



OTP's Hinchman: Selling spectrum space means more jobs.

# CHILTON'S **THE ELECTRONIC ENGINEER**

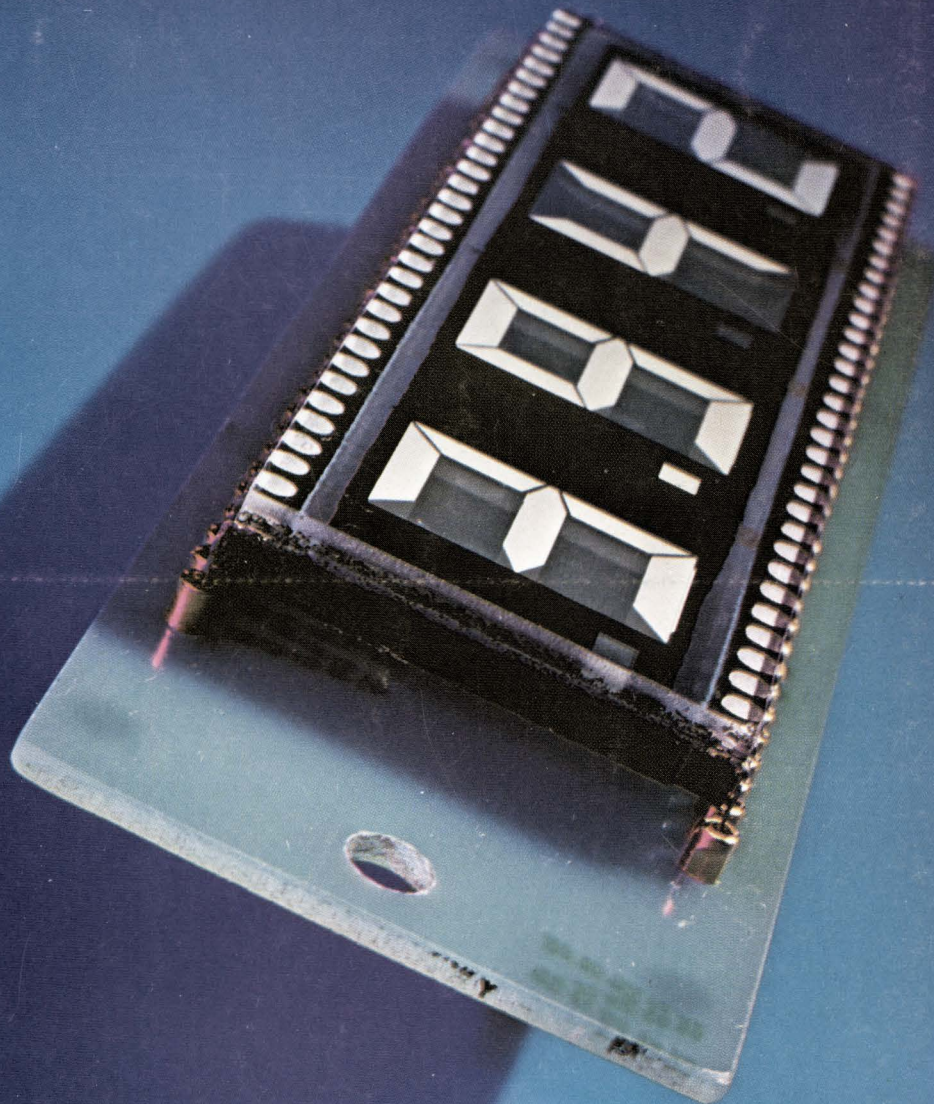
VOL. 30 NO. 11  
NOVEMBER 1971

**What's new with DVMs?**

**Data terminals course—  
CRTs, TTYs & touch-tones**

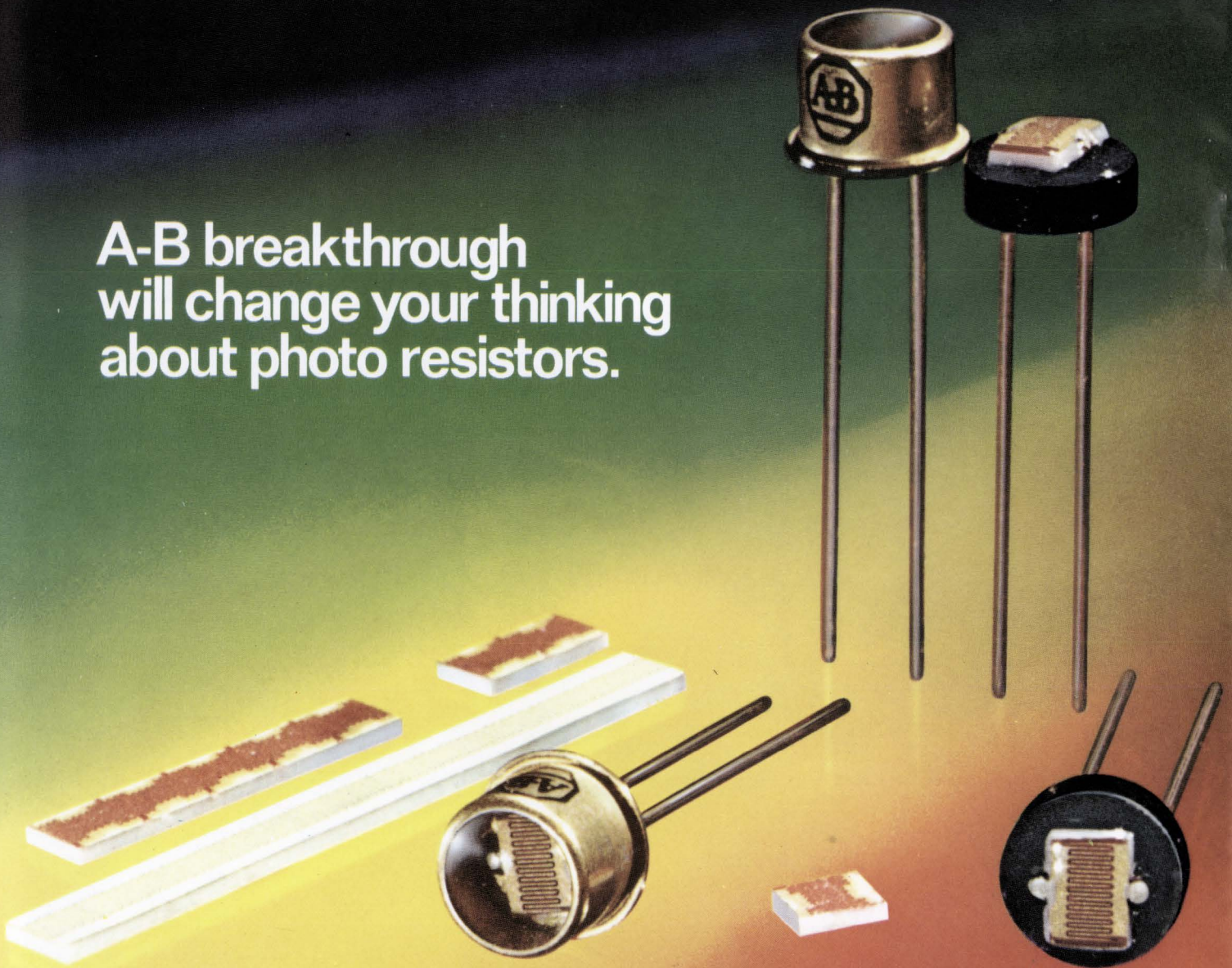
**Plus, the regular Data  
Communications section**

Liquid crystal readouts in your DVM? Not yet, but soon.





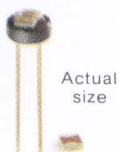
# A-B breakthrough will change your thinking about photo resistors.



Allen-Bradley's unique electroding process gives new material and surface topography improvements. And superior photodetector response and speed. It means a whole new generation of miniaturized cadmium sulfide and cadmium sulfoselenide photodetectors for hybrid applications. Custom styles to fit

your needs. Chips. Bars. Arrays. And leaded devices for circuit board applications. Temperature limit 85°C. Response as fast as 10 milliseconds at 10 footcandles. Three spectral sensitivities. Standards available as PHOTOCHIPS, multi-cell PHOTOCHIP ARRAYS or single-channel PHOTOBAR detectors, and PHOTO-

CHIPS in TO-18 metal or TO-98 plastic packages. All with traditional A-B quality and service. Large-area custom devices are our specialty. Request Publication 5910. Write: Allen-Bradley Electronics Division, 1201 South Second Street, Milwaukee, WI 53204. Export: Bloomfield, N.J. 07003. Canada: Galt, Ontario.



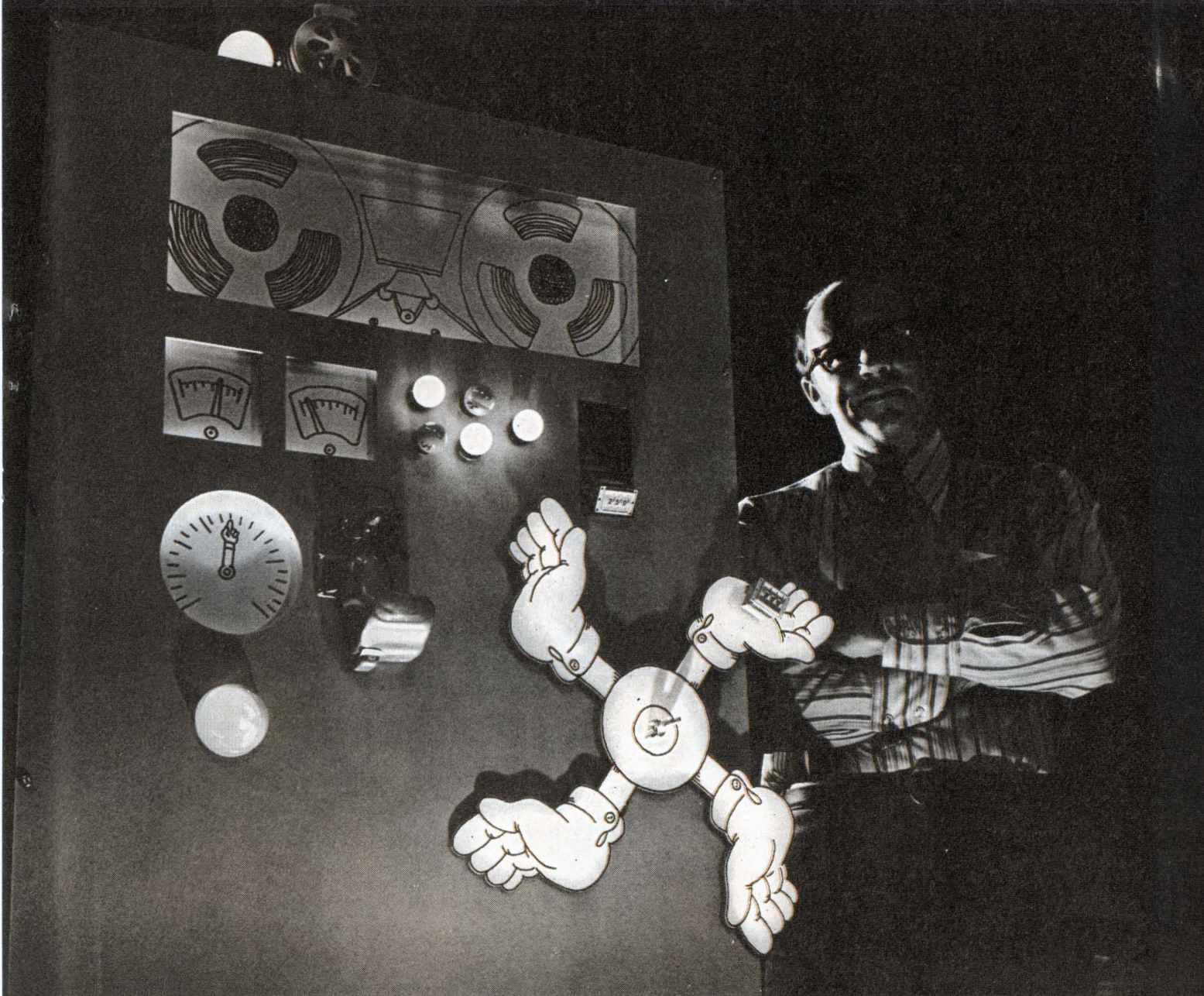
Actual size

NEW DIMENSION ELECTRONICS  
**ALLEN-BRADLEY**



Circle Reader Service #2





# THEY said we couldn't produce a high quality, low cost switch in Pasadena. But there are ways, gentlemen. There are ways.

We didn't go to some far off land to produce our new Series 29000 thumbwheel switch. We're building them right here in Pasadena. Quality with a low price tag. And frankly, it took a little clever tooling. But we did it.

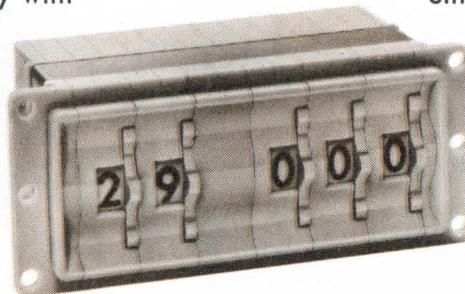
The Series 29000 is of modular construction with each switch-group locked together with a snap-on stainless steel strap. Codes available are: BCD. BCO (10 position with stops). BCD plus complement. Single pole decimal. Single pole, double throw, repeating, plus many more.

Each module is only 0.350" wide and 1.21" high, thereby making them miniature enough to save a lot

of room when you replace those old rotary switches. You won't have to worry about dust or oil spray either. The switching compartment is sufficiently sealed against those things.

If you add up all the features of this new little switch and then compare prices, you'll be pleased and proud of what can be done in little old Pasadena.

Write for our data sheet.



## THE DIGITRAN COMPANY

A Division of Becton, Dickinson and Co. **B-D**

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Circle Reader Service #1



Can you imagine what the signal source of the future will be like?

Will it have excellent frequency accuracy and stability?

Better amplitude characteristics?

Systems capability with inexpensive interfacing and software you can handle yourself?

And how about a reasonable price tag?

Well, the new Hewlett Packard 3320A and 3320B Frequency Synthesizers give you all this—plus a lot more!

Both instruments give you frequency accuracy and stability measured in a few parts per million per year. That's a thousand times better than any RC oscillator.

They both give you the signal purity of a good RC oscillator—a new feature for a frequency synthesizer.

The 3320B offers you amplitude accuracy, resolution and frequency response measured in a few hundredths dB over a 100-dB attenuation range. So it is both a frequency standard and a very precise level generator.

The 3320A and 3320B have optional remote control and the 3320B can even be controlled directly from most tape readers or card readers (like the new HP 3260A Marked Card Programmer).

And to top it off, the 3320 has the widest frequency range of any test oscillator, programmable oscillator or

low cost frequency synthesizer on today's market, 0.01 Hz to 13 MHz.

How about the price tag?

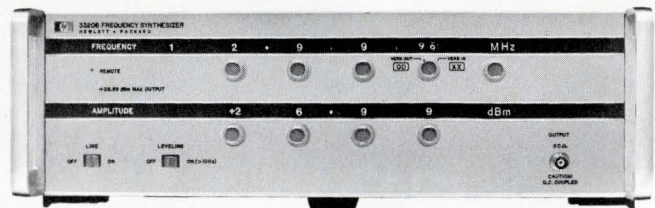
The 3320A, priced at \$1900, and the 3320B at \$2400 give you two great buys in signal sources—both today and in the future.

We call the 3320 "the new price/performance benchmark for precision signal sources." *Electronics* magazine called it a "pacesetter." You'll call it "a steal."

For further information on the 3320A/B, contact your local HP field engineer. Or write Hewlett-Packard, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.

**HEWLETT  PACKARD**

**SIGNAL SOURCES**



091/18

**... at \$1900,  
It's a Steal!**





# THE ELECTRONIC ENGINEER

November 1971 Vol. 30 No. 11

**Cover: top left.** Has "uncertainty concerning the use of radio spectrum and the possibility of harmful radio interference" been a major cause of the loss of "millions of dollars and untold number of jobs"? The Assistant Director of the White House's Office of Telecommunications Policy, Walter R. Hinchman, thinks so and you can read his provocative guest editorial on p. DC-3.

**Bottom right.** One of six types available from RCA on a sampling basis, this reflective liquid crystal readout may eventually show up in your DVM. Both reflective and transmissive readouts, priced now between \$25.00 and \$50.00 for engineering samples, will have to drop, however, to 50¢ a digit (for large quantities) to capture the DVM market. For the story on these readouts, see p. 10; and for our special report (with specifying tables) on DVMs, see p. 31. (Photo courtesy RCA Solid State Div.)

7 Editorial	DC-3 Data Communications Editorial	68 Microworld New Products
10 Up to Date	DC-4 Data Communications News	70 New Products
25 Welcome	57 IC Ideas	80 Literature
26 Preview	63 New Product Features	86 Samples
31 Lab	66 Lab New Products	87 Advertising Index
40 Speak Up		88 International Corner
DC-1 Data Communications		

## 28 1971 FJCC

Instead of heading directly for the 'blackjack' tables, some visitors to Las Vegas this month will be looking at the latest in mainframes, peripherals, software, etc. This year's Fall Joint Computer Conference in Nevada presents papers, panels, and "Computers and the Quality of Life."

## 31 DVMS REVISITED By Stephen A. Thompson

Since we last looked at digital voltmeters in 1969, four more manufacturers and 38% more models have joined the fray. In most cases, this means more DVM for less money. For the complete story on 3, 4, and 5 & 6 digit models as to ranges, features, performance and price, check this.

## DC-1 DATA COMMUNICATIONS following page 40

Events in this vital area have been happening so swiftly and are of such importance that we had to make this section a monthly feature. This month, we have Part 4 of the Data Terminals course, W. Hinchman of OTP on spectrum use, and a new area—Data Communications News.

## DC-3 A SPECTRUM MARKETPLACE? By Walter R. Hinchman

The Asst. Director of Pres. Nixon's Office of Telecommunications Policy on the spectrum.

## DC-7 DATA TERMINALS COURSE—PART 4

Having presented the basics of data transmission, the innards of a terminal, and then the system itself, we now discuss the most common forms of data terminals: teletypewriters, the old reliable; alphanumeric CRTs for sophisticated applications; and touch-tones, familiar to all.

- **Introduction** By Arthur J. Boyle, **The Electronic Engineer**
- **Teletypewriter terminals** By J. Lee Wakefield, Teletype Corp.
- **Alphanumeric CRT terminals** By Troy S. Adcox, Bunker-Ramo Corp.
- **The touch-tone terminal audio response system** By Joel Naive, Wavetek Data Communications

## 57 IC IDEAS

- **Multivator covers 1 Hz to 1 MHz** By R. Scarpulla, Excellon Industries
- **Latch circuit provides noise immunity** By S. R. Martin, Teletype Corp.
- **Polarity inverter uses a dc voltage** By Curtis Sewell, Lawrence Livermore Lab.
- **Pulse differentiation with DTL** By Norton Markin, Elta Electronics Industries, Ltd.





# KEPCO TALKS POWER SUPPLY TECHNOLOGY:

## How to switch loads on your power supply!

Load switching sounds as if it ought to be elementary, yet it is fraught with opportunities for error.

The problem is, we're very "voltage" oriented.

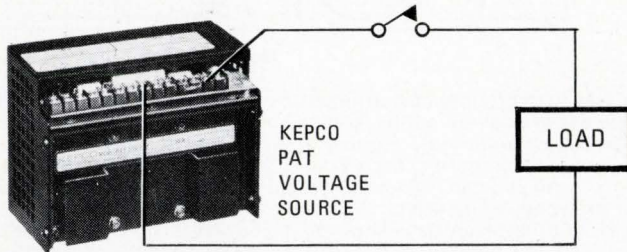


FIGURE A: THIS IS THE WAY WE EXPECT TO SWITCH-OFF A LOAD FROM AN ELECTRIC SOURCE.

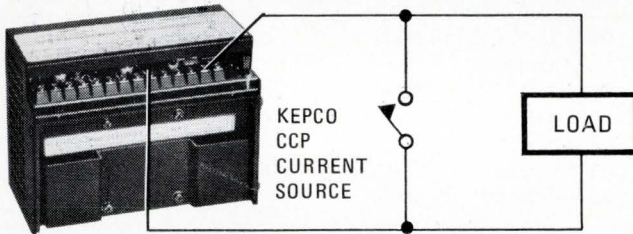


FIGURE B: THIS WAY LOOKS TO BE SOMEHOW "WRONG," YET IT ACCOMPLISHES THE SAME FUNCTION OF REMOVING THE EXCITATION FROM A LOAD.

When you're dealing with *voltage* stabilized sources like the Kepco "PAT" voltage modules, Figure A is quite correct, but it's all wrong if your source is a current stabilized model like the Kepco CCP.

With the PAT voltage stabilizer, a load is manifested as a current drain, and the proper way to switch out the load is to use a series switch to *open circuit* the current. For the CCP current stabilizer, the load manifests itself as a compliance voltage so by complementary logic the proper way to switch out the load is to use a parallel switch to short circuit the voltage.

A voltage stabilizer is idle into an open circuit; a current stabilizer idles into a short circuit.

Get it wrong and you've got problems. If the voltage stabilizer is shorted or the current stabilizer open-circuited—each will rely on a limiting circuit to avoid an unbounded response—but you'll see all sorts of undesirable transient effects as the sources seek to protect themselves. An open-circuited current stabilizer, for example, rises to a high bounding voltage just waiting to zap the next load you connect . . . . Use the circuit of Figure B and the switching is clean and transient free.

Kepco makes many fine voltage and current stabilizers just right to energize your circuits. We've got OEM modules, rack-types and lab/bench styles. For more information, use the reader service number or write:

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Phaue Featherson ..... Artist  
George Baker ..... Washington News Bureau  
Neil Regeimbal..... Washington News Bureau  
K. Robert Brink..... Publishing Vice President

#### Executive and Editorial Offices:

One Decker Square, Bala-Cynwyd, Pa. 19004  
Tel (215) SH 8-2000

#### Address Mail to:

56th & Chestnut Sts., Philadelphia, Pa. 19139

#### Western Offices:

Stephen A. Thompson  
3727 W. 6th St., #202, Los Angeles, Calif. 90005  
Tel (213) DU 7-1271

#### Sheldon Z. Edelman

199 First St. Rm. 335, Los Altos, Calif. 94022  
Tel (415) 941-6655

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#### The Chilton Electronics and Instrumentation Group

The Electronic Engineer  
Instruments and Control Systems  
Instrument & Apparatus News  
Medical Electronic News  
Electronic Components News

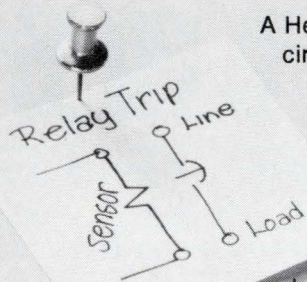
Chilton BPA



# Low-cost limit control for OEM's.

## With a circuit breaker.

## With a circuit breaker?



A Heinemann relay-trip circuit breaker.

With this one economical device, you can take a signal from any low-voltage sensor and, at a preselected

level, switch off a massive current load.

As much as 100 amp, to be precise.

There is no end to the uses you can find for this simple little control device. It will work with pressure sensors, voltmeters, ammeters, tachometers, pH sensors, what have you.

For alarm or other purposes, we can include auxiliary switch contacts right inside the breaker. When the circuit

changes state, you can turn on a light, ring a bell, or start another operation.

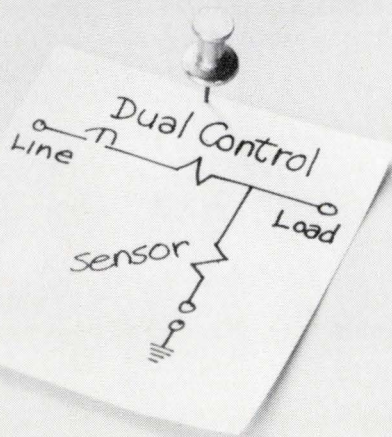
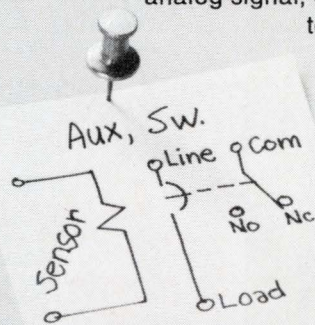
If you want the security of precision fault protection, as well as the relay-trip action, get our Dual-Control breaker (JA or AM Series). It monitors the critical analog signal, or signals, basic

to the operation, and keeps tabs on the electrical integrity of your equipment at the same time.

Whichever design you choose, you can

get a lot of functional value for the price of a circuit breaker.

Like to find out more? Send for our Engineering Guide, and we'll include a copy of Bulletin 3352 on Dual-Control breakers. Free, of course. Heinemann Electric Company, 2806 Brunswick Pike, Trenton, N.J. 08602. Or Heinemann Electric (Europe) GmbH, 4 Düsseldorf, Jägerhofstrasse 29, Germany.



# HEINEMANN

5066



# New line of solid-state devices will broaden your choice of microwave sources and amplifiers

Are you ready to make the design jump from tubes to solid-state in your low-power microwave applications? Sperry Electronic Tube Division is ready to help you.

We've recently acquired the microwave solid-state capability of a sister division, and we're melding that with our own field proved knowledge of microwave systems requirements. Working from that base, company-funded R&D will soon be bringing you a whole generation of solid-state devices.

In the very near future, you can expect both fixed frequency and voltage-controlled transferred electron (Gunn effect) oscillators and a new breed of IMPATT oscillators. A little later, you'll see transferred electron amplifiers, IMPATT amplifiers and a full line of TRAPATT devices. Our R&D efforts will continue in silicon and GaAs technology and other aspects of microwave solid-state.

We'd like to keep you abreast of what's happening in solid-state at Sperry. How about filling in the coupon above, so that we can add you to our mailing list. We'll update you regularly. While you're at it, jot down the details of your thorniest application problem. Maybe we can aim our R&D efforts directly at you. Sperry Electronic Tube Division, Gainesville, Florida 32601.

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SOLID**

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 **SPERRY**  
ELECTRONIC TUBE DIVISION



## A nontechnical development of extraordinary technical significance

Last month, the economic leaders of ten industrial countries\* gathered in Washington to discuss, in nonelectronic terms such as liquidity, gold standard, special drawing rights, and Bretton Woods, several economic developments which undoubtedly will have momentous significance for electronic engineers.

Tool and die makers in Cincinnati, airframe builders in Seattle, computer men in Poughkeepsie, even unemployed engineers in California, all held their breath during the talks of the International Monetary Fund (IMF). Is it any wonder, then, that electronic engineers should, too? Not only should they; it's a must. Does it sound unusual for an electronics magazine to advise electronic engineers to be concerned with international economic policy? Far from it. If you value your job, you should be concerned.

If we were able to ignore such developments in the past, it was only because the electronics industry didn't depend on them for its growth. It could barely keep up with the growth of defense spending, its major customer for almost two decades. In those days we could turn inward and pay attention exclusively to technological developments so as to insure ourselves of a job.

For example, how many of us can trace both our jobs and advancement to the discovery of the transistor? The semiconductor industry alone employed roughly 200,000 persons in 1970, of which we estimate about 3,000 to be electronic engineers. What is more important, semiconductor components have *created* jobs, since none of the solid-state equipment that exists today, from transistor radios to minicomputers, would have been possible without transistors and ICs.

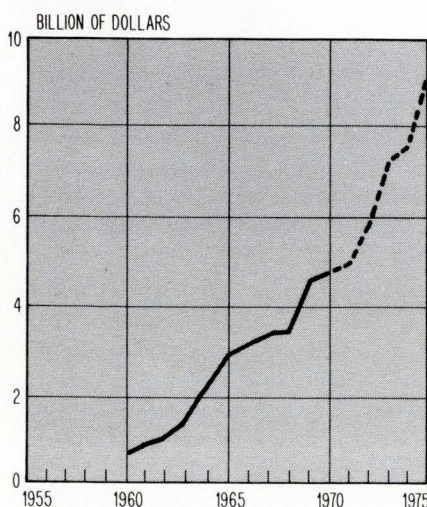
Let us estimate what effect the IMF talks now in progress in Washington may have on jobs. The graph on this page shows that American manufacturers sold about \$5 billion worth of hardware for computers and peripherals in 1970. If the talks have the outcome expected by the United States, these sales could increase at close to 13% per year to almost \$9 billion by 1975. Already, the computer industry employs over 20,000 electronic engineers; if this prediction comes true—and its outcome is largely dependent on how the IMF agrees to relate the dollar to other foreign currencies—the increased activity in the computer field could provide additional jobs for 6 to 9 thousand electronic engineers.

If this argument still isn't enough to interest you in the relationship between international economics and electronics, remember that there actually is no choice. A failure of the IMF talks could mean disaster not only to us in the electronics field, and to the tool and die maker in Cincinnati, but also to copper miners in Chile and to shoe factory workers in Italy.

We are no longer isolated from the economic forces that move the nation, let alone those that influence the whole world. No longer can we continue to be more concerned with computer-aided design, or with semiconductor models, or with bulk semiconductor effects, to the exclusion of the economic factors which shape the future of the industry. To have ignored them in the past was safe, but unnatural. To ignore them in the future will be sheer folly.

*Alberto Socolovsky*  
Editor

### Computers & Peripherals



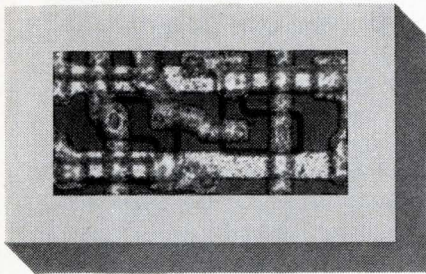
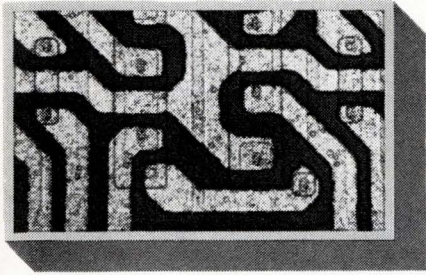
\*These countries (Belgium, Canada, France, Holland, Italy, Japan, Switzerland, United Kingdom, United States, and West Germany) were the major economic powers attending the gathering of the 118-nation International Monetary Fund.



**"ISOPLANAR  
IS HERE, AND  
IT WORKS"**



**For openers, a 256-bit TTL RAM that's dense as MOS but fast as bipolar. Debugged and deliverable now.**



Comparison of one bit of memory in conventional bi-polar design (top) and new isoplanar technique (bottom).

#### There Were Times We Had Doubts.

In March, when we announced the isoplanar process, we also announced that we weren't really sure it was commercially feasible.

We had had a lot of experience in production LSI bipolar memory components and systems (last year we shipped more than 8 million bits to Illiac IV alone). So we went ahead—antsy but optimistic.

We selected a fully-decoded 256-bit RAM to prove we could produce a device of that complexity quickly, efficiently, and profitably, using the isoplanar process.

We could. And did.

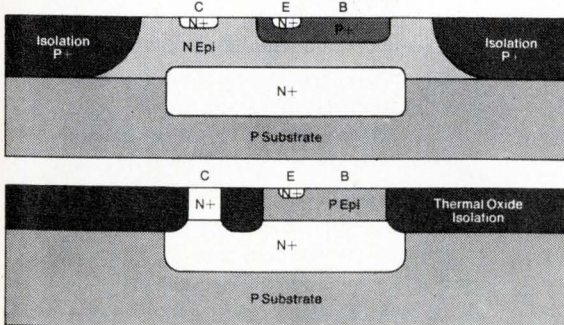
Presenting—debugged and deliverable—our new isoplanar 93410 256-bit RAM. Fast, small, dense.

As Les Hogan, our President, said: "Isoplanar is here, and it works." Beyond our expectations.

And, looking ahead, isoplanar is where it is going to happen.

#### Isoplanar Technology. Briefly.

The old-fashioned planar process required a large region for p+ isolation and isolation-to-base clearance. The isoplanar process shrinks



No space is required between base and collector regions and isolation in isoplanar bi-polar (bottom) compared to conventional planar bi-polar (top).

this region and fills it with thick insulating silicon oxide that needs no separation from base and collector regions.

Selective etching of silicon nitride, without harming the oxide, provides simpler masking rules and a self-aligning base. Transistor geometries are smaller and parasitic capacitance is reduced. The structures are less sensitive to defects in manufacturing (reduction of the active isolation area, for example, eliminates failures due to oxide pinholes). The surface of the chip is flat, so the traditional metal-over-oxide step problems are eliminated; metallization is simpler and more reliable.

We got smaller, denser, more reliable products with higher yield. At a low cost to our customers. Plus a reasonable profit for us.

What we hoped for, we got.

#### Isoplanar Is Good for You.

What do you get?

- More electronics for your dollar.
- MOS density.
- Speed of bipolar.
- Higher reliability from an essentially coplanar structure.
- Devices that are compatible with voltage and logic levels of standard ECL and TTL families.
- Wider choice of speed/power trade-offs— isoplanar design uses energy more efficiently.
- Smaller chip real estate, which reduces costs no matter how you look at it.
- Low-cost advantages from our higher yields.
- Devices that are available now.

#### The First Isoplanar Production IC in the World.

The 93410 high-speed TTL RAM is designed for scratchpad memory, buffer, and distributed main memory application.

- Operates from 0 to 75°C.
- Three chip select lines.
- Uncommitted collector outputs.
- Chip select access time: 20 Nsec.
- Read access time: 50 Nsec.
- Power dissipation: 2 mW/bit.

The 93410 is built on a 96 x 126 mil chip. It uses conventional, high-volume, reproducible metal widths and clearances. (For comparison, our own 256-bit 93400 bipolar memory for Illiac IV occupies a 110 x 140 mil chip, has only partial decoding, and typical access time of 50 Nsec.) It is available now in sample quantities (100-up) at \$21.50 each in 16-pin ceramic DIP.

The 93410 is a superior product, per se. More important, it proves the economic feasibility of the isoplanar process. Today, for production of low cost TTL or ECL read/write memories. Soon, hopefully, for a host of other semiconductor devices.

#### Tomorrow's Memories.

With the 256-bit isoplanar RAM a current reality, let's look at what isoplanar holds for tomorrow's memories.

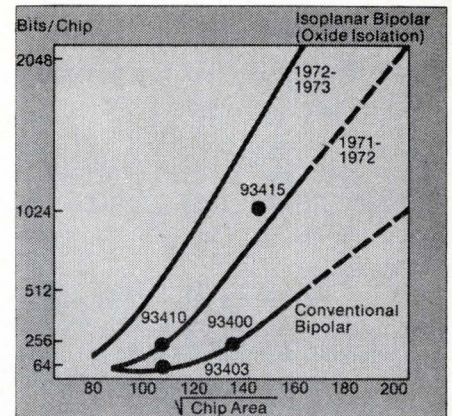
We have in the works a temperature-compensated 9500 Series ECL-compatible 256-bit RAM.

We are in the development cycle of a 1024-bit fully-decoded TTL bipolar memory chip (93415)

that's only slightly larger than our 256-bit isoplanar chip. The great potential in the isoplanar process will begin to be realized in this device. The 93415 is designed for high-speed buffer and main frame applications.

- Address access time: less than 100 Nsec.
- Chip select access time: less than 50 Nsec.
- Uncommitted collector outputs.
- Power dissipation: 0.5 mW/bit.
- 16-pin hermetic ceramic DIP package.

Both the ECL 256-bit RAM and the 1024-bit RAM will be available early in 1972.



The graph gives you some idea of where we've been and where we're going with bipolar memories and isoplanar. It indicates the feasibility of 2048 and 4096-bit read/write memories for 1973. By then we fully expect isoplanar to dominate memories in high-performance and small systems. Memory designers please note that our estimates of packing density and time scale are at least as conservative as our original announcement of the process.

#### Beyond Memory.

But isoplanar doesn't stop with memories.



The process, we feel, will profoundly effect the architecture of future generations of computers. Ultimately isoplanar technology will be used to fabricate together, on the same chip, combinations of logic and memory of

much greater complexity than have been considered to date. Examples are content-addressable memories and multi-port registers. What we have learned thus far indicates that, in the long run, isoplanar will prove valuable in *all* complex bipolar circuits.

The process will also bring about significant improvements in high-frequency low-noise transistors, diodes, linear devices, in low-cost realization of monolithic complementary MOS devices, in radiation-resistant circuits—in the universe of semiconductor devices.

#### For More Information.

We've put together a package of information about the isoplanar process, products and prognosis. It's available for the asking.

Fairchild makes advanced products to uniform standards throughout the world.

**MADE IN FAIRCHILD**

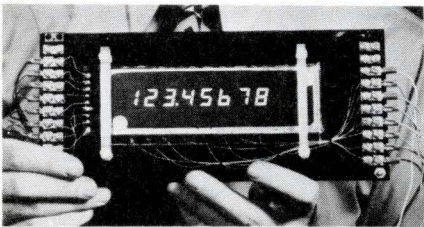


## Liquid crystal displays are beginning to show

The push to get liquid crystal readouts into the market place is on. The three latest contenders for the market are on slightly different time schedules. But never-the-less, they are close to making inroads.

RCA showed liquid crystal displays at WESCON, and have been offering engineering samples. Prices for single-digit, 7-segment, transmissive types is \$25.00. Four-digit, 7-segment reflective types go for \$75.00. We also hear that RCA is willing to license other companies to make liquid crystal displays. Our front cover is an RCA liquid crystal display.

General Electric Co.'s Research and Development Center described liquid crystal display panels under development to the audience at the International Electron Devices meeting in mid-October. Their device consists of eight numerals that require a total of only 16 leads.



This liquid crystal display by G.E. is in the development stages. It requires only 16 leads for all 8 numerals.

A single lead connects all common segments and decimal points. In addition, each of the 8 characters across the display has a separate lead, so that each character can be activated independently or simultaneously. Each character is scanned electronically in sequence to learn which ones are to be activated.

Eight-digit liquid crystal displays are available in engineering quantities from North American Rockwell Microelectronics Co. (NRMEC) for \$40.00. Each digit is a seven-segment numeral with decimal, 1/2 in. high and 1/4 in.

wide. Displays plug into a strip connector. Reflective or transmissive types both operate at 15 to 20 V.

A decision is expected shortly on marketing the displays in quantity. Quantity prices are expected to be about 50¢ per digit, decoding extra.

Liquid crystal displays look very promising because of low power requirements and, hopefully low cost. But they, at this time do have some problems. They are slower in operation than other display types, are temperature sensitive, and require a light source of some type to be seen.

Want more information about liquid crystal displays?

**For RCA, Circle Reader Service #240**

**For G.E., Circle Reader Service #241**

**For NRMEC, Circle Reader Service #242**

## Carrier injection boosts bipolar density.

Scientists at the Philips Research Laboratories, Eindhoven, The Netherlands, are working on a new design/processing technique for integrated circuits. The technique, called Integrated Injection Logic (I<sup>2</sup>L), holds significant advantages for large scale integration of bipolar ICs.

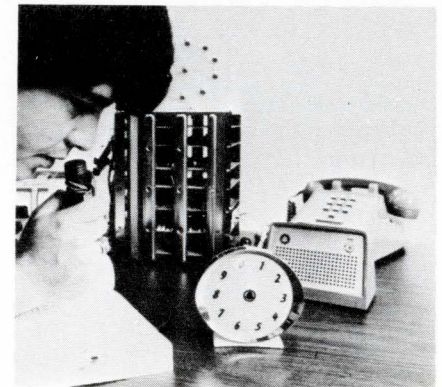
Currently, most ICs include a resistor in the supply lead to the individual transistors in each cell. These resistors serve to protect the transistors from overloading. Naturally enough, the resistors eat up valuable real estate and also create heat dissipation problems.

With the Philips approach, the resistors are replaced with a diode. These diodes, when forward biased, inject charge carriers into the transistor and provide the energy for the circuit to switch. While a conventional TTL gate requires about 20 picojoules to change states, an equivalent I<sup>2</sup>L gate switches on 1 picojoule. This reduction in energy consumption also makes the approach attractive for battery-powered circuits.

## Ma Bell sounds off

Bell Labs engineers are working on a device that dials a telephone number when given spoken commands. The dialer device has integrated circuitry that converts sound waves into electrical pulses. These open and close the switches to obtain a dial tone, execute a phone number, and terminate a call.

A circular display of ten lamps, labeled with the numerals zero through nine, is used with the voice control device. The lamps light continuously in numerical order. Any voice utterance or sound that coincides with a lighted numeral activates that number. Speaking the numbers "one," "three," and "five" (or any other sound) as the corresponding numerals light up enables the device to store all of the digits in a telephone number in its memory.



Handicapped people will now be able to use the telephone thanks to a new phone that may be dialed by sound.

As a sound is made, the corresponding lamps remain lighted slightly longer in the display. This indicates registration of the numbers in the device's memory. The memory transmits stored digits to telephone dialing circuitry on special command.

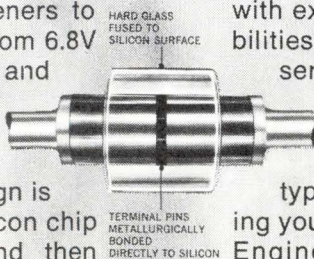
After it is dialed, a telephone number remains in the memory and may be re-used any time the dialing command is given. But, dialing a new number erases the old one. This technology should find many future uses in control-type applications.



# Whiskers are out.

## The new military standard for 1.5 watt power zeners is Unitrode's double pin bonded design.

The 1N4461-89 series from Unitrode is available off-the-shelf as JAN and JANTX zeners to MIL-S-19500/406 in most voltages from 6.8V to 100V. They offer greater reliability and improved electrical characteristics at no more cost than conventional 1 watt whisker-type metal can zeners. The reliability of the double pin design is further increased by bonding the silicon chip directly between terminal pins and then fusing a hard glass sleeve to the exposed silicon surface and pins.



This results in a voidless, monolithic structure with exceptional zener stability. Surge capabilities are 5 times greater than the 1N3016B series. Zener impedances are improved and reverse currents are two orders of magnitude lower. The point is, now you can switch from whisker-type to double slug design without shaving your standards. For fast action, call Sales Engineering collect at (617) 926-0404, Unitrode Corporation, Dept.11D, 580 Pleasant Street, Watertown, Mass. 02172.



**UNITRODE**

Circle Reader Service #8



**Solid state sales way off . . .** According to recent Electronic Industries Association data, U.S. factory sales of solid state industry products during the first six months of 1971 totaled 1.4 billion units valued at \$557.4 million, off 21.4% and 16.2%, respectively, from unit and dollar sales during the same period last year.

**Running to stay even . . .** Semiconductors claimed only a small share of the 19 billion non-IBM bits sold in 1970. Intel's marketing manager, Mike Markkula, contrasts this with the 5-10% share of a 25 billion-bit market semis will capture in 1971, at about 1¢/bit. Semiconductor memory manufacturers will divide about \$12-25 million, but since 1971 prices are only half of 1970 prices, constant cash flow will require doubling sales.

**Put something back . . .** Xerox Corp. has a program whereby employees take time off to individually contribute to social welfare projects. Under set guidelines it's possible for company employees in the U.S. to take up to a year's leave with full pay to pursue a self-selected project that may "put something back into society." Applicants may be any one who has worked for Xerox for a least three years. A seven-member employee evaluation committee will select those to be granted leaves.

**Computer, catch that crook! . . .** Collins Radio Co. was awarded a contract by the state of Iowa to supply a communications oriented computer system for use in a state-wide data network. The system, known as TRACIS (Traffic Records And Criminal justice Information System) will integrate vital information in a single data bank.

**Another one bites the dust . . .** General Electric recently became the fourth large company in 2 years to drop its integrated circuit operation. Following the precedent set by Sylvania, Philco-Ford and United Aircraft (Unisem), GE announced it does not see sufficient returns to justify the large investments required to become a force in the IC business. GE officials stressed that the decision concerns the Integrated Circuit Products Department only and will not affect the other GE semiconductor and component departments. About 520 employees are expected to be affected by the shut-down.

**Filling the printer gap . . .** Printer Technology, of Woburn, Mass., has been founded on the conviction that there is a definite gap in the computer printer field. Their Printec-100 uses a helical print wheel with three complete character sets instead of the conventional single set. The result is a \$1700 (in OEM quantities) printer that gives you full characters (not a dot matrix pattern) and a 100 character/second print rate.

**Circle Reader Service #243**

**Japanese exports to triple . . .** Japanese electronic exports will increase from \$2 billion in 1970 to \$6 billion in 1980, according to a recent SRI report. Industrial and telecommunications exports will replace consumer electronics products in the number one spot. Likewise, opportunities for outside suppliers will mushroom because the internal market growth of the Japanese economy will create an import market growing by more than 15% annually.

**A cadet network . . .** Cadets at the U.S. Military Academy are now learning computer fundamentals, thanks to a data communications network with 65 General Electric "Terminet" teleprinters. After first-year students complete a 45-hour course, they can use the system to solve problems they encounter in advanced engineering and sciences classes.

**Bits of information . . . Zenith Radio Corp.** was presented the 1971 IR-100 award for its M-40R laser light modulator . . . **Avco Electronics Div.** has received a USAF Aeronautical Systems Division contract by which a downed airman can communicate his position to search and rescue teams, from any point on the globe.

**Du Pont's "Freon" 116** is finding applications in high and low voltage gas filled power transformers, as a dielectric in radar transmitters and antennas, high energy particle counters, and in underground high voltage power cables

. . . **Union Carbide** has grown a sapphire which weighs 28,000 carats . . . Our friends at **Integrated Circuit Engineering Corp.** report that they are still alive and well with business prospects increasing.

**Epoxy Technology, Inc.** have completed a test and evaluation program which is said to show that electrically-conductive epoxies are superior as a low-cost method for mounting semiconductor chips . . . **Dumont Electron Tubes Div.** of Fairchild Camera and Instrument Corp. has produced substantial improvement in the luminous and infrared sensitivities of the S-1 photoemissive cathode.

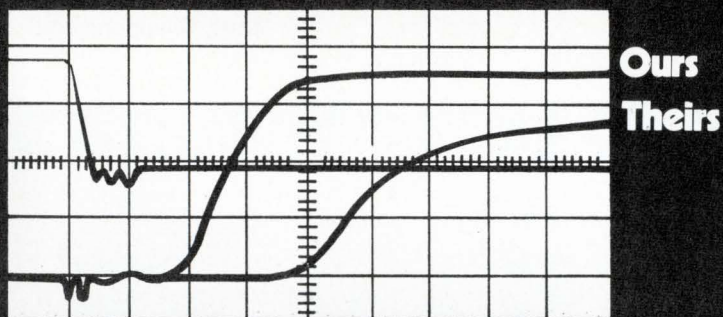
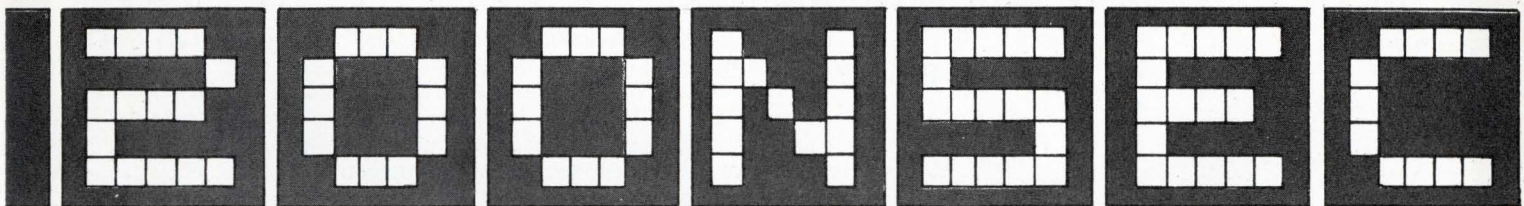
**Metrologic Instruments, Inc.** warned that the construction of a 10-W CO<sub>2</sub> laser described in a *Scientific American* article could create extreme physical health hazards

. . . **Cambridge Research and Development Corp.** Group has applied for patent protection for a new electronic method to speed up or slow down recorded speech without distorting tone and pitch . . . **Corning's** glass memory modules are being used in photocomposition typesetting machine made by Star Parts Co.

**Codex Corp.** recently announced a major contract for high-speed modems. Expected to approach \$500,000, the contract is with Forsvarets Materieverk, the material administration of the Swedish government.



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The **Solitron UC 7541** features static operation, no clocks required, and operates over a large voltage supply range — i.e.  $\pm 12V$  to  $\pm 15V$ . At nominal supply voltages (+14V, 0V, -14V) access time is 600 nsec max.

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## Transparent photo mask blank features better resolution and sharper prints on your wafers

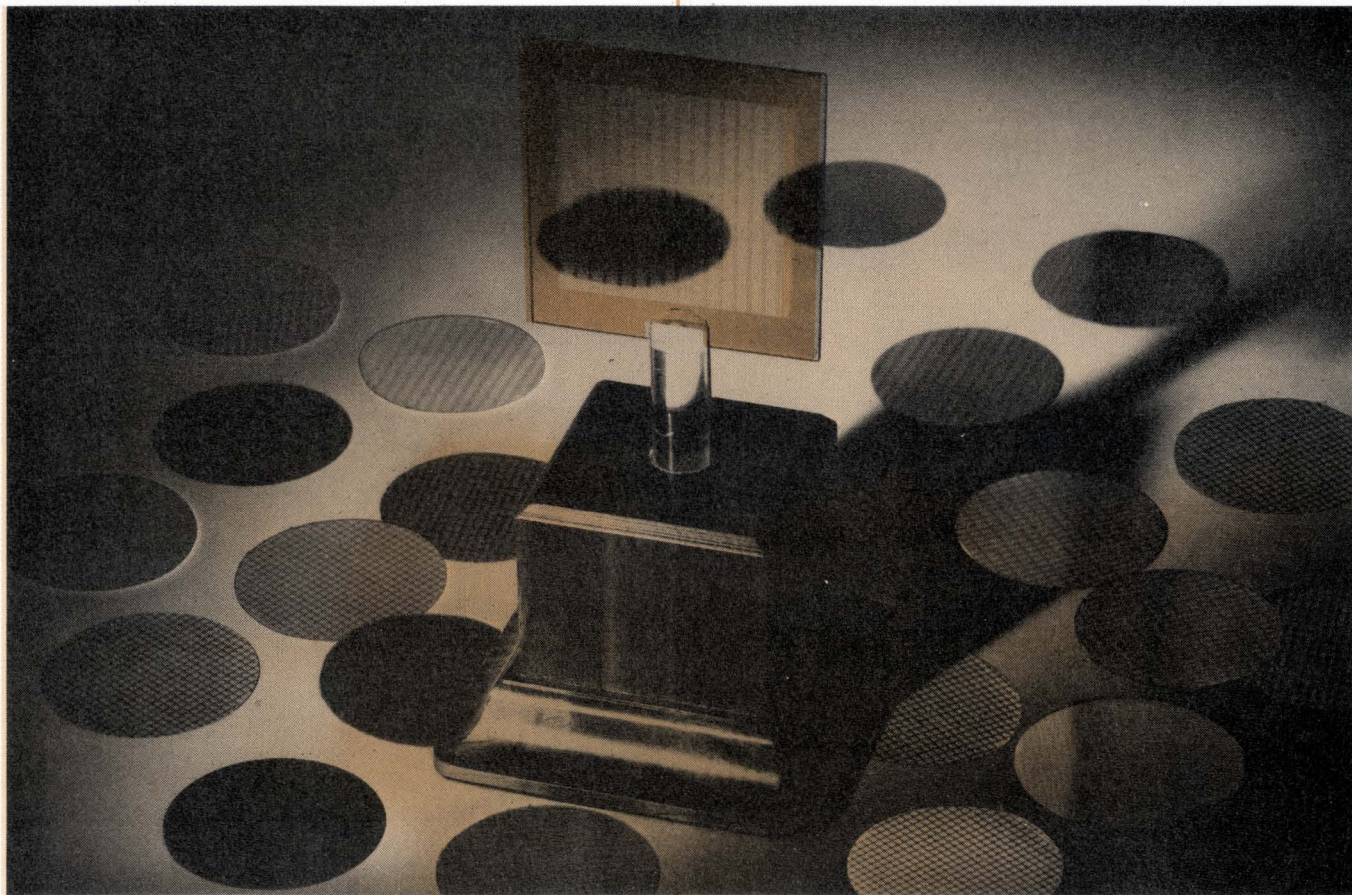
Buckbee-Mears has a great new product. It's the DN Color Mask Blank, and it's good. So good, in fact, that it offers both higher resolution and sharper prints on silicon wafers than chrome or glass emulsion plates.

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*The transparent DN Color Mask Blank is manufactured by Dai Nippon Printing Co., Ltd. and distributed in the U.S. and Canada by Buckbee-Mears. It offers better yields and lower processing costs.*

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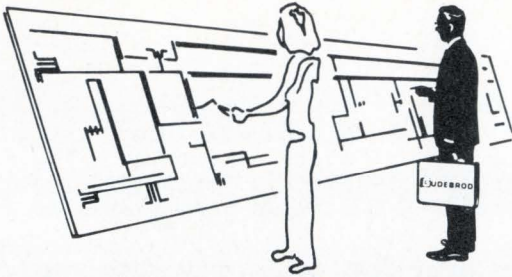
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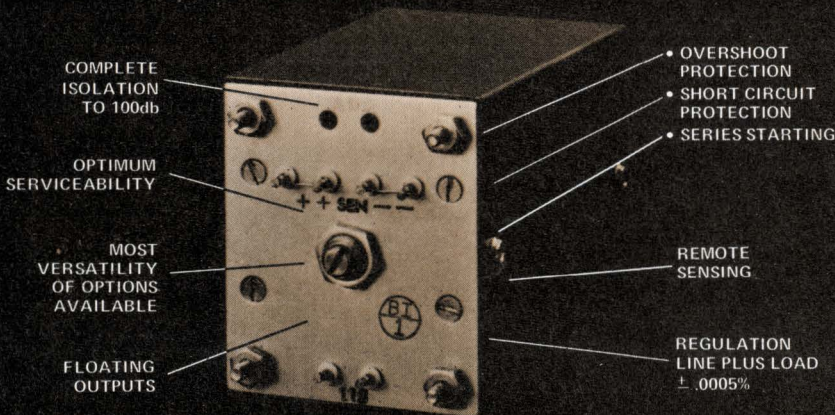
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**Circle Reader Service #245**

## A new OEM power supplier

Former managers of Raytheon's Sorbus operation, left in the dust as a result of the New Hampshire move, have banded together to form Power Pac Inc., in Stamford, Conn. Plans to concentrate on three major product lines include a series of power supply cards offering a variety of power and voltage choices. The cards can be installed close to the designer's circuitry, minimizing wiring and noise pick-up problems. A power module, available in dual and triple output models, offers increased power output and more selective wattage ranges. And a third product, System Pac, gives the designer a range of rack adapters; IC cards; and metered, unmetered, and control options.

**Circle Reader Service #246**

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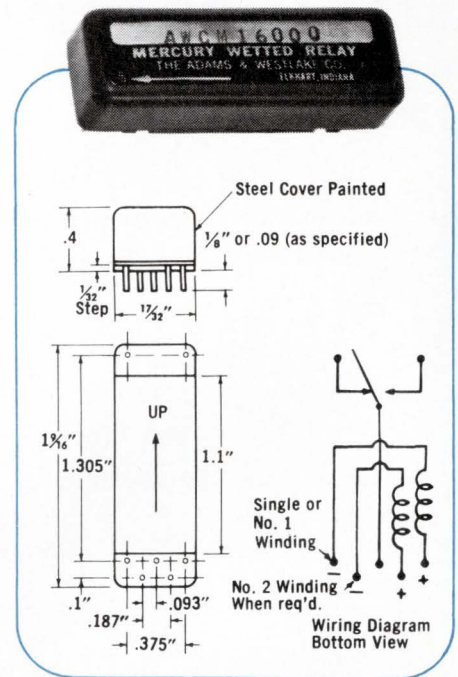
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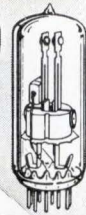
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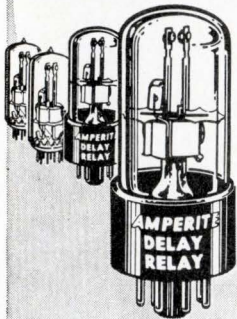
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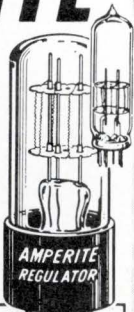
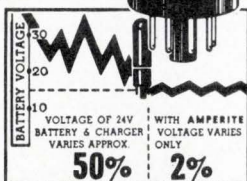
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Circle Reader Service #15

# CALENDAR

NOVEMBER						
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

Nov. 12: Society for Information Display (SID) 4th Annual One Day Technical Conference, Statler-Hilton Hotel, Dallas Texas. Addtl. Info.—W. H. Rodden, President, Box 6015, MS 983 Dallas, Texas 75222

Nov. 16-18: 1971 Fall Joint Computer Conference, Las Vegas Convention Center, Las Vegas, Nev. Addtl. Info.—Friederick M. Hoar, Fairchild Camera & Instrument Corp., 646 Ellis St., Mountain View, Calif. 94040.

DECEMBER						
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Dec. 6-7: Chicago Fall Conference on Broadcast and Television Receivers, Sheraton O'Hare Hotel, Rosemont, Ill. Addtl. Info.—Robert Ashley, Conference Chairman, Warwick Electronics Inc., 7300 N. Lehigh, Chicago, Ill. 60648.

Dec. 6-9: Ultrasonics Symposium, Carillon Hotel, Miami Beach, Fla. Addtl. Info.—Herbert Matthews, Sperry Rand Res. Ctr., Sudbury, Mass. 01776.

Dec. 7-8: 1971 IEEE (22nd) Vehicular Technology Conference, Sheraton-Cadillac Hotel, Detroit, Mich. Addtl. Info.—Marty Barnes, Allen Bradley Co., 6750 E. Davison Ave., Detroit, Mich. 43212.

### '71 and '72 Conference Highlights

1972 IEEE International Solid-State Circuits Conference, Feb. 16-18: Philadelphia, Pa.

INTERCON '72—IEEE International Convention and Exposition, March 20-23: New York, N.Y.

PARIS ELECTRONIC COMPONENTS SHOW, April 6-11; Paris, France.

JANUARY						
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30	31					

Jan. 25-27: Annual Reliability and Maintainability Symposium, Sheraton-Palace Hotel, San Francisco, Calif. Addtl. Info.—C. M. Bird, Dept. 942, IBM Corp. 8600 N. Astronaut Blvd., Cape Canaveral, Fla. 32920.

Jan. 31-Feb. 4: 1972 International Symposium on Information Theory, Asilomar Conference Grounds, Pacific Grove, Calif. Addtl. Info.—Donald L. Schilling, Dept. of Electrical Engineering, City University of N.Y., N.Y. 10031.

Jan. '72: U.S. Solo Exhibition, Computer Graphics & Computer Aid Design, London, England. Addtl. Info.—Eugene Shaw, Dept. of Commerce, Washington, D.C. 20230.

### Call for Papers

May 15-17: 1972 Electronic Components Conference, Washington, D.C. Submit 4 copies of a 300-500 word abstract by Nov. 15, to: Harold Sobol, Program Chairman ECC, RCA Corp., David Sarnoff Research Center, Princeton, N.J. 08540.

May 22-24: 1972 IEEE G-MTT International Microwave Symposium, Chicago, Ill. Submit a 35-word abstract and 500-100 word summary by Jan. 7, to: Dr. Peter P. Toullos, Co-Chairman, Technical Program Committee, ITT Research Institute, 10 West 35th St., Chicago, Ill. 60616.

May 23-25: 1972 Society for Information Display (SID) International Symposium, San Francisco, Calif. Submit both a 35-word abstract and a 500-word draft of your paper by Jan 17, to: John L. Simonds, Eastman Kodak Co., Research Labs. 1B-81, Kodak Park, Rochester, N.Y. 14650.

INTERMAG—International Conference on Magnetism, April 10-13, 1972. Summaries of papers must be submitted by Nov. 20, 1971, to: Professor Eiichi Goto, c/o INTERMAG 72 Secretariat, KDD Research & Development Laboratory, 1-23 Nakameguro 2-chome, Meguro-ku, Tokyo, Japan.

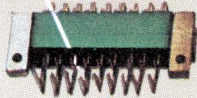


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# 1971 FJCC

November 16th to 18th is the date, and the Convention Center in Las Vegas, Nev. is the place where it's happening—the Fall Joint Computer Conference, that is. It's there that you'll see the world's largest and most diverse exhibit of computer hardware, software, systems and services; and it's there that you'll hear about the latest developments, applications, and impact of computer technology.

A maximum of 768 booths, located in the combined North and South exhibit Halls of the Convention Center, will house products and services of over 200 exhibitors from the U.S., Canada, and abroad. So here's your chance to evaluate and compare the latest that is available in the computer field.

Areas covered in the exhibits will include computer mainframes; I/O devices; peripheral equipment; time sharing, software, and consulting services, digital and analog computer systems; hybrid and special purpose systems; technical trade publications; data communications and conversion equipment; test equipment; microfilm/microfiche equipment and services; and source data collection devices.

And don't forget the technical program. It will include the presentation of 69 formal papers, supplemented by 16

panel discussions. In keeping with the conference theme, "Computers and the Quality of Life," there will be sessions on the use of computers in emerging nations, in law enforcement and criminal justice, in urban planning, and in forecasting. The life and earth sciences will be represented by sessions relating to computer techniques in simulation of environmental dynamics, medicine, biology, and laboratory automation.

In addition to applications oriented sessions, a major portion of the technical program will be devoted to new developments in hardware and software technology. Also, of particular interest are sessions covering data communications, terminals, and large-scale integration.

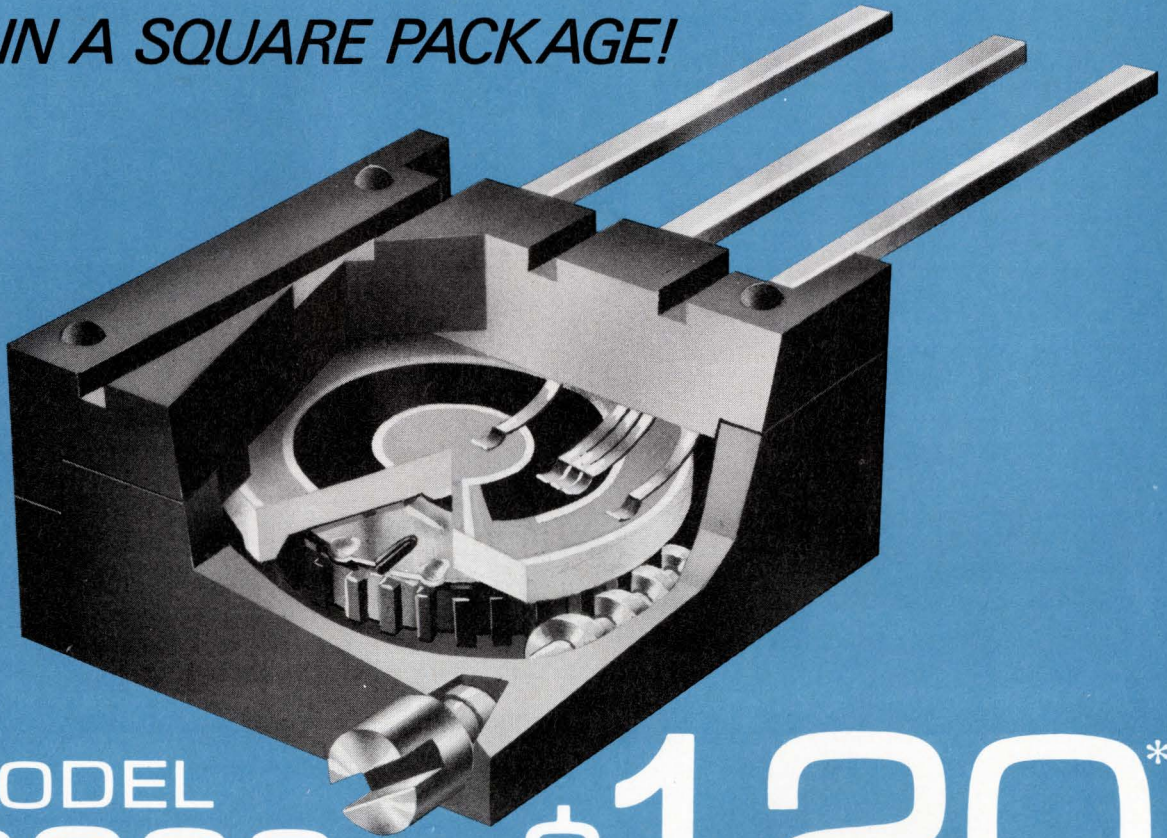
Registration at the conference will cost you \$30 if you are a member of ACM, IEEE, SCI, ACL, AIAA, ASIS, SIAM, AICPA, SID, SLA, ASA or ISA. For non-members it's \$60 (\$15 of this may be applied to membership in any of the societies listed above). If you are only interested in the exhibits you can purchase an "exhibits only" registration for \$10.

You can register at the Convention Center on Monday, Nov. 15th, from 4 pm to 10 pm; Tuesday, Nov. 16th, from 8 am to 6 pm; Wednesday, Nov. 17th, from 8 am to 6 pm; and Thursday, Nov. 18th, from 8 am to 5 pm.

<p><b>Tuesday</b> November 16</p> <p>Exhibit hours 9:30 - 6</p>	 Keynote Address Dr. Arthur G. Anderson	<p>1 Data Communications</p> <p>2 Applications of Computers in Emerging Nations</p> <p>3 Operating Systems: Some Models and Measures</p>	 Science Theatre	<p>4 Terminals</p> <p>5 Simulation of Environmental Dynamics</p> <p>6 Images and Patterns</p>	<p>7 Large Scale Integration (LSI)</p> <p>8 Computers in Medicine—Problems &amp; Perspectives</p> <p>9 The User Interface for Interactive Search</p>	 Science Theatre   Conference Reception International Hotel Convention Area							
<p><b>Wednesday</b> November 17</p> <p>Exhibit hours 8 - 6</p>	<p>10 State of the Computer Art in Biology</p> <p>11 Simulation of Aerospace Systems</p> <p>12 Programming Languages and Language Processors</p>	<p>10 State of the Computer Art in Biology</p> <p>13 Applications of Computers to Law Enforcement and Criminal Justice</p> <p>12 Programming Languages and Language Processors</p>	 Science Theatre	<p>14 Experiments in On-Line Delphi Research</p> <p>15 Interactive Continuous-System Simulation in Research and Education</p> <p>16 Computer Structures: Past, Present and Future</p>	<p>17 Computers in Sports</p> <p>15 Interactive Continuous-System Simulation in Research and Education</p> <p>18 Twenty Years in Passing</p>	 Science Theatre							
<p><b>Thursday</b> November 18</p> <p>Exhibit hours 8 - 5</p>	<p>19 Numerical Methods</p> <p>20 Laboratory Automation</p> <p>21 Data Base Systems Design</p>	<p>22 Interactive Text Editing Systems</p> <p>20 Laboratory Automation</p> <p>23 Planning and Designing of High Performance Systems</p>	 Conference Luncheon Dr. Frank B. Ryan Main Showroom International Hotel	<p>24 Data Security in Data Base Systems</p> <p>25 The Application of Computers to Urban Planning and Development</p> <p>26 Selected Papers in Digital Simulation</p>									
	8	9	10	11	Noon	1	2	3	4	5	6	7	8



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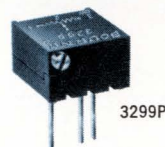
1/2 watt at 70°C.

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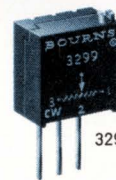
... provides designers with the most popular pin styles for greater design flexibility.

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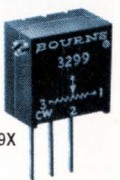
... enhance ruggedness of construction. Of course the unit is sealed to withstand printed circuit board cleaning processes.



3299P



3299W



3299X

**SPECIFICATIONS**

Dimensions ..... .375" x .395" x .250"  
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Resistance Tolerance ..... ±10% Standard  
Power Rating ..... .05 Watts at 70°C  
Operating Temperature Range ..... -55 to +125°C  
Temperature Coefficient ..... ±150 ppm/°C

Delivery is off-the-shelf. Get full details on this new Cermet unit today by contacting your local Bourns Field Office, Representative, or the Factory direct.



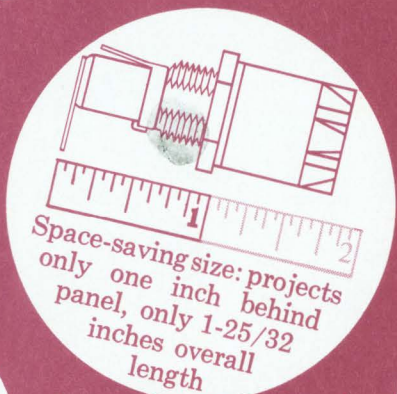
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Circle Reader Service #17

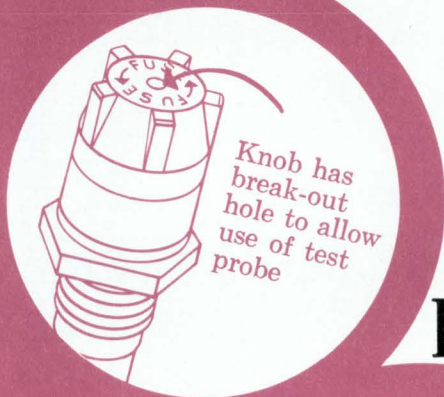
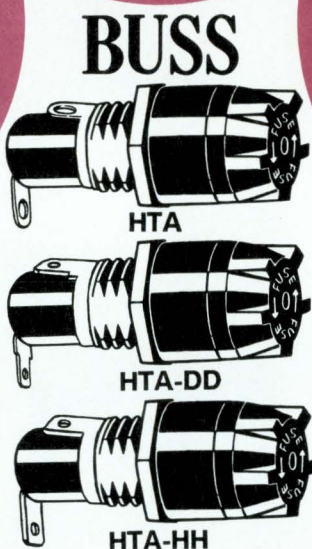
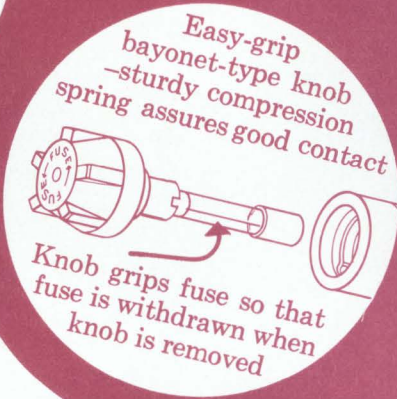
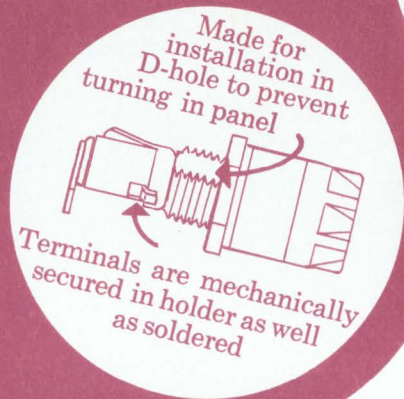


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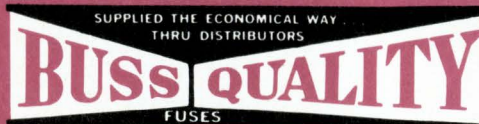
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# DVMs revisited

More DVMs within a narrower price range mean a better buy for you.

**Stephen A. Thompson**, Western Editor—Los Angeles

Fierce competition and tighter markets have not halted the swell of companies making digital voltmeters or the proliferation of different models. Since our last survey,\* there are four more manufacturers and 38% more models to choose from. The table shows the changes.

	Class of full digits			Total
	3	4	5 & 6	
DVM manufacturers, 1969	14	25	11	32
DVM manufacturers, 1971	20	28	12	36
Models available, 1969	21	51	22	94
Models retired	7	22	6	35
Models introduced	25	30	16	71
Models available, 1971	39	59	32	130

When you compare surveys, you will notice the general improvement in specs. Our list includes base prices and prices with options of 130 DVMs. The option that offers the widest price fluctuation is ac voltage. Also, there are wide variations in measurement methods and cost, from simply scaling the peak voltage value, to sophisticated, accurate determination of rms values of complex waveforms. Any prospective buyer should be familiar with these various methods, and evaluate their merits against his needs before making a decision. Most manufacturers can supply excellent literature on this subject.

### Three's a crowd

Any feeling that 3-digit DVMs are getting cheaper is pure illusion. On average, models introduced since 1969 have a \$90 higher base price and a \$79 higher all-option price than the 1969 survey. Unretired 1969 models tend to be the

higher-priced ones, and they actually push the price averages of all 1971 models up an additional \$2 (base price) and \$40 (all options price) over the new model averages.

Averages for the 1969 listings and the new listings are shown at the bottom of each chart. The 3-digit DVMs with all the options are better than 1969 models by about two and one-half ranges, one-half a feature, and 50¢ less per range. Three of them have frequency ranges, which could be the next major evolutionary step for DVMs.

Performance specifications are almost ignored in this classification, because 3-digit DVMs are bought to replace analog multimeters. When I asked one representative for CMR (common mode rejection) and NMR (normal mode rejection) data, he replied, "They drilled those numbers into me over and over when we first got this meter, and said everyone would ask for them. You are the first, and now it's been so long that I forgot them."

### Four's too many

The 4-digit class is still the numerical king with 59 models. Since multimeters are invading this domain, prices are dropping. Almost every spec improved since 1969, and the base price dropped an average of \$255. The average new listing, with all the options, gives you six more ranges and an extra system feature for \$110 less. The cost per range dropped \$50, or about 40%. Three models have frequency ranges too, and that number should rise rapidly.

### Great bargains, if you have the money

The 5 & 6-digit class saw the average base price cut by \$980, and the all-option price by a whopping \$1,430. In the performance specs, which is what this class is all about, it was a mixed bag. Common mode noise rejection deteriorated by 14 dB, and ac measuring speed lost one quarter of a second. Combined 90-day accuracy specs improved about 13%. The significant performance improvement came in the temperature specs. They improved by about 64%, largely through improvements in IC technology.

\*"DVM specs compared." Stephen A. Thompson, *The Electronic Engineer*, Nov. 1969, pp. 69-73.





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For more information on DVMS, check the Reader Service Numbers of the following companies:

Anaonic, Inc.	<b>201</b>	DataTechnology Corp.	<b>208</b>
Ballantine Labs	<b>202</b>	Denelcor Inc.	<b>209</b>
Boonton Electronics Corp.	<b>203</b>	Digilin Inc.	<b>210</b>
California Instruments Co.	<b>204</b>	Disa Electronics	<b>211</b>
Cimron Div. of Lear Siegler Inc.	<b>205</b>	Dixon Inc.	<b>212</b>
Dana Labs	<b>206</b>	Doric Scientific Corp.	<b>213</b>
Data Precision Co.	<b>207</b>	Dynasciences Corp.	<b>214</b>
		Eldorado Electrodata Corp.	<b>215</b>
		John Fluke Mfg. Co. Inc.	<b>216</b>

### 3-digit DVMS

MANUFACTURER	MODEL NUMBER	Overrange (%)	NO. OF RANGES						FEATURES					PERFORMANCE					PRICE	
			DC Volts & mV	AC Volts	Ohms	Ratio	DC	AC	TOTAL	Autorange	Programmable	Recorder output	Guarded input	Battery operated	CMR near 60 Hz (dB)	NMR near 60 Hz (dB)	DC measuring <sup>1</sup> speed (seconds)	AC measuring <sup>2</sup> speed (seconds)	Sensitivity (µV)	Basic price (\$)
1 Dixon	Digitest 500	100	5	5	5	1/4	1/4	25					X	100	30	2.0	5.0	100	250	320
2 Honeywell	Digitest 500	100	5	5	5	1/4	1/4	25					X	100	30	2.0	5.0	100	250	320
3 United Systems	Digi Tec 261	100	5	5	5			10					X	100	35	0.7	N/A	100	279	354
4 Eldorado	1800	100	5	5	5	1	1	17					X	90	40	0.2	3.0	100	295	440
5 Systron-Donner	7050	50	4	5	5			14						60	40	0.15	N/A	1000	319	369
6 Data Technology	361/361B	100	5	5	5	5		15		X		X		80	30	0.2	N/A	100	345	410
7 Dixon	Digitest 750	0	5	5	5	5	5	25	X					90	50	0.3	3.0	100	349	—
8 Dana	3860A	100	5	6	6			11			X			100	60	1.0	N/A	100	350	—
9 Eldorado	1810A	100	5	5	6			16		X				80	40	0.1	1.5	100	350	395
10 Digilin	340A	100	4	4	5	5	5	23						100	60	0.2	1	1000	375	N/A
11 United Systems	Digi Tec 262A	100	5	5	5	5	5	25				X		100	35	0.7	2.0	100	375	450
12 Hickok	DMS 3202	1300	6	6	9	8		58 <sup>5</sup>			X	X		120	60	1.0	1.0	1	375	2715
13 Data Technology	360/360B	100	5	5	5	5	5	25			X	X		80	30	0.2	2.0	100	385	450
14 Hickok	3301	100	5/1	5/1	7	5/1	5/1	36 <sup>6</sup>			X	X	X	120	60	1.0	1.0	100	385	835
15 Simpson	460	150	5	5	6	5	5	26						90	60	4.0	4.0	100	395	N/A
16 Systron-Donner	9000	50	4	5	5	5		14						80	30	0.15	N/A	1000	395	445
17 Weston	1240	100	5	5	6	5	5	26				X		80	35	2.0	5.0	100	395	525
18 Dynasciences	330	50	4	4	5	5/3		21				X		100	40	0.1	2.0	1000	399	444
19 Dana	3800A	100	5	4	6	6		21			X			100	60	1.0	2.0	100	425	N/A
20 Hickok	3300A	100	5/1	5/1	7	5/1	5/1	36 <sup>6</sup>			X	X		120	60	1.0	1.0	100	435	885
21 Dana	3800A-01	100	5	4	6	6		21		X	X			100	60	1.0	2.0	100	495	—
22 Dixon	MN 124	25	5	5	5	1	1	17			X			100	70	0.4	3.0	100	495	—
23 Systron-Donner	9015	50	5	5	5	5		15						80	30	0.15	N/A	100	495	545
24 Systron-Donner	9025	50	4	4	5	5		18						80	30	0.15	ND	1000	495	545
25 Practical Automation <sup>3</sup>	PDM 611	100	3/1	2	4	10		10			X			80	35	0.3	N/A	100	500	625
26 Kiethley	160	100	7	8	8	8		23			X			120	60	2	N/A	1	545	670
27 Hewlett-Packard	3469A	100	5	7	8	6		26						40	40	0.07	2.0	1	595	595
28 Non-Linear Systems	MX-3	100	6	3	6	6		21		X	X			100	60	0.3	1.0	10	595	670
29 Non-Linear Systems	X3-A	100	6	3	9	9		27			X	X		106	60	0.3	1.0	10	765	840
30 Hewlett-Packard	3430A	60	5	5	5	10		10				X		90	40	0.5	N/A	100	800	880
31 Simpson	2701	0	6	6	7	9	9	37	X					120	ND	1.0	4.0	10	835	—
32 Hickok	3310	100	5/1	5/1	7	5/1	5/1	41 <sup>7</sup>			X	X	X	120	60	1.0	1.0	100	845	1295
33 Disa	55D31	100	3					3			X			80	ND	0.2	N/A	1000	927	—
34 Boonton	92AD	5		8				8	X	X	X			N/A	N/A	N/A	1.0	300	995	1220
35 Boonton	93AD	5		12				12	X	X	X			N/A	N/A	N/A	1.0	300	1100	ND
36 Kiethley	615	100	4	11	12			34 <sup>8</sup>			X	X		ND	50	2	N/A	100	1295	1395
37 Hewlett-Packard	3403A	90	5	6				17 <sup>9</sup>	X	X	X			120	60	1.0	1.0	10	1400	2100
38 Pacific Measurements <sup>4</sup>	1010	100		4	1			5			X			N/A	N/A	N/A	1.0	300	1900	—
39 Health Kit	IM-102	20	5	5	6	5	5	26				X		80	35	2	2.0	100	to be announced	—
Triplet	8035	100	5	5	5	4	4	23				X		80	30	1.0	3.0	100	385	—

1969 Avg. (*Denotes Mean)	100* (cost per range = \$32.20)	19.2	5%	0	26%	10%	38%	94.5	43.3	1.035	2.43	100*	492	618
Avg. of New Listings.	100* (cost per range = \$31.70)	21.5	16%	12%	48%	36%	32%	96.0	49.5	1.048	2.18	100*	582	697
Improvement or (Loss)	—	\$-0.50/range	+2.3	+11%	+12%	+22%	(6%)	+1.5	+6.2	(+0.013)	-0.25	—	(+90)	(+79)

- (1) Includes amplifier settling time.
- (2) Includes amplifier settling time and full filtering, where applicable.
- (3) A printer is included as part of the instrument.
- (4) Display is in linear, dBm, or dB units.
- (5) Includes, seven frequency, six period, six time interval, and 10 capacity ranges.
- (6) Includes five frequency ranges.
- (7) Includes five frequency and five decibel ranges.
- (8) Includes seven coulomb ranges.
- (9) Includes six decibel ranges.

ND indicates No Data is available. N/A indicates Not Applicable.  
 Color in Manufacturer and Model Number columns indicates new listing since November, 1969. Color elsewhere indicates options.



4-digit DVMs		NO. OF RANGES	FEATURES					PERFORMANCE					PRICE									
			Overrange (%)	DC Volts & mV	AC Volts	Ohms	Ratio	DC	AC	TOTAL	Autorange	Programmable	Recorder output	Guarded input	Battery operated	CMR near 60 Hz (dB)	NMR near 60 Hz (dB)	DC measuring <sup>1</sup> speed (seconds)	AC measuring <sup>2</sup> speed (seconds)	Sensitivity (µV)	Basic price (\$)	With options (\$)
MANUFACTURER	MODEL NUMBER																					
1	AnaConic 390	20	4	2	6	7	33 <sup>3</sup>	X	X						ND	ND	ND	ND	100	290	—	
2	Disa Electronics 55D30	0	3				3								ND	ND	4.0	N/A	1000	470	—	
3	Preston 723A	100	4				4			X					120	45	0.1	N/A	100	485	560	
4	Denelcor DV101	20	4				4			X	X				100	ND	1.0	N/A	100	495	—	
5	United Systems DigiTec 266	100	4				4			X	X				120	56	0.45	N/A	100	525	—	
6	Data Precision 2420	20	4/1			4	9	X	X	X	X	X	X		120	60	0.33	N/A	10	580	870	
7	Tyco 404	40	4				4			X					100	50	0.5	N/A	100	595	—	
8	Weston 1242	100	5	5	5	5	5	5	5	5	5	5	5		80	40	0.5	3.0	10	595	825	
9	Simpson 2700	10	4	4	4	4	16		X	X	X				90	60	0.2	ND	100	615	1015	
10	United Systems DigiTec 267	100	4				4	X	X	X	X	X			120	56	0.45	N/A	100	625	—	
11	Data Precision 2430	20	4/1		5	4	14	X	X	X	X	X	X		120	60	0.33	N/A	10	625	915	
12	Data Precision 2435	20	4/1	4		4	13	X	X	X	X	X	X		120	60	0.33	2.5	10	635	925	
13	Eldorado 1820A	100	4/5	4	5	6	24	X	X	X					80	40	0.1	1.5	10	645	895	
14	Preston 723	100	5	4	7		16			X					120	45	0.1	1.0	100	645	905	
15	Ballantine Labs 3600/3572	25	5				5	X	X	X					130	100	0.075	N/A	10	645	1445	
16	Ballantine Labs 3600/3571A	25		6			6	X	X	X					N/A	N/A	N/A	0.5	1	645	1770	
17	Ballantine Labs 3600/3573	25		6			6	X	X	X					N/A	N/A	N/A	0.5	1	645	2165	
18	Systron-Donner 7004	30	5	5	5	5	5	5	5	5	5	5	5		100	60	0.2	0.5	10	650	790	
19	Data Precision 2440	20	4/1	4	5	4	18	X	X	X	X	X	X		120	60	0.33	2.5	10	675	965	
20	Calif. Instruments 8420	50	4	4	5		17 <sup>4</sup>			X	X				100	40	0.3	0.3	100	695	745	
21	United Systems DigiTec 269	40	4	4	5	5	5	5	5	5	5	5	5		120	56	0.45	2.5	100	695	—	
22	Fluke 8100A	20	4	4	5	6	6	25			X	X	X		100	50	0.5	3.0	100	695	795	
23	Data Technology 350	40	4/2	4	5	1	16	X	X	X	X	X	X		100	60	2.0	3.0	1	695	1570	
24	Greibach 620B	20	3/3	4	5	2	17	X	X	X	X	X	X		140	66	0.25	0.2	1	745	1535	
25	Data Technology 351	80	4/2	4	5	1	16	X	X	X	X	X	X		100	60	0.1	3.0	1	749	1559	
26	Fluke 8120A	20	5	5	5	5	5	25			X	X	X	X		100	50	0.5	3.0	100	750	895
27	Doric DS-100-K4	20	1			1	1	3			X	X	X		148	60	0.5	N/A	1000	790	990	
28	Monsanto 200A	20	4				4		X	X	X	X	X		120	70	0.25	N/A	100	795	—	
29	United Systems DigiTec 268	100	6				6			X	X	X	X		120	56	0.45	N/A	1	795	—	
30	Non-Linear Systems LX-2	20	4	4	5	4	4	21	X	X	X	X	X		100	60	0.25	0.25	100	795	1330	
31	Dynasciences 414	100	6	5	7	6	6	30	X		X	X	X		100	30	0.1	ND	1	795	1395	
32	Rohde & Schwarz UGWD	50	5	5	5		15								120	54	0.33	0.33	100	835	—	
33	Fluke 8110A	20	4	4	5		13			X	X	X	X		100	50	0.5	3.0	100	850	950	
34	Philips Elect. Inst. PM2421	20	6	6	9	9	9	39	X		X	X	X		80	ND	0.1	0.1	10	890	965	
35	Doric DS-100-K3	20	1			1	1	3			X	X	X		148	60	0.5	N/A	100	890	1090	
36	Doric DS-100-K2	20	1			1	1	3			X	X	X		148	60	0.5	N/A	10	890	1120	
37	Hewlett-Packard 3480 Series	50	5	10	6	5	26	X	X	X	X	X	X		160	80	0.001	0.1	10	900	4600	
38	Doric DS-100-K1	20	1			1	1	3			X	X	X		148	60	0.5	N/A	1	975	1190	
39	Doric DS-100-K5A	20	4			4	4	12			X	X	X		148	60	0.5	N/A	100	975	1475	
40	Dana 4700	100	5	4	6		15	X	X	X	X	X	X		100	40	0.15	0.15	10	985	—	
41	Dixon VN954	20	5				5	X	X	X	X	X	X		140	50	0.05	N/A	10	995	—	
42	Cimron 6453	20	5	4	5		14	X	X	X	X	X	X		100	60	0.22	0.6	10	995	1555	
43	Fluke 8200A	60	4/2	4	6	4	20	X	X	X	X	X	X		140	60	0.0023	0.5	1	995	1795	
44	Doric DS-100-K5	20	4			4	4	12			X	X	X		148	60	0.5	N/A	1	1045	1590	
45	Doric DS-100-K6	20	6			6	6	18	X	X	X	X	X		148	60	0.5	N/A	1	1090	2090	
46	Northwest Electronics 2000	20	5	5			16 <sup>5</sup>	X							ND	ND	1.0	1.0	100	1095	—	
47	Systron-Donner 7000A	20	4/1	4	5		18	X		X	X	X	X		60	30	0.2	1.0	10	1095	2150	
48	Non-Linear Systems X-2	20	3/3	4	5	3	6	24	X	X	X	X	X	X	120	40	0.134	0.6	1	115	2540	
49	Calif. Instruments 8300	20	3/2	5	5	5	5	5	34 <sup>4</sup>			X	X		120	60	0.5	5.0	10	1145	1595	
50	Dynasciences 440	20	3/3	3	5	1	15	X	X	X	X	X	X		140	60	0.1	2.0	1	1145	2020	
51	Dana 4800	100	5/2	5	9	15	36	X	X	X	X	X	X		140	100	0.05	0.35	10	1295	2695	
52	Hewlett-Packard 3440A/3445A	5	3	3			6	X	X	X					70	30	0.45	3.0	1000	1300	1955	
53	Doric DS-100-T3D	100	1				6 <sup>6</sup>			X	X	X	X		160	70	0.5	N/A	1	1340	1690	
54	Calif. Inst. 8303	20			9		9			X	X				120	60	0.5	N/A	N/A	1495	—	
55	Kiethley 180	100	5				5	X	X	X	X	X	X		160	80	3.0	N/A	0.03	1695	1880	
56	Cimron 6653A	10	3/3	4	5	3	18	X	X	X	X	X	X		80	70	0.001	0.45	1	1740	2780	
57	Systron-Donner 9340	20	5	4	5	5	5	24	X	X	X	X	X		100	120	0.2	0.5	10	2395	3145	
58	Systron-Donner 7100A	60	5	4	4	1	5	19	X	X	X	X	X		120	20	0.05	0.5	10	2175	2850	
59	Fluke 9500	20		5			5	X	X	X					N/A	N/A	N/A	3.00	10	2485	2730	
1969 Avg. (*Denotes Mean)		20*	(cost per range = \$127)					11.2	45%	47%	94%	44%	6%	108	58.6	0.554	1.58	100*	1085	1425		
Avg. of New Listings		20*	(cost per range = \$ 77)					17.2	63%	63%	90%	77%	30%	116	60.3	0.381	1.33	10*	830	1315		
Improvement or (Loss)		—	— \$ 50					+6.0	+18%	+16%	(-4%)	+33%	+24%	+8	+1.7	-0.173	-0.25	1 range	-255	-110		
(1) Includes amplifier settling time.							(4) Includes four frequency ranges.															
(2) Includes amplifier settling time and full filtering, where applicable.							(5) Includes five frequency and one decibel ranges.															
(3) Includes four frequency, four time interval, and six capacity ranges.							(6) Includes two thermocouple ranges.															
ND indicates No Data available. N/A indicates Not Applicable.																						
Color in Manufacturer and Model Number columns indicates new listing since November, 1969. Color elsewhere indicates options.																						



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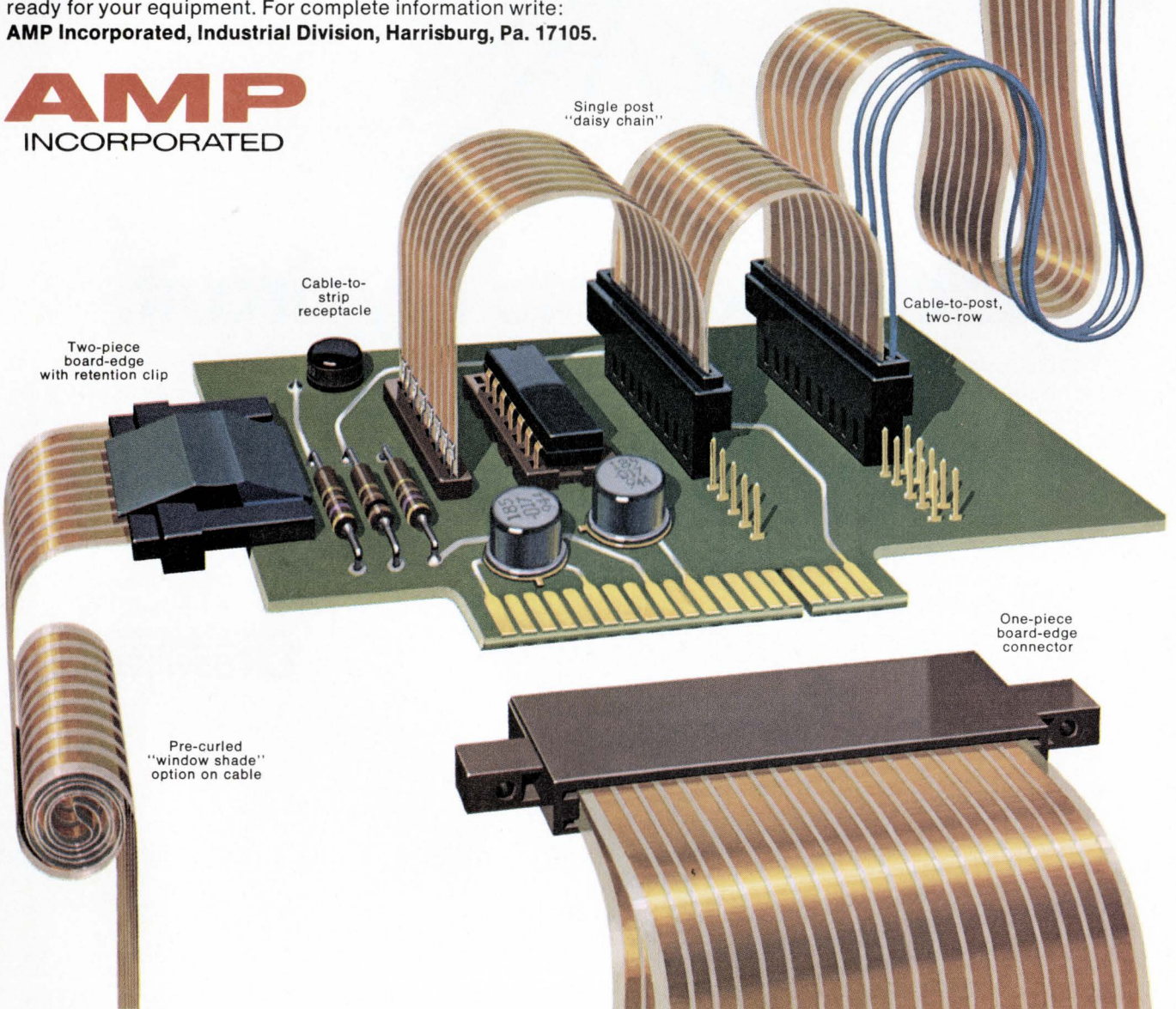
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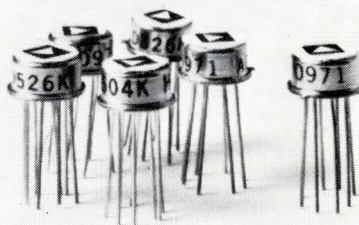
In fact you are wide awake and asking yourself what we compro-

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op amps, eliminating extra circuitry to achieve moderate speeds.

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Hewlett-Packard	<b>219</b>	Simpson Electric Co.		<b>231</b>
Hickok Instrumentation Group	<b>220</b>	Systron-Donner Corp.		<b>232</b>
Honeywell Inc.	<b>221</b>	Triplet Corp.		<b>233</b>
Keithley Instruments	<b>222</b>	Tyco Inst. Division		<b>234</b>
Monsanto Co.	<b>223</b>	United Systems Corp.		<b>235</b>
Non-Linear Systems, Inc.	<b>224</b>	Vidar Corp.		<b>236</b>
Northeast Electronics Corp.	<b>225</b>	Weston Instruments, Inc.		<b>237</b>
Pacific Measurements Inc.	<b>226</b>			
Philips Electronics Industries	<b>227</b>			
Practical Automation Inc.	<b>228</b>			

**INFORMATION RETRIEVAL**  
Instruments and measurements, Data acquisition and processing

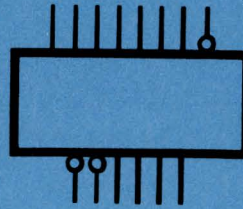
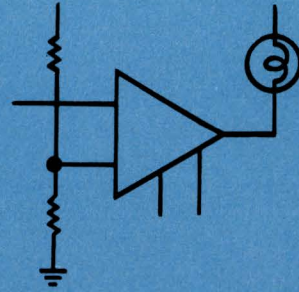
<b>5-/6-digit DVMs</b>																				
MANUFACTURER	MODEL NUMBER	NO. OF RANGES							PERFORMANCE							PRICE				
		# of full digits	Overrange (%)	DC Volts & mV	AC Volts	Ohms	Ratio	DC	AC	TOTAL	90 day accuracy (% of range)	90 day accuracy (% of full scale)	90 day accuracy conditions (°C ± °C)	Tempco (%/°C) <sup>1</sup>	CMR near 60 Hz (dB)	NMR near 60 Hz (dB)	DC measuring <sup>2</sup> speed (seconds)	AC measuring <sup>3</sup> speed (seconds)	Sensitivity (µV)	Base price (\$)
1 Data Precision	2520	5	20	4/1			4		9	0.007 <sup>5</sup>	0.001 <sup>5</sup>	23±5	0.0012	120	60	0.33	N/A	1	995	1235
2 Non-Linear Systems	MX-1	5	20	3	3		3		9	0.01	0.01	(?)	0.0003	120	60	0.250	0.6	100	1000	1700
3 Data Precision	2530	5	20	4/1			5	4	14	0.007	0.001	23±5	0.0012	120	60	0.33	N/A	1	1070	1320
4 Data Precision	2535	5	20	4/1		4			13	0.007	0.001	23±5	0.0012	120	60	0.33	2.5	1	1125	1375
5 Data Precision	2540	5	20	4/1		4	5	4	18	0.007	0.001	23±5	0.0012	120	60	0.33	2.5	1	1195	1445
6 Doric	DS-100-K5-R3	5	0	4			4	4	12	0.01	0.01	23±1	0.002	148	60	0.5	N/A	1	1240	1490
7 Heath	EU-805A	6	12	4					4	ND	ND	ND	0.05	ND	ND	0.1	N/A	10	1250	
8 Dana	5300/600	5	20	4/1		4	5	5	19	0.008	0.002	25±5	0.001	120	74	0.22	2.0	1	1275	2475
9 Doric	DS-100-K6-R3	5	0	6			6	6	18	0.01	0.01	23±1	0.001	148	60	0.5	N/A	1	1285	1690
10 Systron-Donner	7005A	5	20	4/1		4	5	5	19	0.01	0.004	23±1	0.0005	100	80	0.2	1.0	±1	1295	2325
11 Fluke	8300A	5	20	3/2		4	5	5	6	0.01	0.003	25±5	0.001	140	60	0.025	0.5	1	1295	2995
12 Dana	5300/700	5	20	4/1		4	6	5	20	0.008	0.002	25±5	0.001	120	74	0.22	0.5	1	1375	2775
13 Data Technology	370	5	20	5		4	6	1	16	0.006	0.002	25±5	0.001	140	ND	0.2	ND	1	1450	2400
14 Doric	DS-100-T2	5	0	1				2	3	0.005	0.005	23±1	0.005	160	100	1.0	N/A	1	1470	
15 Systron-Donner	7110	5	30	5		4	6	5	5	0.008	0.003	23±1	0.0003	120	80	0.03	0.5	±1	1695	2765
16 Dana	5333/603	5	20	4/1		4	5	5	19	0.008	0.002	25±5	0.001	120	74	0.22	2.0	1	1995	2895
17 Dana	5333/703	5	20	4/1		4	6	5	20	0.008	0.002	25±5	0.001	120	74	0.22	0.5	1	2095	3195
18 Fluke	8400A	5	20	5		4	7	4	20	0.001	0.003	23±5	0.007	140	65	0.033	0.08	1	2450	4350
19 Vidar	502B	5	160	6			7		13	ND	0.025	25±1	0.005	90	10	0.025	N/A	1	2500	4300
20 Non-Linear Systems	X-1	5	20	3/2		4	5	3	17	0.006	0.0008	31±19	0.0003	140	76	0.016	0.6	1	2785	5010
21 Cimron	6753	5	10	4/2		4	5	4	19	0.01 <sup>5</sup>	0.002 <sup>5</sup>	25±5	0.0003	120	90	0.05	0.7	0.1	2990	4015
22 Dana	5800	5	10	4/2		4	9	6	25	0.006	0.001	25±5	0.0003	140	100	0.013	0.118	10	3150	4595
23 Hewlett-Packard	3450A	5	20	5		4	6	4	19	0.008	0.004	25±5	0.0007	130	26	0.065	2.7	10	3300	4795
24 Greibach	85	5	0	4/1		4	5	3	17	0.008 <sup>5</sup>	0.009 <sup>5</sup>	26±14	ND	130	60	0.01	0.5	1	3500	6000
25 Cimron	6853	5	10	4/2		4	9	4	23	0.005	0.001	25±5	0.0001	140	100	0.035	0.6	0.1	3700	5790
26 Hewlett-Packard	3460B/3461A	5	20	4/1		4	5		14	0.004	0.002	25±5	0.0003	145	26	0.066	0.55	1	3850	6850
27 Hewlett-Packard	2401C	6	300	5					5	0.01 <sup>5</sup>	0.005 <sup>5</sup>	25±1	0.001	160	20	0.1	N/A	1	4300	5250
28 Dana	5700	5	10	4/3		4	5	4	20	0.004	0.001	23±5	0.0005	140	80	0.012	0.123	10	4500	7650
29 Vidar	521C	6	300	6			7	1	20 <sup>4</sup>	0.004	0.01	25±1	0.003	>126	>40	0.011	N/A	0.1	4850	6650
30 Hewlett-Packard	3462A	6	20	4					4	0.005	0.0005	25±5	0.00022	165	45	1.1	N/A	1	4900	
31 Dana	5740	5	10	4/3		4	5	4	20	0.004	0.001	23±5	0.0005	140	80	0.012	0.123	10	5300	8450
32 Hewlett-Packard	2402A	5	30	5		4	5		14	0.01 <sup>5</sup>	0.003 <sup>5</sup>	25±1	0.0021	168	48	0.023	0.52	1	5950	7400
1969 Avg. (*Denotes Mean)		20*	(cost per range = \$298)	15.9	0.0074	0.0055	±3.9	0.0042	137	63.4	0.207	0.78	1*	3030	4580					
Avg. of New Listings		20*	(cost per range = \$188)	16.8	0.0072	0.0040	±3.9	0.0015	123	64.4	0.180	1.04	1*	2050	3150					
Improvement or (Loss)		-	-\$110	+0.9	-0.0002	-0.0015	-	-0.0027	(-14)	+1.0	-0.027	(+0.26)	-	-980	-1430					

(1) Sum of (% of reading + % of full scale). (4) Includes three frequency and three period ranges.  
(2) Includes amplifier settling time. (5) Six month spec.  
(3) Includes amplifier settling time and full filtering, where applicable.  
ND indicates No Data available. N/A indicates Not Applicable.  
Color in Manufacturer and Model Number columns indicates new listing since November 1969. Color elsewhere indicates options.



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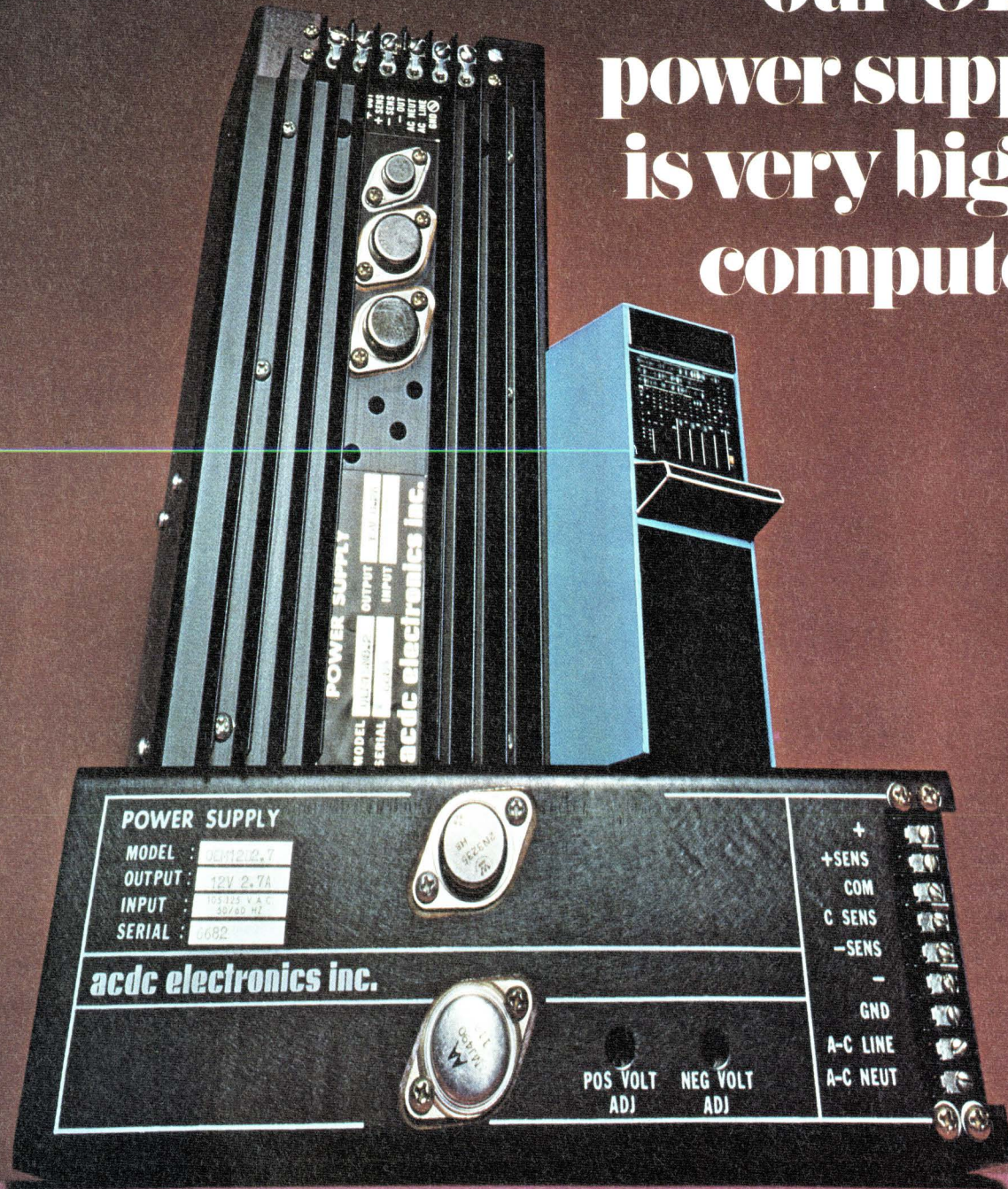
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# our OEM power supply is very big in computers



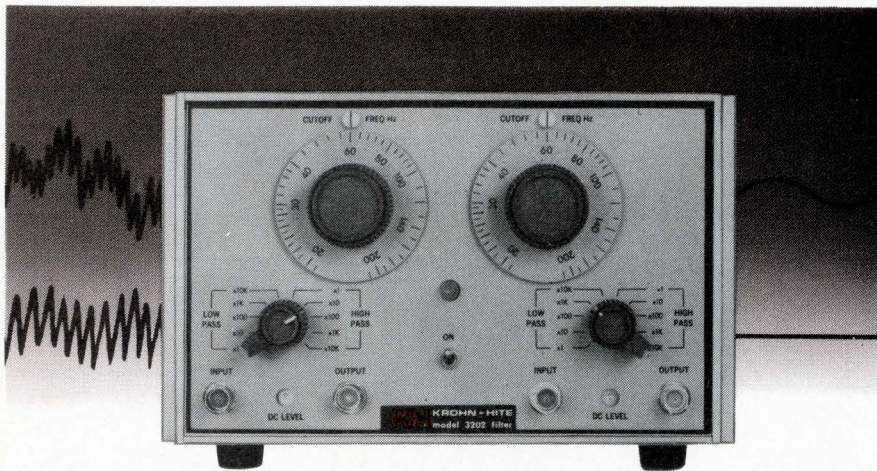
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#### Analog measurements

Sir:

A brief comment on the "IC Idea" on the measurement of offset and bias currents by Jack Goldberg, [*The Electronic Engineer*, July, 1971, p. 56.]

The engineer should be certain that his circuit is as pictured and does not contain sneak paths to ground or to either supply (i.e., leads should be well-shielded and guarded). For example, if the leakage resistance to  $V_s$  were  $10^7 M\Omega$ , the resulting current could be 1.5 pA. If the leakage resistance to ground were  $10^4 M\Omega$ , the voltage at the + input would seek to settle out at 10 mV (with 1 pA bias current), and would be only 63% of the way after 10 s. Switch leakages (and of course, capacitor leakage) should also be low. Watch out for leaks across dirty IC headers!

One cannot stress too strongly the need for capacitors having low dielectric absorption (such as polystyrene, mentioned by Mr. Goldberg). For example, if one were so unwise as to use ceramic (typically 2%), and the switch had been closed after the capacitor had been charged to 1 V, and immediately opened, the capacitor would tend to drift toward 20 mV (200 mV at the output), even if the amplifier's bias current was zero, while the charges within it returned to equilibrium.

Dan Sheingold  
Analog Devices, Inc.  
Norwood, Mass. 02062

#### Medicine and profit

Sir:

An associate and I have recently founded a company in Santa Clara, Calif., to serve the medical community in the San Francisco Bay area. We believe that though a substantial amount of equipment is being produced by various companies, there exists a lack in the more mundane, yet very important aspects of hospital/user staff training, safety inspection, maintenance, repair and coordination of user groups requirements.

Though as a company, we are, of course, profit oriented; as individual engineers, we have a keen interest in helping to develop any worthwhile idea with physicians, hospitals, or even other engineers.

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## A spectrum marketplace?

Extensive study and debate about use of the radio spectrum has led to many new concepts, including spectrum pollution, waste, engineering, and monitoring, during the last decade. One particular concept which enjoys a widespread consensus is that there exists a "spectrum resource," whose allocation and use must be "optimized." However, there are widely divergent views on the exact nature of this resource, what constitutes its "optimum" allocation and use, and how that goal can best be achieved.

Some people view the spectrum resource as unidimensional, i.e., possessing only the frequency domain. Others attribute to it varying degrees of multi-dimensionality. I have advanced the concept of the spectrum resource as a multi-dimensional "space" (electrospace) whose dimensions correspond to the several characteristics by which electromagnetic radiation from one source can be distinguished from that of any other.

Equally divergent views on what constitute "optimum" allocation and use of the spectrum resource are held by those concerned with spectrum use. The defense communicator considers the allocation and use which provide complete flexibility in meeting operational and contingency requirements to be the optimum. To the typical business user, it is the arrangement which allows him to maximize profits or minimize costs. The allocator sees optimum allocation as the one which lightens his work load or the pressures placed on him by existing and prospective users. And the communication engineer generally seeks the allocation and use which will maximize the information transfer capacity per unit of bandwidth or cost.

Because each of these optimization concepts reflects a particular value system, it is difficult to challenge any one of them. However, the economist has challenged their collective use, claiming it results in a series of sub-optimizations and inefficiencies rather than in overall optimization. Instead he suggests that the "optimum" is the allocation which maximizes the net benefit society realizes from the spectrum resource—a concept quite different from any of the others.

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### Introducing Walter R. Hinchman

On returning from the World Administrative Radio Conference held in Geneva, Switzerland, this summer, Walter Hinchman commented, "You lose in some areas, while you gain in others." A pragmatic approach on a meeting that set international boundaries for space communications for the next 10 years, and one reflected in this editorial on spectrum economics. At present, Hinchman, Assistant Director in the White House's Office of Telecommunications Policy, holds program management responsibility for broadband communications services, domestic satellites, communications carriers, and spectrum plans and policies. Previously, he assisted in the development of White House recommendations on domestic satellite systems, served on the President's Task Force on Communications Policy (radio spectrum management and domestic satellite communications), and worked as an engineer in government and private industry.

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Under existing mechanisms, spectrum resource use is allocated by Federal administrators operating under the vague objectives of serving the public interest, convenience, and necessity; supporting the national security; or protecting life and property. The economist contends that this approach does not facilitate the maximization of net benefits to society because it does not take into account the value the spectrum resource has for individual users or potential users. He also maintains that spectrum value can only be measured in economic terms, for only in that context can the user evaluate the comparative value of other resources or of non-radiating communications alternatives. Finally, the economist holds that no centralized system of value analysis is likely to serve as well as the marketplace in achieving the most efficient allocation of scarce resources.

These are powerful arguments which cannot be substantiated or refuted within the confines of this editorial, but it can be demonstrated that they are neither superficial nor of purely academic interest. *For example, the introduction of domestic satellite systems and specialized communications common carriers, and the expanded use of mobile communications systems have been delayed for years in the regulatory process. These delays have cost the U.S. economy millions of dollars and an untold number of jobs by foreclosing investments which would have been made.* While many factors have contributed to these delays, a major cause has been the uncertainty concerning the use of the radio spectrum and the possibility of harmful radio interference.

Simply stated, the way in which the radio spectrum is allocated has a major impact on economic growth and employment patterns in the communications industry. But unlike the other resources which this industry consumes, there is no mechanism in the spectrum allocation process whereby economic value can be taken into account.

The FCC has recently taken an important step toward incorporating economic values in the spectrum allocation process by establishing a sliding scale of license fees. This step is in many ways incomplete and imperfect, lacking as it does an exact measure of the amount of spectrum resource used or a measure of the actual value derived from that resource use. In addition to this step, others are needed, including the elimination of regulatory barriers to the entry of new radio services and to the direct transfers of spectrum rights among individual users and between government and non-government use. In the extreme, these mechanisms could take the form of a "free market" in spectrum resource rights, although it would be difficult to define clearly such rights in order to avoid centralized coordination. *But the most important step will occur when the communications/electronics industry and its customers realize that the way to greater growth in radio services lies in some form of spectrum marketplace and that this is a necessary prerequisite to many of the sophisticated spectrum engineering approaches which have been suggested.*

*Walter Hinchman*



**Circuit quality** . . . The Defense Communication Agency suggested to the FCC that leased circuit tariffs should contain "a clear indication as to what action the carrier will take to insure the circuit quality as ordered is actually provided on a continuing basis." DCA continued, "the advent of our sophisticated voice and data networks and associated switching and terminal equipment has tended to mask the degradation of individual circuits."

**Government think tank** . . . A mixed bag of electronic engineers, physicists, social scientists and others have quietly slid over from the Department of Commerce's Office of Telecommunications to the White House's Office of Telecommunications Policy. Given a far-reaching charter, these think-tankers, some 50 in number, will try to understand the needs of our society and how communications can help solve them. Top priority item: CATV.

**Digital modulation inquiry** . . . Reacting to the data comm explosion, the FCC has called for an inquiry into the use of digital modulation techniques in microwave radio operations. The agency stated that PCM systems might cause destructive interference to FDM systems, such as those used in private and common carrier setups now. Comments were requested by Nov. 15 and replies by Dec. 16.

**Overseas data** . . . The *Conference Europeane Des Postes et Telecommunications* (CEPT), the European telecomm group, recently commissioned a \$1 million market study on the future of data communications in Europe. The two firms jointly handling the study will be England's PA International Management Consultants Ltd., and Quantum Science Corp., Palo Alto, Calif.

**Baby, it's cold out here** . . . The Federal Communications Commission has instituted a telephone answering service for questions on the price freeze. For problems related to the communications industry and the price freeze, call area code 202, 632-7052 or 632-7030.

**Doctor, I've got a sick terminal** . . . A new service, called "Termicare," has been offered to Western Union Data Services Co. customers with ailing terminals. These customers may call Mahwah, N.J., without toll charge, to test and diagnose the patient.

**The sky's the limit** . . . Beginning what has been estimated as a \$257 million system, the Board of Directors of Aeronautical Radio, Inc. gave the go-ahead for planning of two initial microwave segments. Speaking of the recent FCC decision and the planned air transport industry system, the ARINC chairman, John S. Anderson said, "The recent FCC action . . . may open new opportunities in providing the most cost-effective systems."

**Change of heart** . . . Just one year and two days after RCA's Robert W. Sarnoff pledged that, "We are determined to attain an industry rank second only to IBM in this country. . . . RCA is prepared to commit whatever resources are necessary," the giant electronics firm left the general-purpose computer business. In addition to absorbing an estimated \$250 million loss, RCA will now channel its computer efforts into "the development, manufacture and marketing of specialized data communications systems . . . and specially designed business systems."

**A challenge** . . . In asking for a modification of the FCC's new rules on microwave radio facilities, Western Union stated that industry could not supply either an i-f combiner or a hitless switch. Western Union elaborated, "To date, no equipment manufacturer has demonstrated the ability to supply . . . a switch or combiner, and . . . no such component will be operational . . . within at least the next three years."

**Improved cable** . . . Bell Telephone Laboratories reported a new low capacitance cable that permits signal regenerators to be spaced at 2½-mile intervals, instead of 1-mile distances. The cable, which is undergoing field-testing before implementation in the T-2 system next year, is said to offer lower crosstalk and lower signal loss.

**Electronic mail** . . . New York and Washington businessmen, tired of waiting days for important papers, can rely now on prompt electronic service, according to the U.S. Postal Service. Costing \$4.25 for the first page (8½ x 11 in.) and \$3.00 for each succeeding page, the new facsimile service will transmit mail "in hours rather than days," says a postal official.

**Two digital communication test systems** will be built by Tau-Tron, Inc. of Lowell, Mass., for ComSat, under a \$35,000 contract. They will test ComSat's global satellite communications system (now under development) under simulated noise, to measure errors at data rates from 1 to 120 Mb/s.

**Bits and bytes** . . . GTE International was awarded a \$6,500,000 contract for the first microwave communications system in the Republic of Central Africa.

**Statistics of Communications Common Carriers** for 1969 is available from the Superintendent of Documents, U.S. Government Printing Office, Wash., D.C., 20402 at \$1 a copy.

**Nippon Electric Co.** has been awarded a \$48,763 Intelsat contract to fabricate, test and deliver two FDM/PCM Co-decs, to be used with experimental digital satellite communications equipment employing time division multiple access techniques.

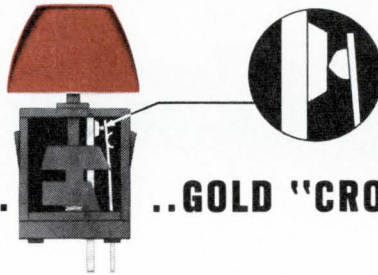




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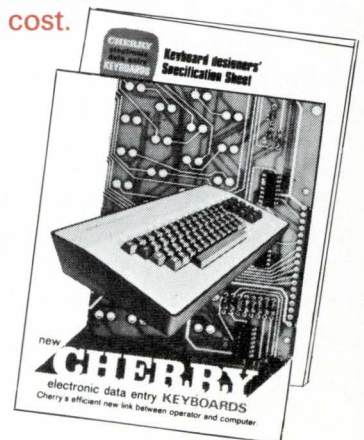


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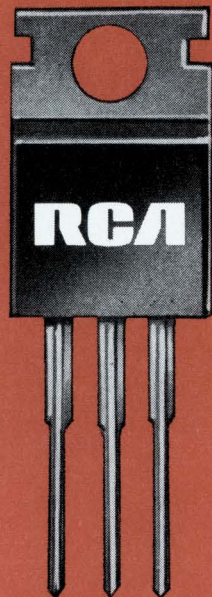


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# DATA TERMINALS:

## Part 4

**Arthur J. Boyle**, Technical Editor

Up to now, our course has not been concerned with specific types of data terminals. This installment is going to remedy that situation. It is devoted to data terminals in their three most common forms.

### Teletypewriters

The teletypewriter is a rare breed of cat. Basically an electromechanical device, it has been successfully adapted to the electronic world. Conceived and developed before World War I, the teletypewriter has a history of yeoman service in message communication systems spanning more than four decades before the modern computer even came on the scene. Finding widespread application as both an I/O device and a remote terminal, the teletypewriter has moved from the message environment to the data environment with scarcely a noticeable loss in stride.

### Alphanumeric CRTs

If the teletypewriter is the workhorse among terminals, then the alphanumeric CRT terminal is the thoroughbred. Utilizing technologies far more suitable than teletypewriters for interfacing with high-speed computers, the CRT gives the user quick and convenient access to very large amounts of data. Its impact on industries, such as the airlines and brokerage houses, has been nothing short

of phenomenal.

One of the biggest pluses the CRT offers is its ease of operation. Operators entering data can edit and correct before this data is ever transmitted. Preprinted formats can be displayed to guide the operator as to where and when each bit of information is entered. In addition, as an output device, the CRT can give you relatively large amounts of data at electronic speeds. Since the CRT does not give you hard copy directly, most systems use a combination of CRTs and some type of hard copy terminals.

### Touch-tone terminals

We are all familiar with the most common example of touch-tone terminals, the Touch-Tone® telephones of the Bell System. Combining tone generating keyboards with an audio response capability gives you a computer communications system which is close to being the ultimate in human compatibility. The last article in this installment is based on just such a system designed by Wavetek Data Communications and installed at the Rohr Corp. plant in Chula Vista, Calif. The system includes over 400 touch-tone terminals plus 70 CRT displays.

In the next installment, our course is going to look at some of the more advanced forms of terminal equipment. Among the topics we will cover are two of the hottest areas in data communications today, the non-impact printer and facsimile transmission equipment.





# TELETYPEWRITER terminals

**J.-Lee Wakefield**, Teletype Corp., Skokie, Ill.

Among the definitions you will find for communication in Webster's Collegiate Dictionary is "a process by which meanings are exchanged between individuals through a common system of symbols." This must have been the definition which a certain young engineer, Frank Pearne, had in mind in 1902 when he conceived the first practical teletypewriter. Although Pearne himself lost interest in the project, his concepts were developed by the founders of Teletype Corp. and in 1912 Western Union and five railroads were using the teletypewriter to "exchange meanings through a common system of symbols." You will find further acceptance of his ideas in the records of the Chicago Police Force, which mentions the installation in 1922 of 37 Model 12 teletypewriters. As the story goes, all 37 were kept extremely busy trying to keep up with a number of well-known, not-to-mention infamous, citizens who populated the Chicago area during the 1920's.

Of course at that time teletypewriters were just that, typewriters with an ability to communicate over distance. Since then, however, they have grown in both complexity and flexibility, until today when they are probably the most widely used terminal in the data communications industry. No longer just a keyboard and a printer, most teletypewriters now include punched or magnetic tape recording, sophisticated control logic, and newer faster printers that bear little resemblance to the original typing mechanisms.

Regardless of sophistication, today's "teletypewriter" terminals include at most five main components that directly contribute to its communications capability. These are printer, keyboard, tape recorder, tape reader, and terminal logic. The proliferation of terminals available to the systems designer is mostly a result of combining these basic building block components into a variety of configurations, and offering them in a variety of speeds, codes, and flexibilities.

### Choosing a terminal

When selecting a terminal, the first consideration is that of speed. Data terminals, in general, are divided into three speed classifications: standard, medium, and high speed. Teletypewriter type of equipment fit into the standard and medium speed ranges. Standard speed terminals operate in the range from 0 to 30 character/s; medium speed terminals from 30 to 480 char/s; and high speed terminals operate above 480 char/s.

To arrive at the optimum speed (or possibly speeds) for the system, you must know the volume of data going to

and from each terminal location in the system; and the urgency associated with the data communicated to each location.

Another basic consideration is the choice of a communications language or code. There are two universally accepted communications codes, Baudot and ASCII, plus other codes which are either primarily data processing codes or are special communications codes for special interest groups.

The choice between one or the other code is basically a choice between a small and a large vocabulary. With the Baudot code, 58 characters and machine controls can be communicated. With ASCII, 128 characters and controls can be communicated. If the data is largely of the message variety, Baudot code is probably sufficient. But if the data is more complex, either as to the number of symbols or as to the number of machine controls required to format the data or control the communications procedure, ASCII may be the better choice.

### Receive capability

A very important constraint on the system is the receive capability, if any, required for each location. You must decide whether a man-readable or a machine-readable output is required, or possibly both are needed at certain locations.

For a man-readable output, the choice is between a printout or a volatile display. With a printout output, there are page-width printouts and tape-width printouts. Tape-width printout can be used, however, at a savings in paper costs, where the data is in a highly redundant format, such as stock quotations.

If your system calls for the page-width printout, the next choice is between impact and non-impact methods of printing. Non-impact printers are faster than impact printers, but cannot produce copies of the printout. Consequently there will be a tradeoff between the need for speed and the need for copies, if both are required.

For the machine-readable option, you have a choice of media to consider: punched paper tape, punched card, or magnetic tape. Magnetic recording is more expensive, both the tape itself and the recording terminal. But magnetic recordings are reusable; and they are also much more compact, since the recording density is much greater. The other side of the coin is with punched cards or tape, short recordings can be economically recorded on separate cards or lengths of tape. Short recordings, however, cannot be economically recorded on separate magnetic tape cartridges. The investment in cartridges would be too great.



In choosing between punched cards and punched tape, remember that cards provide the room to hand-write additional unrecorded information, and lend themselves more readily to hand sorting, than do lengths of punched tape. Also, if the data is printed as well as punched, the printing on tape is harder to read since it must be squeezed between the holes on punched tape but is allotted an area of its own on punched cards. On the other hand, recording data on punched cards can be wasteful. Seldom do recordings come out to be card length, so either the remainder of the card is wasted if the recording is less than card length, or the remainder of the next card is wasted if the recording runs longer than card length. With punched tape recording, each recording is exactly as long as it needs to be.

### Send capability

The fundamental decision regarding the send capability of a terminal is whether manual or record entry is required. Manual entry is a direct way to communicate. Record entry is indirect in that manual entry must precede it. But record entry is more efficient in that errors can be seen and removed prior to transmission, without wasting valuable transmission time.

Record entry terminals are also efficient in that the transmission takes place at maximum terminal speed instead of maximum typing speed. Also, with recording capability, data can be recorded and batched during business hours and transmitted after business hours to take advantage of the lower after hours transmission charges.

For manual data entry, there are several types of keyboards from which you may choose. These are alphanumeric keyboards, numeric-only keyboards, and alphanumeric with numeric cluster keyboards. If the terminal uses the Baudot code, the choice is restricted to an alphanumeric keyboard, whose format operation will be familiar only to a trained teletypewriter operator. With ASCII code, the choice is between alphanumeric, of a format familiar to any typist; numeric-only, familiar to an adding machine operator; and alphanumeric with numeric cluster, familiar to a typist with a keypad telephone dial. The decision is

based on the type of data to be entered and the operator's training.

### Error control

In trying to control errors, here are some figures you must consider. Operators cause one error per every 1000 characters that they keyboard. The transmission facilities add to this one error per every 10,000 characters, and the terminals add to these one error per every 100,000 characters. Obviously, the largest source of errors is the terminal operator. Operator errors can be reduced with training, and experience, and in some cases with equipment. Terminals are available with optional operator control features which alert the operator to block out improper format or erroneous character sequence. Still other schemes involve record verification via double entry of the data, by the same or different operators.

In order to catch transmission errors, many terminals are available with optional error detection devices. Such devices include error flagging data with the data being communicated. The vertical parity scheme, for example, adds a parity bit to the bits that represent a character during its transmission. Should an odd number of bits change states during the transmission, the parity bit will indicate character errors due to transmission distortions.

Other, more effective, error check schemes are available. Horizontal and spiral parity schemes, for example, check for probable errors by adding an entire check character for a certain number of characters in the transmitted data. The receiving terminal, equipped for the scheme, compares this check character against its own computation of what the check character should be. If the computed check character does not agree with the received check character, the entire block of characters sent since the last check character is declared erroneous and is re-sent. Still other schemes are available, at the price of increasing sophistication, and accuracy. How powerful an error checking scheme you should choose depends on how devastating an error in your data will be. Costly errors dictate sophisticated error control hardware; inexpensive errors do not warrant the expense.

## Alphanumeric CRT terminals

**Troy S. Adcox**, Bunker-Ramo Corp., Trumbull, Conn.

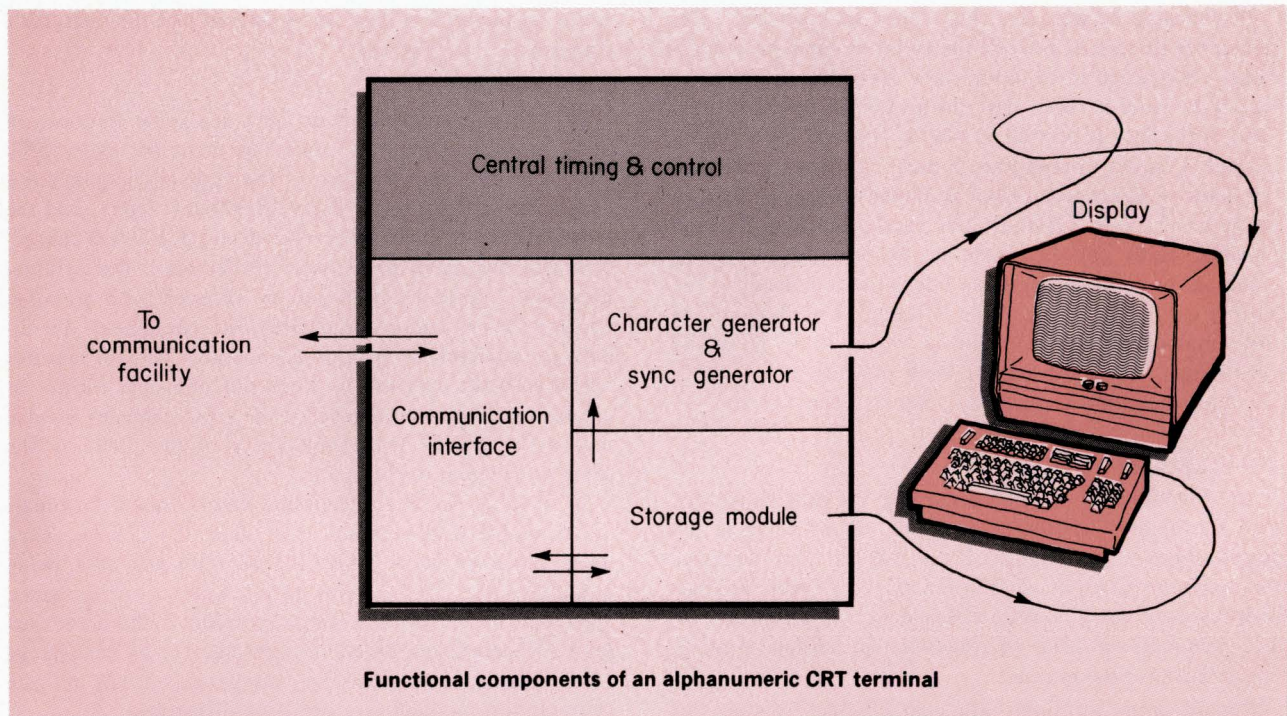
Since CRT terminals were introduced to the commercial user several years ago, their growth has been explosive. Almost all phases of teleprocessing use one or more of the many available models.

The early pioneers in the CRT field were the commercial airlines. Reservation and other similar inventory functions were being served by CRT terminals as early as 1963. Other industries soon discovered the versatility of these terminals and thus began the phenomenal population growth of the alphanumeric CRT terminal. Now it is common to see CRT

terminals in banks and brokerage houses, on factory floors, in warehouses, at nursing or laboratory stations in hospitals, on executive's desk or anywhere that requires speedy access to a data base.

The A/N CRT terminal is a normal evolutionary step up from mechanical devices such as the teletypewriters. It has the basic elements of a teletypewriter: an alphanumeric keyboard for data entry and a display area for output. The other elements that make up an A/N CRT terminal are a character generator, communication adapter, storage modules, and video/sync drivers. Hard-copy printers can





be slaved to the terminal, if permanent copy is required.

The advantages over the electromechanical devices are numerous. The sending and receiving of data can be accomplished at computer speeds in local environments and at full line speeds for remote locations. Most commonly used communication facilities are 1200 baud asynchronous and 2400 baud synchronous, although 4800 baud is gaining in popularity as the quality of modems and lines improve. Some 9600-baud systems exist today and will undoubtedly be common in the near future.

The keyboard functions are simple and lend themselves to the operator's needs. The ease of editing and making corrections simply by overtyping, erasing, or just moving data from one field to another, makes the job of reducing errors an easy task. Local buffering of the messages in the terminal allows the operator to perform the necessary verification and corrections off-line without taking computer or communication time. Only after the message has been composed and verified, does the operator depress the SEND or TRANSMIT key and cause the data to be sent to the computer at high speeds. Costly errors are eliminated before they reach the system.

The CPU can pre-format the screen with fixed headings such as name, customer number, etc., with tab points, leaving spaces to be filled in by the operator. The cursor or entry marker is automatically repositioned to the next field after the proper number of characters have been entered. Individual characters or entire fields may blink to alert operator to errors or other critical conditions. The speed and ease of operation permits order entry clerks, customer

service representatives, etc. to create, retrieve and update records of a central data base while the client is still on the phone.

Of the several types available, your keyboard should be selected with your application in mind. The typewriter-oriented keyboard is required for extensive data entry and text composing applications. Other keyboards have the keys arranged in a block formation, i.e., from A through Z. Non-typist personnel such as nurses, doctors, clerks, and executives adapt better to these simple layouts. Keyboards with numeric clusters are useful for applications requiring numeric input. System application and editing keys are integral parts of the keyboards and should be conveniently located. Sending commands to the program by depressing one function key eliminates the thought and time required for a multiple keystroke instruction.

The display area uses a phosphor-coated cathode ray tube. Some of the available displays use commercial television tubes, but others use specially designed displays. The latter are usually of a better quality because environmental factors such as lighting and contrast are taken into consideration in the design.

Local storage can be core, delay lines, or MOS chips. The early units used magnetostrictive delay lines, which at that time were the most economical. Dynamic MOS RAMs have recently become inexpensive enough to be used. Data is recirculated in storage synchronized with the refresh rate of the CRT. The modular storage units can be expanded to meet the display requirements.

Communication adapters are of two basic types. Serial



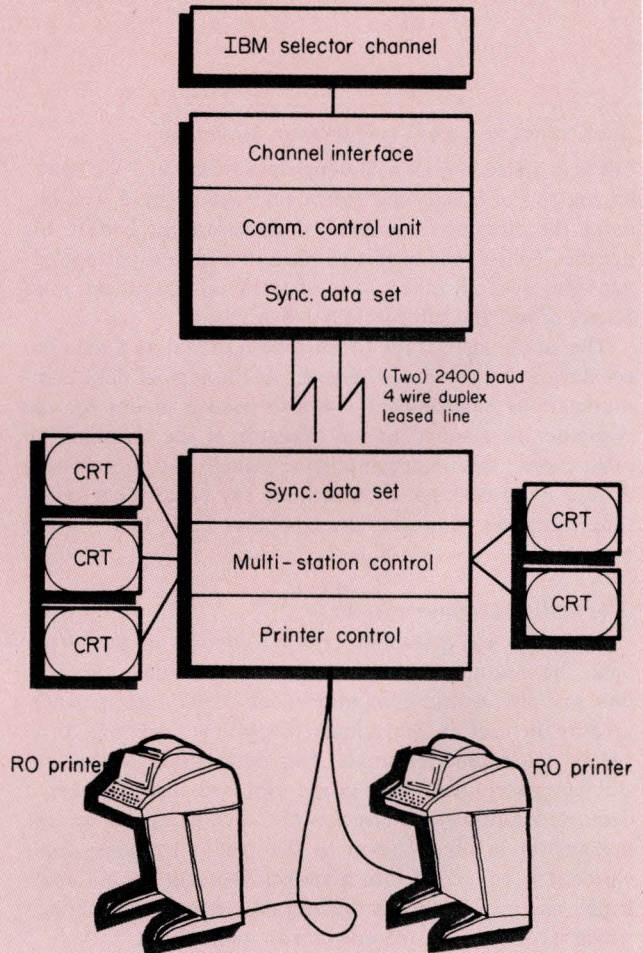
### How many yen to the dollar?

The CRT terminal has found its way into a wide variety of data communications systems. A typical example (although the application may be somewhat atypical) is the CATS (Computer Assisted Trading System) installed at American Express International Banking Corp.

The system supports the American Express traders who deal in the buying and selling of foreign currencies. It is not at all unusual for these traders to turn over up to a million dollars of foreign currency during one transaction. In so volatile a business, up-to-the-second information is an absolute necessity.

The system itself consists of four CRT terminals operating on-line with an IBM 360/65 located two blocks away. Traffic between the two locations is carried by a 2400-baud synchronous line which is duplexed to provide backup. Through the terminal keyboard, each trader can call up the latest information to establish his position in any currency by reviewing the screen.

A fifth CRT terminal is used to verify all trades and a pair of receive only printers complete the system. The printers provide contracts on-line and are used to prepare various checks, ledgers and positions off-line.



adapters that interface to modems use standard (EIA RS-232-C) signals. Modem controls and delays must be handled by the adapter. Parallel adapters can connect directly to the computer input/output channels such as the selector or multiplexer of the IBM 360/370. Operating in bit-parallel mode in a local environment allows high-speed transfer of data between the terminal and computer.

Selecting a terminal is a logical process. First, you should analyze the job that the CRT will serve and itemize the required and desirable features. Simple, uncluttered keyboards and crisp, stable displays are absolutely necessary for the operators. Standard and reliable communication disciplines are required by the system network. Flexibility and optional features should be analyzed closely by the system programmers. The supplier must be reliable and capable of servicing the product he sells. After analyzing

your requirements and the capabilities of the terminal, only then can a cost justification program begin.

The system can make use of both single station and multi-station units in the same network. The single station can serve locations requiring no more than one CRT and one hard-copy device. A multi-station configuration can cluster as many as 36 terminals and several hard-copy printers to one control unit. The CPU can send a general poll to the control unit instead of individually polling the terminals. This technique eliminates unnecessary traffic on the communication lines.

The alphanumeric terminal will very soon relinquish the spotlight to the more glamorous and intelligent terminals on the horizon. However, it will remain a very vital part of the teleprocessing industry for many years to come, much as the teletypewriter has survived the electronic revolution.





# The touch-tone terminal audio response system

**Joel Naive**, Wavetek Data Communications, San Diego, Calif.

There is a sleeping giant among data terminals. We're referring to the touch-tone\* terminal, and it could well become the most used terminal of all before the end of this decade. Touch-tone terminals have two very important advantages over all other types of terminal equipment: simplicity of use and substantially lower cost.

The advantages of the touch-tone terminal as a data entry device are obvious. However, in the typical data communications environment, we also need a means for the computer to respond to the operator at the terminal. In most cases, this is accomplished visually by means of a printer of some kind, or a cathode ray tube. With touch-tone terminals, however, the computer can "talk" to the operator.

### The audio response system

A typical audio response system consists of the terminals, the communications equipment, the audio response unit and the central computer. Tone-coded data is generated by the user on an ordinary touch-tone telephone or on special touch-tone terminals. This data is sent to the central computer over voice-grade switched lines or over a dedicated communications network. The computer returns the answer in digital form to the Audio Response Unit where it is converted into a spoken message by automatically assembling words, numerals, letters and phrases which have been pre-recorded on an audio drum.

Modern audio response systems have large vocabularies and offer a great number of computer access channels, making it possible for many users to simultaneously communicate with the central computer. As an example, the Rohr Corp. has an audio response system with over 400 touch-tone terminals. At 3:30 each afternoon, in less than 3 minutes, over 1,000 Rohr employees sign out using touch-tone terminals. Each receives back a cheery "OK" from the central computer with the average transaction taking less than 5 seconds.

### Touch-tone terminals

Just about everyone is familiar with the pushbutton telephone offered by the Bell System under the name of Touch-Tone®. One of its most important features is that it can be used for entering data as well as voice messages which gives every home, office, hotel room, gas station, etc., the potential of becoming an on-line computer data entry/retrieval station.

In addition to the telephone, a number of companies are offering special touch-tone pads to input data for computer-controlled audio response systems. These compact terminals, designed for desk-top operation, are small and light enough to be carried in a briefcase.

Touch-tone terminals generate audio frequencies each time a key is depressed. A typical example is the numeric terminals which use a multi-frequency coding system consisting of two groups of four frequencies each, permitting up to 16 separate button combinations. Numeric characters require the depressing of only one button, while alphabetic characters require two or three depressions. Wavetek recently developed the industry's first alphanumeric touch-tone terminal. It has 49 keys and contains all the letters of the alphabet, numerals 0 through 9, punctuation marks and special characters for inputting data to the computer via an audio response system. This simplifies the use of such response systems in areas where quantities of alphanumeric input data must be generated.

### The Audio Response Unit

The general-purpose controller for a voice-response computer/communications system is the Audio Response Unit (ARU). Linking the computer multiplex channel and the receiver data sets, it provides voice response (and in some instances, ASCII code) to the remote terminals.

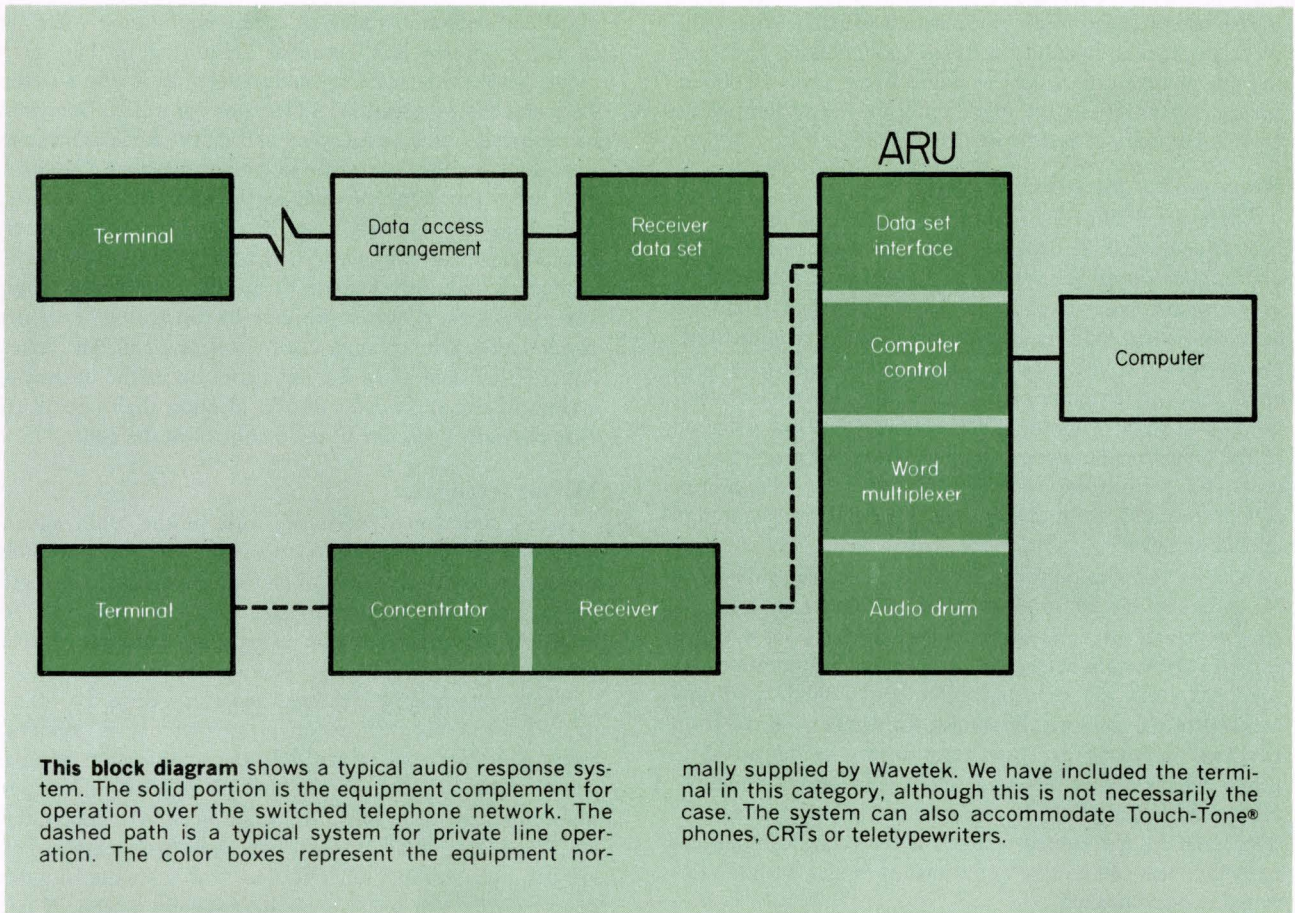
Various methods are used to generate the voice response. Some ARUs employ photographic film strip techniques, a few use digital-to-analog conversion schemes, and others utilize magnetic audio drums. In Wavetek systems, the ARU is a fixed head-per-track magnetic audio drum with individual words pre-recorded on separate tracks. A single ARU handles up to 64 input/output lines and has a vocabulary of up to 256 words.

The Audio Response Unit accepts inquiries or data from the remote terminals and transmits it to the central computer under control of a teleprocessing monitor program. After the required processing, the computer constructs a response message which is transmitted to the ARU where it is interpreted one character at a time. Each character identifies a unique word pre-recorded on the analog drum. The associated word is extracted from the drum and transmitted to the terminal originating the transaction. The sequence in which words are transmitted to a terminal is controlled by the computer application program which constructs the response message. The vocabulary (either male or female voice) is chosen by the user from words associated with the planned applications.

Our experience with Rohr Corp. on their audio response system points out that relatively few words are required to

\* Touch-tone is a registered trademark of the American Telephone and Telegraph Co.





**This touch-tone terminal** includes a full alphanumeric keyboard. The built-in speaker for the audio response system can be seen on the upper left portion of the unit.





handle many transactions. Each day over 3,000 people use this system for labor and attendance records. The system is also used to keep track of thousands of parts being built, work-in-process inventory control, tool tracking and engineering change orders, just to name a few. Over 50,000 individual transactions are made daily on the system with a total vocabulary of just 96 words.

### Receivers for the switched network

There are a number of communications equipment configurations available depending on such factors as the size and application of the system and whether it is to operate over private lines or over the public switched telephone network. When the system operates over the switched telephone network, the receiver contains multiple data sets, each independently controlled by the computer transmission control program. Each receiver data set is linked to the telephone network through a Data Access Arrangement (DAA), providing tone detection and demodulation of signals received from the remote terminal over common telephone lines.

When a terminal initiates a call to a receiver data set, a transmission circuit is established between the terminal, DAA, receiver, ARU and computer. Each character is transmitted to the data set as the user enters information. As the characters are detected, they are demodulated and transmitted to the ARU. Response words are received from the ARU following an instruction from the control program, which places the data set in a transmit mode. As each word is accepted, it is transmitted to the terminal. As instructed by the control program, the receiver continues to switch between receive and transmit modes until the terminal is disconnected.

### Concentrator receiver for private lines

This type of unit concentrates or switches incoming calls to idle receiver data sets in addition to performing all the functions of the receiver described above. When a terminal initiates a call, the concentrator detects an off-the-hook signal as a request for service. It makes the connection between the terminal and the first available receiver data set, signals that the connection is made, automatically generates terminal identification, and proceeds to the next available receiver, data set and requesting terminal.

The concentrator/receiver can also operate as a remote unit, concentrating or switching incoming calls from a remote facility to idle receiver data sets located at the central computer site. Each concentrator line and receiver data set is linked to leased telephone lines through a Data Access Arrangement.

### Receiver/controller

This unit performs all of the functions of the receiver data set. However, in addition, it can switch an Audio Response Unit line from a calling terminal to a supervisor control station and make a voice connection between the terminal and the supervisor. When the computer transmission program issues an attendant instruction, the calling terminal is disconnected from the ARU line and the supervisor control stations are signaled. When a supervisor control station responds, the ARU line is connected to the responding supervisor for visual display and the supervisor

is connected to the calling terminal for voice communication. This type of receiver/controller is very useful in applications such as banking or credit verification when the computer answer is a "maybe," requiring further interaction between the clerk at the remote station and a supervisor at a central location. Supervisor control stations may be equipped with a CRT display and a switchboard, making it possible for the supervisor to answer requests for assistance from the computer and at the same time, converse with the audio terminal user. In operation, the receiver/controller signals the supervisor control stations that assistance is required. The first available supervisor to answer this request takes the call by operating a lighted patch board. When a supervisor answers a call, all request lights go out and an in-use light goes on at the answering station. If two supervisors answer at once, the switchboard automatically gives one of them control of the call.

### Mixing terminals

As we mentioned previously, one of the main advantages of an audio response system is the low cost of remote touch-tone terminals. This, of course, means that for a given price an audio response system can have far more remote stations than systems using CRT displays or teleprinters.

Audio response is flexible, however, since more expensive terminals such as CRTs, teleprinters or alphanumeric pads can be integrated into the total system in areas where more detailed information is required or a permanent record is needed. An example is a bank system where low-cost numeric touch-tone pads are located at every desk, counter and teller station, with a smaller number of CRT displays or teleprinters strategically placed. A person wishing to make an inquiry dials the computer as though making a common telephone call. Once this is done, the caller receives a ready tone indicating connection with the computer. The caller now enters inquiry information through the touch-tone keypad. The application program analyzes this information and constructs the appropriate output message which is transmitted as voice to the telephone terminal originating the inquiry. A typical response message might say "Account balance overdrawn." In cases where a complete account profile is desired, the response can be on the CRT displays or teleprinters.

### Summary

On-line computer audio response systems have a lot going for them. They offer simplicity and economy and the spoken word is fast and to the point. The touch-tone telephone is the simplest, most economical remote terminal of them all.

All of this means that audio response makes it feasible for a company's computer communications network to be within arm's reach of hundreds, or even thousands, of people who need to input data regularly and receive answers back immediately, regardless of where they are physically located with respect to the central EDP center. In fact, the on-line audio response system utilizing large numbers of touch-tone terminals and a fewer number of CRT displays, might well be the beginning of a true paperless society.



## VOICE AND DATA MODEM

You can use the Model DVM 1300 to simultaneously transmit data and a quality voice channel over the same single telephone channel. It has a data capacity of 1300 b/s in addition to the voice channel. Phonplex Corp., subs. of Instrument Systems Corp., 410 Jericho Tpke, Jericho, N.Y. 11753.

**Circle Reader Service #250**

## PORTABLE FAULT ISOLATOR

The Model 220 has an audible line



monitor which allows you to hear normal and changing line or data conditions. It also displays bit or block error counts to eliminate the need for "clock watching" and calculations to determine error rate. You can use it at rates up to 330,000 b/s with either synchronous or asynchronous modems. International Communications Corp., 7620 N.W. 36th Ave., Miami, Fla. 33147.

**Circle Reader Service #251**

## 103-COMPATIBLE UNITS

This line of 103-compatible, plug-in modems and acoustical couplers is designed specifically for OEM built-in applications. The single circuit-board assemblies provide any combination of acoustic or direct access interface in originate only, answer only or answer-originate modes. Novation, Inc., 18664 Topham St., Tarzana, Calif. 91356.

**Circle Reader Service #252**

## DATA MODEM

Because it makes extensive use of LSI, the 1200/5-150 modem can offer you a direct replacement for the Bell 202-C in one 4 in. square pc card. The modem is primarily intended for half-duplex operation at 1200 b/s with a supervisory channel of 5 b/s. Penril Data Communications, Inc., 960 Thompson Ave., Rockville, Md. 20852.

**Circle Reader Service #253**

## CRT TERMINAL

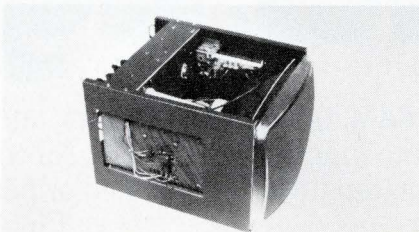


The Model 440 Data-Screen features a 72 character line—24 line screen with a display capacity of 1728 characters (or switch selectable 80 character/line—1920 character display). The unit is a direct plug-for-plug Teletype replacement. TEC, Inc., 9800 N. Oracle Rd., Tucson, Ariz. 85704.

**Circle Reader Service #254**

## TWO COLOR VIDEO MONITOR

This 14-in. monitor, the SDM5305-C14, uses a new two-color, shadow



mask CRT. The CRT features electronic driving circuits, finer electron beams, and a high-density shadow mask containing almost double the number of holes in previous masks. The monitor can display 80 alphanumeric characters/line and over 3000 characters in a single frame of data. GTE Sylvania, Electronic Tube Div., Johnston St., Seneca Falls, N.Y. 13148.

**Circle Reader Service #255**

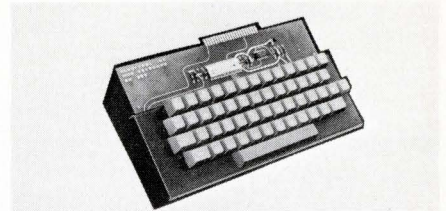
## DATA REPEATERS

The PULSECOM series of interfacing and hubbing modules interface circuits and terminal equipment of the same or different operating characteristics. Four basic models provide for hubbing, for interfacing lines and/or equipment at interface locations or at any interconnecting point, and for extension of capability of a dc operated facility. Pulse Communications, Inc., 5714 Columbus Pike, Falls Church, Va.

**Circle Reader Service #256**

## MOS KEYBOARDS

This line of rigidly constructed MOS



keyboards uses a metal mounting panel to support "Snap-Lock" data keys. Offering flexibility of key layout, the new MOS keyboards can be designed to exact requirements using MOS or TTL logic circuitry, with double shot legend buttons available in a variety of sizes, colors and legends. Electrol, Inc., 26477 N. Golden Valley Rd., Saugus, Calif.

**Circle Reader Service #257**

## MOS/LSI RCVR/XMTR

The UART (Universal Asynchronous Receiver/Transmitter) features full duplex asynchronous operation for digital data, TTL compatibility and a dc to 10,000 baud rate. The receiver section will process an asynchronous serial data stream, check for parity and frame timing, and convert the data bits to a parallel format. The transmitter section is constructed to convert parallel input data into serial asynchronous communication format, adding start, stop and parity bits. American Micro-Systems, Inc., 3800 Homestead Rd., Santa Clara, Calif. 95051.

**Circle Reader Service #258**

## PORTABLE A/N TERMINAL

The Source 2002 is a complete battery powered, portable data recording



and transmission terminal in a briefcase. The unit has full alphanumeric capability, a strip printer, and a special option which provides two way communication with an EDP center. MSI Data Corp., 1381 Fischer Ave., Costa Mesa, Calif. 92627.

**Circle Reader Service #259**



# The RAM built by hindsight.

Being the first 1024-bit MOS RAM, the 1103 was quickly designed into many systems. (A big reason we wasted little time second sourcing it.)

At the same time, we (along with many others) felt that there was plenty of room for improvement in terms of cost and performance on an overall system level.

Hence, we're now building our very own 1024-bit MOS RAM, the vastly superior MM5260.

Like the 1103, our MM5260 comes with chip-select.

*Unlike* the 1103, the thoughtfully designed MM5260 features a Tri-State logic common data I/O structure with TTL-compatible on-chip decoding and an internal sense amplifier. Plus precharge decoding to reduce system power dissipation significantly.

On a *system* level, the results speak for themselves: A power dissipation savings of almost 66% (two standard supplies versus three supplies); a 100% reduction in the number of overhead

circuits; and a 200% savings in overhead costs. All without sacrificing system speed or performance.

Finally, the new MM5260 comes in a 16-pin dual in-line package and is available for immediate delivery.

(Realizing the hard-core realities of phasing out an existing format, we will also continue to act as a volume supplier of the MM1103.)

All of which means that there's now only one place you need to write, phone, TWX or cable when it comes to 1024-bit MOS RAMs:

National Semiconductor Corp.,  
2900 Semiconductor Dr., Santa Clara,  
California 95051. Phone (408) 732-5000.  
TWX: (910) 339-9240. Cable: NATSEMICON.

(Hot-off-the-drawingboard Dept.:  
In a blatant attempt to become the most respected name in RAMs, we will soon announce a couple of highly interesting 2048-bit MOS RAMs.)

## National



<b>THIS MONTH'S IDEAS</b>	<b>PAGE</b>
Multivibrator covers 1 Hz to 1 MHz.....	58
Latch circuit provides noise immunity .....	58
Polarity inverter uses a dc voltage .....	60
Pulse differentiation with DTL gates .....	60

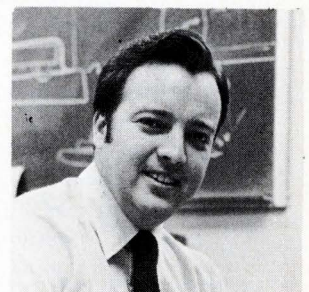
**VOTE** for the one you like best  
Write the number of the Idea you like best in the box  
on the inquiry card and send it to us.

**SEND** us practical, reproducible ideas that are original with you  
and which have been implemented with linear or digital integrated circuits.  
If we publish your idea, you win a check for \$25.00.  
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you will receive a check for \$50.00.

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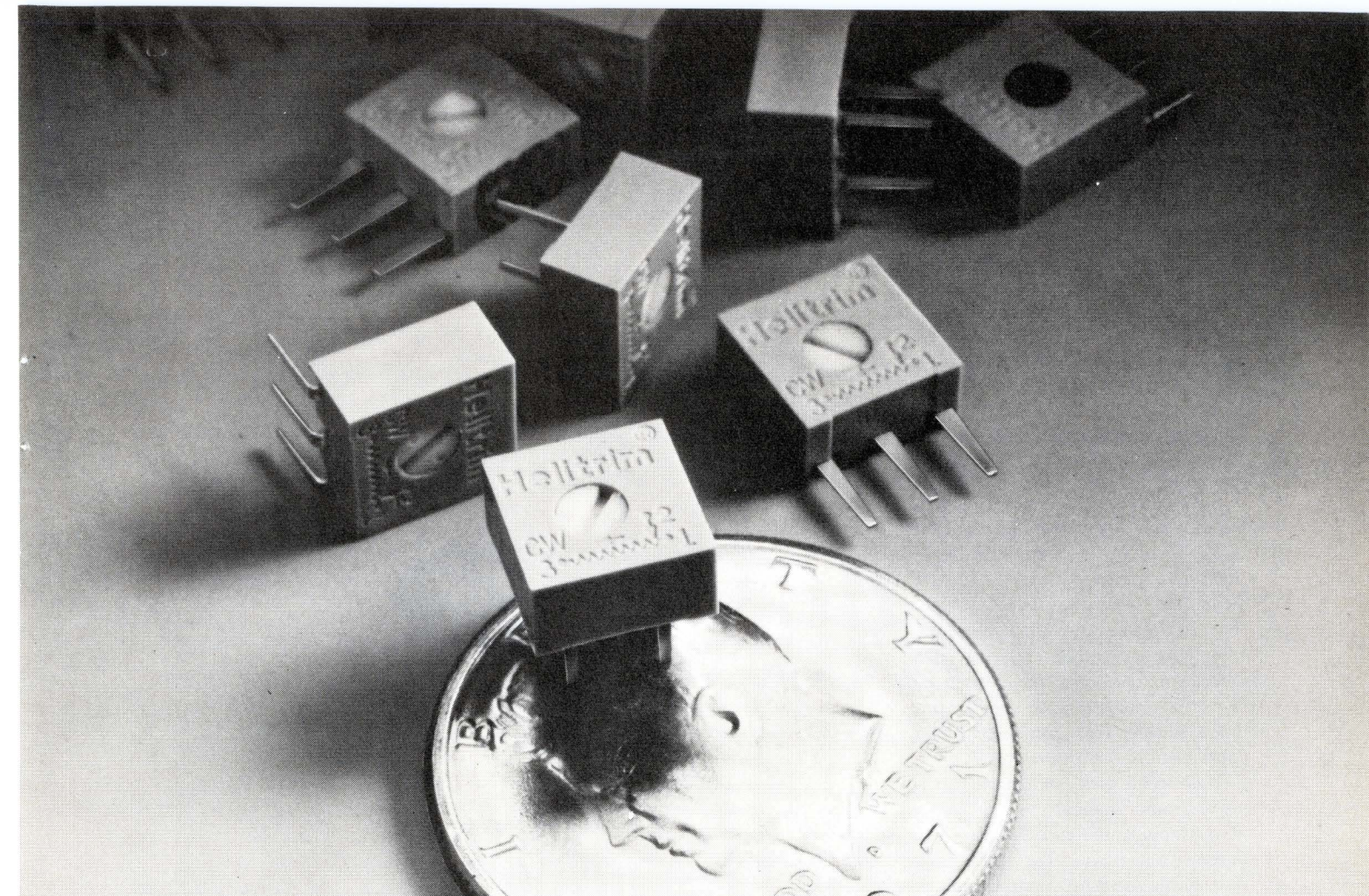
Receiving the largest number of your votes as the outstanding Idea of our June 1971 issue is "Sinusoidal frequency halving." The winning Idea was authored by Mr. Marvin K. Vander Kooi. Mr. Vander Kooi has an extensive background in applications engineering, particularly in the operational amplifier area. At the time he submitted this IC Idea to us, he was employed by Fairchild Semiconductor, in Mountain View, Calif. Since that time he has made a change and is now at National Semiconductor.











# HELIPOT BREAKS THE HALF-BUCK BARRIER.

Here they are: the best buys. Our new Series 72 single-turn  $\frac{3}{8}$ " cermet trimmers at an eye-opening 49¢ each in the 1,000 quantity. They're equally well-priced in other quantities, too. One alone costs just 70¢.

But there's also that dependable Helipot quality and performance, plus things you don't get elsewhere. Like our resistance and slider stability . . . change is less than 0.5% in the first 1,000 operation hours, progressively less thereafter. Impressive, when the life expectancy exceeds five years' continuous duty under full-rated power. And the Series 72 sealing — compatible with wave soldering, low-viscosity potting, and board washing even with chlorinated solvents.

Add the wide range of values,  $\pm 100$  ppm/ $^{\circ}$ C tempco, and off-the-shelf availability from 17 nationwide stocking points and what have you got? The best reasons in the world for requesting complete specs and data on this breakthrough line of Helipot cermet trimmers. Do it now — it won't cost you a cent.

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Circle Reader Service #29

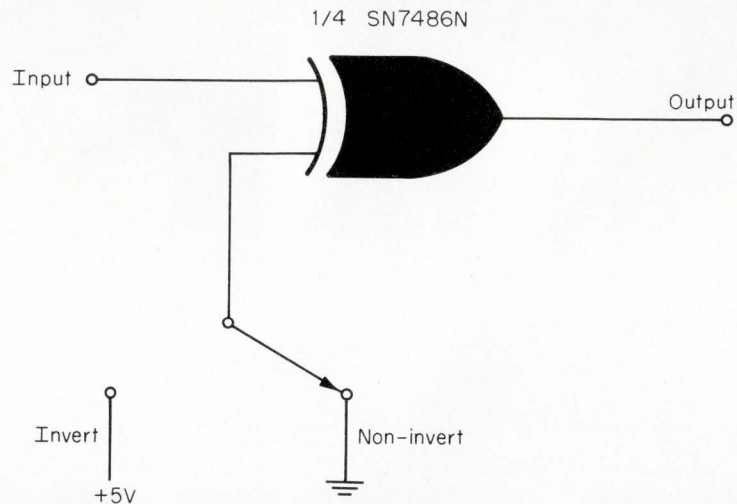


## Polarity inverter uses a dc voltage

Curtis Sewell, Lawrence Livermore Laboratory, Livermore, Calif.

You may find this simple circuit a handy addition, especially when building test equipment. In this type of application, it is often desirable to include a pulse polarity inverting switch that allows you to select positive or negative pulses. If you use the most obvious method and switch an inverter in and out of the circuit, the switch is included in the signal path. The resulting stray capacitances can cause degradation of the pulse.

This circuit uses a single exclusive-OR gate and changes the dc voltage at one input so the gate either inverts or does not invert. The result is a switchable inverter with no pulse degradation.



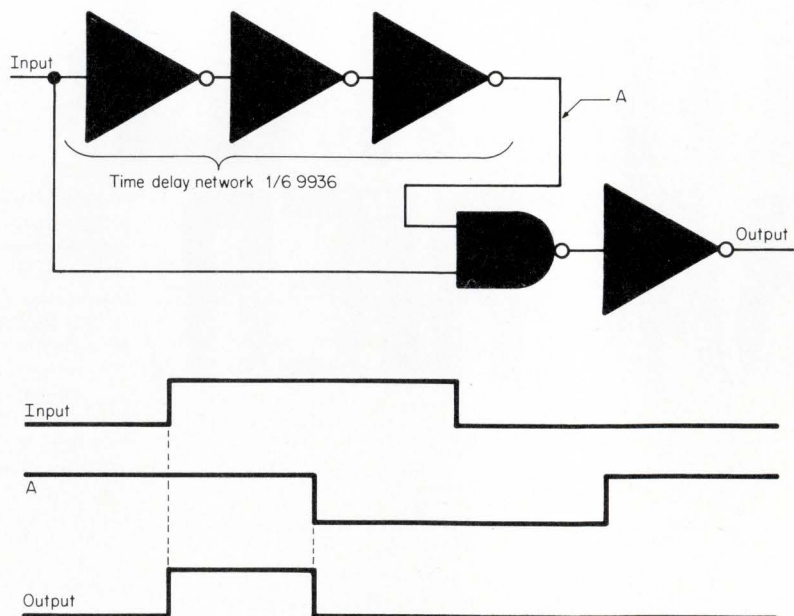
To vote for this IC Idea, circle 909 on the Reader Service Card.

## Pulse differentiation with DTL gates

Norton Markin, Elta Electronics Industries Ltd., Ashdod, Israel

Many applications require differentiated pulses to clock flip-flops, reset logic or initiate a sequence of action. The conventional approach is to use an RC circuit to do this differentiation. With this scheme, you use only DTL circuits and eliminate the need for discrete components.

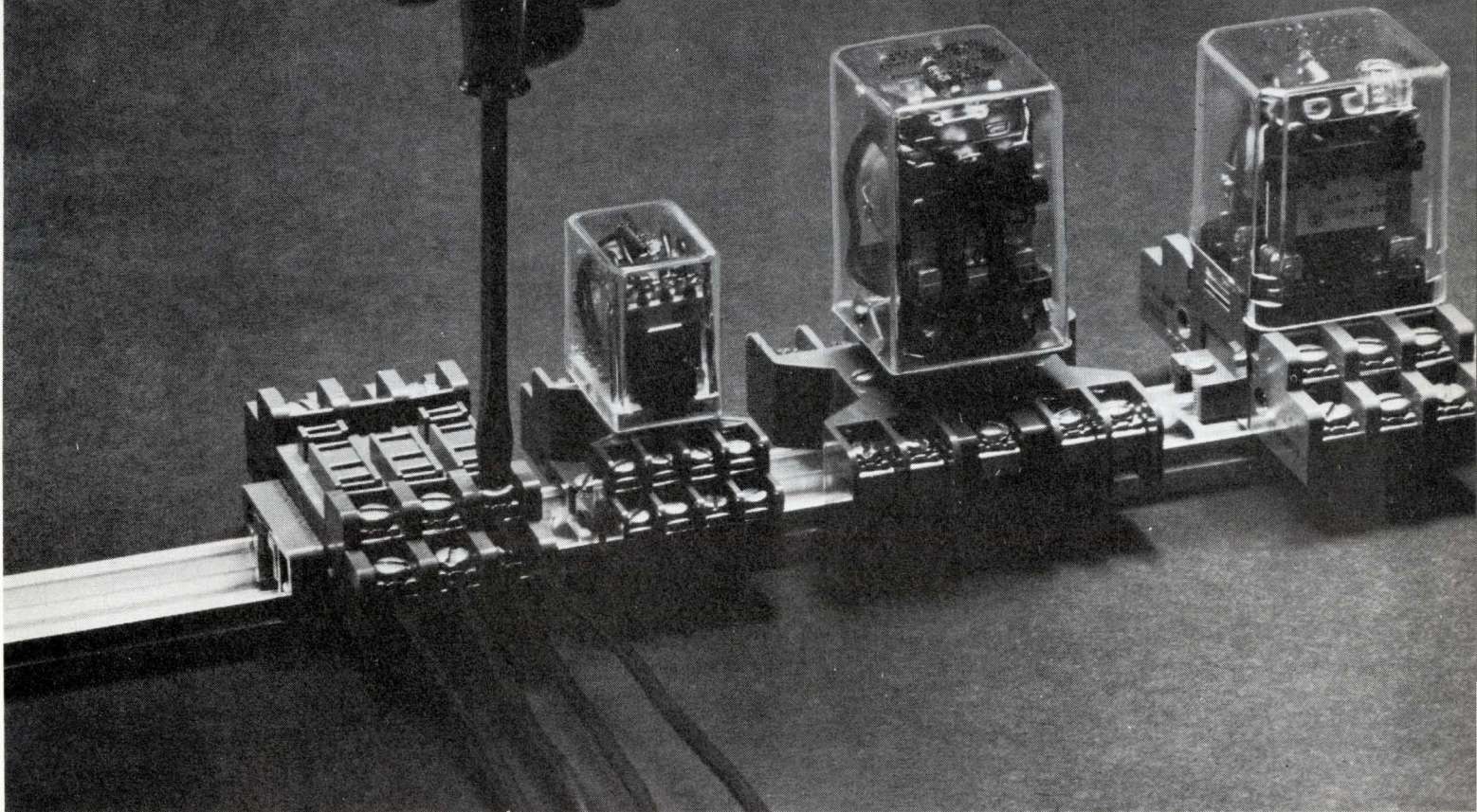
The input pulse is first sent through a time delay network consisting of a number of inverter stages. The resulting pulse, which is the delayed complement of the input, is then ANDed with the input. The output from the circuit is therefore a positive pulse which occurs at the leading edge of the input. The pulse width in the circuit shown can vary from 45 to 140 ns, as calculated from the min. and max. propagation delays of the 9936 inverter.



To vote for this IC Idea, circle 910 on the Reader Service Card.



# A screwdriver is all you need to hook up to most P&B relays



The new Potter & Brumfield socket system with screw terminals gives you a whole new world of relays to choose from.

How?

By converting octal and quick-disconnect tab termination relays to screw terminals.

Quickly. Simply.

Our system comes complete with mounting channel. Brackets. Retainers. Spacers. And sockets made of virtually indestructible Lexan.

Think of it!

Now you can use newer, more sophisticated relays.

Just as compatible as the ones you've been using. And every bit as reliable.

But they cost less. And take up less space.



(You probably can save as much as 75 percent of the space you're now using.)

This is just part of what's possible with P&B's new socket system.

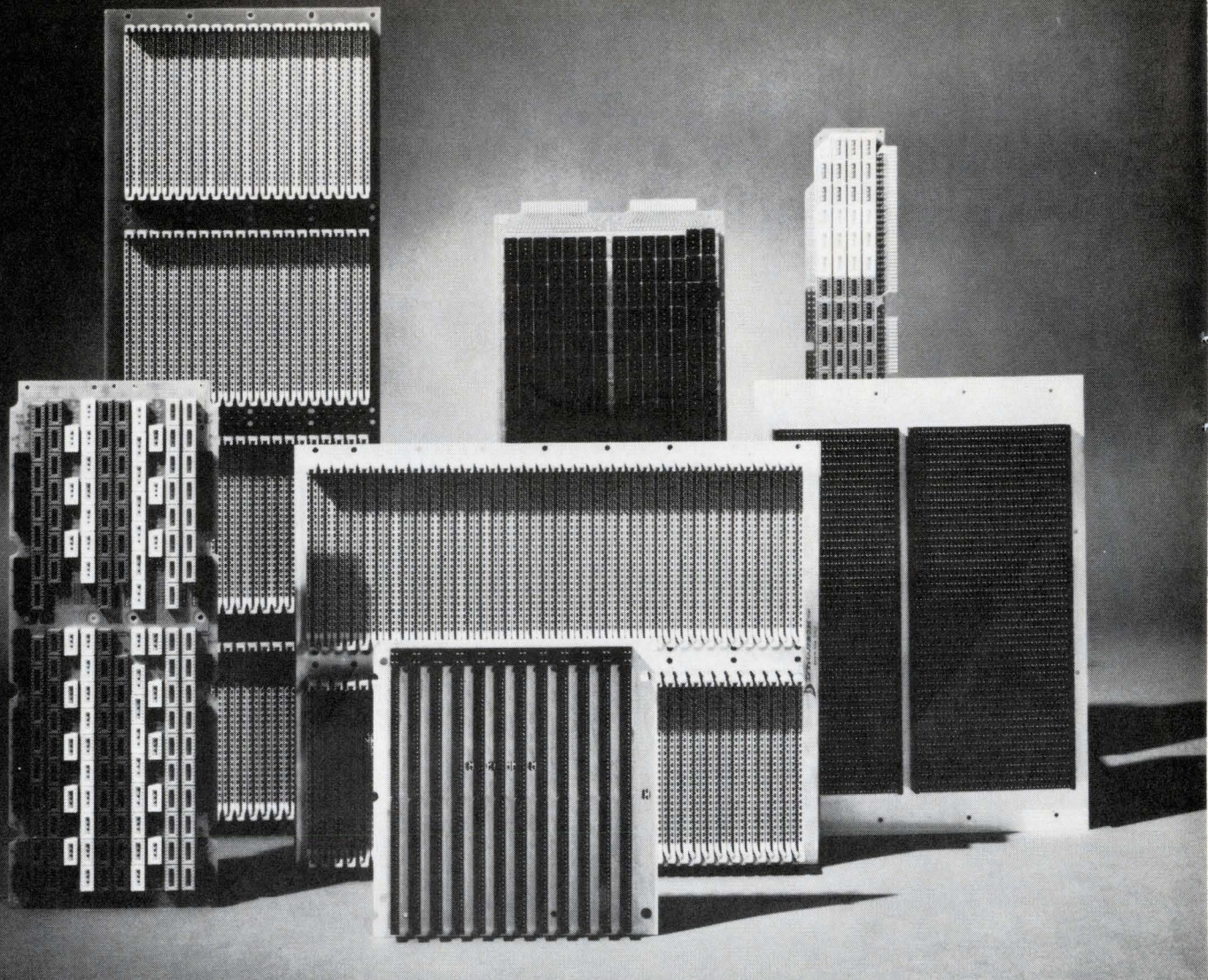
To find out more, write or call Potter & Brumfield Division, AMF Incorporated, Princeton, Indiana 47670, (812) 385-5251.

Or talk to your local P&B distributor or representative.

**AMF**  
**POTTER & BRUMFIELD**

Circle Reader Service #32





## DYNATECH PANEL ASSEMBLIES ARE READY WHEN YOU ARE

There's a simple story about why Dynatech delivers your custom back panel assemblies when you need them ■ For the past several years, we've been solving connector and interconnection problems on a custom basis. That in itself is not so unique ■ However, there was one thing we had that put us ahead. Our capabilities permitted the production of precision interconnection devices in any quantity on short notice. Part of this accomplishment came from building one of the most completely automated connector manufacturing facilities in the industry ■ Today, our flexibility encompasses all sizes, shapes and degrees of panel complexity with the common need for trouble-free operations. Working to your specifications or designed for you by our engineering department, we can consistently shave weeks off what many consider normal delivery times. And at no premium in cost ■ Time is only one advantage Dynatech offers. There are many others ■ For complete information, contact your local Dynatech engineering representative or call: (714) 547-6559. Dynatech Corp., 1225 E. Wakeham Avenue, Santa Ana, California 92702

### **Dynatech Custom Panel Assemblies**

*Mounting planes:* PC board, aluminum and laminated aluminum

*Connectors:* card edge, DIP socket and custom

*Terminations:* wrap tail and dip solder

*Options:* hand, semiautomatic and automatic wiring; bussing systems, input-output cabling, polarizing keys, card guides, ground and voltage connections, selectively gold plated contacts, and more.



**Dynatech**  
CORP.

Circle Reader Service #33



# NEW PRODUCTS

## New mini has ROM microprocessor

Though the 2100A may look simply like a more powerful 2116 to the outside world, this new general-purpose minicomputer from Hewlett-Packard has innards vastly different than those of its predecessors.

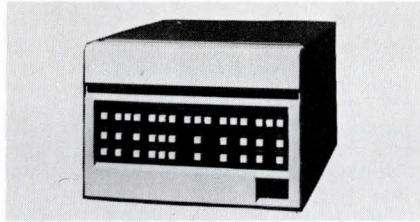
In fact, it is different than any of its mini competitors in that the 2100A has a microprocessor in the heart of its control section; and this microprocessor—which gives the machine its power and unique features—is built with ROMs, not with hardwired diode matrices.

### The computer within

The microprocessor controls the communications between the input storage, arithmetic and logic unit output, and control portions of the machine. Thus, it is an inner computer that implements the operation of program instructions, and retains full systems compatibility (including software and interfacing) with HP's previous machines—the 2114, 2115, and 2116.

The inner computer is a 196-ns, microprogrammed processor that uses a 24-bit microinstruction. Microcoding is in a three-operand format and stored in 1024 words of non-destructive read-only memory. (These ROMs are bipolar ICs with a 75-ns access time.)

The 2100A's processor uses 256 words of read-only memory; but the ROM storage has 1024 words available. So you can use three-quarters of the ROM storage for future needs: you can incorporate special instructions, add macro instructions, hardware functions, and so on. In short, you can expand the 2100A to meet your future needs and



you can tailor it, should you like, to facilitate a particular class of applications.

### Cores still here

The 2100A's mainframe memory is an HP-designed three-wire, folded-planar core structure that includes parity generation and checking. The microprocessor provides page-oriented addressing (1024 words/pg.), with two pages of direct addressing and indirect addressing to all pages.

Memory modules provide 4k, 8k, 12k, 16k, 24k, and 32k-word configurations without additional power supply or cabinetry. Cycle time is 980 ns, and word length is 16 bits, with a 17th parity bit.

### Input/output

The 2100A can use all of HP's 49 (so far) interface cards. Equipment interfaces to the computer via plug-in cards in the machine's mainframe.

There are 14 I/O channels, and an extender increases this to 45 channels. An optional multiplexed I/O lets you connect 56 devices to a 2100A I/O channel through your own controller.

Normally, data moves over an I/O bus between the peripheral gear and the 2100A's memory via two working regis-

ters (A and B, 16 bits each). As an option, should you need higher speed or program-independent transfers, direct memory access (DMA) is available.

With DMA, two channels are dynamically assignable to any of the 45 I/O channels. Operating in a cycle-stealing mode, DMA provides a maximum data-transfer rate of 1 MHz. Maximum blocks of 32k words can be transferred.

Interrupts are multilevel priority based, and the location of the interrupt processing subroutine may be anywhere in memory. Within three machine cycles after an interrupt, transfer may be made to an interrupt processing subroutine, and the return linkage stored in memory.

### Getting it all together

The 2100A inherits a wide range of software packages, including assemblers, compilers, operating systems, and subroutines. Plus, of course, all of HP's peripherals and I/O interface kits.

In short, the 2100A is a powerful mini; its microprocessor provides, as standard features, such things as extended arithmetic instructions, power-fail interrupt with automatic restart, memory parity check with interrupt, and memory check.

The cost? It's all yours for \$3750, without memory. A 4096-word memory—Model 12884A-001—adds \$3500. For more information, contact Inquiries Manager, Hewlett-Packard Co., 1601 California Ave., Palo Alto, Calif. 94304. (415) 493-1501.

**Circle Reader Service #275**

### IC SOCKET ADAPTERS

These adapters are used for mating discrete components with dual-in-line sockets. The family includes 2 8-pin, 1 12-pin, 2 14-pin, 2 16-pin, and 1 18-pin adapter. Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass.

**Circle Reader Service #276**

### MODULAR POWER SUPPLIES

Series B supplies come in five case sizes with dc outputs from 1 to 200 V and from 50 mA to 10 A. Line and load reg. are 0.1% and ripple 1 mV rms for most models. From \$60.00 to \$190.00 ea. Acopian Corp., Easton, Pa. 18042.

**Circle Reader Service #277**

### SS TIME DELAY MODULES

These relays operate from 10 to 250 Vac or Vdc with factory preset delays from 1-300 s. Packages include axial lead, plug-in, and pc mounting. As low as \$6.25 ea. in small quan. TDR Electronics, 19 Burnside St., Bristol, R.I.

**Circle Reader Service #278**



## One package for the basic measurements

A new class of digital instrument, the Multimeter-Counter, is in production at California Instruments Co. in San Diego. The CALICO Model 8420 is the first to have pushbutton selection of voltage, resistance, and frequency in one instrument. It is designed for general purpose field service or laboratory use and costs \$695 each.

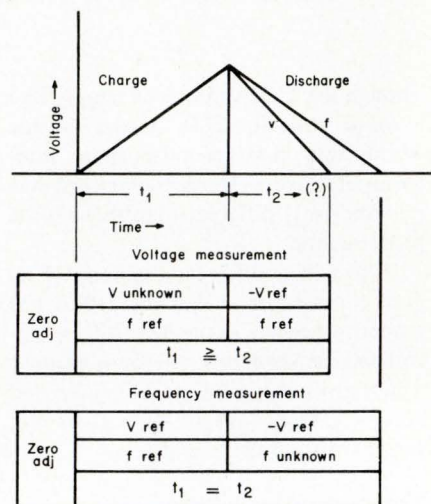
The 8420 is a 4½ digit multimeter with 50% overrange. It has four ac and dc voltage ranges from 1-1,000 V full scale, five ohms ranges from 1k-10MΩ, and four frequency ranges from 10 kHz to 10 MHz. All ranges are protected to 200 V, minimum. You can connect the inputs to a wall socket and select ranges without damaging anything.

Frequency is automatically counted at voltages from 0.1-250 V rms. There is a sensitivity control for measuring noisy signals. Voltage and resistance integration times are 100 ms, and frequency takes one second. Accuracy is 0.01% for 30 days at 25° C ± 10 C, or for 90 days at ± 5° C.

The three-step integration and ratio-metric measurement techniques are used in all ranges, i.e., the external (unknown) resistance, voltage, or frequency is compared to an internal reference. This maximizes common circuitry and

**The circuit commonality** for voltage and frequency measurements is best understood by looking at the three-step timing diagrams. Zero adjustment is automatic during  $t_0$ . When voltage is measured, the unknown voltage charges a capacitor during  $t_1$ , which is the time it takes the reference clock to fill an internal counter. The unknown voltage is disconnected from the integrator input and a reference voltage of opposite polarity discharges the capacitor. The counter counts reference clock pulses until 0 V is reached. The reference voltage is chosen such that when the unknown voltage is equal to full scale,  $t_1 = t_2$ . A lesser unknown voltage causes  $t_2$  to be some fraction of  $t_1$  proportional to full scale. The count stored during  $t_2$  is read directly as voltage by adjusting the decimal point.

Voltage was read, but time was measured. To measure frequency, the clock is switched in and out instead of the voltage, and the reference voltage used above charges and discharges the capacitor so that  $t_1 = t_2$ . The time it takes the clock to fill the counter is still  $t_1$ . The known frequency is counted during  $t_2$ ; as



long as it is less than the full scale frequency, its count is proportional to full scale and is read out directly as frequency.

minimizes redundant components. One A/D converter and amplifier are common to many circuits. A 1 MHz crystal oscillator clocks all functions. The precision resistors used in the ohms circuits are also used in the voltage circuits.

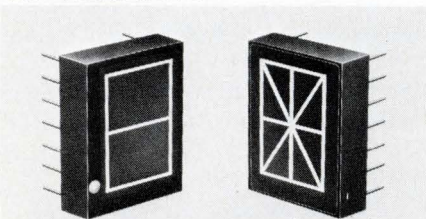
The high circuit commonality simplifies servicing. All four measurement functions are packaged on one PC board, which can be removed from the

housing by loosening two screws. Normally, at least 17 calibration points are needed for a 17 scale meter. The 8420 has only 12.

Price is \$695 each. Add \$50 for rack mounting. Delivery is from stock to 30 days ARO. California Instruments Co., 5150 Convoy Ct. San Diego, Calif. 92111.

**Circle Reader Service #279**

### DIP READOUTS



"Dynamic Duo" matching readout consists of the Dip 1050-Digital (a 7-segment device which can be mounted into a std. 0.300 in., 14-pin dual-in-line socket) and the Dip 1050A-Alphanumeric (a full 16-segment device which can be mounted in a std. 0.600 in., 24-pin dual-in-line socket). Both units operate on ic compatible 5 V providing 7000 ftL brightness. Pinlight Div., Refac Technology Development Corp., 1275 Bloomfield Ave., Fairfield, N.J. 07006.

**Circle Reader Service #280**

### HIGH SPEED RELAY

The HGQ is an ultra-high speed mercury wetted relay with low noise and bounce free operating characteristics. Response time at nom. coil power is < 950 μs. It can be driven to 500 Hz with a minimum of jitter. Contact noise settles to < 5 μV in 2 ms. C. P. Clare & Co., 3101 Pratt Ave., Chicago, Ill. 60645.

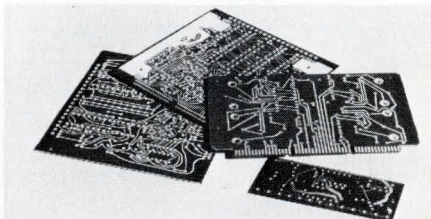
**Circle Reader Service #281**

### SCRs

IR140 and IR141 SCRs feature fast switching with unusually low losses. They also have fast turn-on time, and high re-applied dv/dt capability. Minimum critical dv/dt is 200 V/μs. International Rectifier Corp., Semiconductor Div., 233 Kansas St., El Segundo, Calif. 90245.

**Circle Reader Service #282**

### METAL CORE CIRCUIT BOARD



This pc board accomplishes heat dissipation and conduction functions plus all the normal PCB functions in one integral component. Called Metal Core Circuit Board, (MCCB), it lets you operate circuitry at power dissipation levels several times that possible with common epoxy boards while maintaining the same rise above ambient without having to use heat sink/dissipators. International Electronic Research Corp., 135 West Magnolia Blvd., Burbank, Calif. 91504.

**Circle Reader Service #283**





# It's as versatile as a PDP-8.

As far as we can tell, there's a PDP-8 computer doing every job that's ever been done by a mini-computer.

We have them in steel mills. Nuclear reactors. Automotive plants. Hospitals. Laboratories. Newspapers. Businesses. All over the place. All over the world.

So it should come as no surprise to learn that the PDP-8 is the most

popular minicomputer ever made. In fact, more PDP-8's are installed every month than all the other minis put together.

Of course, it takes more than versatility to make the PDP-8 so popular. Having more than sixty peripherals to pick and choose from helps, too. As does PDP-8's library of software. It's the biggest collection of mini-computer software in the world.

And all the big computer company backup we offer doesn't hurt either. Over fourteen hundred sales/service engineers, for example.

But a lot of it must go back to what you learned as a kid: That there's nothing like something that'll do almost anything.

Digital Equipment Corporation,  
Maynard, Massachusetts 01754.  
(617) 897-5111.

**digital**

Circle Reader Service #34



# DIGITAL VOLTMETERS

by the originator...



**MX-1**  
FIVE DIGIT  
AUTO-RANGING  
DIGITAL  
VOLTMETER

**LX-2**  
FOUR DIGIT  
AUTO-RANGING  
DIGITAL  
MULTIMETER



**MX-2**  
FOUR DIGIT  
HIGH ACCURACY  
DIGITAL  
MULTIMETER

**X-3A**  
THREE DIGIT  
DIGITAL  
MULTIMETER



**GSM-64**  
FIVE DIGIT  
MIL SPEC  
DIGITAL  
VOLTMETER

**X-2 MIL**  
FOUR DIGIT  
FLIGHT LINE  
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Circle Reader Service #35

# LAB INSTRUMENTS

## PROGRAMMABLE WORD GENERATOR

The Model 1602 is intended for variable word length applications such as memory core testing, memory exercising, and logic stimulation. It has 16 independent channels, each with a basic 16-bit word capability. Each bit or series of bits can be repeated independently, from 1 to  $99 \times 10^5$  times. Bit start and stop points are both manually controllable and remotely programmable to allow variable word length for complex pattern generation. E-H Research Laboratories, Inc., Box 1289, Oakland, Calif. 94604.

Circle Reader Service #284

## COMPUTER INTERFACE

The Model 67 interface package includes an interface card that fits any I/O slot of Hewlett-Packard and other compatible computers. Also included are cable, connectors and software (paper tape), required to operate the system. The interface was designed primarily to provide "plug-in-and-operate" capability to the Model 605 and 606 programmable waveform generators, but can be adapted for use with other programmable instruments simply by using different software. Exact Electronics Inc., 455 S.W. 2nd Ave., Hillsboro, Ore. 97123.

Circle Reader Service #285

## TRANSVERTER

The LAB 210 Transverter combines the ac measuring characteristics of an oscilloscope with the reading simplicity



of a DVM. The unit will operate on either external signals or an internal clock as a 10-bit A/D with word rates from dc through 2 MHz. One available option makes it a combination A/D and 100-word memory, while another option makes it an A/D and transient detector capable of displaying the maximum or minimum of a transient pulse. Still another option makes it a combination A/D and D/A. Computer Labs, 1109 S. Chapman St., Greensboro, N.C. 27403.

Circle Reader Service #286

## PLUG-IN CURVE TRACERS

The 5CTIN curve tracer is a plug-in unit for the 5100-Series oscilloscope systems that displays characteristic curves of small-signal semiconductor devices with power levels up to 0.5 W. A variable collector/drain sweep produces a maximum peak voltage of at least 250 V, and a base/gate step generator produces up to 10 calibrated current or voltage steps. \$350.00 Tektronix, Inc., Box 500, Beaverton, Ore.

Circle Reader Service #287



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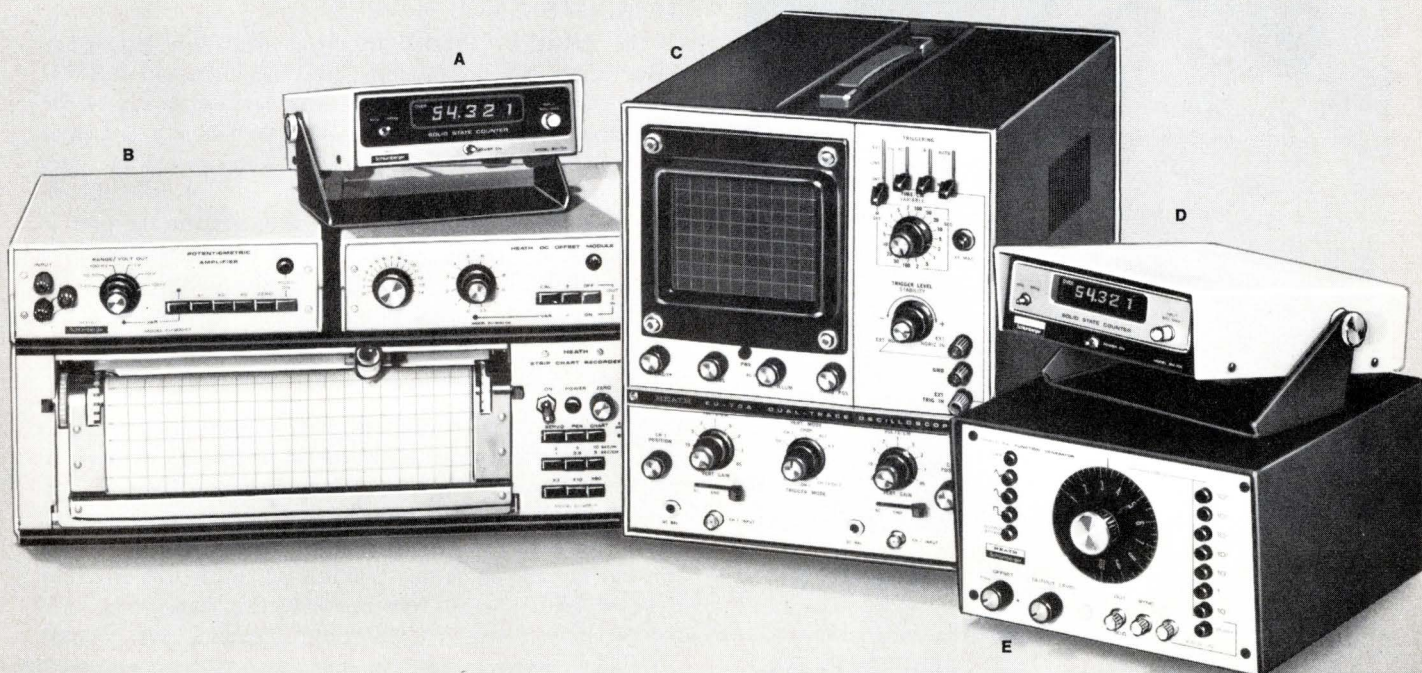
A. SM-104A 80 MHz counter. BCD output. 1 MHz TCXO with 1 ppm/yr. stability. \$500.

B. EU-205B solid-state strip chart recorder. 23 speeds, 30 in/min. to 0.2 in/hr.; 18 calibrated ranges, 1 mV to 500 V full scale. 0.5 sec. pen response. 0.1% tracking accuracy and linearity. Completely programmable. \$675.

C. EU-70A solid-state dual trace scope. DC-15 MHz. Complete dual trace capability. Triggered sweep. 18 calibrated time bases. X-Y capability. \$595.

D. SM-105A 80 MHz counter. Same as SM-104A above but without BCD output and uses a 1 MHz crystal with  $\pm 10$  ppm/yr. stability. \$350.

E. EU-81A function generator. Sine, square and triangle wave output. 0.1 Hz to 1 MHz. Linear dial. External voltage control. \$245. EK-308





## AUDIO POWER AMP ICs

These two audio power amplifier ICs are aimed at the consumer products market. The MFC9020 is rated at 2 W output



and is housed in an 8-pin stagger-lead plastic package with two heat dissipating tabs. The MFC6070 is the 1 W version and is supplied in a smaller 6-pin stagger-lead case. Input impedance is in the order of a megohm, and only 200 mV input is required for full output. Total harmonic distortion averages about 1% at rated output. Prices, in quan. of 100-up, are MFC9020, \$1.56; MFC6070, \$0.95. Technical Information Ctr., Motorola Inc., Semiconductor Div., Box 20924, Phoenix, Ariz. 85036.

**Circle Reader Service #288**

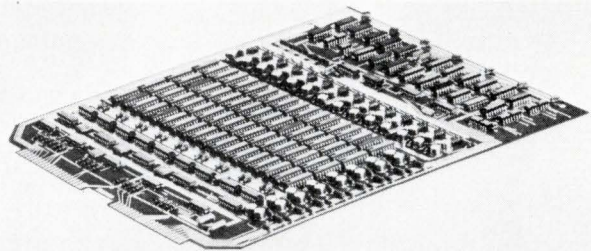
## DUAL N-CHANNEL FETS

The SMF3954, SMF3955, SMF3956, and SMF3958 are the first in a family of dual monolithic, N-channel, field effect transistors. The series is a direct replacement for the 2N3954 and the 2N5452 series but have much better thermal tracking characteristics over a broad range of operating currents and temperatures. Some of the applications for the series include video amplifiers, ultra low drift amplifiers, low noise differential amplifiers, and very high input impedance differential amplifiers. Solitron Devices, Inc., Box 1416, San Diego, Calif. 92123.

**Circle Reader Service #289**

## 73,728-BIT MEMORY CARD

The SF418 is a 72-chip MOS-RAM memory card, containing



a random access memory of 73,728 bits plus all electronics for address and data registers, and refresh and timing controls. It is available in bit/word configurations of 4,096 x 18, 4,096 x 16, 8,192 x 9 and 8,192 x 8, and carries a single unit price of \$1,859 or approx. 2.5c/bit, with OEM quantity discounts. When a customer takes delivery of his 200th SG418 card, he will also receive at no extra charge, complete art work, manufacturing drawings, test procedures and vendor parts lists. Signal Galaxies, Inc., 6955 Hayvenhurst, Van Nuys, Calif. 91406.

**Circle Reader Service #290**

## MONOLITHIC MOS DRIVERS

The MH0026/MH0026C are two-phase drivers designed to drive the big, new MOS random-access memories and shift registers at maximum speed. Six of these devices can run all the precharge and input address lines of a 100,000-bit RAM memory array. Pulse rate is typically 5 MHz with rise and fall times < 20 ns when the driver is pushing a 1200 pF load. Loads near 2000 pF can be driven 2 MHz with rise and fall time < 25 ns. With light loading, the rate climbs to 10 MHz and the rise and fall times drop to 10 ns. National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051.

**Circle Reader Service #291**

## POWER DRIVER IC

You can use this device, the 540, in applications such as driving complementary output transistors in audio power amplifiers, positive and negative voltage-regulator solenoids, relays, controlled current sources, and ultrasonic equipment. Featuring a 13 mA typical standby current, the driver can provide typically more than 120 mA output. It will drive any type of load, whether resistive, inductive, capacitive, or a combination. Signetics Corp., 811 E. Arques Ave., Sunnyvale, Calif. 94086.

**Circle Reader Service #292**

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**Circle Reader Service #37**



### LOW-POWER 64-BIT MEMORY

The Am31L01 has a power dissipation of 35 mA and has an access time of 70 ns typical. The Schottky-diode memory is organized 16 words by 4 bits, and is suited for scratch pad and high-speed buffer memory applications. Advanced Micro Devices Inc., 901 Thompson Place, Sunnyvale, Calif.

**Circle Reader Service #293**

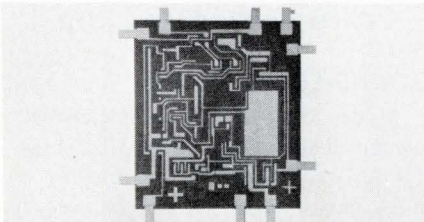
### CMOS COUNTER

The SCL54004 is functionally interchangeable with the CD4004 and equivalent types but features an accessible eighth stage, higher speed and synchronous rather than ripple-carry counting. The price is \$5.75 in quan. of 100. Solid State Scientific Inc., Montgomery, Pa. 18936.

**Circle Reader Service #294**

### BEAM-LEAD LINEAR ICs

These eight new linear devices feature



beam leads and sealed junctions. Included are an op amp, a general purpose transistor array, a differential cascade amp, a diode array of six matched diodes, a general purpose transistor array, a dual independent differential amp, a general purpose pnp transistor array and an op amp (internally compensated). RCA Solid State Div., Somerville, N.J. 08876.

**Circle Reader Service #295**

### FET FOLLOWER OP AMP

This differential FET input op amp, the FST-160 A/B, settles to 0.01% of full scale ( $\pm 10$  V) within 0.6  $\mu$ s max., when used as a follower amplifier. A min. CMRR of 20,000 and 100 V/ $\mu$ s slew rate make it a logical choice for a wide band differential amplifier, a programmable buffer or many high speed non-inverting applications. Dynamic Measurement Corp., 6 Lowell Ave., Winchester, Mass. 01890.

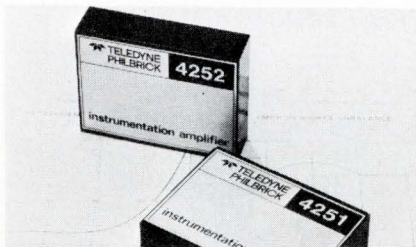
**Circle Reader Service #296**

### 256-BIT RAM

IM5523 and IM5533 are fully decoded, bipolar RAMs in a 256 x 1 organization. They feature on-chip address decoding, chip select and a 60 ns access time. The IM5533 has an uncommitted collector output, while the IM5523 provides a three-state output. Intersil, 10900 N. Tantau Ave., Cupertino, Calif. 95014.

**Circle Reader Service #297**

### INSTRUMENTATION AMPS



Designed to provide precision amplification of low-level signals in the presence of high common mode noise, Models 4251 and 4252 have a CMRR of 80 dB min. ( $A = 100$ , balanced source). Other features include a 30 M $\Omega$  common mode input impedance, 2  $\mu$ V/ $^{\circ}$ C offset drift and a bias current drift of  $< 1$  nA/ $^{\circ}$ C. Teledyne Philbrick, Allied Dr. at Rte 128, Dedham, Mass. 02026.

**Circle Reader Service #298**

### CALCULATOR ON A CHIP

The TMS1802C is a standard on-chip calculator logic circuit. The basic calculator logic unit consists of a 3520-bit read only program memory; a 182-bit RAM; a decimal arithmetic logic unit and control, timing, and output decoders. The package is a 28-pin plastic DIP. Texas Instruments Incorporated, Inquiry Answering Service, Box 5012, MS/308, Dallas, Tex. 75222.

**Circle Reader Service #299**

### PRECISION COMPARATORS

The HA-2111 Series of voltage comparators operates at current levels of 50 mA with voltages as high as 50 V. You can use them with supply voltages ranging from  $\pm 15$  V to a single +5 V power supply, with an input bias current of 60 nA. Harris Semiconductor, div. of Harris-Intertype Corp., Melbourne, Fla.

**Circle Reader Service #300**

# The 'Answer Manual' for those who apply, specify or purchase Crystal Filters

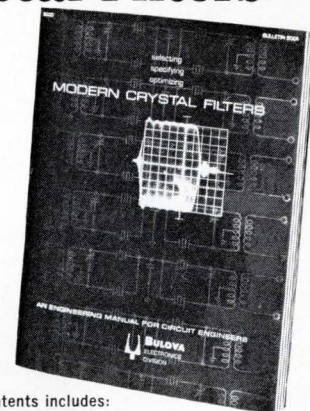


Table of Contents includes: materials on Filter Theory; Parametric Interdependence; Practical Considerations of Packaging vs. Performance; Specifying for Optimum Design; & Design Trade-offs for Maximum Performance/Minimum Cost.

Prepared by network designers who have pioneered the evolution of the modern crystal filter, this Bulova 'Answer Manual' contains all you need to know to Select, Specify and Optimize Modern Crystal Filters. Details the procedures to follow to get . . . • best performance per dollar • best performance per unit/weight • lowest cost for given requirement • highest quality, regardless of design. If your business is circuit designing, you need the Bulova Answer Manual "Selecting, Specifying, Optimizing Modern Crystal Filters." The cost to you of only \$3.00 will more than be made up by the man-hours and materials saved. Just fill out the request form below so that you can start saving immediately.



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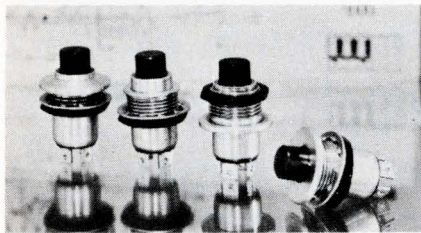
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for \$3.00 is enclosed.

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Street \_\_\_\_\_  
City, State, Zip \_\_\_\_\_

**Circle Reader Service #38**



## PUSHBUTTON SWITCHES



New P3 series miniature moisture-proof snap-action switches have  $< 10 \text{ m}\Omega$  contact resistance and over 1 million cycle mechanical life. Rated 10 A, res.: 5 A, ind. Higher than normal (120 g) contact pressure. Otto Controls Div., Otto Engineering, Inc., 36 Main St., Carpenterville, Ill. 60110.

**Circle Reader Service #302**

## COMPACT TCXO

New compact JKTCXO-7 is a low cost, low power TCXO providing excellent characteristics for time base applications. Three series offer a stability selection of  $\pm 5 \times 10^{-7}$  ( $-15^\circ$  to  $+70^\circ\text{C}$ );  $\pm 1 \times 10^{-6}$  ( $0^\circ$  to  $+70^\circ\text{C}$ ); and  $\pm 5 \times 10^{-6}$  ( $-40^\circ$  to  $+70^\circ\text{C}$ ). As low as \$42.50 ea. (1000 pc quan.). CTS Knights, Inc., Sandwich, Ill. 60548.

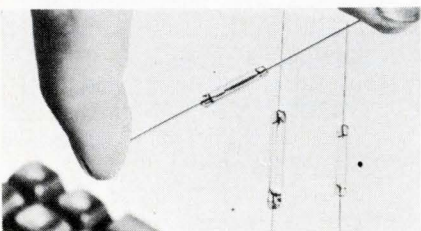
**Circle Reader Service #303**

## PHOTOBAR DETECTOR

New photoconductor called, a PB photobar detector, is for use on hybrid networks or PC board applications where you must monitor wideband or long length. Three basic materials are offered, with peak spectral responses at 515, 575, and 625 nm. \$9.20 ea. (500 quan.). Allen-Bradley Co., 1201 S. 2nd St., Milwaukee, Wis. 53204.

**Circle Reader Service #304**

## KEYBOARD REED SWITCH



The low-profile, Mark 6 is a Form A, spst switch, that can reduce the overall height of the key assembly. Glass enclosure length is only 0.560 in., and glass diameter 0.105 in. \$0.69 ea. (1000 quan.). Hamlin, Inc., Lake Mills, Wisc. 53551.

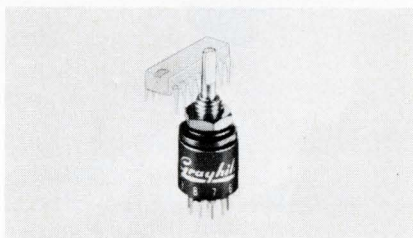
**Circle Reader Service #305**

## LIQUID CRYSTAL READOUTS

Six new developmental reflective- and transmissive-type liquid crystal readouts are for numeric display applications. They can be interfaced easily with COS/MOS ICs, feature low power drain, high readability under amb. light conditions (including direct sunlight), and a special plug-in type design without external leads. \$25.00 for TA8032 and TA8034; \$75.00 for TA8040 through TA8043. RCA Solid State Div., Somerville, N.J. 08876.

**Circle Reader Service #306**

## PRESET SWITCH



This Johnson Coded  $\frac{1}{2}$  in. dia. rotary switch is for use with COS/MOS divide by "N" IC counters. It is available in a 1-pole or a 2-pole version of the Series 50. Grayhill, Inc., 543 Hillgrove Ave., La Grange, Ill. 60525.

**Circle Reader Service #307**

## HEAT SHRINKABLE TUBING

Type ST100 is a thin-walled flexible tubing made from high temp. PVC, with a continuous duty rating of  $105^\circ\text{C}$ . It meets MIL-I-23053B/2 as well as the applicable portion of Mil-I-0310. Cole-Flex Corp., 91 Cabot St., West Babylon, N.Y. 11704.

**Circle Reader Service #308**

## BI-DIRECTIONAL COUNTER

Series 800 counter provides an accurate digital display of shaft position of incremental shaft encoders. It has a LED display for long operating life and TTL ICs for high noise immunity. Encoder Products Co., 1240 Logan Ave., Costa Mesa, Calif. 92626.

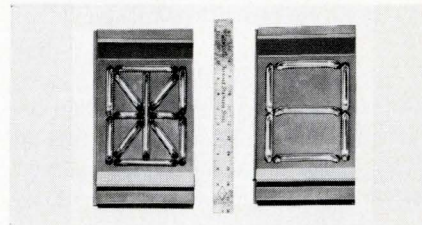
**Circle Reader Service #309**

## POWER SUPPLY FOR IC'S

Model 50A, a miniature ( $3 \times 4 \times 6\frac{3}{4}$  in.) dc supply is for IC's, logic circuits, and test equipment. Eleven models are available 3 to 30 V, 2 to 5 A. Electrostatics Inc., 7718 Clairemont Mesa Blvd., San Diego, Calif. 92111.

**Circle Reader Service #310**

## 7 AND 13 BAR DISPLAYS



These numeric and alphanumeric displays feature 6, 12, and 24 in. character heights in either 7 or 13 bar configuration. They are well suited for information displays, and system status boards. Inputs are TTL compatible. Power Technology, Inc., Box 4403, Little Rock, Ark. 72204.

**Circle Reader Service #311**

## DUAL-OUTPUT CONVERTERS

WW4.0 series units convert 115 Vac, 400 Hz power to any desired dual output voltage between  $\pm 3$  and  $\pm 30$  Vdc at full load current of 4.00 A/output. Abbott Transistor Laboratories, Inc., 5200 W. Jefferson Blvd., Los Angeles, Calif. 90016.

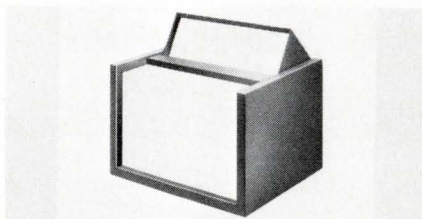
**Circle Reader Service #312**

## SOUND-LEVEL METER

Model SPL-103 is a completely self-contained sound-level meter that is useful for rapid surveys and checks on noisy environments. It can be used either directly on the site or remotely with its detachable microphone placed in areas where the danger sound-level is exceeded. Columbia Research Labs, Inc., McDade Blvd. & Bullens Lane, Woodlyn, Pa. 19094.

**Circle Reader Service #313**

## INSTRUMENT ENCLOSURE



"Flip Top" cabinet has a retractable viewing surface that provides additional "read-off" space. The "Flip Top" section is activated by slight pressure applied to the front edge of the hood. Normal pressure on the unit will return it to its closed position and secure it in place. Bud Radio, Inc., 4605 East 355th St., Willoughby, Ohio 44094.

**Circle Reader Service #314**



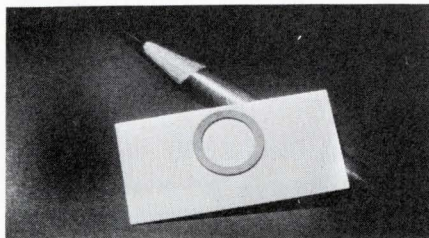
For quick information use the reader service card inside the back cover.

#### INDUSTRIAL REED RELAY

Offered in both latching and non-latching versions, the Series R relay has a mechanical life of more than 1 billion operations, bifurcated contacts for increased reliability, high sensitivity, and fast response for operation to 500 Hz. Babcock Electronics Corp., 3501 N. Harbor Blvd., Costa Mesa, Calif. 92626.

**Circle Reader Service #315**

#### MOS/LSI PACKAGE



This 40-lead Cer-Dip MOS/LSI edge mount package is for quick plug-in and interchangeability in high-density circuit applications. It has a thick film die attach area, which eliminates the need for the costly gold perform. Owens-Illinois Electronic Materials Group, Box 1035, Toledo, Ohio 43601.

**Circle Reader Service #316**

#### IC BOARDS

Boards come in any shape, size, or configuration.  $V_{cc}$  and ground planes are plated on opposite sides of the boards with optional or committed  $V_{cc}$  /ground pins. Scanbe Mfg. Corp., 3445 Fletcher Ave., El Monte, Calif. 91731.

**Circle Reader Service #317**

#### SPRAYABLE DIELECTRIC

Castall 343 is a conformal spray coating for use between semiconductors and heat sinks. It has a low thermal resistance of  $0.2^{\circ}\text{C}/\text{W}$ , and a high dielectric strength of 1000 V/mil. About \$15.00 a qt. Castall, Inc., Weymouth Ind. Park, East Weymouth, Mass. 02189.

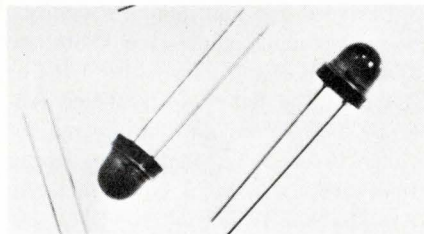
**Circle Reader Service #318**

#### FLUX FOR MICROELECTRONICS

Here is a non-spattering, low fuming, mildly activated flux, especially designed for micro-electronic uses. Micro-flux No. 5004 is applied by brushing, dipping, spraying and other normal methods. Alpha Metals, Inc., 56 Water St., Jersey City, N.J. 07304.

**Circle Reader Service #319**

#### SOLID-STATE LAMP



Solid-Lite® red light emitting lamps use the high efficiency electroluminescence from gallium phosphide diodes to obtain bright, wide-viewing-angle properties. Type OSL-3 lamp has an optical power output of 225  $\mu\text{W}$ , equivalent to 4.5 millilumens, at 15 mA. OPCOA, Inc., 330 Talmadge Rd., Edison, N.J. 08817.

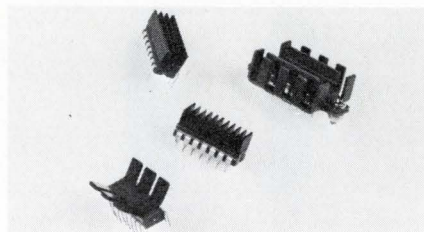
**Circle Reader Service #320**

#### SS RELAY

Model 640-1 SerenDIP™ is a fully isolated, bipolar output, totally ss relay in a TO-116 dual-in-line package. The spst, four terminal device is capable of bounceless switching up to 0.1 A @ 50 Vac or dc, and at switching rates up to 100 kHz. \$4.45 ea. (1000 pc quan.). Teledyne Relays, 3155 W. El Segundo Blvd., Hawthorne, Calif. 90250.

**Circle Reader Service #321**

#### DIP HEAT SINKS



These heat sinks are for 14- and 16-pin DIPs. The 6007A is a two-piece unit that provides for heat removal from both top and bottom surfaces of the DIP. The one-piece 6010, 6011, and 6012 sinks can be bonded to the top of the DIP with thermally conductive epoxy after assembly. Thermalloy Co., 8717 Diplomacy Row, Dallas, Tex. 75247.

**Circle Reader Service #322**

#### LOW PROFILE KEYSWITCH

MOD 220 has both audio and tactile feedback along with the ability to accomplish up to 10-level diode encoding and rollover within the keyswitch. Average bounce is  $<25 \mu\text{s}$ . Universal Technology, Inc., 29 Commerce Ct., Verona, N.J. 07044.

**Circle Reader Service #323**

# Reliable White, gaussian Noise



## Solitron's MSD-8256

A tiny all solid state high output noise module offering grassy, gaussian noise of unusually uniform spectral density, with an output of 1 to 1.5 vac into 200 ohms. Operates from 10 KHz to 200 KHz within  $\pm 3 \text{ db}$ , and from 50 KHz to 150 KHz within  $\pm 1/2 \text{ db}$ . Maximum current flow only 75 milliamp. Functions from  $-30^{\circ}\text{C}$  to  $100^{\circ}\text{C}$  with a maximum  $\pm 3 \text{ db}$  output variation.

Other units with differing package designs, dimensions and inputs available, from 10 Hz to more than 8 GHz, operating over narrower and broader bandwidths. Modules with peak to rms ratios of 5:1 — or higher on special order. Write for additional information.

## Solitron Devices, Inc.



256 Oak Tree Road  
Tappan, N.Y. 10983 (914) 359-5050

**Circle Reader Service #39**



## WIREWOUND TRIMMER



TPW and TPS series Ohmitrim™ trimmers have a nominal 1 W rating and are offered in values ranging from 10 to 20 kΩ. Model TPW is lead-screw operated and Model TPS is slide operated. Ohmite Mfg. Co., 3601 W. Howard St., Skokie, Ill. 60076.

**Circle Reader Service #324**

## FLEXIBLE CABLE SYSTEM

Here's a lightweight, flexible cable system that minimizes emi/rfi/emp by effectively reflecting or attenuating radiation of electromagnetic and electric (E&H) fields. The system is easily modified and field repairable. Amphenol SAMS Div., Bunker Ramo Corp., 9201 Independence Ave., Chatsworth, Calif. 91311.

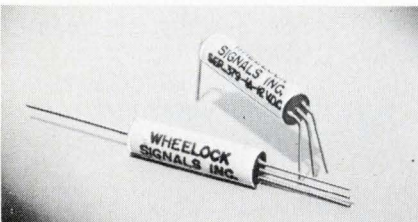
**Circle Reader Service #325**

## HYBRID TRANSISTOR

The J01001 provides 70 W of CW power in a broadband fixed tuned circuit over any 70 MHz increment from 30 to 200 MHz. Guaranteed specs are 70 W at 180 MHz, 28 Vdc; 6 dB gain; 70% eff.; 146 W diss.; and infinite vswr at 60 W, 28 V. \$67.50 ea. (100 pc. Quan.). TRW Semiconductor Div., 14520 Aviation Blvd., Lawndale, Calif. 90260.

**Circle Reader Service #326**

## NEEDLE RELAYS



Series 372 glass reed relays occupy only 0.02 in.<sup>3</sup>, measure 0.19 in. in dia. and weigh only 1.1 g. Contact rating: 7 Wdc @ 150 V or 250 mA; contact resistance: 100 mΩ; release time: 0.06 ms @ rated voltage. Wheelock Signals, Inc., 273 Branchport Ave., Long Branch, N.J. 07740.

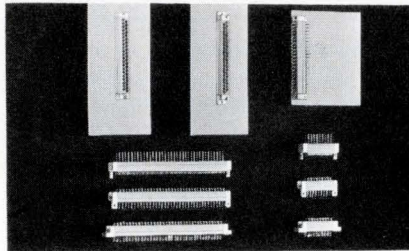
**Circle Reader Service #327**

## CONTROL KNOBS

Designed for multiple-turn controls, these two new spinner-type knobs are available in diameters of either 1.764 or 2.262 in. The RB-67-4-CT-M and RB-67-5-CT-M knobs may be ordered for either ¼ or ⅜ in. shaft sizes. Rogan Brothers, Inc., 8025 N. Monticello Ave., Skokie, Ill. 60076.

**Circle Reader Service #328**

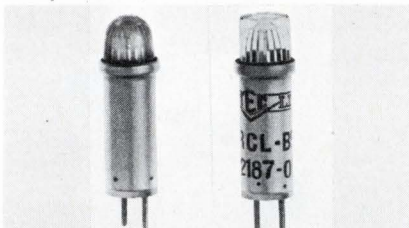
## PRINTED CIRCUIT CONNECTOR



Most important feature of this two-piece metal-to-metal connector family is a new low withdrawal force (1 to 6 oz.) Varicon™ hermaphroditic contact which meets the requirements of Mil-C-55302. Series 8219 has contacts on 0.050 in. centers. Connector sizes are 18, 30, 36, 42, 54 and 72 contacts. Elco Corp., Willow Grove, Pa. 19090.

**Circle Reader Service #329**

## LED CARTRIDGE LITE



TEC-LITE L-1015 directly replaces incandescent cartridge lamps without circuit modification. It is available in five models covering 5.0, 6.3, 10.0, 14.0 and 24 V supplies. \$1.25 ea. (500 to 999). TEC, Inc., 9800 N. Oracle Rd., Tucson, Ariz. 85704.

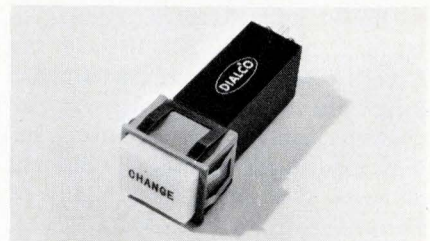
**Circle Reader Service #330**

## WIDE CAVITY PACKAGES

You can now get wide cavity 28- and 40-lead composite MOS packages with up to 44% more chip area. Both the AISPak brand packages are now available with 0.240 in.<sup>2</sup> cavities to accommodate the increasing use of larger chips. They are 0.040 in. deep. American Lava Corp., Chattanooga, Tenn. 37405.

**Circle Reader Service #331**

## SNAP-ACTION SWITCH



Series 513 DPDT snap-action switch comes in both momentary and alternate action models. The switch circuit is insulated from, and independent of, the lamp circuit. Dialight Corp., 60 Stewart Ave., Brooklyn, N.Y. 11237.

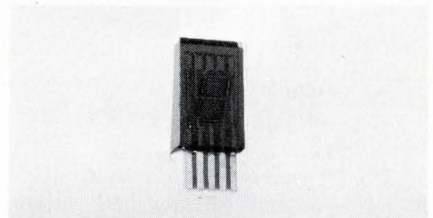
**Circle Reader Service #332**

## CIRCUIT BREAKERS

Hydraulic-magnetic breakers (Series AM1 and series JA) provide economical over-current protection, without nuisance tripping, for tape drives, printers, and other DP equipment which require high-magnitude and sub-harmonic starting surges. Heinemann Electric Co., 133 Magnetic Dr., Trenton, N.J. 08602.

**Circle Reader Service #333**

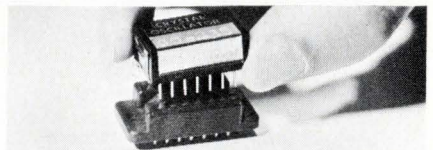
## NUMERIC DISPLAY



The EP3 is a 7-segment display with single plane, wide angle viewing. It has a 0.70 x 0.295 in. overall size, 500 ftL at 20 mA brightness and a low 480 mW power consumption. \$11.00 ea. (100 pcs). European Electronic Products Corp., 10150 W. Jefferson Blvd., Culver City, Calif. 90230.

**Circle Reader Service #334**

## CLOCK OSCILLATOR



The CO-238 DIP-compatible oscillator drives 10 TTL loads at any freq. in the 3-30 MHz range. It provides stability better than ±0.0025% over 0° to 70°C. Vectron Laboratories, Inc., 121 Water St., Norwalk, Conn. 06854.

**Circle Reader Service #335**



# LINEARS FROM RAYTHEON SEMICONDUCTOR.

## OP AMPS

702 Wideband Amplifier  
709 General Purpose  
725 Precision  
741 General Purpose  
747 Dual 741  
748 Uncompensated 741  
4709 Dual 709  
  
101 General Purpose  
107 Compensated 101  
108 Precision\*  
  
4558 Dual 741 (Available in mini-DIP)  
  
4531 High Slew Rate  
4131 Precision  
4132 Micropower

## INTERFACE ELEMENTS

710 High Speed Comparator  
711 Dual High Speed Comparator  
9622 Dual-Line Receiver  
7520 Series Core Memory Sense Amplifiers  
4431 Dual-Line Receiver  
1414 Dual 710 with strobes  
1488 Quad Line Driver / EIA Compatible\*  
1489 Quad Line Receiver / EIA Compatible\*

## VOLTAGE REGULATORS

723 Precision Positive / Negative  
109 +5V Voltage Regulator\*

## RAYTHEON LINEARS ARE AVAILABLE IN ALL POPULAR PACKAGES:

Plastics — 8-pin mini DIP; 14 and 16-pin DIPs  
T Pak — TO-3; 8 and 10-pin TO-5  
Ceramic — 14 and 16-pin DIPs; 10 and 14-pin flat packs

When you need a linear IC of any kind, give us a call. We've got what you want. We're stronger than ever in both proprietary and off-the-shelf linear circuits.

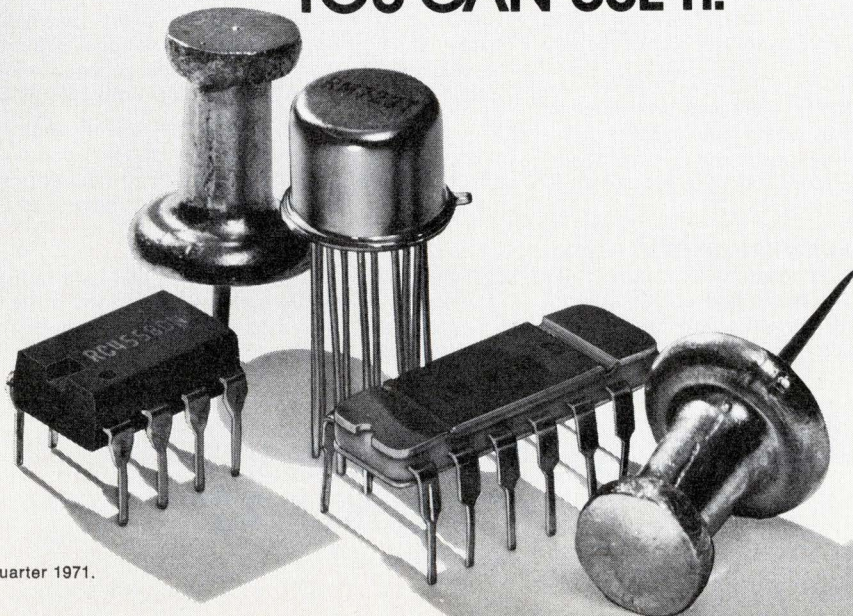
And that's not our only strength. Raytheon Semiconductor has changed. Our new technical team is deeply involved in development programs to provide new design tools. New digital analog interfacing that allows active switching and amplifying. Greater integration of external parts in voltage regulators. Super Beta process for precision op amps.

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Raytheon Semiconductor, 350 Ellis Street, Mountain View, California 94040. (415) 968-9211.



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AND TACK IT ON YOUR WALL.  
YOU CAN USE IT.**



Circle Reader Service #42



# fact

this fully loaded, high-performance DMM equals or exceeds the performance of any other comparable DMM,



yet costs you 50% to 80% less.

The three major circuit advances incorporated into our Tri-Phasic™ Digital Multimeter eliminates 3 of the 4 principal sources of error found in all conventional dual-slope DMM's. Taken together, these circuits offer a sophisticated simplicity that dramatically reduces the cost of producing high-performance DMM's . . . and provide an *order-of-magnitude improvement* over previous techniques.

Very briefly, here's what the three circuit advances do:

**TRI-PHASIC™ A/D CONVERSION** — prevents any component or circuit, except the internal voltage standard, from affecting accuracy of the A/D conversion.

**ISOPOLAR™ REFERENCE STANDARD** — delivers both positive and negative reference potentials by using only a *single*, unipolar reference source. The premium-grade, aged, current-servoed zener reference is optimally stabilized by a temperature-controlled oven.

**RATIOHMIC™ 4 — WIRE RESISTANCE MEASUREMENT** — eliminates expensive, error-contributing constant-current sources. By comparing the drop across the unknown to that across internal precision standards, under identical current conditions, the circuit is rendered insensitive to current variations.

Our fully loaded, top-of-the-line 5½-digit, high-performance DMM — Model 2540 — sells for \$1195 (*that's 50% to 80% less than all comparable DMM's*). And it's one-half the size, one-half the weight, and consumes one-half the power. Standard features include:

DC Volts; AC Volts; 2 and 4-wire resistance; Voltage Ratio; Auto Ranging; Auto Polarity; Isolated BCD Outputs; Remote Triggering; and Remote Ranging. Basic accuracy ( $\pm 0.001\%$  f.s.  $\pm 0.007\%$  of reading  $\pm 1$  LSD) is guaranteed for 6 months.

**There's a Tri-Phasic™ DMM for every purpose.** Every useful combination of capabilities and optional features is available as a *standard*. There are 8 models to choose from: four 5½'s from \$995 to \$1195; and four 4½'s from \$580 to \$675.

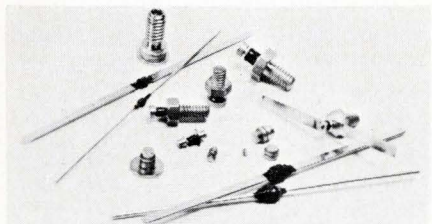
Now you can buy two or three 5½'s with what you would have spent for any other comparable DMM. If you were planning to buy a high performance 4½, you can now afford a high performance 5½ . . . and still get the most advanced DMM available.

Call Bob Scheinfein at (617) 246-1600 to arrange for a demonstration . . . or, for complete specifications, write Data Precision Company, Audubon Road, Wakefield, Massachusetts 01880. We'll give you the facts. They'll speak for themselves.

 **DATA PRECISION**  
...years ahead



## PIN DIODES



These new diodes satisfy strict harmonic or intermodulation product requirements in vhf or uhf systems. They feature low insertion loss, fused-in-glass high reliability and the additional advantage of low distortion switching and attenuating. Unitrode Corp., 580 Pleasant St. Watertown, Mass. 02172.

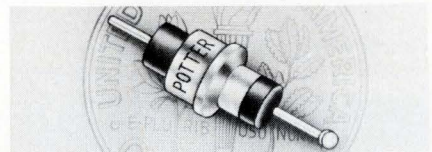
**Circle Reader Service #336**

## 3½ DIGIT DPM

Model 300 is a bipolar meter featuring small size, < 4.2 W power consumption, < 2  $\mu\text{V}/^\circ\text{C}$  zero drift, < 30 ppm/ $^\circ\text{C}$  full scale drift and zero warm-up time. It will meet all its specs over a range of  $-10^\circ$  to  $+60^\circ\text{C}$ . Electro-Numerics Corp., 2961 Corvin Dr., Santa Clara, Calif. 95051.

**Circle Reader Service #337**

## EMI FILTERS



New subminiature emi filter is for use in cable tv, uhf, vhf, microwave and related applications. Typical attenuation is over 50 dB throughout the range from 200 MHz to 10 GHz. Under 40¢ ea. in quan. The Potter Co., 500 W. Florence Ave., Inglewood, Calif. 90301.

**Circle Reader Service #338**

## SELF-TEST RELAYS

Two new 4pdt, 5 A plug-in relays eliminate the use of circuit testers. The Built-In "Test" Lamp 1310N has a neon lamp that glows each time the coil is energized—or indicates a circuit fault when the lamp fails to glow. The Push-to-Test 1310B with an easily-accessible, insulated button lets you check the relay circuit performance without applying voltage to the coil. Guardian Electric Mfg. Co., 1550 W. Carroll Ave., Chicago, Ill. 60607.

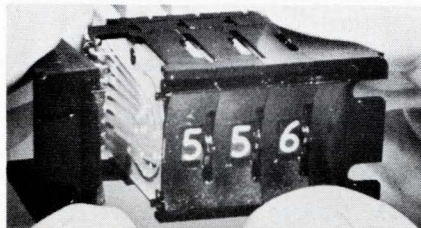
**Circle Reader Service #339**

## EDGEMOUNT PACKAGES

"InCert," a new edge-mount family, consists of a 64-lead double-sided package with 32 contacts on each side; a 40-lead miniature double-sided package that measures 1 x 0.750 in., and a 40-lead single-sided package that is interchangeable with edge-mount packages already in use. Metalized Ceramics Corp., West River Ind. Park, Providence, R.I. 02904.

**Circle Reader Service #340**

## THUMBWHEEL SWITCHES



These miniature switches snap together, side by side, on 5/16 in. centers. They come in a range of switching versions which include encoders, decoders, decimal and 1248 BCD code—straight and complementary. The A. W. Hayden Co., 232 N. Elm St., Waterbury, Conn. 06720.

**Circle Reader Service #341**

## DIP PLASTIC PACKAGES

Both of these new low-cost 14 and 16 lead DIP packages will plug in on 0.300. One is a pin-type package available with either tin or gold plated pins. About 16¢ in quan. The other is a standard lead frame "ic" type. 13¢ ea. in quan. U.S. Electronic Services Corp., Holgar Ind. Park, Clifton Heights, Pa. 19018.

**Circle Reader Service #342**

## LOW PROFILE PC RELAY

MPC series, dc operated relay is only 0.400 in. high but affords power handling capability of 50 W/pole. Standard coil voltages are 6, 12, 24 and 48 Vdc. Allied Control Co., Inc., 100 Relay Rd., Plantsville, Conn. 06479.

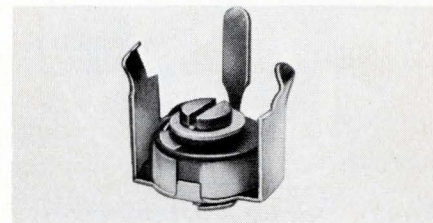
**Circle Reader Service #343**

## AC VOLTAGE CONTROL

New 201 Series (2.0 A) and 291 Series (3.0 A) variable autotransformers come in single, two gang and three gang units for single and multi-phase applications. Staco, Inc., 2240 E. Third St., Dayton, Ohio 45403.

**Circle Reader Service #344**

## BOTTOM TUNING CAPACITOR



Series 9320 variable ceramic capacitors are designed for those hard to get to places. Their construction allows "through the board" adjustment. Available in ranges from 1.7 to 50.0 pF. with working voltage of 250 Vdc. Operating temp. range,  $-55^\circ$  to  $+85^\circ\text{C}$ . \$1.35 to \$0.25 ea. Johanson Mfg. Corp., 400 Rockaway Valley Rd., Boonton, N.J. 07005.

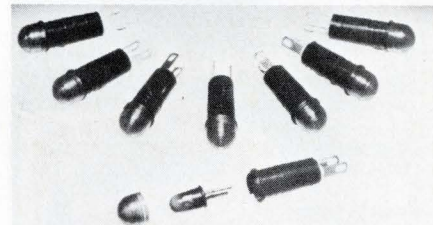
**Circle Reader Service #345**

## PLUG IN TIMER

Model 1017 time delay relay is available with "unit timing" indicating light in eight adjustable time ranges from 0.02 to 1000 s. Industrial Solid State Controls, Inc., 435 W. Philadelphia St., York, Pa. 17405.

**Circle Reader Service #346**

## LED INDICATOR



Series "QT/D-200 LED indicator, intended for application in computer and control display applications, has a micro-grooved lens which scatters but does not attenuate light. Marco-Oak Industries, subs. of Oak Electro/Netics Corp., 207 So. Helena St., Anaheim, Calif. 92803.

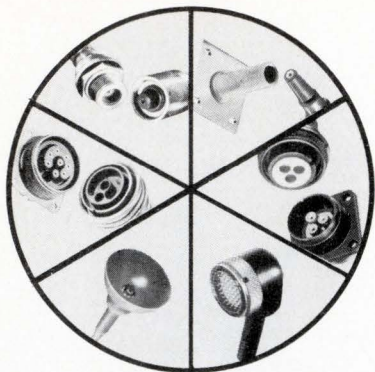
**Circle Reader Service #347**

## SCOPE-LIKE LOGIC PROBE

Model LP-520 has a color coded visual readout system at the probe tip that indicates logic "1", "0" and "pulse" (50 ns or greater) conditions in any 5 V digital logic system. Gating, memory and high speed pulse detection features are available as add-ons. Kurz-Kasch, Inc., 1421 S. Broadway, Dayton, Ohio 45401.

**Circle Reader Service #348**





## Need Special Connectors or Cable Assemblies?

High voltage corona problems?  
Pressure or temperature problems?

**DESIGNERS AND MANUFACTURERS OF  
INTERCONNECTION SYSTEMS FOR:**

High-voltage • Corona-free • High-altitude  
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SPECIAL TEST  
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**put your components**

**through**

**environmental**

**test**

**quickly**



The INRECO static handling system is a must for testing I.C.'s, diodes, transistors, resistors, etc. Devices are clipped to special test P.C. cards which are inserted into inner door mounted connectors. With the door in place and the required temperature in the chamber, all the devices may be powered and/or sensed individually by the scanner plugged into connectors on the door exterior.

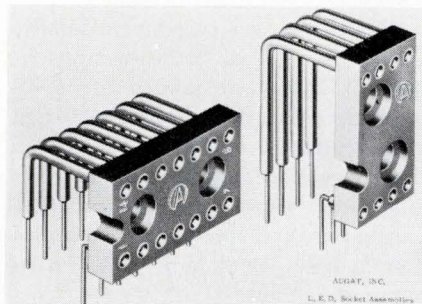
## INRECO

INDUSTRIAL REFRIGERATION CO., INC.  
8940 Ellis Ave., Los Angeles, Calif. 90034  
Telephone Area Code (213) 870-6664

Circle Reader Service #45

# NEW PRODUCTS

## LED SOCKETS



Low profile socket assemblies for 8- and 14-lead displays have BeCu contacts, gold over nickel plated, insuring low contact resistance. Molded socket material is glass-filled nylon. Augat Inc., 33 Perry Ave., Attleboro, Mass. 02703.

Circle Reader Service #349

## HIGH-ENERGY BATTERY

The G2600-B has a nominal voltage of 3.2 V and operates on a flat discharge curve. It will operate for 500 h at from  $-40^{\circ}$  to  $75^{\circ}\text{F}$  with a continuous current drain of 1 mA and for 400 h at  $165^{\circ}$ . Honeywell Inc., Power Sources Ctr., Montgomeryville, Pa. 18936.

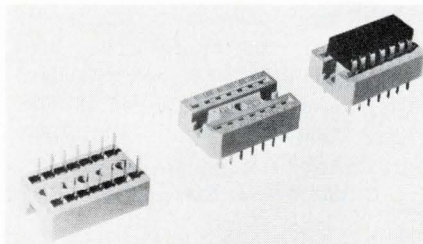
Circle Reader Service #350

## HIGH INDUCTANCE COILS

These inductors are for compact audio filters, tone control circuits, amplifiers and wherever space is at a premium. Series RL1124 is  $\frac{1}{4}$  in. in dia. x  $\frac{1}{2}$  in. long and Series RL1123 is  $\frac{1}{2}$  in. in dia. x  $\frac{3}{4}$  in. long. Both offer a range of 10 mH to 5 H. \$0.40-\$0.90 ea. (1000 pc. quan.). Renco Electronics, Inc., 240-A Old Country Rd., Hicksville, N.Y. 11801.

Circle Reader Service #351

## DIP SOCKETS



These 14 contact DIP sockets, have a low 0.218 in. profile to provide high density packaging. Large tapered entry channels aid IC insertion and reduce lead damage. Vero Electronics, Inc., 171 Bridge Rd., Hauppauge, N.Y. 11787.

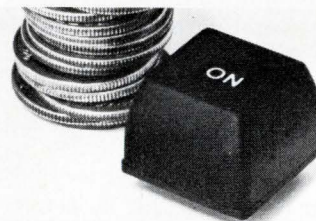
Circle Reader Service #352

## RESISTOR NETWORKS

Type FDP networks (with up to 15 resistive elements) come in std. 14 and 16-pin molded DIP configurations, with power ratings of up to 0.05 W/resistor. Maximum diss. is  $\frac{1}{2}$  W/package over an operating range of  $-55^{\circ}$  to  $+150^{\circ}\text{C}$ . Range is from  $10 \Omega$  to  $1 \text{ M}\Omega$ /resistor. You have a choice of thick film or discrete film resistive elements. Dale Electronics, Inc., Box 609, Columbus, Nebr. 68601.

Circle Reader Service #353

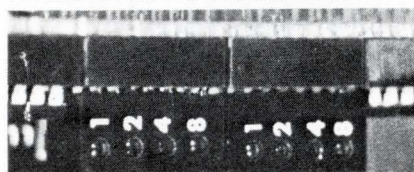
## KEYTOP SWITCH



FASTouch is a light-pressure, low-profile (0.53 in.) miniature keytop switch. It has an actuation force of only 2 oz. (with no contact bounce), a contact rating of 0.5 A @ 28 Vdc max., and a contact resistance of 25 m $\Omega$ . Kam Corp., 845 Commercial St., San Jose, Calif. 95112.

Circle Reader Service #354

## LOGIC STATUS INDICATOR



The LL-4S provides four bits of side viewing logic status in a DIP package. It is TTL/DTL compatible and each input represents only one unit load. \$6.00 (500 quan.). Unique Devices Co., Box 786, Reseda, Calif. 91335.

Circle Reader Service #355

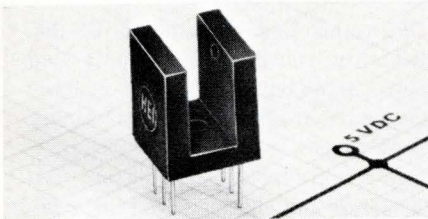
## FLAME-RETARDANT PLASTIC

Merlon® SE series (SE-2100 and 2200) of flame-retardant polycarbonate resins meet increased performance requirements of the appliance, telecommunications, aircraft, electrical and electronic industries. They are recognized by the UL as self-extinguishing, Group 0, and have a higher degree of flame resistance than most thermoplastic resins. Mobay Chemical Co., Pittsburgh, Pa. 15205.

Circle Reader Service #356



#### OPTICAL SWITCH



New optical switches (Model OS-391S-060 or -200) have Schmitt Trigger circuitry and custom thick film phototransistor and an infrared LED (light emitting diode). The circuit has typical square wave rise times of 50 ns and fall time of 200 ns. HEI, Inc., Jonathan Industrial Ctr., Chaska, Minn. 55318.

**Circle Reader Service #357**

#### DIGITAL PANEL METER

Compact, 3 1/2 digit, ac type digital panel meter Model 4335-F has a single plane 7-bar fluorescent wide angle display, indicating capabilities to 1999, accuracy from  $\pm 0.2\%$  to  $\pm 1\%$  and a display response time of 3 s. \$320.00. Triplitt Corp., Bluffton, Ohio 45817.

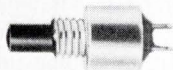
**Circle Reader Service #358**

#### CONDUCTIVE COATING

New, conductive polyurethane coating for use in severe environments is a single-package, heat-activated product, curing at temps of 250°-350°F. It offers resistivity values in the range of 200-500  $\Omega$ /in. Lord Corp., 1635 W. 12th St., Erie, Pa. 16512.

**Circle Reader Service #359**

#### MICROMINIATURE SWITCH



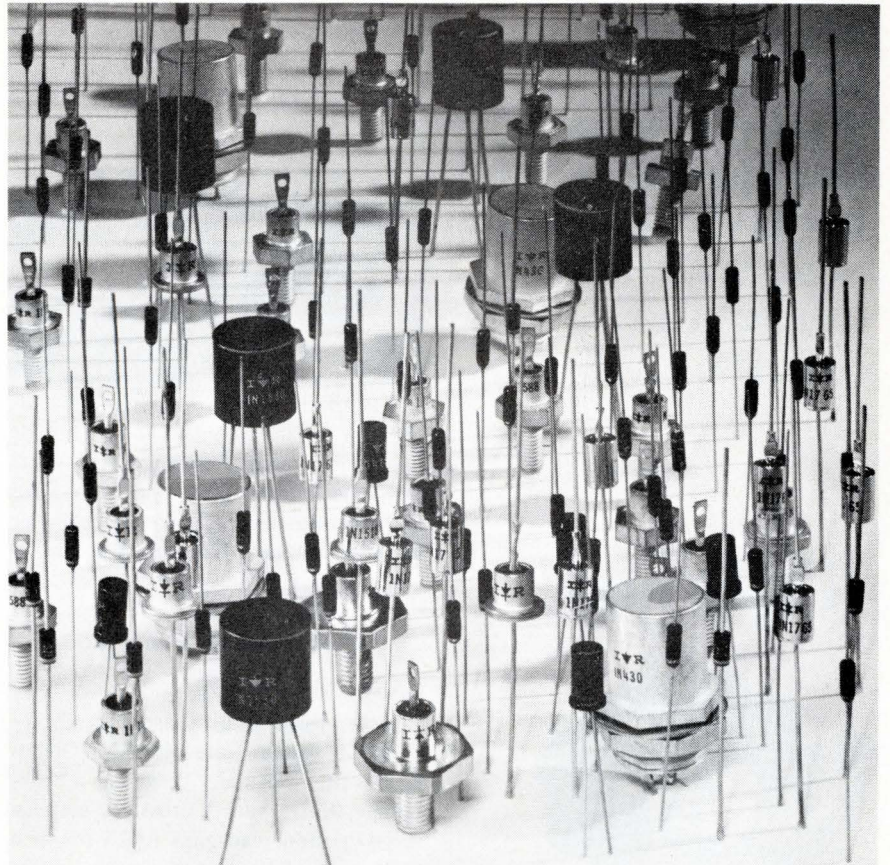
Model 8631 butt contact spst momentary pushbutton switches are only 0.635 in. in overall length with a 0.251 in. dia. Contacts are rated at 1/2 A res. load at 115 Vac or 28 Vdc; or 1/4 A at 250 Vac. C&K Components, Inc., 103 Morse St., Watertown, Mass. 02172.

**Circle Reader Service #360**

#### PHOTO-RESIST STRIPPER

Dynastrip 400 stripper removes a wide range of photo-resists. Miscible with water, it is non-oxidizing, reducing or corrosive to metals used in photo-etching. Munciplex, Inc., 10 Stuyvesant Ave., Lyndhurst, N.J. 07071.

**Circle Reader Service #361**



## When it comes to a dependable Zener source...

Rely on IR, the quality house that's been supplying them all, and then some, since Day One!

Why burden yourself with having to search-out and deal with a number of limited-line suppliers, when you can depend on IR to deliver any Zener type (even those hard-to-get types nobody else can provide), in any voltage tolerance, in any quantity, to the most stringent MIL specs or in commercial versions... and deliver them when you need them.

Packages — we've got them all, from 150mW "glass" case all the way up to 50-Watt configurations, and everything in-between. Voltages — we supply them all, from 2.0 to 200 Volts in tolerances as low as 1%. And, when it comes to reference devices, we can provide just about any voltage from 5.9 to 49.6 Volts, with temperature coefficients to 0.0005%/°C.

We've been making quality Zeners since their inception, that's why we're in the best position to fulfill any and all of your Zener requirements!

Popular types are stocked locally by IR Authorized Industrial Distributors, everywhere. And, if you can't find exactly what you need right off-the-shelf, chances are we can deliver it post-haste directly from the factory.

**INTERNATIONAL RECTIFIER** 

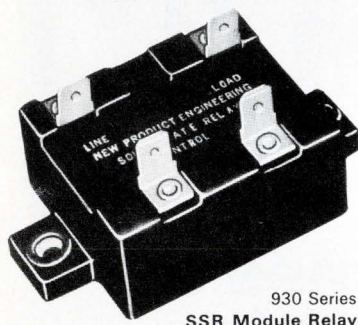
Semiconductor Div., 233 Kansas St., El Segundo, CA 90245 • (213) 678-6281

**Circle Reader Service #46**



The people that buy from us wondered why we didn't have a low-profile isolating Solid State Relay that was TTL compatible...

Right now!



930 Series SSR Module Relay

So we made it Right now! And are ready to deliver Right now!

At our prices—and you can't beat that. Write for the data.

Also ask about our:

- Dry Reed Switches
- Proximity Detectors
- D.I.P. Reed Relays
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- Solid State Relays
- Electronic Module Boards

If you don't have our condensed catalog—TWX or write for one.

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**NEW PRODUCT ENGINEERING, INC.**

A Subsidiary of Wabash Magnetics, Inc.

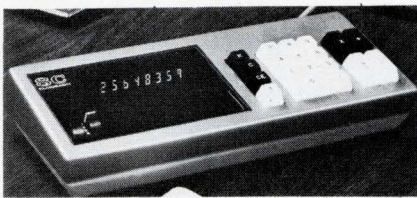
First and Webster Streets  
Wabash, Indiana 46992  
Telephone (219) 563-2191

TWX 810-290-2722

Circle Reader Service #40

## SYSTEMS

### ELECTRONIC CALCULATOR



The Eldorado 8C is a desk-size machine with an 8-digit readout, full 4-function keyboard, constant key, overflow and minus signs, and both fixed and floating decimal. And, it sells for less than \$200.00. Eldorado Electrodata Corp., 60 Chalomar Rd., Concord, Calif. 94520.

Circle Reader Service #362

### CASSETTE HEADS

New Mini-Digital Cassette heads for 0.150 in. systems, are offered in "read-after-write" format. They use a technology which reduces crossfeed between the write and read gaps to 2%-4% at a tape speed of 10 ips and a write current of 150% of saturation compared with previous crossfeed levels of about 20%. Nortronics Co., Inc., 8101 Tenth Ave., N. Minneapolis, Minn. 55427.

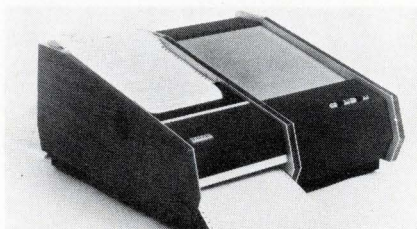
Circle Reader Service #363

### WRITABLE CONTROL STORES

Omn-ROM units let you modify on site, in real time; under keyboard, console or software control, the contents of your ROM—and to do so as many times as is necessary to debug or to optimize your software. After the new contents are in place the unit operates as a true ROM. Memory Systems, Inc., 3341 W. El Segundo Blvd., Hawthorne, Calif.

Circle Reader Service #364

### COMMUNICATIONS PRINTER



This 100 line/m data communications printer terminal fills the price/performance gap between teletypewriter output devices and computer oriented line printers. Clear multiple copy print-out can be delivered at 1200 Baud over a dial-up or leased line network. Tally Corp., 8301 S. 180th St., Kent, Wash.

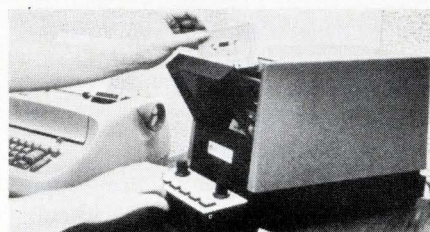
Circle Reader Service #365

### ALTERABLE ROMS

With this line of standard off-the-shelf ROMs you need only supply your desired data contents in either punched tape, cards, or tabulated listing formats. Speed ranges of 50 to 300 ns access times are available. All units are field alterable by simply separating the memory and wiring in the desired new data word. Datapac Inc., 3180 Redhill Ave., Costa Mesa, Calif. 92627.

Circle Reader Service #366

### DIGITAL RECORDER



Model 240 digital cassette recorder has a tape drive that operates wholly external to the cassette. This design makes possible a tape path similar to that of large reel-to-reel transports with precision tape guidance and positive tape tension control in all operating modes. It has a recording density of 800 bpi (ECMA compatible) and a transfer rate of up to 16,000 bps. Bell & Howell Co., Electronics & Instruments Group, 360 Sierra Madre Villa, Pasadena, Calif. 91109.

Circle Reader Service #367

### 12-BIT D/A CONVERTER

These DTL/T<sup>2</sup>L compatible MP1812A and AN1812M high speed converters come in all std. unipolar and bipolar 12 binary bit or 3 BCD digit configurations. Typical settling time to 1/2-bit accuracy is 5 μs. The AN1812M consists of a MP1812A modupac mounted on a PC card. Analogic, Audubon Rd., Wakefield, Mass. 01880.

Circle Reader Service #368

### HV MULTIPLIERS

"CRT Pac" multipliers have a metal (aluminum) case to shield rfi and permit wide latitude in mounting. Designed for use in TV receivers, monitors, radars, and various visual displays, they can be supplied as a tripler or quadrupler, with output voltages up to 36 kV. Semtech Corp., 652 Mitchell Rd., Newbury Park, Calif. 91320.

Circle Reader Service #369



## MULTIPLYING D/A CONVERTER



Model 310-12 is a 12-bit D/A converter that combines sub-microsecond settling time and multiplication in a single package. Analog settling is  $<5 \mu\text{s}$  full scale, and full scale output current is 2 mA. Hybrid Systems Corp., 95 Terrace Hall Ave., Burlington, Mass.

**Circle Reader Service #370**

## INTERFACE UNIT

"Hyper-Typer" interface unit lets you incorporate an IBM I/O Selectric typewriter into your EDP system as either an output printer or an input station. Hypertech Corp., 7343 W. Wilson Ave., Harwood Heights, Ill. 60656.

**Circle Reader Service #371**

## OPTICAL ROM MEMORY

Model 401-22 uses fiber optics rather than complex and delicate lens systems of normal optical memories. It is for applications requiring frequent program changes. Quadri Corp., 2950 W. Fairmont, Phoenix, Ariz. 85017.

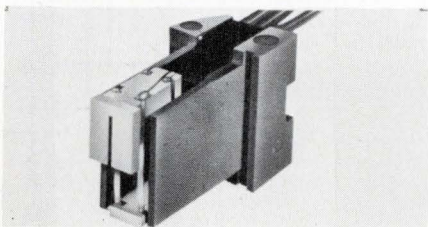
**Circle Reader Service #372**

## BATCH TERMINAL

Model 345 is a cassette magnetic tape system designed to expand the power of terminal installations, and to give the terminal user the convenience and ease of handling of cassette data storage. Dicom Industries, Inc., 715 N. Pastoria Ave., Sunnyvale, Calif. 94086.

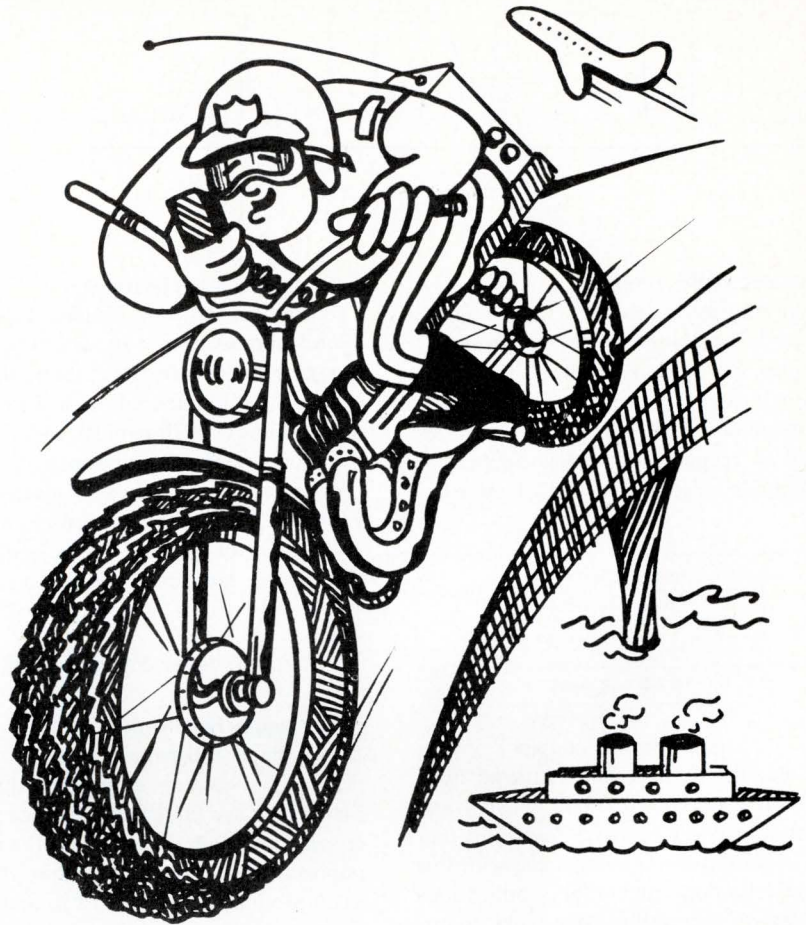
**Circle Reader Service #373**

## DRUM RECORDING HEAD



This precision, flying magnetic drum recording head uses high density barium titanate pad materials. The single channel unit costs as little as \$7.00 ea. Lipps, Inc., 1630 Euclid St., Santa Monica, Calif. 90404.

**Circle Reader Service #374**



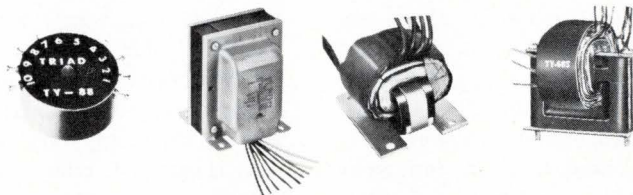
# Have power — will travel

If you're working on mobile equipment for roadway, seaway or skyway, Triad has the right transistor power supply transformer for you.

For example, if you're after high power, you'll want to take a hard look at Triad's TY-85. This sturdy, epoxy-molded toroidal unit works from a 12-volt source and puts out 350 DC milliamps at 600 DC volts from a full-wave bridge rectifier. Its specifications exceed Mil-T-27B requirements. Peripheral terminals and single mounting hole simplify installation, facilitate stacking.

The TY-85 is only one of a complete line of epoxy-molded toroidal transformers for use with 6, 12 and 28-volt battery-driven transistor inverters. The feedback winding is split on most of these units, allowing operation in either common emitter or grounded collector circuits. Operating efficiency ranges from 2000 Hz for the high power units to 5000 Hz for some of the low power types.

Triad also makes and stocks DC to DC and DC to AC open style, ferrite core transformers, and DC to AC vertical-shielded types. Engineering Bulletin TY-67 gives you complete information on all Triad transistor power supply transformers. Write for information: Triad-Utrad Distributor Division, 305 N. Briant St., Huntington, Ind. 46750.



**T Triad-Utrad Distributor**  
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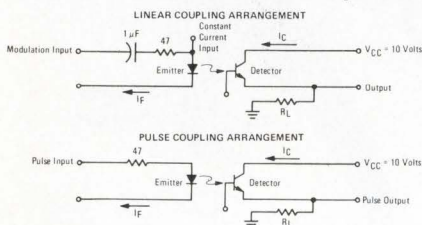
**Circle Reader Service #47**



# LITERATURE

## Optoelectronics revolution

An interesting and informative article titled "The Vanguard of the Optoelectronics Revolution" comes to us from knowledgeable sources of Motorola Semiconductor Products. Stressing the need to recognize that new application potentials exist in the field of optoelec-



## Optoelectronic coupler

tronics, the authors have directed most of their discussion to light sensors and light emitters. The article indicates that LSI capabilities are compatible with this new technology and offers applications to prove the point. Motorola Semiconductor Products, Inc., 5005 E. McDowell Rd., Phoenix, Ariz. 85008.

**Circle Reader Service #375**

## Keyboard wall chart

This keyboard selection guide is a handy wall chart summarizing essential data on keyboards for you. It's sponsored by Micro Switch and compiled by the editors of *The Electronic Engineer* (you saw it in our September issue). It gives you explanations of common terms, reference graphs of the USASCII and the EBCDIC codes, a keyboard illustration and diagrams of keyboard switches, and a useful checklist for keyboards. For your free copy of this keyboard selection guide

**Circle Reader Service #376**

## Disc recorders

One of two new brochures from Ampex describes wideband magnetic disc recorders and gives you plenty of information on applications where the recorders might be used to record and reproduce bandwidths up to 12.6 MHz. The other discusses the DE-700 phase encode package that provides every function needed to read and write phase-encoded information with automatic conversion to and from NRZ format. Ampex Corp., M.S. 7-13, 401 Broadway, Redwood City, Calif. 94063.

**Circle Reader Service #377**

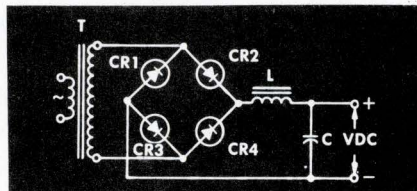
## Scan converter applications

Based on the new Hughes type H-1268B miniaturized 1-in. dia. tube, this 8-page brochure discusses the basic operation (supplemented with diagrams and dimensional drawings) and typical data processing applications of scan converters. Look for information on computer buffer-storage service, multi-sensor display, picture freeze, and scan conversion. Hughes Aircraft Co., 2020 Oceanside Blvd., Oceanside, Calif. 92054.

**Circle Reader Service #378**

## Power supply handbook

This huge 130-page catalog is more than just a catalog of power supplies. First, there are the quick reference power selection guides, giving you the most important specs in handy chart form. Then products are classified in four sections: components, systems, in-



## Choke-input filter power supply circuit

struments, and kits, and you're given thorough technical data as well as photos for each product. All this helps you to find the power supply that's really the best suited for your application. Lambda Electronics Corp., 515 Broad Hollow Rd., Melville, N.Y. 11746.

**Circle Reader Service #379**

## Recorders and accessories

Included in this short form catalog are typical applications, the advantages of bit-by-bit incremental recording vs continuous buffered incremental recording, descriptions and specs for continuous and incremental digital cassette recorders, plus accessory modules for interfacing to data terminals, minicomputers, etc. Applications covered include minicomputers, key to tape, data acquisition, remote data logging, graphic display systems, and automatic message transmission/receiving equipment. Memodyne Corp., 369 Elliot St., Newton Upper Falls, Mass. 02164.

**Circle Reader Service #380**

## DataPrint™ system

The CMC 36 DataPrint system offers you a computer-controlled, off-line means of operating IBM 1403 Model N1 line printers. This 12-page booklet describes the features and capabilities of the system, summarizes hardware specs, and depicts basic and dual system configurations for you through block diagrams. Computer Machinery Corp., 2231 Barrington Ave., Los Angeles, Calif. 90064.

**Circle Reader Service #381**

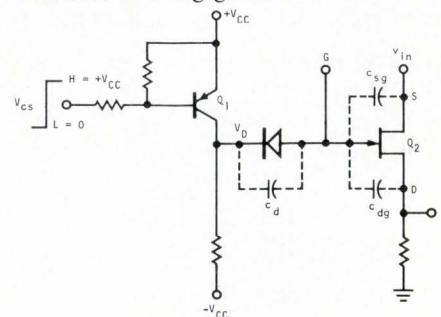
## Semiconductor applications

Articles on the selection, application, use, and maintenance of discrete power semiconductors and subsystems are available in the form of "technical tips." Suggested for design engineers, engineering managers, and purchasing managers, the data provided gives concrete information for solving design problems pertaining to power semiconductors and subsystems. The first tip, titled "Thyristor Selection and Calculations for Pulse Applications" discusses a new procedure for selecting the right thyristor for the right application using information available on data sheets. Westinghouse Electric Corp., Semiconductor Div., Youngwood, Pa.

**Circle Reader Service #382**

## Designing with analog gates

This 8-page application note shows you how hybrid analog gates can be used to obtain extreme isolation between a control or switching signal and information being gated. It's illustrated



with schematics, and it covers ac and dc swing, interfacing with TTL, and the use of referral resistors. Even applications for analog gates are covered. Teledyne Semiconductor, 1300 Terra Bella Ave., Mountain View, Calif. 94040.

**Circle Reader Service #383**



### Power supply selection

Here's the latest update of HP's famous dc power supply selection guide. The 40-page handbook lists both general-purpose and special-purpose power supplies by voltage and current in easy-to-read tables. Performance data and operating features are included, plus you get outline drawings and photos. Hewlett-Packard Co., 1601 California Ave., Palo Alto, Calif. 94304.

**Circle Reader Service #384**

### Diode guide

Detailed information is provided for all kinds of diodes in this 8-page guide. There are specs and dimensions for voltage variable capacitors, low-current Zeners and reference diodes, logarithmic and high voltage diodes, click suppressors, and precision voltage standard modules. All data is clearly arranged in chart form supplemented by occasional charts and diagrams. CODI Semiconductor, Pollitt Dr., Fair Lawn, N.J.

**Circle Reader Service #385**

### ROM system

A high-speed random access ROM system has been designed for PDP users. The subject of a new catalog, the system features capacity additions of 1024 words to 32,768 words, and includes the controls needed to interface with the PDP-8's data break, a mechanical chassis for easy rack mounting in the PDP-8 cabinet, a power supply, and a user software system. Memory Technology Inc., 83 Boston Post Rd., Sudbury, Mass. 01776.

**Circle Reader Service #386**

### Op amp design & applications

That's a lot for one book to handle, but this book does it well. The first part covers design, outlining both the factors that determine performance characteristics and the techniques available for their control. The second part goes on to applications, describing circuit operations allowing design adaptation from the specific circuits described. You'll also find sections on op amp theory and definitions of the performance parameters. It's over 500 pages long and is yours for \$15 from Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz. 85706.

### MOS/LSI catalog

Here's a huge 314-page catalog that gives you specs, schematics, comprehensive cross-reference guides, details on plastic and ceramic packages, and applications data for TI's line of



MOS ICs. There's detailed information for shift registers, read-only memories, programmable logic arrays, random access memories, and special purpose MOS circuits. Texas Instruments Inc., Box 5012, MS/308, Dallas, Tex. 75222.

**Circle Reader Service #387**

## TOOL CASES



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**Circle Reader Service #30**

## New! New!

### ORYX-50



TEMPERATURE CONTROLLED SOLDERING IRON

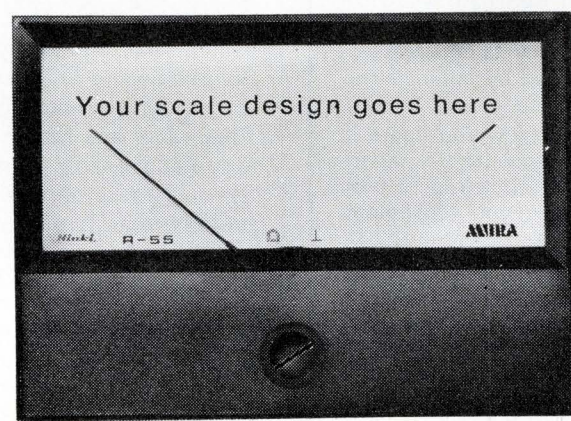
Now you can use one soldering iron for a wide variety of soldering assignments—from delicate semiconductors to heavy lugs and terminals. Built-in thermostatic control holds tip temperature constant. Adjusts in seconds (while iron is running) to any setting between 400° and 750° F. Long-life iron-coated tip furnished as standard. Twenty different tip sizes available from 1/32" to 1/4". For 115 volts AC.

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**Circle Reader Service #48**



# monolithics: the figures

Recently we've tried to dispel some of the misconceptions about monolithic crystal filters with some straight facts. Now, we'd like to augment these facts with some straight figures. Figures that should convince you that monolithics combine high performance/small size with low cost. Here goes.

1. Replacing conventional crystal filters with monolithics usually saves 10 to 20%, and sometimes as much as 50%!
2. PTI standard monolithic models save time and money. Over 20 models off-the-shelf at 10.7 MHz. Plus our new low-cost standards at 21.4 MHz. More on the board, too.
3. Designing from scratch around monolithics can save money by eliminating unnecessary parts and by optimum parameter choice.
4. No matter how you figure it, the performance of PTI monolithics makes money for you by adding value to your equipment.

It all adds up to this — higher performance at a price you can afford. Talk to us about your project. We've been making monolithics longer — and more of them — than anyone else. And we've got the figures to back it up.

**PTI**  
Piezo Technology Inc.  
2400 Diversified Way  
Orlando, Florida 32804  
305-425-1574

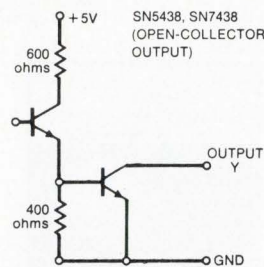
The standard in monolithic crystal filters

Circle Reader Service #49

## LITERATURE

### Core memory

The 3690 series core memory is for applications in medium and large computers. This 4-page data sheet gives you information on its high-speed performance, expandability, interchangeable modules, overall construction, core-



Typical output driver

stack features, and reliability. Specs are given as are schematics illustrating a typical input receiver and output driver. Ampex Corp., Computer Products Div., 9937 W. Jefferson Blvd., Culver City, Calif. 90230.

Circle Reader Service #388

### IC packaging panels

A revised catalog gives you 28 pages of information on high density packaging panels and related accessories for interconnecting dual in-line ICs. You're given test data in chart form, info on available options, specs, and photos and dimensional drawings for each product. Information to look for includes data on panels, enclosure and rack assemblies, plugs and header assemblies, accessories and separate pins, custom panels, and wire wrap services. Augat Inc., 33 Perry Ave., Attleboro, Mass. 02703.

Circle Reader Service #389

### IC catalog for design

This is probably the most comprehensive reference on ICs that you can find. It's the "Integrated Circuits Catalog for Design Engineers" with 1616 pages packed with design information. There are pages and pages of application data, thousands of schematics, and comprehensive circuit specs. One section discusses the MACH IV high-reliability procurement system—documents, general requirements, etc. Plus you'll find indices and cross-reference guides for just about any IC you can think of. It's hard to tell you all that's included here, but we're sure you'll find it worth the \$4.95 it sells for. Texas Instruments Inc., Box 5012, MS/84A, Dallas, Tex. 75222.

### Antenna chart

Sponsored by Watkins-Johnson, this antenna selection guide is a wall chart perfect for your office. The handy reference describes and illustrates pattern types, frequency ranges, and the characteristics and matching of antennas. You probably saw this colorful chart in the September issue of *The Electronic Engineer*, but you're welcome to an extra copy. For your free antenna wall chart, simply

Circle Reader Service #390

### Delay lines

A 20-page catalog describes a line of electromagnetic delay lines. Applications covered include data processing, sonar (ASW) traffic control systems, aerospace, and missile industries. Specs and descriptions for a variety of types are included. ESC Electronics Corp., 534 Bergen Blvd., Palisades Park, N.J. 07650.

Circle Reader Service #391

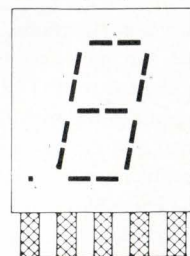
### Power amplifiers

High power hybrid audio amplifiers are the subject of a 24-page application note. Applications and performance features are provided for the amps, a new one of which includes a single-ended hybrid type, available at 10-, 20-, 25-, and 50-W continuous power, covering 20-100,000 Hz. Airpax Electronics, International Div., Box 8488, Fort Lauderdale, Fla. 33310.

Circle Reader Service #392

### Optoelectronic components catalog

Detailed data is provided for 13 new optoelectronic devices in this 12-page catalog. Typical circuit configurations, characteristic curves, and dimensional drawings accompany data on photo-



Pin configuration

transistor opto-isolators, numeric indicators and displays, light emitting diodes, and infrared emitters. European Electronic Products Corp., 10150 W. Jefferson Blvd., Culver City, Calif.

Circle Reader Service #393



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## Thermal cycling ratings

Thermal cycling ratings for RCA's 2N3055 homotaxial base silicon npn power transistors are included in a revised technical data bulletin. The rating curve enables a circuit designer to avoid transistor thermal fatigue failures during the operating life of his equipment. All data sheets from RCA will now begin to include thermal cycling ratings. RCA Commercial Engineering, Harrison, N.J. 07029.

Circle Reader Service #394

## EMI/RFI filter catalog

Types of filters covered in this 17-page catalog include button, subminiature, miniature, and feed-thru, all meeting or exceeding the requirements of Mil-F-15733. In addition, there's a new line of filters designed to meet all UL and European requirements for electronic data processing units and systems. Typical insertion loss curves are given for each model covered. USCC/Centralab, 2151 N. Lincoln St., Burbank, Calif. 91504.

Circle Reader Service #395

## Automatic testing

This 42-page catalog gives you a representative sampling of the automatic test systems and instruments made by Teradyne. You'll find data on test equipment for ICs, transistors, diodes, Zener diodes, resistors, capacitors, relays, and wiring. And there's a list of application notes discussing various aspects of testing problems that you might send for. This comprehensive catalog is offered to you by Teradyne Inc., 183 Essex St., Boston, Mass. 02111.

Circle Reader Service #396

## A new kind of keyboard

... uses a simple design and scanning technique. Very simply, when the counter reaches the appropriate key code, cross matrix continuity is sensed, the multiplexer evokes a 1-ms pulse, and the clock is inhibited by the pulse and the counter stops on the desired code. New gold "crosspoint" contacts on the keys eliminate contact failure. This brochure explains it all and gives you a step-by-step checklist of the mechanical and electrical specs basic to any complete keyboard design. Cherry Electrical Products Corp., 3600 Sunset Ave., Waukegan, Ill. 60085.

Circle Reader Service #397

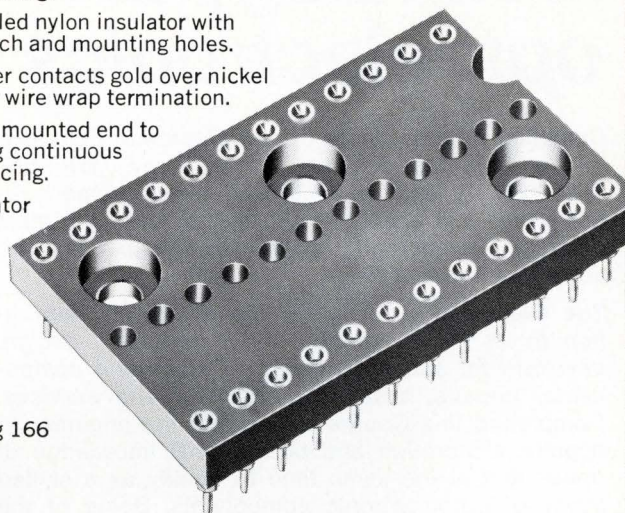
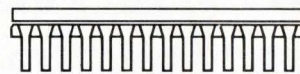
Sockets available in 24, 28, 36 and 40 contacts on .600 in. spacing between rows. Also available with 14, 16, 18 contacts on .300 inch spacing.

Molded glass filled nylon insulator with polarization notch and mounting holes.

Beryllium copper contacts gold over nickel plated in P.C. or wire wrap termination.

Sockets may be mounted end to end maintaining continuous .100 in. grid spacing.

.125 inch insulator height.



Request Catalog 166

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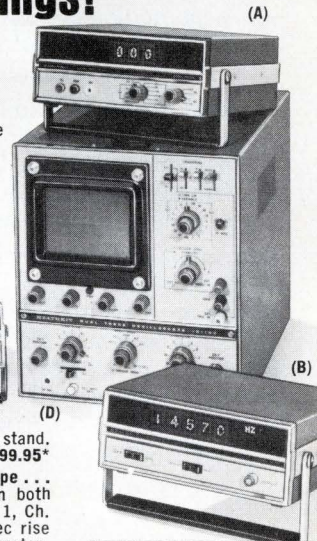
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(A) New Heathkit solid-state digital multimeter. A true lab-grade digital multimeter at about half the cost of comparable DMMs! 5 overlapping DC voltage ranges, 100  $\mu$ V to 1000 V; AC ranges, 100  $\mu$ V to 500 V; 10 ranges measure 100 nanoamperes to 2 amperes on AC or DC; 6 resistance ranges, 0.1 ohm to 20 megohms. Automatic polarity indicators. Automatic decimal point, over-range light. Precision DC calibrator furnished plus transfer method for AC calibration. Solid-state with cold cathode readout tubes & "memory" circuit for stable, non-blinking operation. Assembles in about 10 hours. Kit IM-102, 9 lbs. ... 229.95\*

New Heathkit 175 MHz scaler & counter combo... for less than \$300! (B) The Heathkit IB-101 counts from 1 Hz to over 15 MHz. Hz/kHz ranges & over-range indicator let you make an 8-digit measurement down to the last Hz. 5-digit cold-cathode readout; extremely low input triggering... less than 30 mV at 100 MHz; all solid-state with 26 ICs, 8 transistors. (C) Heathkit IB-102 scaler extends capability well into the VHF range at a price far below a 175 MHz counter. Compatible with virtually any counter. 10:1 & 100:1 scaling ratios give resolution down to 10 Hz... 1:1 ratio provides straight-through counting. Solid-state, fully regulated supplies. Carrying handle/tilt stand. Kit IB-101, 7 lbs. ... 199.95\* Kit IB-102, 7 lbs. ... 99.95\*

(D) New Heathkit DC-15 MHz dual trace solid-state oscilloscope... \$399.95\* Features rock-solid triggered sweep; full bandwidth in both automatic & normal modes; complete dual trace capability - Ch. 1, Ch. 2, chop, alternate; X-Y mode with 5% or less phase shift; 24 nsec rise time; 9-position 1, 2, 5 sequence vertical attenuator; 8 x 10 cm rectangular flat-face CRT with mu-metal shield. Kit IO-105, 35 lbs. ... 399.95\*



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Circle Reader Service #51



# NOW... a COURSE on the New technology of optoelectronics

Compiled by the editors of *The Electronic Engineer*, this is truly *the* definitive course on OPTOELECTRONICS. It is a practical and tested demonstration which will enable you to master even the most complex assignments, *many of which can now be solved for the first time!*

**The Course** is an essential technological contribution to all those involved in the research, design, development and engineering of electronic components, circuits, systems, equipment and services. Completing this Course will enable the engineer to acquire a thorough and professional knowledge of optics and at the same time to qualify as a skilled buyer of optoelectronic components. Some of the subjects covered in the Course are:

**The background** on Optoelectronics . . .

Physics of light—as applied to semiconductors . . .

Physical definitions of optoelectronic terms . . .

Materials—for both sources and detectors . . .

Sources — Light-emitting diodes — Materials, efficiency . . .

Detectors—Photoconductors (or photoresistors) photodiodes—Materials, efficiency . . .

Amplifiers—Phototransistors, photoFETS—Materials, efficiency, sensitivity . . .

**The Course** also includes many simplified, practical applications for optoelectronic components such as light choppers, modulators, signal isolators, card and paper-tape readers, counters, sorters and detectors.

**This complete**, authoritative and *timely* Course in Optoelectronics costs just \$4.00 postpaid and includes an examination for those who wish to qualify. *All who pass the examination will receive a Certificate of Completion from The Electronic Engineer.* To get your copy simply send check, cash or money order to Course Editor, The Electronic Engineer, One Decker Square, Bala Cynwyd, Pa. 19004.

E-11

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# A Course in MOS INTEGRATED CIRCUITS

The editors of *The Electronic Engineer* have just compiled a complete 9 part course on MOS technology, applications and costs which appeared originally in *The Electronic Engineer*. It is a definitive volume that provides you with all the background you need as a user or a designer to master this new technology.

This state of the art course in MOS technology presents completely authoritative, up-to-the-minute guidance in using every aspect of this dynamic science. It covers the processing of MOS circuits, applications of MOS circuits, complementary MOS, MOS memories (random access, read only, associative memories and cost) and the testing of complex MOS integrated circuits.

This course is an exclusive from *The Electronic Engineer*. *It is, in fact, the only one of its kind available.* The authors, all recognized experts in their respective fields, take you with technical precision from the fundamentals on through to the most sophisticated phases of this dramatic technology. This course is the *one* authoritative way to keep ahead in these changing times.

Order your copy of the *only* course available on the new MOS technology and manufacturing processes for only \$5.00 per copy. Send your order today to: *The Electronic Engineer*, One Decker Square, Bala Cynwyd, Penna. 19004, Dept. E-11

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Send me special quantity prices  E-11



## Optoelectronics

Texas Instruments' optoelectronics product line is covered in a 6-page brochure. Included are sources, sensors, coupled devices, standard source/detector arrays, custom sensor and emitter arrays, beam lead phototransistor arrays, and IR detectors. Salient features are provided for each. Texas Instruments, Box 5012, Dallas, Tex. 75222.

**Circle Reader Service #398**

## Parallel interface extender

The beauty of this instrument is that it makes remote communication between data processing equipment as simple as interfacing between local devices. It extends the parallel interface of the local device to the remote end, there duplicating the data, command, status, and control information in the original format and with guaranteed data integrity. This 8-page brochure gives you all the details. Paradyne Corp., 2040 Calumet St., Clearwater, Fla. 33515.

**Circle Reader Service #399**

## Digital computers

Minicomputers, peripheral equipment, and a new fast Fourier transform processor are outlined in this 16-page brochure. You'll find discussions on systems characteristics, command structure, logic descriptions, direct memory access, input/output, and software. There's a lot covered here, and all is supplemented with charts and diagrams. UniComp Inc., 18219 Parthenia St., Northridge, Calif. 91324.

**Circle Reader Service #400**

## Read only memories

Briefly, this short 4-page brochure describes a ROM series that features a combination micro-program memory and character generator. This particular feature allows a more creative design of computers, electronic switching equipment, various types of data equipment including terminal devices, and automatic control equipment. Nippon Electric Co. America Inc., 200 Park Ave., Suite 4321, New York, N.Y. 10017.

**Circle Reader Service #401**

## Ferroresonance

OEM designers—here it is—a guide to the ferroresonant technique of voltage stabilization. The 6-pager describes PRM voltage stabilizers which range from 4.5 V to 240 V dc with ratings from 60 W to 300 W. Included, too, are charts, performance graphs, and complete mechanical installation information. Kepco Inc., 131-38 Sanford Ave., Flushing, N.Y. 11352.

**Circle Reader Service #402**

## Instrument rental catalog

Hundreds of instruments are made available to you through the latest edition of this instrument rental catalog. Within its 60 pages you'll find details on analyzers, bridges, power supplies, generators, amplifiers, oscilloscopes, counters, and meters. Leading manufacturers are represented here, and there's even an index of manufacturers to help you find a particular company's product. Rental Electronics Inc., 16600 Oakmont Ave., Gaithersburg, Md. 20760.

**Circle Reader Service #403**



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**Circle Reader Service #52**

THE ELECTRONIC ENGINEER • Nov. 1971



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**Circle Reader Service #53**



# SAMPLES

## Chip resistors

Evaluation samples of these thin-film chip resistors are offered to you free, but if you decide to buy, prices range from 37¢ to \$1.45 per chip. Power dissipation varies from 50 to 100 mW according to which chip you buy. You'll find they feature low resistance values, ranging from 0.5Ω to 10Ω, making them ideal for applications in hybrid circuitry and low VSWR microwave termination. Film Microelectronics Inc., 17 A St., Burlington, Mass.

**Circle Reader Service #404**

## Rocker switch

This switch is ideal for use in consumer entertainment products, computers, appliances, instrumentation, or anywhere that snap-action is needed with a touch of style and at low cost. It may be used with the rocker knob and bracket, or without it as a toggle switch. Samples of the switch are offered to you by Stackpole Components Co., Box 14466, Raleigh, N.C. 27610.

**Circle Reader Service #405**

## Reed relays

Here's a reed relay that offers Mil-Q-9858A specs at commercial prices, magnetic shielding for high density packing, and contact resistance of less than 100 mΩ. Contacts are rated for 1 A or 250 V switching at 20 W. Automatic tooling allows prices to go as low as 29¢ in quantities of 1 million. Electronic Applications Co., 2213 Edwards Ave., So. El Monte, Calif. 91733.

**Circle Reader Service #406**

## Splicing patches and strips

These products were developed for repairing, splicing, and correcting all perforated tapes. This, of course, makes them ideal for computers, communications systems, and numerical control equipment. They're available in paper, mylar clear, and mylar opaque (black) materials, with pressure-sensitive adhesive and peel-off backing. All splicing tapes and patches are available in 5, 6-7, or 8-channel modes. A free sample kit is yours for the asking from Data-Link Corp., Box 2792, San Diego, Calif.

**Circle Reader Service #407**

## Glass zeners

You can get samples of 1, 2, and 3-W zener diodes ranging from 6.2 to 33 V. Each is packaged in a glass-to-metal, hermetically sealed DO-7 case, and they're supplied with standard or heavy leads depending on their wattage rating. Complete engineering data goes with the offer. American Power Devices Inc., 7 Andover St., Andover, Mass. 01810.

**Circle Reader Service #408**

## Continuous connector-patterns

A line of continuous connector patterns introduces advantages and time-saving features for preparing master artwork for your printed wiring boards. Seven basic patterns in three connector types (insertion, staggered, and in-line) are pre-printed on Accufilm™, an anti-static, stable based, pressure-sensitive 2-mil polyester film. Patterns may be fitted and positioned easily before removing backing, and replaced repeatedly without damage. A sample is yours from Bishop Graphics Inc., 7300 Radford Ave., N. Hollywood, Calif. 91605.

**Circle Reader Service #409**

## Insulated magnet wire

For use in computer and aerospace applications, try this Kapton polyimide insulated magnet wire. It's dependable in fail-safe systems, capable for long periods at temperatures up to 240°C and short periods up to 400°C. The film insulation exhibits dielectric strength as high as 7000 V/mil. All gauges are available from 34 to 8 AWG. Berk-Tek Inc., Box 60, R.D. #1, Reading, Pa. 19607.

**Circle Reader Service #410**

## WATS rate calculator

This WATS rate guide helps you to quickly ascertain monthly rates for full-time WATS service (either inward or outward) between any two points in the continental United States. It's easy to use, and helps define the use of WATS service which allows communication to or from all telephones in selected areas, and allows for both voice and data transmission. The calculator is pocket-size and will come in very handy. For your sample calculator, write on company letterhead to Paradyne Corp., 2040 Calumet St., Clearwater, Fla.

## Precision lubricants

This company will send you a sample of a lubricant especially selected for your specific application. Outline your needs on the lubricant recommendation card and your sample will be on its way. The catalog you receive gives you details on all types, as well as information on lubricant kits and the new aerosol lubricants including dry film lubricants, mold release sprays, and metalworking compounds. William F. Nye Inc., Box G-927, New Bedford, Mass. 02742.

**Circle Reader Service #411**

## Polyolefin

Toughness, high impact strength, outstanding abrasion resistance, chemical resistance, and excellent lubricity are qualities you'll find characteristic of Pennlon®, a new molecular-engineered polyolefin. It's an inexpensive (usually less than 10¢/in.<sup>3</sup>) high performance material that comes in a wide variety of sheets, slabs, rods, profiles, tapes, and fabricated parts. Dixon Industries, Metacom Ave., Bristol, R.I. 02809.

**Circle Reader Service #412**

## Flat cable clamps

These self-adhesive clamps are ideal for the permanent positioning of flat, flat harness, ribbon cable, and flexible cable conductors. Four standard sizes hold 1/2, 1, 2 or 3-in. wide cable up to 3/32 in. thick. They're great for cramped installations because their flat top surface allows them to be stack mounted. Samples are free. Richo Plastic Co., 5825 N. Tripp Ave., Chicago, Ill. 60646.

**Circle Reader Service #413**

## Woven cable

You get fast lead exposure for fast production at lower costs and with no damage to insulation with this woven cable. The folder illustrates lead separation methods that reduce your handling time. Insulation remains unscathed by the quick tie-off and trimming of weaves with single conductors, twisted pairs, or twisted triads. A sample piece of cable and a "quick stick" enable you to try these methods yourself. Woven Electronics, Box 189, Mauldin, S.C. 29662.

**Circle Reader Service #414**



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# Advertisers—November 1971

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<b>ACDC ELECTRONICS</b> .....	39	<b>JENSEN TOOLS &amp; ALLOYS/TELVAC</b>	
Rose Associates		<b>INSTRUMENT CO.</b> .....	81
<b>ADAMS &amp; WESTLAKE CO.</b> .....	25	Sheldon W. Gates	
Scofield, Hiers & Malone, Inc.		<b>KEPCO, INC.</b> .....	4
<b>ALLEN-BRADLEY CO.</b> .....	IFC	Weiss Adv.	
Hoffman-York, Inc.		<b>KROHN-HITE CORP.</b> .....	40
<b>AMF, INC., POTTER &amp; BRUMFIELD</b> .....	61	Ingalls Assoc., Inc.	
Fuller & Smith & Ross, Inc.		<b>LITTON INDUSTRIES, INC.</b>	
<b>AMP, INC.</b> .....	35	<b>TRIAD DISTRIBUTOR DIV.</b> .....	79
Aitkin-Kynett Co., Inc.		D'Arcy-MacManus-Intermarco, Inc.	
<b>AMPERITE CO.</b> .....	26	<b>MURA CORP.</b> .....	81
H. J. Gold Co.		Kameny Associates, Inc.	
<b>ANALOG DEVICES, INC.</b> .....	36	<b>NATIONAL SEMICONDUCTOR</b> .....	DC-16
Kalb & Schneider, Inc.		Chiat/Day, Inc.	
<b>AUGAT, INC.</b> .....	83	<b>NEW PRODUCT ENGINEERING, INC.</b> .....	78
Horton, Church & Goff, Inc.		Waldie and Briggs, Inc.	
<b>BECKMAN INSTRUMENTS—HELIPOT</b> .....	59	<b>NON-LINEAR SYSTEMS, INC.</b> .....	66
N. W. Ayer/Jorgensen/Macdonald, Inc.		Marketing Directions, Inc.	
<b>BOURNS, INC.</b> .....	29	<b>PANDUIT CORP.</b> .....	68
Marlborough Assoc., Inc.		Donald L. Arends, Inc.	
<b>BUCKBEE-MEARS CO.</b> .....	14	<b>PIEZO TECHNOLOGY</b> .....	82
Midland Assoc., Inc.		Shattuck, Roether, Frailey & Wilson, Inc.	
<b>BULOVA, Electronics Division</b> .....	69	<b>POTTER &amp; BRUMFIELD, AMF., INC.</b> .....	61
Caroe Marketing, Inc.		Fuller & Smith & Ross, Inc.	
<b>BUSSMANN MFG. Div., McGraw-Edison Co.</b> .....	30	<b>RCA, Solid State Division</b> .....	DC-6
Henderson Adv. Co.		<b>RCA, Electronic Components Div.</b> .....	BC
<b>CEA, Div. of Berkleonics</b> .....	16	Al Paul Lefton Co., Inc.	
Jansson Adv., Inc.		<b>RAYTHEON SEMICONDUCTOR</b> .....	73
<b>CHERRY ELECTRICAL PRDTS. CORP.</b> .....	DC-5, 85	Durel Adv.	
Kolb/Tookey & Assoc., Inc.		<b>ROCKLAND SYSTEMS CORP.</b> .....	IBC
<b>DATA PRECISION</b> .....	74	Fletcher-Walker-Gussell, Inc.	
Allied Adv.		<b>ROWE INDUSTRIES</b> .....	76
<b>DIGITAL EQUIPMENT CORP.</b> .....	65	Carr Eyster Assoc., Inc.	
Creamer, Trowbridge, Case & Basford, Inc.		<b>SAE ADVANCED PACKAGING, INC.</b> .....	32
<b>DIGITRAN CO.</b> .....	1	Rose Associates	
Jansson Adv., Inc.		<b>HOWARD W. SAMS &amp; CO., INC.</b> .....	15
<b>DYNATECH CORP.</b> .....	62	Aitkin-Kynett Co., Inc.	
J. R. Bloome Co.		<b>SOLITRON DEVICES, INC.</b> .....	71
<b>ELCO CORP.</b> .....	27	Tobias Associates, Inc.	
Mort Barish Assoc., Inc.		<b>SOLITRON DEVICES, INC.</b> .....	13
<b>ELECTRO SCIENTIFIC INDUSTRIES</b> .....	88	Sol Advertising	
Commark Communications		<b>SPERRY RAND—Sperry Electronic Tube Div.</b> .....	6
<b>FAIRCHILD SEMICONDUCTOR</b> .....	8, 9	Hall & McKenzie Adv.	
Carson/Roberts/Inc.		<b>TEKTRONIX, INC.</b> .....	DC-2
<b>GRAYHILL, INC.</b> .....	88	Dawson, Inc.	
Carr Liggett Adv., Inc.		<b>TELVAC INSTRUMENT CO./JENSEN TOOLS</b>	
<b>GUDEBROD BROS. SILK CO., INC.</b> .....	16	<b>&amp; ALLOYS</b> .....	81
Coastline Adv.		Sheldon W. Gates	
<b>HEATH CO.</b> .....	67, 83	<b>UNITRODE CORP.</b> .....	11
Advance Advertising Service		Impact Adv., Inc.	
<b>HEINEMANN ELECTRIC CO.</b> .....	5	<b>VARIAN ASSOCIATES</b> .....	17-24
Thomas R. Sundheim, Inc.		Jack Herrick Adv., Inc.	
<b>HEWLETT-PACKARD, LOVELAND</b> .....	2		
Tallant/Yates Adv., Inc.			
<b>HOTWATT, INC.</b> .....	85		
Sears Adv.			
<b>INDUSTRIAL REFRIGERATION CO.</b> .....	76		
J. R. Underwood Adv.			
<b>INTERNATIONAL RECTIFIER CORP.,</b>			
<b>Semiconductor Division</b> .....	77		
William E. Wilson Co.			



## Cathode ray tubes

These high performance cathode ray tubes feature channel-plate electron multipliers. Using these multipliers, bandwidths of 2 GHz and 3.3 GHz have been obtained at deflection sensitivities of 20 mm/V and 5 mm/V, respectively. Laboratories d'Electronique et de Physique Appliquee, 3 Ave. Descartes, 94, Limeil-Brevannes, France.

**Circle Reader Service #415**

## Random access memory

This 1024-bit MOS RAM is pin and performance compatible with Mostek's 4006, featuring an access time of less than 400 ns. Other features include ion implantation, full internal decoding, TTL/DTL compatible inputs, and a 16-bit dual-in-line packaging with a low stand-by power requirement of less than 50 mW. No special interfacing circuitry is required, and depletion mode transistors have been added to increase operational functional density. ITT Semiconductors, Foots Cray, Sidcup, Kent, England.

**Circle Reader Service #416**

## Semiconductor components

Varistors and resistors are included in this literature. You're given characteristics and specs, and are told why these varistors are suitable for applications such as spark suppression, voltage stabilization, and surge voltage protection of transistors, diodes, and TV tubes. Features and applications for the other resistors in the series are provided as well. C. Conrady, Nurnberg, Postfach 480, Germany.

**Circle Reader Service #417**

## Solid-state relays

Ideal for use in the data, telecommunication, computer, teletypewriter, and telemetry fields are these solid-state polarized relays. Available standard interface relays fit standard sockets or PC boards, are suitable for high and low level data circuits, and provide speeds of up to 5000 and 1200 baud. Distortion is less than 1% and no resetting or adjustment is required. Pye TMC, 15 Sheffield St., Toronto 385, Ontario, Canada.

**Circle Reader Service #418**

## Digital shaft encoder

The key to this digital shaft encoder system is its transducer. It contains no lamps, photocells, switches, or electronic devices, making it ideal for hazardous environments. The system can be fitted with various output modules, enabling it to interface with many digital computers and control systems. IDM Electronics Ltd., Arkwright Rd., Reading, RG2 OHL, England.

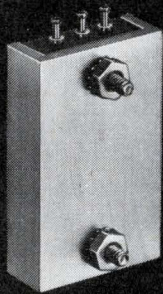
**Circle Reader Service #419**

## Two new ICs

New members of this family include a BCD-to-decimal decoder/driver and a monostable multivibrator. Both are available in ceramic dual-in-line packages. The first is ideal for counting/display applications, and the second in logic systems or as frequency-to-current converters, voltage-to-pulse width converters, or double pulse generators. Be sure to ask about the other members of this family from Societa Generale Semiconduttori, Via C. Olivetti, 1, 20041 Agrate Brianza, Milan, Italy.

**Circle Reader Service #420**

## New Solid State Switch



**Ageless  
Responsive  
Rugged**

Multiply switch life with the new 5 AMP Solid State Switch from Grayhill.

Absence of moving parts, contactless operation assures infinite switch life with proper use. Provides immediate response to a low current control signal.

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**Circle Reader Service #54**

**ESI**

## DEKASTAT® stacks up as the best in a decade

Here's the smart way to build true-precision resistance decades into your instrument or system—Use an ESI panel-mounted, coaxial-dial multiple DEKASTAT. You get  $\pm 0.01\%$  warranted accuracy in two, three or four decades (interpolating rheostat on last decade), throughout dc and audio frequency ranges. Exclusive ESI DEKADIAL® coaxial dials provide fast in-line reading and take up little space. Precision resistor elements are unifilar wound on mica cards using wire with exceptionally low T.C. Switch contacts are solid silver alloy. Wide range of resistance values. Buy standard values off the shelf for \$95-\$150 or give us your specifications for a custom assembly.



**Circle Reader Service #55**

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# \$2450



Model 5100

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- **0.001 Hz to 2 MHz Range**
- **No Switching Transients**
- **0.001 Hz Resolution**
- **Direct Digital Technique**  
NO MIXING OR PHASE LOCKING
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—60db HARMONIC
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 $\pm 2 \times 10^{-10}/^{\circ}\text{C}$  OPTIONAL
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0 TO 85db IN 1db STEPS PLUS CONTINUOUS CONTROL  
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10 VOLTS P-P, 50-OHM SOURCE IMPEDANCE

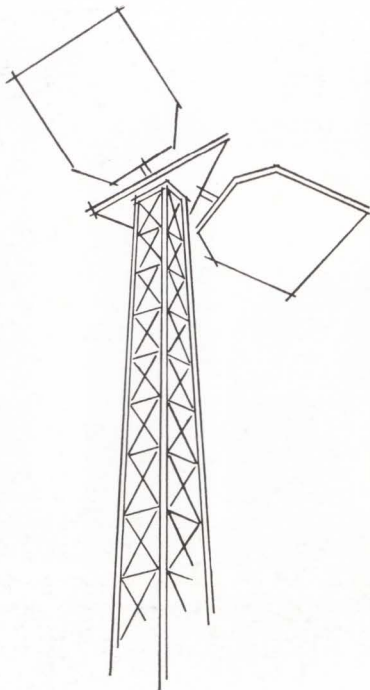
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# ROCKLAND

Circle Reader Service #56





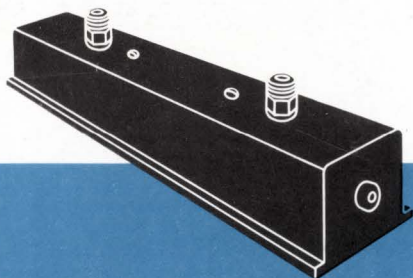
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These devices are performance-proved. You get maximum dependability in communications applications.

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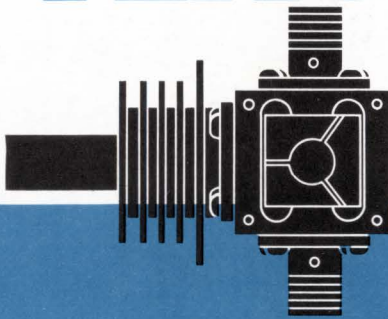
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Choose RCA traveling-wave tubes. Select from one of the industry's widest lines, supported by a 20-year background in developing and field-testing state-of-the-art systems.

RCA Type	Power Output (W)	Frequency (GHz)	Application
A1378	20	7.9 - 8.4	Government
A1446	20	9.8 - 10.7	Government
A1447	5	7.9 - 8.4	Government
A1390	20	10.7 - 11.7	Common Carrier
A1443	15	10.7 - 11.7	Common Carrier
A1455	20	12.7 - 12.95	Community Antenna Relay System
A1456	20	10.7 - 13.2	Common Carrier, Community Antenna Relay System
A1460	15	13.0 - 14.0	Government

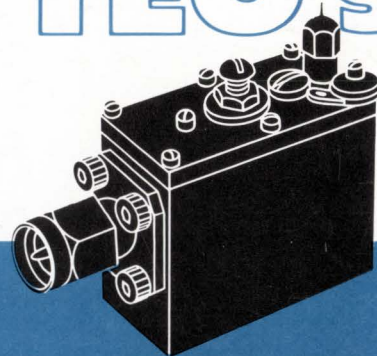
## TEA's



Now you have the transferred-electron amplifier, introduced by RCA to the industry earlier this year. This is believed to be the first available octave bandwidth solid-state amplifier for C-band and above.

RCA Type	Power Output (mW)	Frequency (GHz)	Application
S384	250	6.0 - 8.0	Common Carrier
S385	250	8.0 - 10.0	Government, Common Carrier
S386	120	14.0 - 16.0	Community Antenna Relay System

## TEO's



You have accepted the transferred-electron oscillator as another of RCA's major contributions to microwave design. Now you have a choice in standard products and subsystems for pulsed and CW applications from L- through Ku-band.

RCA Type	Power Output (mW)	Frequency (GHz)	Application
S409	100	6.0 - 8.0	Common Carrier
S410	30	8.0 - 10.0	Government, Common Carrier
S411	30	10.0 - 12.0	Common Carrier
S412	10	12.0 - 14.0	Business Radio, Community Antenna Relay System

# RCA