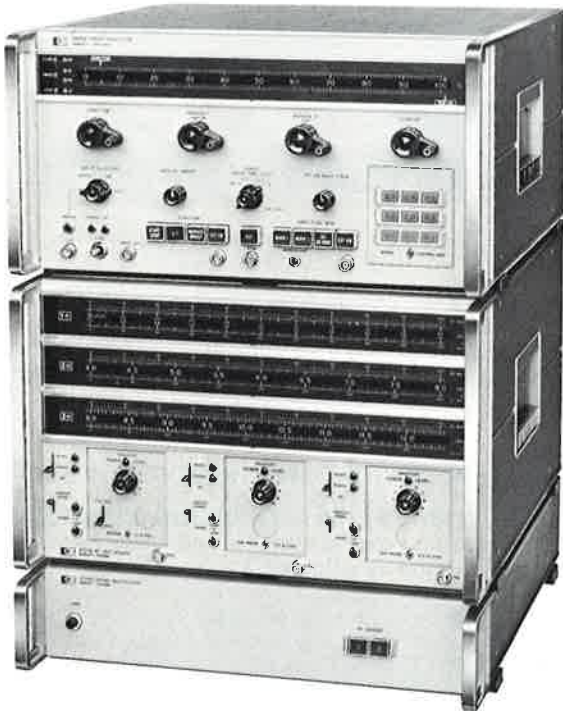
## Coaxial rotary joints ensure accurate, repeatable measurements

Accuracy-destroying variations in your precision measurements caused by the flexing of coaxial cables can now be virtually eliminated — which is especially meaningful for insertion loss measurements where a reference must be established prior to inserting the unknown into the system.

The solution is to use sections of rigid coaxial air line and new **11588A** Rotary Joints, rated from dc to 12.4 GHz with less than 1.10 VSWR. The joints (\$180 each) use precision 7 mm connectors (APC-7), and variations in signal level due to joint rotation are at least 57 dB down.



## Sweep over ultra-wide bands by using programmable multiplexer

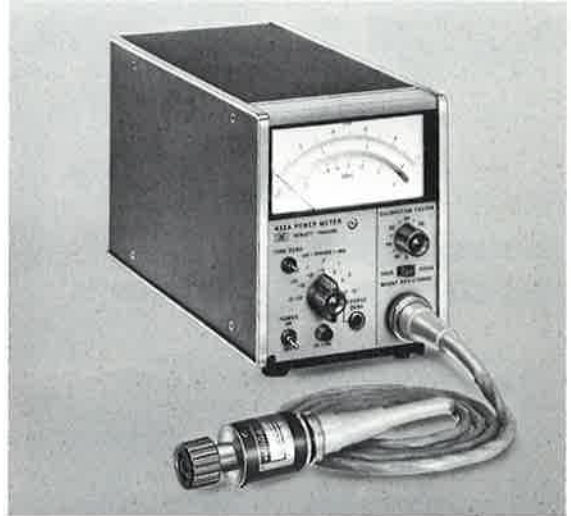


(top) 8690B sweeper w/8706A control plugged in,  
(middle) 8707A holding 3 RF units,  
(bottom) 8705A multiplexer

Your RF and microwave swept measurements no longer need be limited to octave bandwidths of sweepers. For now you can combine the outputs from three HP 8690-series sweeper RF units to get a single output signal spanning as wide as from 100 MHz to 12.4 GHz — using the **8705A** Signal Multiplexer designed for use with the HP 8960B Sweep Oscillator (equipped with 8706A Control Unit and 8707A RF Unit Holder with plug-ins).

Band selection is performed through the Control Unit by either pushbutton or remote programming, and normal auxiliary sweeper functions such as “leveling” and “sweep reference” are automatically switched with band changes. The signal can be routed to either of two output ports by simple push-button selection on the multiplexer front panel. A multiplexed sweeper system is the ideal source for use with the wideband HP 8410A Network Analyzer. Multiplexer price: \$1750.

## This microwave power meter automatically sets itself to zero



432A power meter (with separately-supplied thermistor mount)

New convenience in microwave power measurement is yours with the **432A** Power Meter. Just depress a front panel switch and the meter automatically sets itself to zero — saving you the time and trouble of knob twisting! What's more, this new meter uses the same temperature-compensated thermistor mounts (covering 10 MHz–18 GHz in coax, 2.6–40 GHz in waveguide) now supplied for the popular HP 431-series power meters.

The Model 432A ranges in 5 dB steps, measuring from 10  $\mu$ W fs to 10 mW with an accuracy of  $\pm 1\%$  fs, from 0° to 55°C. Price: \$495 (plus \$100, if rechargeable field-use battery pack is desired).

## Octave-bandwidth coax switches

You can now satisfy your switching needs within the 1 to 18 GHz frequency range with a new series of **Octave Bandwidth Coaxial SPST Switches** available from HP. They come complete with Type-N or miniature 3 mm female coaxial connectors at the RF ports, and with BNC or miniature 3 mm female connectors at the bias port. The RF line is isolated from bias. The mechanical dimensions and prices (\$200 to \$275 each, 1–9 quantities) vary depending on the switch used. Other connector options and/or non-standard frequency octaves are available on special order.



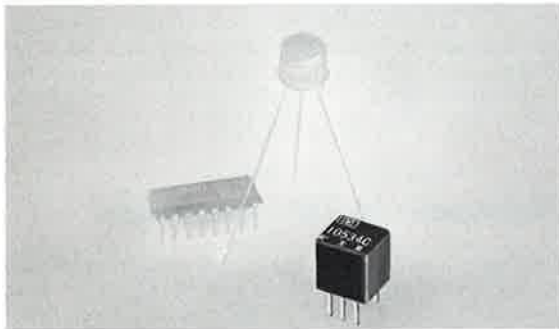


## Precision coaxial coupler . . . flat over 3 octaves to 12.4 GHz



You get flat coupling over an extremely wide bandwidth with the precision high-frequency **779D** Coaxial Directional Coupler. It is a 20 dB coupler with  $< \pm 1$  dB variation, 1.7 to 12.4 GHz. Directivity is better than 30 dB up to 8.2 GHz, 26 dB to 12.4 GHz. VSWR of any port is under 1.2. Priced at \$550, the coupler has APC-7 precision 7 mm connectors (type N connectors optional).

## Miniature double balanced mixer

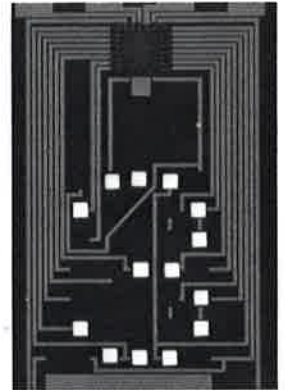


Compact 10534C double balanced mixer (shown with TO-5 transistor and flat-pack IC)

The new high performance **10534C** Double Balanced Mixer is a real space saver, measuring only 0.4 x 0.4 x 0.35 inches (0.056 cu. in.). Requiring only little more printed circuit board room than a TO-5 size transistor, it simplifies circuit layout and construction since pin spacing is compatible with flat-pack integrated circuits. Frequency ranges are dc-150 MHz on one port and 50 kHz-150 MHz on the other two ports; conversion loss is 6.5 dB over the hf band, 8 dB over entire range; balance is 12 to 35 dB, depending on frequency and test connections (typical performance is much better). Single sideband noise performance, 6.5 to 8 dB depending on frequency. Price: \$60 (quantity discounts for 4 or more units).

## Solid-state numeric indicator

Here's a new compact and rugged numeric display module for information presentation. It requires only about  $\frac{1}{2}$  W of power and a standard four-line negative-logic 8421 BCD signal to cause any number from 0 through 9 to appear, at intensity levels adequate for full daylight viewing. Brightness is variable over the range of 5 to  $> 50$  foot-lamberts. The 0.25" high numbers are easily read at several feet and at extremely wide vertical and horizontal off-axis viewing angles ( $60^\circ$  from normal).



Interior detail  
(4 times actual size)

The small **5082-7000** Numeric Indicator module can be used where space is at a premium, for its overall size is only 1" high, 0.5" wide and 0.16" deep, complete with switching logic. There are four electrical connections at each end, with conventional 0.100" c-c spacing: one ground, one 5 V at 50 mA for the LSIC logic, one 5 V at 0-250 mA for the light emitting diodes which make up the numbers, one for actuating a decimal point, and four BCD.

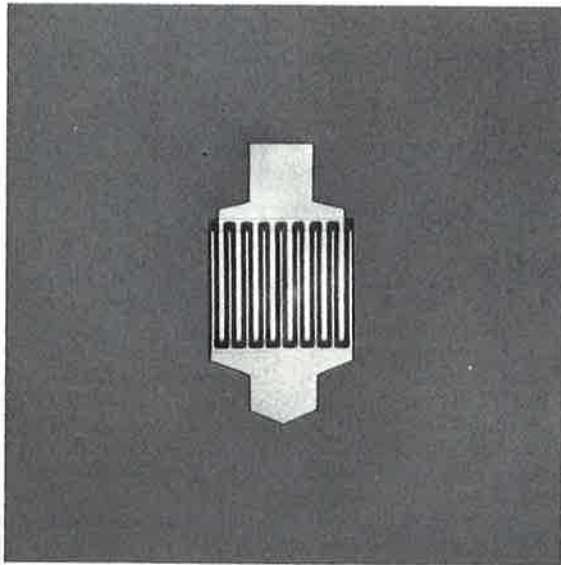
## Visible light source diodes

The gallium arsenide phosphide diodes used in the new HP Numeric Indicator (mentioned nearby) are also available separately for use in your circuit designs. These solid state **Visible Light Sources** are manufactured by HP under closely controlled conditions to assure consistent quality in production quantities, and they are available in a variety of package styles to suit your needs. Compatible with integrated circuits, these devices offer the advantages of long life, shock and vibration resistance, and freedom from catastrophic failure.

## These step recovery diodes are completely characterized

Uniform and reproducible performance in the time domain is yours with HP's new **Pulse Specified Step Recovery Diodes**. Fully time-domain tested, surface passivated and radiation resistant, these diodes are useful for test waveforms, fast clock pulses, odd-numbered harmonics, special drive waveforms, sharp linear triangular waveforms, etc. And the price is reasonable (for example, HP 5082-0202 diodes are \$5.50 each in 100-999 quantities).

## Chip transistors with guaranteed microwave performance



If you design hybrid microcircuits for RF or microwave applications, consider these two major benefits of using new HP Microwave Chip Transistors: (1) *Your circuits will perform better and more predictably* because HP transistors are 100% tested at microwave frequencies, and their characteristics (stated as "s" parameters) are guaranteed; and (2) *You'll get a higher circuit yield* because of the 100% testing mentioned above and because the unique moly-gold contact system permits reliable, high temperature alloying.

Optimized for use in oscillator and amplifier applications, these gold-backed, passivated NPN epitaxial silicon transistor chips include the HP 35800A (typical  $F_{max} = 6$  GHz,  $F_T = 4$  GHz), HP 35801A ( $F_{max} = 4.3$  GHz,  $F_T = 3.5$  GHz), HP 35802A ( $F_{max} = 3$  GHz,  $F_T = 3$  GHz). Small quantity prices from \$65 to \$80—and for slight additional cost, actual s-parameter data can be supplied with each individual chip.

## Hybrid integrated packages

If you are working with thick or thin film hybrid integrated circuits, you should be aware that selected HP semiconductor devices are available in chip form and on carriers for just such applications. For example, the 5082-2800 Hot Carrier Diode comes in chip, ministrip and LID forms—while the HP 5082-2700 X-Band Mixer Diode is available in beam-lead configuration. Please check with us if there's a specific type of quality HP device you would like to incorporate into your hybrid circuit.

## Current-controlled RF resistor

The new **5082-3003** Current Controlled RF Resistor is ideally suited for use in AGC circuits, constant impedance leveling circuits, or as an element in any circuit requiring the use of dc or low frequency control of an RF resistance. It consists of a specially processed and tested silicon PIN diode selected on the basis of similarity of RF resistance variation with bias; resistance is measured and specified at 500 MHz and at two bias points on each unit. Fabrication is closely controlled, and these extremely reliable devices are particularly suited for aerospace and defense use. \$15.30 each, in 10-99 quantities.

## Photocell/lamp combinations

The **5082-4521** device combines a long life 5 V lamp with one of several photoconductors in a small, hermetically sealed TO-5 case. It provides a low cost (\$5.25 each in 1000 quantity), noiseless light-dependent resistor for use where small space and good environmental performance are required. With a maximum power dissipation of 100 mW at 25° C, it is being used in gain control circuits in both industrial and military communications equipment.

The **5082-4530** axial device provides in an economy package (\$3.75 each in 1000 quantity) characteristics similar to the 5082-4521 photocell/lamp above. It can be designed with a wide variety of lamp and photocell combinations—and offers an advantage of isolation between the lamp and cell leads of greater than 3000 volts, so that it can be used for isolation in circuits where conventional lamp/photocell combinations are impractical.

## Photocells in TO-5 packages

Five new photocells in TO-5 packages are available in the **5082-4620** series, priced at \$1.75 each in quantities of 1-9. Their major characteristics listed below also indicate the broad range of HP capability available to you in custom devices, which we will produce to your specifications on large-quantity orders.

HP Type	Resistance		Min. dark resistance 5 sec. after 2 FC	Max. peak voltage	Peak spectral response
	@ 2 FC	@ 100 FC			
5082-4620	10 M $\Omega$	100 K $\Omega$	1000 M $\Omega$	300 V	6550A
5082-4621	1 M $\Omega$	10 K $\Omega$	1000 M $\Omega$	300 V	6550A
5082-4622	300 K $\Omega$	4 K $\Omega$	1000 M $\Omega$	300 V	6550A
5082-4623	25 K $\Omega$	225 $\Omega$	100 M $\Omega$	250 V	7250A
5082-4624	4 K $\Omega$	150 $\Omega$	10 M $\Omega$	200 V	7250A



# INFORMATION REQUEST

## AUTUMN 1968

Contact me immediately to discuss: \_\_\_\_\_

My phone: \_\_\_\_\_

Send technical data on items checked below:

- |   |  |
|---|--|
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| <input type="checkbox"/> 221A Square Wave Generator   | <input type="checkbox"/> 5560 Auto Nuclear Counting Systems          |
| <input type="checkbox"/> 432A Microwave Power Meter   | <input type="checkbox"/> 5584A, 5585A Nuclear Modules                |
| <input type="checkbox"/> 653A Test Oscillator   | <input type="checkbox"/> 5590A Nuclear Scaler/Timer                  |
| <input type="checkbox"/> 675A/676A Network Analyzer   | <input type="checkbox"/> 5610A Analog-to-Digital Converter           |
| <input type="checkbox"/> 712C Power Supply  | <input type="checkbox"/> 6921A AC Calibrator                         |
| <input type="checkbox"/> 779D Coaxial Directional Coupler                                     | <input type="checkbox"/> 6947A Picture Monitor                       |
| <input type="checkbox"/> 1208A/AR X-Y Display Scope   | <input type="checkbox"/> 7825A Trend Recorder                        |
| <input type="checkbox"/> 1802A 100 MHz plug-in for 180/181<br>(also 1123A probe; 1820B/1822A) | <input type="checkbox"/> 8054A Audio Spectrum Analyzer               |
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| <input type="checkbox"/> 2018 Data Acquisition Systems  | <input type="checkbox"/> 8743A Reflection/Transmission Test Unit     |
| <input type="checkbox"/> 2060A Digital Logic Test System                                      | <input type="checkbox"/> 9100A Desk-Top Calculator                   |
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| <input type="checkbox"/> 3950 Magnetic Tape Recording Systems                                 | <input type="checkbox"/> 5082-4530 Axial Photocell/Lamp              |
| <input type="checkbox"/> 4329A High Resistance Meter<br>and 16008A Resistivity Cell           | <input type="checkbox"/> 5082-4620 etc. TO-5 Photocells              |
| <input type="checkbox"/> 4440B Decade Capacitor   | <input type="checkbox"/> 5082-7000 Numeric Indicator                 |
| <input type="checkbox"/> 5050B Digital Recorder & Clock                                       | <input type="checkbox"/> Octave Bandwidth Coax Switches              |
| <input type="checkbox"/> E21-5065A Portable Atomic Clock                                      | <input type="checkbox"/> Pulse-Specified Step Recovery Diodes        |
| <input type="checkbox"/> E40-5245L 40 GHz Measuring System                                    | <input type="checkbox"/> Visible Light Source Diodes                 |
| <input type="checkbox"/> 5248L/M 135 MHz Counters   | <input type="checkbox"/> X-Band Hot Carrier Diodes                   |

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### HONG KONG

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Cable: SICO Allahbad

The Scientific Instrument  
Co., Ltd.  
240, Dr. Dadabhai Naoroji Road  
**Bombay 1**  
Tel: 26-2642  
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The Scientific Instrument  
Co., Ltd.  
11, Esplanade East  
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Tel: 23-4129  
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The Scientific Instrument Co., Ltd.  
30, Mount Road  
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Tel: 86339  
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### INDONESIA

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Djalan Merdeka 29  
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240 Kh. Saba Shomali  
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### ISRAEL

Electronics & Engineering  
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### PHILIPPINES

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### SINGAPORE

Mechanical and Combustion  
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