

# New product applications

## More calculators thinking Polish as a famous pioneer faces some rough competition

Only three short years ago, the HP-35 (featuring Reverse Polish Notation) was introduced and soon won the praise and acceptance of engineers everywhere at an initial \$395. But on a strict cost/performance basis, the "veteran" of portable scientific calculators could be headed toward early retirement. Hewlett-Packard's latest pocket marvel, the scientific HP-21 at \$125, retails \$70 below the current price of an HP-35! Not only is the HP-21 cheaper, it also includes a degree/radian switch and handles inverse trig functions, two useful features its older brother lacks. Using fewer batteries and logic chips than any other H-P portable calculator, the HP-21 operates five hours on a full charge.

Contact Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304.

Circle No. 40 on Reader Service Card

One calculator manufacturer just now entering the scientific arena is the Corvus Corp. Its entry is the Corvus 500 with a ten-digit mantissa and two-digit exponent display. Standard engineering functions are coupled with metric conversions, statistical capabilities, and easy transition between rectangular and polar coordinates. Like H-P, Corvus has chosen RPN for its scientific calculator. The Corvus 500, along with two other new calculators for business applications (Corvus 600 and 615) should now be entering the consumer market in quantity. The Corvus 500 lists for under \$200, complete with rechargeable NiCad batteries.

For further information, write Corvus Corp., 13030 Branch View Lane, Dallas, Tex. 75234.

Circle No. 41 on Reader Service Card

Also joining the RPN bandwagon are four new calculators from Novus, the consumer products arm of National Semiconductor Corp. Model 4510 at \$69.95 features a three-level stack plus separate accumulating memory and an eight-digit LED display, but does not have scientific notation (keyboard includes trig, inverse trig, logs, exponents, and radian/degree conversion). A programmable version, Model 4515 at \$139.95 has the same basic features as the 4510 combined with a learn-mode capacity of 100 steps.

A rollable four-level stack and scientific notation capability earmark Novus' Model 4520 at \$99.95, and programmable Model 4525 at \$169.95. While these two machines have no "dual-purpose" keys, they handle a full complement of scientific functions, excluding the degree/radian feature of their lower priced companions.

In every case, Novus' programmable calculators have a "delete" feature which allows correction of programs while they

are being entered. All machines come with NiCad batteries and a charger.

Contact Novus, 1177 Kern Ave., Sunnyvale, Calif. 94086.

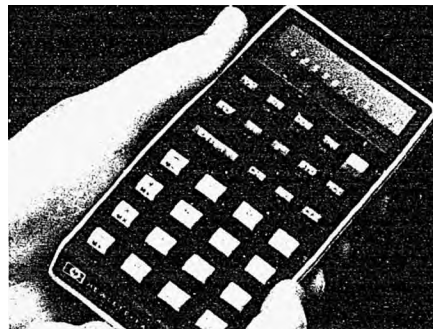
Circle No. 42 on Reader Service Card

Meanwhile, Texas Instruments has bested its popular SR-50 calculator with the new SR-51. (Both machines feature algebraic entry.) Intended for scientific and statistical applications, the SR-51 handles standard deviation, variance, linear regression, and factorials, in addition to its impressive slide-rule capabilities. The calculator also serves as a random-number generator, generating random two-digit numbers between 00 and 99. The SR-51's LED display is a 10-digit mantissa and two-digit exponent. Twenty commonly used engineering conversions round out the SR-51's "can-do" list. Calculator, batteries, charger, and carrying case come complete for \$224.95.

Need to know more? Write Texas Instruments Inc., P.O. Box 5012, MS 84 Attn: SR-51, Dallas, Tex. 75222.

Circle No. 43 on Reader Service Card

More functions without fumbling means most keys must do "double duty" on advanced calculators such as the HP-21 (left) and the Corvus 500 (right).



## IC socket "pops" into PC boards to accept 14- and 16-pin DIPs

The "Popit", a solderless push-on or press-on IC socket, can be used with single- or double-sided PC boards. When installed on a PC board, the socket provides intimate contact between the printed-circuit pads and the leads of a dual-in-line package, by the compression of an internal spring.

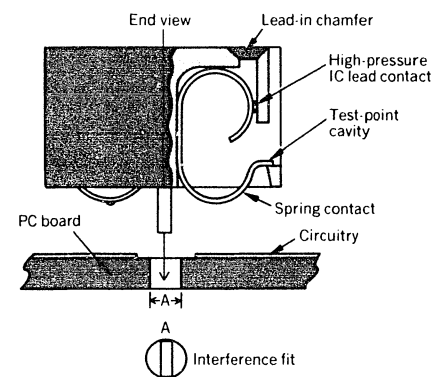
It is completely solderless, accepts 14- and 16-pin arrangements, and is easily removed for replacement.

Other features include high-pressure contacts to both IC leads and board circuitry, a lead-in chamfer, only two mounting holes, contacts with wiping action, a contact pressure of 250 grams,

contact resistance of 25 m $\Omega$  at 1 ampere, and a continuous operating temperature range of  $-55$  to  $+85^{\circ}\text{C}$ .

The socket is manufactured of glass-filled polyester thermoplastic and contains contacts of spring copper alloy. It is designed for use in consumer electronics equipment, instrumentation and control equipment, and computer and peripheral equipment.

More details and information are available by contacting Cannon Electric Div., ITT Corp., 666 E. Dyer Rd., Santa Ana, Calif. 92702.



A simple tool like an arbor press can be used to install this IC socket in a PC board. An internal spring compresses to make intimate contact between the PC

## New product applications

### Op amp provides continuous input/output isolation of 1200 volts dc

The 3452 unit in this manufacturer's "Iso-Op-Amp" family features an isolation voltage of  $\pm 1200$  volts dc. Other units in this series only offer an isolation of 500 volts. The unit is tested at four times the rated voltage ( $\pm 4800$  volts dc) for one

second. The 3452 also offers isolated input power at  $\pm 15$  volts dc,  $\pm 10$  mA.

The isolation voltages of the unit are suited for the industrial control market, particularly in dc-motor applications for which armature voltage and current need

to be monitored. The isolated-input-power feature may find applications in medical areas, where there is a need for isolated power for bridge excitation.

Like its predecessors, the 3452 can be operated in the noninverting, inverting, or difference-amplifier configuration. Other amplifiers may offer isolation, but they are usually only unity gain isolators, or are capable of only a few fixed gains.

This series of amplifiers can also be connected in the current-to-voltage configuration and can provide better gain linearity and stability than ordinary isolation amplifiers.

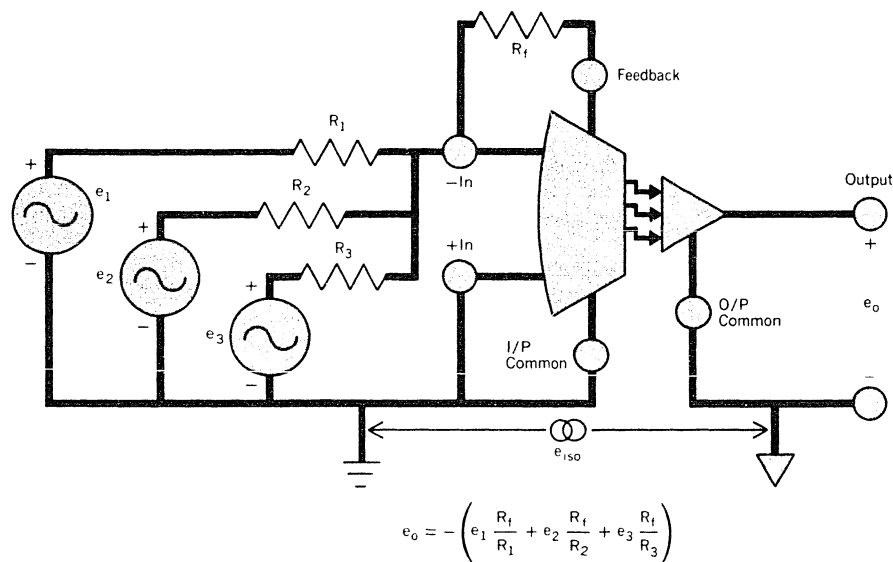
Designed for use with high-level voltage sources or low-level current sources, the 3452 has a FET input that provides  $10^{11}$ -ohm input impedance, and a bias current of  $-20$  pA, maximum. Common-mode rejection is 90 dB at  $\pm 10$  volts, and isolation-mode rejection is 160 dB, minimum. Input voltage drift is  $\pm 5\mu\text{V}/^\circ\text{C}$ , maximum, and gain linearity is guaranteed at  $\pm 0.05$  percent.

The 3452 is useful in instrumentation and test equipment applications, in amplifying low-level signals in the presence of high common-mode voltages, or in breaking ground loops between transducers and other signal-conditioning circuits.

Unit price is \$135, with small quantity delivery available off-the-shelf.

Contact Dennis Haynes, marketing engineer, Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz. 85734.

The 3452 series op amp can be used for a variety of inverting-circuit applications. Shown are the proper circuit connections for summing a number of signals that are all at the same common-mode level.



Circle No. 45 on Reader Service Card

### Five-digit, LED-display synthesizer is priced below \$1600

The model 1013 frequency synthesizer, priced at \$1595, covers the 0.1-Hz to 13-MHz frequency range with a minimum of 5-digit resolution. It features a metered, leveled output up to 3 volts rms and a precision output attenuator, adjustable in 10-dB steps from 0 to 90 dB with continuous-level control.

Low phase noise (greater than 40 dB

down at the top of the band, and greater than 60 dB down below 1 MHz), low harmonic distortion ( $-50$  dB from 0.1 Hz to 1 MHz and  $-40$  dB from 1 to 13 MHz), and low spurious outputs (greater than 60 dB down) ensure signal purity.

In addition, the unit has a square-wave output to drive 50 ohms and TTL logic. It features an LED display that indicates

frequency and permits monitoring of the output during remote operation.

The unit is designed to replace bulkier and costlier synthesizers in test, production, and systems instrumentation applications.

For more information and detailed description of the synthesizer, contact Comstron Corp., 120-30 Jamaica Ave., Richmond Hill, N.Y. 11418.

Circle No. 46 on Reader Service Card

### CCD memory available commercially on a production basis

This charge-coupled device (CCD) memory, to be offered in production quantities, is a 1-kilobyte serial storage element that is designed for applications in terminal buffers, video-display refresh, microprocessor-control data stores, smart terminals, and electronic switching in data communication networks.

The CCD 450 has 1024 words by nine bits. It contains nine 1024-bit low-power CCD registers that are shifted in parallel to provide storage and retrieval

of nine-bit words in a byte-serial mode. Each register is accessed by its own bidirectional data line, and all nine registers are serviced by common two-phase clocks and read and write control functions. The device has four modes: read, write, read/modify/write, and recirculate.

Power dissipation in read and write modes is 250 mW maximum, and 30 mW in the standby-recirculate mode. Average random-byte access time is 200  $\mu\text{s}$ . The device uses simple two-phase clocking

and is packaged in a standard 18-pin ceramic DIP. Data rate is 50 kHz to 3 MHz.

Evaluation quantities of the CCD 450 are now available on a four-week delivery basis. Production quantities will be offered in the fourth quarter of this year.

Sample prices are \$90 each in quantities of one to ten. Production-quantity pricing for volume orders will be less than 0.1 cent per bit by the end of 1975.

Contact Fairchild Camera and Instrument Corp., Integrated Circuits Group, 464 Ellis St., Mountain View, Calif. 94042.

Circle No. 47 on Reader Service Card

## Serial impact printer incorporates microprocessor

The 30-character-per-second, serial impact Carousel printer provides an integral one-board microprocessor control system that is part of the printer mechanism. Previous industry practice has been to leave the task of providing the control system to a systems builder or an OEM.

The latter approach for printer mechanisms can require up to 100 ICs for internal hardwired logic. Another 100 ICs will often support the microprocessor chip. By contrast, this unit's entire microprocessor control system, including all necessary internal logic, requires fewer than 100 ICs. The control system uses TTL logic and bipolar ROMs and RAMs.

The print cup rotates during its character-selection movements at rates up to 6000 steps per second. The sides of the cup are divided into 100 fingers: 94 contain the alphanumeric of the standard ASCII set, and six have been shortened to provide the operator with a viewing window. The print cup is interchangeable to permit selection of different fonts.

Digital stepper motors eliminate the

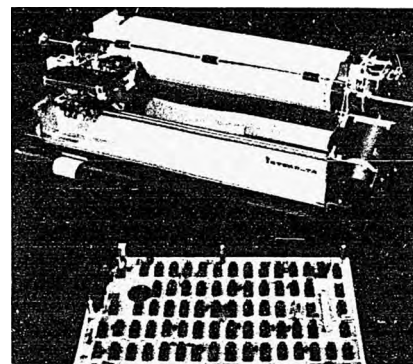
need for the analog-to-digital conversion circuitry found in units that use analog dc-servo motors.

The two-register controller accepts 8-bit parallel data, has a cycle time of 1.5  $\mu$ s, and operates directly on data without the need for microinstructions. It is also expandable to 4k words of ROM and RAM for those OEMs who wish to control other components in their systems.

Other key features include: independent addressing of horizontal and vertical print positions in increments of 0.025 cm ( $\frac{1}{100}$  in) and 0.052 cm ( $\frac{1}{48}$  in), respectively; interchangeable ribbon cartridges; two paper paths for cut forms and continuous six-part multiforms; and compact packaging for desk or table operation.

In addition to the printer, the manufacturer has introduced modular building-block options that can be used to create an interactive terminal. These options include a keyboard, communications interface, molded cover, power supply, and forms-handling accessories.

The Carousel costs \$1478 in quantities



This printer-mechanism features an integral one-board microprocessor control system. The microprocessor has a two-register controller that accepts 8-bit parallel data.

of 50, and the Carousel 300 terminal costs \$2009 in quantities of 50. Production deliveries will begin in May.

Contact the Terminal Products Group of Interdata, Inc., 2 Crescent Pl., Oceanport, N.J. 07757.

Circle No. 48 on Reader Service Card

## Monolithic CMOS A/D converter offers microprocessor compatibility

The AD7570—an IC A/D converter that is microprocessor-compatible and uses CMOS construction—has a quiescent power consumption of 20 mW.

It is a 10-bit successive-approximation converter that is compatible with all TTL/DTL/CMOS logic. The converter features a 20- $\mu$ s conversion time and a 50-kHz throughput rate—fast enough for multichannel data acquisition.

The unit includes its own internal

clock, as well as three-state status and output data lines for interfacing to an 8-bit microprocessor data bus. For operation, the AD7570 requires only an external comparator, a  $\pm 10$ -volt dc reference supply, a 15-volt dc supply, a 5-volt dc logic supply (if TTL compatibility is required), and a resistor and a capacitor to program the internal clock up to 0.6 MHz.

Other features include: no missing

codes over the 0 to 75°C specified temperature range, parallel- and serial-output data lines, and ratiometric operation.

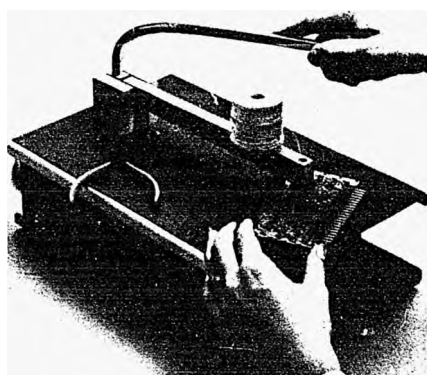
The A/D converter is packaged on a 28-pin ceramic DIP.

Available with 8-bit accuracy for \$52 or 10-bit accuracy for \$69 (1 to 49 quantities), evaluation and production quantities are now being offered from stock.

For more information, write or call Analog Devices, Inc., Rt. 1 Industrial Park, P.O. Box 280, Norwood, Mass. 02062.

Circle No. 49 on Reader Service Card

## Bender offers alternative to wire-wrap interconnection



Offering the advantages of multilayer printed-circuit density and good electrical characteristics, this unit augments welded-wire technology. Another advantage

The "Wire-bonder" welds wires to socket terminals—instead of wrapping wires on posts. The socket terminals are held in a printed-circuit board. The interconnection of the terminals is performed on the Wire-bonder, where an insulated wire is fed through the center of a hollow electrode and is permanently bonded from terminal to terminal. This can be accomplished easily, without cutting or stripping the wire.

Two advantages of this process, as compared with wire wrapping, are high density and low profile. The socket terminals can be spaced on 0.25-cm (0.1-in) centers and are less than 0.318 cm (0.125 in) high on the wire side of the board. Because the wires lie close to the ground plane of the PC board, the assem-

characteristics—especially for ECL circuits. As a result, the impedance has a more uniform characteristic, and crosstalk is reduced. Further, the assembly is easy and fast to produce, because the wires do not have to be cut or stripped. Bonded wires can be changed by cutting off unwanted wires and bonding new ones in their place.

The unit measures 20 by 33 by 28 cm (8 by 13 by 11 in) and weighs approximately 4.5 kg (10 lbs). It can be used with boards with a minimum dimension of 38 cm (15 in).

The list price is \$495 in single quantities. The manufacturer also supplies terminal sockets, wire, and PC boards for the process.

For further information, contact the 3G Co., Inc., 37a Williams Canyon Rd., Gaston, Ore. 97119.

## New product applications

### Synchronous, 1024-bit, CMOS RAM features access time of 100 ns at 10 volts

Available in military (-55 to +125°C) and commercial (0 to +70°C) versions, the IM6508 CMOS RAM has a 250-ns access time over the full temperature range with a 5-volt supply, decreasing to less than 100 ns at 10 volts. Total power requirements are 5 mW in standby and 10 mW at 1 MHz.

The device is a synchronous RAM with TTL-compatible inputs and outputs, and

operates from a single 3- to 10-volt power supply. The military device is packaged in a 16-pin DIP or flatpack, and the commercial version is a 16-pin DIP. An address register, controlled by the chip enable line, is contained on the chip.

Another version, the IM6518, available in an 18-pin DIP, contains three chip-enable inputs—two to control write-ena-

ble and output-buffer circuitry and one to control the address registers.

The new memory has the largest bit capacity of any CMOS RAM now available and a pinout identical with existing bipolar RAMs such as the IM5508 or 93415.

The memory is available now in both commercial and military ranges. Price in quantities greater than 100 is \$70 for the military, and \$28 for the commercial model.

Contact Intersil, Inc., 10900 North Tantau Ave., Cupertino, Calif. 95014.

Circle No. 51 on Reader Service Card

### High-voltage transformer has epoxy seal to protect against contaminants

These high-voltage transformers are built with the primary winding vacuum-cast in an epoxy resin that seals out moisture, grease, dirt, and corrosive atmospheres. In addition to providing the 95 000-volt basic impulse level, the epoxy-cast design opens up applications heretofore reserved for oil-filled and askeral-cooled transformers.

The high dielectric strength of the epoxy material also permits the trans-

former to be built with reduced spacing between the conductors and the magnetic core, thereby cutting overall transformer size in comparison with open-construction, high-voltage "dry type" units.

End applications for the transformers divide into two groups: power and control. Units with the higher kVA ratings develop the low-voltage power required to energize: radar, television, radio, and communication systems; variable-speed SCR motor drives; remote reporting stations for environmental conditions; and the signaling equipment for gas, oil, water, electric, and railway networks. The transformers are used when the electrical utility's power is made available at intermediate voltages between 2400 and 14 400 volts—a common range in remote locations and industrial plants.

In the second application category, the transformers play an auxiliary role, stepping down high voltage to provide a small amount of 120/240-volt energy that is used to monitor and control high-power equipment. A representative application of this type is the 120/240-volt power required by large, and sometimes portable, industrial rectifier equipment.

The transformer line includes units with primary voltage ratings from 2.4 to 14.4 kV, and power ratings of 5 to 50 kVA for single-phase types, extending from 15 to

150 kVA for three-phase versions. Standard outputs are 120/240, with primary taps up to a 7½-percent variation.

All units are designed to withstand high-voltage transients on the input circuit without insulation breakdown. The entire line is built in accordance with ASA Standard C37.20-5.2.1.

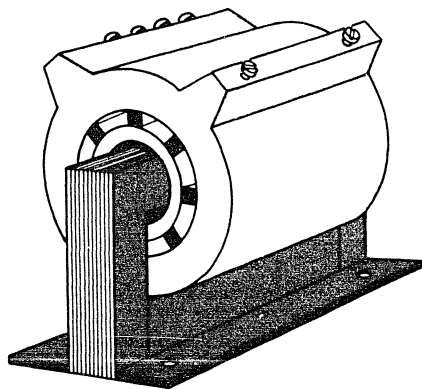
The transformer's solid epoxy casting provides excellent heat conduction and thermal mass, enabling the units to operate at 600-percent overload for up to five minutes, or to sustain a 175-percent overload for a full hour. Other advantages are their small physical size and the absence of special precautions for indoor application.

Single-phase Epoxycast transformers start at \$389 for the smallest 5-kVA type designed for 2.4-kV operation, and rise to \$1524 for a single-phase 50-kVA unit rated at 13.8-kV primary voltage. A 15-kVA three-phase transformer for 2.4-kV primary lists for \$980; a 75-kVA version for 13.8-kV operation is priced at \$2375. The manufacturer will quote prices for special transformers that extend the kVA ratings up or down and will also provide transformers for frequencies outside the 50- to 60-Hz range.

Contact Frequency Technology, Inc., TDC Division, Box 365, Whitcomb Ave., Littleton, Mass. 01460.

Circle No. 52 on Reader Service Card

**This high-voltage transformer resolves the condensation-, dust-, and insulation-breakdown problems of dry-type transformers, as well as the safety hazards of oil-filled types.**



### Small chip size characterizes high-speed, 4k-bit, dynamic RAM

The 2107B RAM design features the smallest chip size of any 4k RAM currently available. The chip is 55 percent smaller than previous RAMs with single transistor cells and 75 percent smaller than designs of three-transistor cells.

The 2107B has a worst-case access time of 200 ns and a guaranteed minimum cycle time of 400 ns over the operating-temperature range of 0 to 70°C. A lower cost version, the 2107B-1, has a

worst-case access time of 250 ns and a minimum cycle time of 450 ns. Both types are available from stock.

Unlike earlier RAMs with single-transistor cells, the 2107B operates at standard MOS supply voltages of -5, +5, and +12 volts. The design avoids charge-sensing and substrate-voltage problems. It also allows nonvolatility to be achieved with a small backup battery.

The 2107B retains the industry stan-

dard 22-pin configuration of the 2107A. It is a single-clock, fully decoded RAM with a TTL-compatible, three-state output, and TTL-level inputs. Clocks are ±1 volt.

These characteristics reduce system overhead costs to about 0.05 cent per bit, compared with 0.15 cent per bit for 1k dynamic RAMs.

Prices in quantities of 100 to 999 are: C2107B, \$28.90; and C2107B-4, \$23.35.

Contact Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051.

Circle No. 53 on Reader Service Card

## X-band TWT offers 40-percent minimum efficiency

The TH-3525 traveling-wave tube provides 40-percent guaranteed minimum efficiency for communications-satellite applications. The combined use of a tapered-helix arrangement and a two-stage depressed collector produces excellent phase characteristics. The two-stage collector also eliminates temperature changes due to communications-traffic

variations through the TWT by making the tube's thermal dissipation independent of the RF drive.

With high gain—over 60 dB under small-signal conditions—the tube delivers more than 20 watts at saturation in its 10.95- to 11.70-GHz operating band. It is designed to withstand the severe conditions encountered in launching, orbital in-

sertion, and operation in space (the unit has a design life of seven years for in-space operation).

The TH-3525 also features the minimum fine-grain, small-signal gain variations and flat-gain characteristics needed for satellite transponder service.

Contact Thomson-CSF, Electronic Tubes Group, 8 Rue Chasseloup-Laubat, 75737 Paris, France.

Circle No. 54 on Reader Service Card

## LSI boosts performance-price ratio of compact digital multimeter

This multimeter combines low cost (\$335) with high reliability and accuracy. The manufacturer guarantees the specified accuracies for the lifetime of the instrument; as a result, there is no need to recalibrate. Lifetime accuracy is specified by the manufacturer at 0.2 percent for dc voltages ( $\pm 0.1$  percent of range  $\pm 0.1$  percent of reading).

The multimeter, the PM2522, uses an analog-to-digital conversion technique that eliminates the need for filters and rejects series-mode signals down to 0.1 percent of their original value.

The 3-digit LED display has an automatic decimal point, as well as polarity and overrange indication. All functions and controls are push-button selected, and there is no need for lead changing when going from voltage to resistance measurements.

Up to 1000 volts can be applied to the voltage ranges without damage. Current ranges are fuse-protected. Full-ac-line voltages of 115 volts, 60 Hz, can also be applied to the resistance ranges without harm.

The PM2522 can be supplied with rechargeable batteries which fit inside the cabinet and provide about eight hours of operation. They can be recharged through the ac line voltage of 115 volts, 60 Hz, available on the instrument. Ac-line recharging can be accomplished in as little as 15 hours.

Other optional accessories extend the PM2522's high-voltage and high-frequency ranges. The HT probe allows dc-voltage measurements up to 30 kV. The HF probe for high-frequency ac-voltage measurements, extends the multimeter's frequency range up to 700 MHz. Also available are an optional dc current shunt and an ac current transformer, for extending ac and dc measurements.

The PM2522's dc-voltage range extends from 200 mV to 1000 volts, full scale, in five push-button-selectable ranges. The ac-voltage range also extends over the same span, except for the top range, which is only 600 volts.

Both ac and dc ranges extend from 200  $\mu$ A to 2 amperes, in five ranges each, while the resistance-measurement span



MOS IC circuitry is used throughout this digital multimeter to provide a lifetime accuracy of 0.2 percent (guaranteed by the manufacturer) on dc voltages. This eliminates the need to recalibrate.

extends from 200 ohms to 20 megohms, in five ranges. Ac-voltage measurements are possible over a frequency range of 30 Hz to 30 kHz. The PM2522 is rated to operate over a nominal operating-temperature range of 0 to 50°C.

Deliveries of the PM2522 digital multimeter are from manufacturer stock. For additional information, contact Phillips Test and Measuring Instruments, Inc., 400 Crossways Park Dr., Woodbury, N.Y. 11797.

Circle No. 88 on Reader Service Card

## Spectrum's hardware review

For more information on the following new products, circle numbers on the reader service card corresponding to bracket numbers.

DIP slide switch, AMP Inc. [55]; Low-cost cooling fans, Amphe-nol [56]; Modular instrumentation amplifier with 0.002-percent nonlinearity, Analog Devices, Inc. [57]; Thin-film GaAs-FET amplifiers cover 4 to 8 GHz, Avantek, Inc. [58]; \$13 universal active filter, Burr-Brown Research Corp. [59]; Gas-discharge and LC-display connectors, Dale Electronics, Inc. [60]; Universal voltage-frequency converter, Dattel Systems, Inc. [61]; Proximity switch detects cigarette-package foils, R. B. Denison Inc. [62]; 15-MHz A/D converter, Function Modules, Inc. [63]; Low-cost portable digital IC tester, fut-heuristic devices [64]; Radiation-hazard meter for 0.3-to-18-GHz range, General Microwave Corp. [65]; Low-cost printer/plotter operates at low speed, Gould Inc., Instruments Systems Div. [66]; 1- to 18-GHz Schottky-diode quads in stripline packages, Hewlett-Packard Co. [67]; High-performance monolithic op amps, ILC Data Device Corp. [68]; TV-flyback cores cut heat generation and core loss in half,

Indiana General [69]; Linear self-scanned photosensor arrays with 1024 elements, Integrated Photomatrix, Inc. [70]; Tabletop microcomputer for implementing 4040 CPU, Intel Corp. [71]; Rotary switch for dry-circuit switching, Janco Corp. [72]; 5-Mb opto-isolator reduces noise pick-up 50 dB, Litronix, Inc. [73]; High-sensitivity photoconductive TV camera tubes, Matsushita Electronics Corp. [74]; 10-volt precision references in DIPs, Micro Networks Corp. [75]; Scientific-converter one-chip calculator IC, MOS Technology, Inc. [76]; Dual-sense amplifier for NMOS memories, Motorola Semiconductor Products Inc. [77]; Double-gun CRT, The M-O Valve Co. Ltd. [78]; Reusable instant photographic material, National Physical Laboratory of Israel [79]; Microprocessor disk-operating system, National Semiconductor Corp. [80]; 22-volt, 10-watt transistors for the 1.7- to 2.3-GHz range, Power Hybrids, Inc. [81]; 150-MHz scopes with 100-MHz multipliers, Phillips Test & Measuring Instruments, Inc. [82]; Thermopile detector with low noise, Sensors, Inc. [83]; TV sound-channel TIC, SGS-Ates Semiconductor Corp. [84]; 1.32-watt zeners for 3.3- to 200-volt range, Siemens [85]; Solid-state attenuator has 0.1-dB steps, Telonic Altair [86].