

# Electronic Design 16

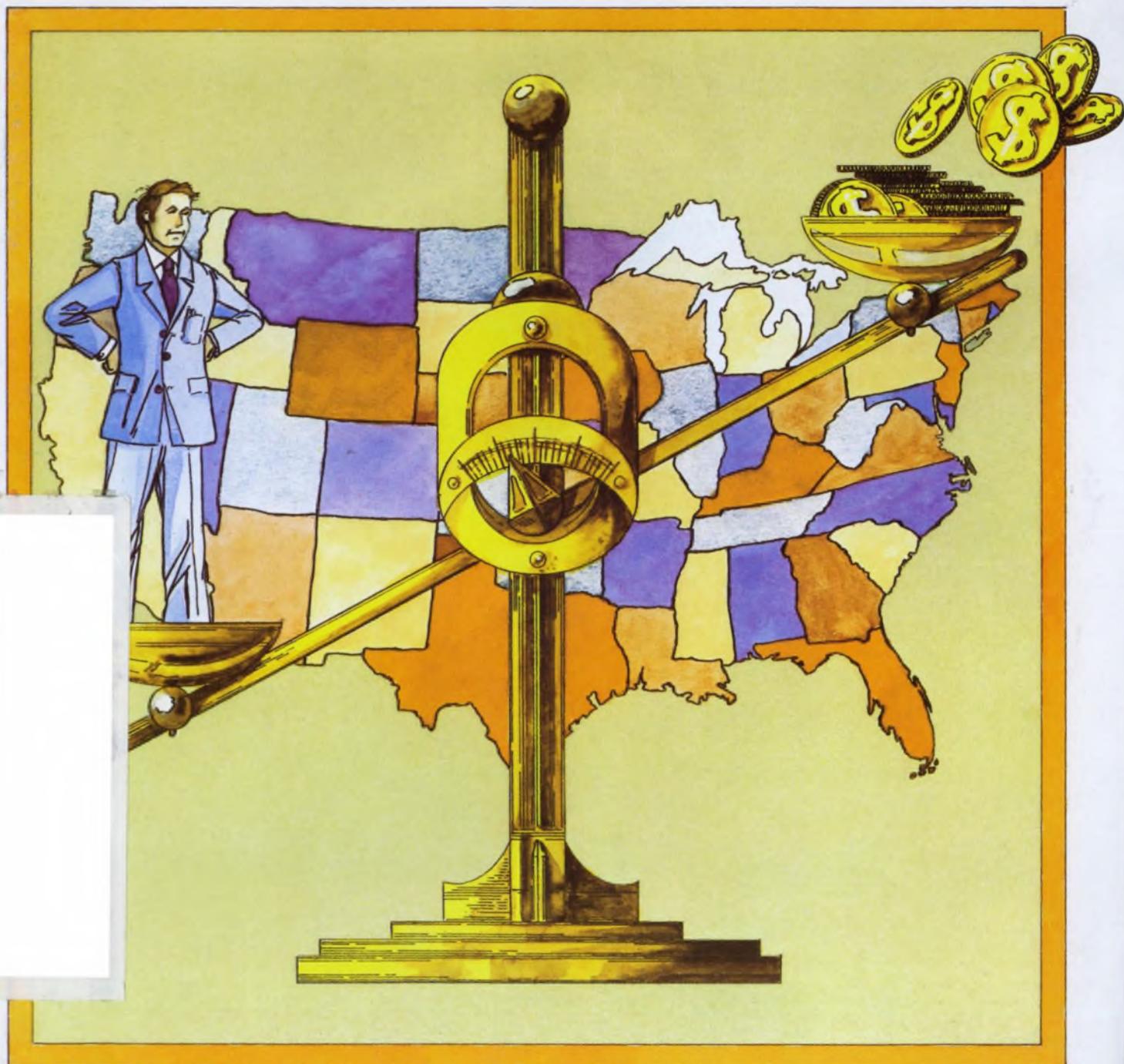
VOL. 25 NO.

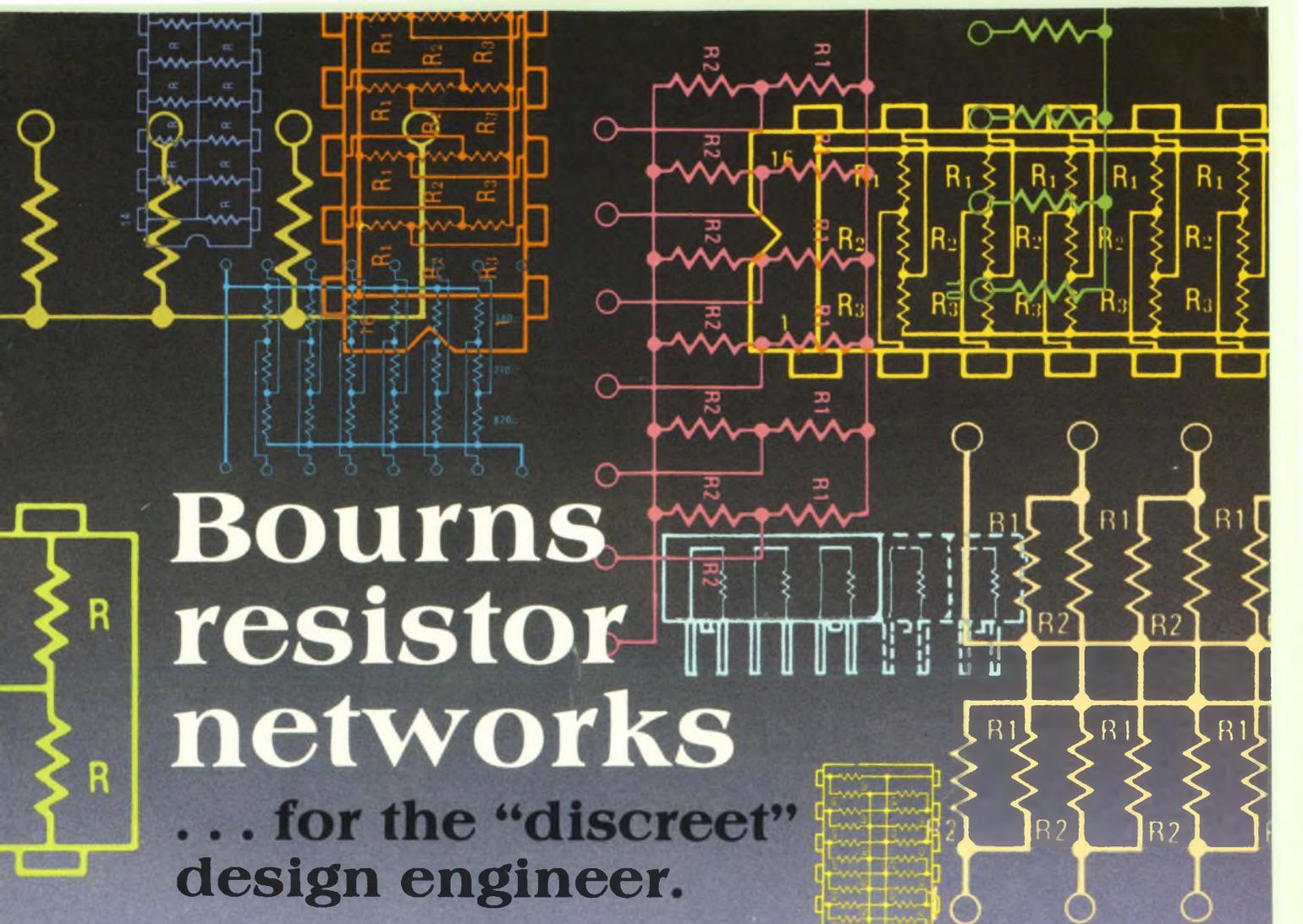
FOR ENGINEERS AND ENGINEERING MANAGERS

AUG. 2, 1977

**How do you weigh in** against other engineers and engineering managers throughout the nation? The work you do, the money you make: Are they limited by

education, location, other factors? Your colleagues: Are they making more or less for the same work? How does the scale tilt for you? Measure yourself. Turn to p. 36.





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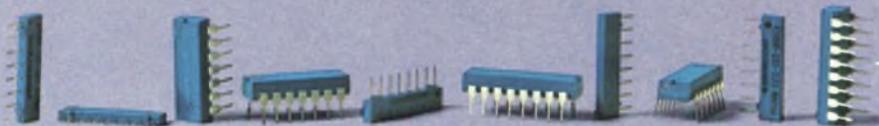
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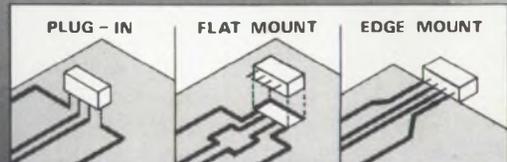


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TFM-4	5-1250	5-1250	DC-1250	6.0	7.5	7.5	8.5	50	45	45	40	30	35	25	30	25	20	5-49	\$19.95
TFM-11	1-2000	1-2000	5-900	7.0	8.5	7.5	9.0	50	45	45	40	35	25	27	20	25	20	1-24	\$39.95
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**Cover:** Cover illustration by James Jany

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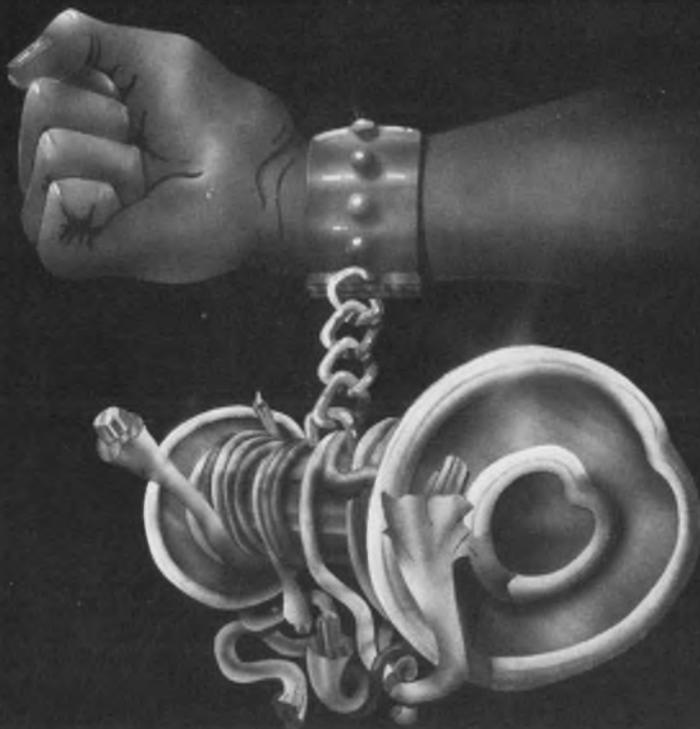
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## Pre-trigger info spots analyzer errors

Stanley Runyon's "Focus on Logic Analyzers" (ED No. 3, Feb. 1, 1977, p. 40) was one of the most comprehensive and best written logic-analyzer articles I have ever read. The article was a clear exposition of every factor of consequence involved in assaying the true cost and the true worth of an analyzer. This sort of article is a valuable service to manufacturer and customer alike.

As an advocate of both the dual-threshold and glitch-capture feature for analyzers, I wish to add that the combination of dual thresholds and glitch capture can record such anomalies as ringing, glitches, and improper level *before the trigger on all channels* while recording a transient event. On the other hand, using the trigger output of the analyzer to trigger an oscilloscope allows waveform anomalies to be detected only after the trigger and only on one channel per occurrence. When the trigger event indicates a system failure (such as a detected parity error or an interrupt on an unassigned channel), then pre-trigger information is infinitely more valuable than post-trigger information.

*Carver Hill*

E-H Research Laboratories, Inc.  
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Oakland, CA 94604

## Segments make weighty words

I read with interest the seemingly exhaustive treatment of seven-segment conversion by Mr. Kostanty in his Idea for Design, "Convert Seven-segment Numerical Code," (ED No. 4, Feb. 15, 1977, p. 137).

From the article's table, only five

segments—a, b, e, f, and g—are needed to identify a digit, a minus or a blank—12 items in all. However, the five segments, weighted as binary words, yield decimal equivalents as follows:

zero	— 30	six	— 23 (or 7)
one	— 8	seven	— 24
two	— 29	eight	— 31
three	— 25	nine	— 27
four	— 11	minus	— 1
five	— 19	blank	— 0

Clearly, such binary words also can be used to identify the seven-segment-coded digits.

*Mark Gardner*  
President

Portatron  
P.O. Box 2015  
Station A.  
Champaign, IL 61820

## Misplaced Caption Dept.



3.2.4.1: Progress reviews shall be held at regular intervals.

Sorry. That's Antonio and Piero Pollaiuolo's "The Martyrdom of Saint Sebastian," which hangs in the National Gallery in London.

*(continued on page 8)*

Electronic Design welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to Managing Editor, Electronic Design, 50 Essex St., Rochelle Park, NJ 07662. Try to keep letters under 200 words. Letters must be signed. Names will be withheld upon request.

## Is he really thinking?



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## Across the desk

(continued from page 7)

### What we don't know can be a problem

I have observed several problems with TTL ICs within my company. Frankly, I had not thought of outside communication until I read the short note from Richard F. Binder about flip-flop input synchronization in "Across the Desk" (ED No. 4, Feb. 15, 1977, p. 8). Therefore, I pose some questions to your readers.

Problems we experienced with the 74LS160 series counters appear to be known only to subscribers to the Government Industry Data Exchange Program. First, has there been any honest and open acknowledgment or warning about the defective design of one manufacturer's parts? If they were automobiles, they would have been recalled with a public announcement!

Second, is there anyone with a good body of knowledge on the reaction of R-S flip-flops to pulses that are just below the required time and amplitude thresholds required for a true change of state? Someone should do a thorough article on the subject in a widely circulated journal such as ELECTRONIC DESIGN.

R. Schuchman  
Design Specialist

Stromberg DatagraphiX Inc.  
P.O. Box 82449  
San Diego, CA 92138

### Put metric conversion on future dashboards

Regarding "Liquid-Crystal Panels Put Car Functions on Display" (ED No. 9, April 26, 1977, p. 27): I suggest that auto manufacturers consider metric speed-conversion capability in future auto-panel systems. This includes a three-digit speed display (instead of the two-digit displays described) to accommodate 100 kilometers per hour (62 MPH).

Also, it might be attractive to the public if a dashboard switch were included to allow conversion between kilometers per hour vs miles per hour during the imminent period of transition to the metric system. Regardless of when road signs are changed to metric speed limits (or how quickly), I believe that most U.S. drivers will continue to think in terms of miles and miles per hour for a few years, even

after they buy their next new car.

As part of our sacrificial future of energy conservation, it would be nice to have a dashboard indicator that tells us our fuel-consumption rate since the last fill-up. This would serve as a constant reminder to conserve energy and help notify the auto owner when maintenance or a tune-up is needed to reduce fuel consumption. This should not cost much to add to the new digital-speed and fuel-level indication system described in your article.

Tom Shamburger  
Sr. Mfg. Research Engineer  
Lockheed Missiles & Space Co., Inc.  
Industrial Engineering & Facilities  
Sunnyvale, CA 94088

### Focus on our company



Thank you for your informative article, "Focus on Logic and Microprocessor Analyzers," by Stanley Runyon (ED No. 3, Feb. 1, 1977, p. 40). We appreciate your mention of our 80-M logic analyzer, but unfortunately our company name, Digital Broadcast Systems, did not appear under the picture of our instrument.

Donald Hawkins  
Digital Broadcast Systems, Inc.  
4306 Governors Dr.  
Huntsville, AL 35805

*Ed. Note: The editor who confused Digital Broadcast Systems—the real manufacturer of the 80-M analyzer—with Digital Laboratories, a competitor, has been sent to broadcasting school to learn the business.*

### Loved the beefcake, but watch that chain

If you do not get a lot of letters from disgusted male engineers concerning the use of beefcake (masculine version of cheesecake) in the advertising of ECD Corp. (ED No. 11, May 24, 1977, p. 189), it will serve to prove that we aren't as rotten sports as females are.

I would not advise wearing the meter on a chain as shown, however, since the

chest hairs will occasionally catch in the chain, causing a type of pain no female could ever know. There are certain similarities, however, which is why one seldom finds topless accordion players of either sex.

James Rieger  
Engineer

205 South Silver Ridge Dr.  
Ridgecrest, CA 93555

### First steps are the last

On p. 95 of Lance A. Leventhal's Microprocessor Basics: Part 13 (ED No. 8, April 12, 1977, p. 90), two discrepancies exist in the 8080 and 6800 programs for finding the maximum of an array of unsigned 8-bit numbers. The first jump instruction in the 8080 program and the first branch instruction in the 6800 program are incorrect. As written, the programs will both drop to DONE on the first pass. A Branch If Equal instruction should be used instead.

This was a very fine article, incidentally, and I hope you keep publishing articles aimed at the newcomers to the micro field.

Ralph Rocuzzo  
R&D Engineer

Merrick Scale Mfg. Co.  
180-192 Autumn St.  
Passaic, NJ 07055

### Mr. Leventhal replies

Ralph Rocuzzo is absolutely right about the errors. In fact, exactly the same error occurs in the multiword maximum programs on pp. 95 and 96. I can only apologize to the readers and editors of ELECTRONIC DESIGN for these inadvertent mistakes, which escaped several rounds of proofreading.

I should also note a slight error on p. 97—the result of some 8080 instructions getting into a 6800 program and somehow never getting corrected (my fault entirely). Anyway, the last program for the 6800 on p. 97 should read:

```
DSTRT LDAA #MESS CTR = LENGTH OF MESSAGE
      STAA CTR
      LDX #MESS PTR, DPTR = START OF MESSAGE
DRUN STX PTR SAVE STARTING POINTER
      LDAB #NDSPLY DCTR = NUMBER OF DISPLAYS
DSPLY LDAA X GET A CHARACTER FROM ARRAY
      JRS SEND SEND CHARACTER TO DISPLAYS
      INX DPTR = DPTR + 1
      DECB DCTR = DCTR - 1
      BNE DSPLY SEND NDSPLY CHARACTERS
      LDX PTR
      INX UPDATE PTR TO START AT NEXT CHARACTER
      DEC CTR COUNT DOWN NUMBER OF DISPLAY RUNS
      BNE DRUN
      WAI
```

# hp MEASUREMENT COMPUTATION **news**

product advances from Hewlett-Packard

AUGUST 1977

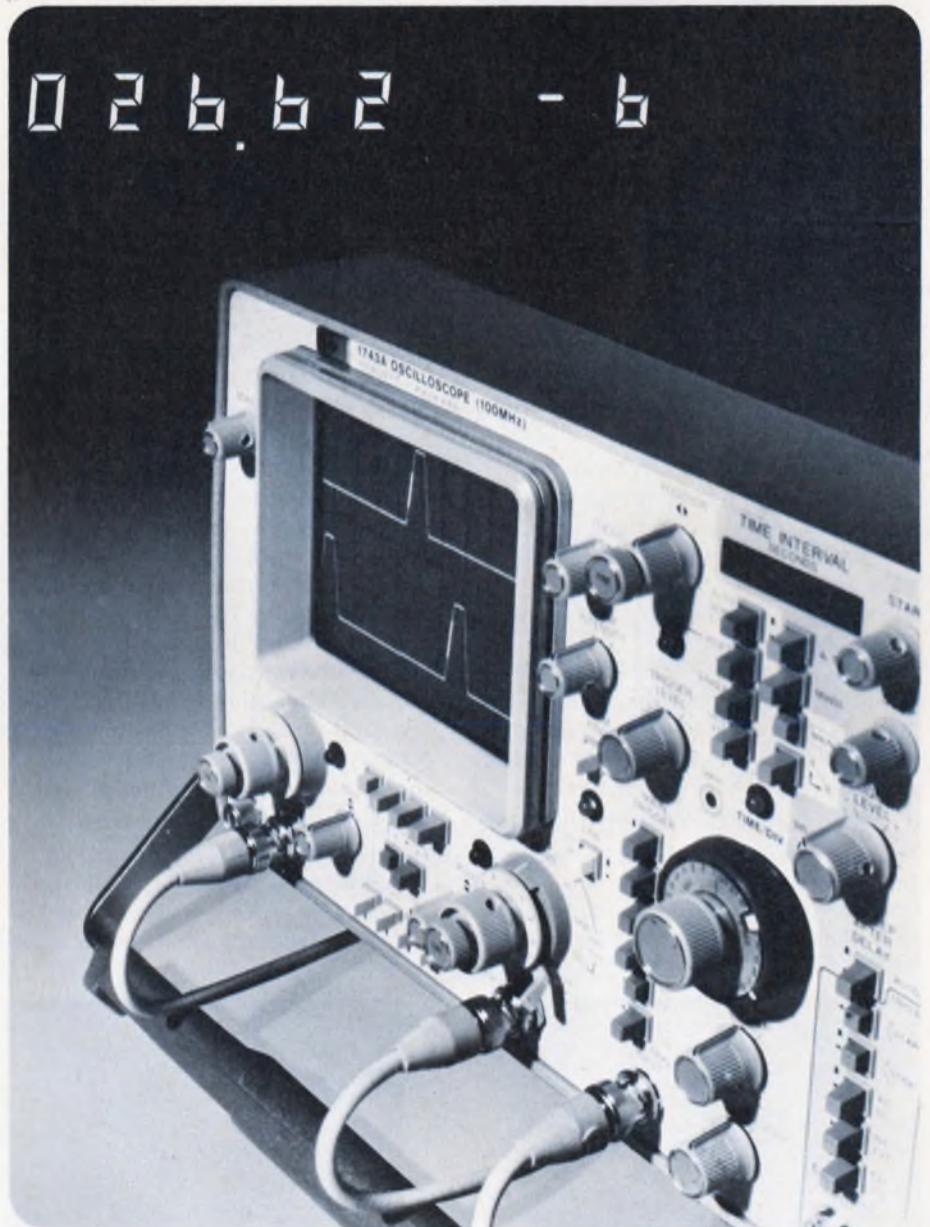
## 100 MHz scope with unprecedented time-interval measuring accuracy

Here's a brand new concept in oscilloscopes. By incorporating a crystal controlled, time interval averaging counter with a 5-digit LED display into a 100 MHz delta time oscilloscope, the new HP 1743A offers major improvements in ease-of-use and accuracy. Nanosecond time intervals can easily be measured to 100 ps resolution, longer time intervals to 0.002 percent accuracy.

Additional features include:

1. Measurements of delta-time can now be made from the pulse that triggers the sweep, thus improving measurements of low rep rate or infrequently occurring pulses.
2. In the triggered delta-time mode, the 1743A automatically displays the time interval of interest without any "fine-tuning" by the operator.
3. With crystal timing you can use the sweep vernier to calibrate the CRT divisions for various measurements without uncalibrating the LED time readout.
4. Phase measurements on dual clocks or skew measurements between data channels are easily made between both channels. Three channel measurements can be made between the two vertical channels and on external trigger by using the third channel trigger view.

*And there's much more. Check B on the HP Reply Card.*



New dual-channel oscilloscope with third-channel trigger view and delta-time measurements also incorporates a 5-digit automatic time-interval averaging counter. Measurements are now 200 times more accurate than those using previous delta-time techniques.

## New 2–18 GHz microwave pulser has 10 ns rise time

Modern high resolution radars and other microwave systems require fast risetime pulses for testing purposes. The HP 11720A Pulse Modulator provides pulses from 2-18 GHz with an 80 dB on-off ratio using a newly-designed PIN diode switch arrangement.



Now, signal generators can be upgraded to pulse modulation capability from 2 to 18 GHz with new fast pulse modulator.

An ideal input signal is the HP 8672A microwave synthesized signal generator or 8620C/86290A microwave sweep generator, both of which cover 2-18 GHz. Of course, any current microwave generator or source in use can be upgraded to provide high performance pulses by use of the 11720A Modulator. Sources with up to 100 mW output can be switched.

Rise/fall times are  $<10$  nS and internal delay is  $<70$  nS. Minimum pulse widths of  $<50$  nS are possible. This in-line switch has less than 10 dB insertion loss at 18 GHz (6 dB to 13 GHz). Input video is TTL compatible with  $>3$ V (on) and  $<0.5$ V (off), with a complement function provided.

For more details, check A on the HP Reply Card.

## New developments enhance RF network analysis

The HP 8505A RF Network Analyzer (0.5-1300 MHz) acquires significant new capabilities by virtue of two new developments:

1. The new HP 8501A Storage-Normalizer accessory brings digital storage of displays, normalization of system characteristics, CRT labeling plus measurement enhancement through signal averaging and resolution magnification.
2. Ability to phase-lock the 8505A to general-purpose reference sources such as the HP 8640 and 8660 signal generators. Phase-locking permits full characterization of narrowband devices such as crystal filters with reso-

lution and stability as high as 1 Hz.

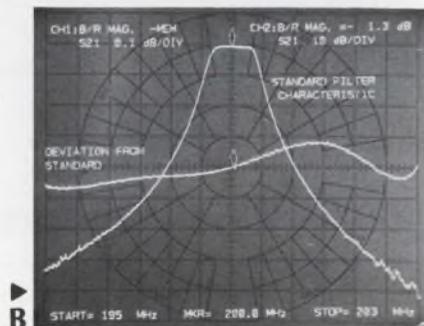
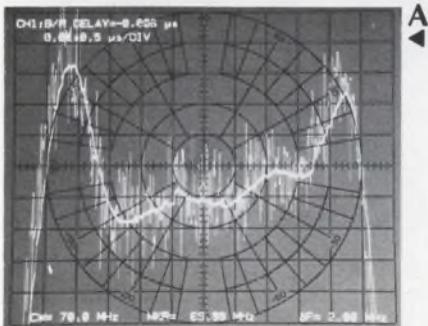
The new 8501A Storage-Normalizer brings flicker-free displays which can be annotated with scale factors and frequency data. Signal averaging improves resolution in narrowband group delay measurements and where signal levels are low. The magnification feature permits resolution to be increased up to 10 times.

Using the HP Interface Bus and an HP computing controller, powerful graphics capability is available. Add test limit lines, or display and annotate program listings and instructions.

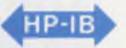
For additional technical information, check K on the HP Reply Card.

New storage-normalizer brings additional capabilities to HP 8505A network analyzer:

**Storage and Averaging** (photo A)—two traces, with and without averaging, are stored, to demonstrate improvement that averaging brings to group delay measurements of narrowband devices. **Normalization and Labelling** (photo B)—test device's response deviation from standard is displayed directly along with overall response of standard.



## Complex signal analysis made very easy



HP's 5420A digital signal analyzer is the "smartest" commercially available instrument for low frequency signal analysis. Here it analyzes the read/write head positioning servo of a disc memory.

Once restricted to specialists, the time and frequency domain analysis of complex signals by Fourier transform and related techniques can now be done with far less understanding of the theory involved, and in a fraction of the time previously required.

Applications include characterizing the open loop gain of an operating control system, measuring close-in phase noise, and the study of vibration and noise in mechanical structures.

HP's 5420A new dual-channel analyzer offers capabilities not found even in instruments costing up to twice as much.

Dynamic range exceeds 75 dB and frequency resolution to 0.004 Hz can be achieved anywhere in the 25 kHz range. Measurements include: linear spectrum, auto and cross power spectrum and spectral density, transfer function, coherence, time average, auto and cross correlation, impulse response and amplitude histogram.

The 5420A is the easiest to use digital signal analyzer with a continuous, fully annotated, calibrated display. Dual x and y axis cursors provide data readout and measurement control. A CRT-displayed "menu" guides you through instrument set up, and the built-in digital tape cartridge can store up to 50 instrument set ups and 120 measurement results for later use.

Check G on the HP Reply Card.

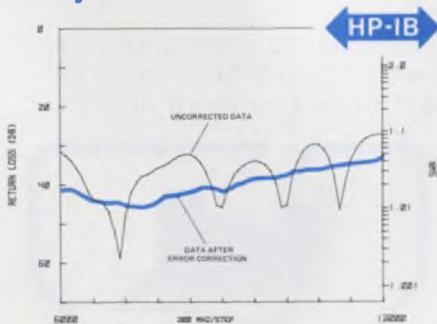
## New microwave power measurement Application Note

One of the classic application notes from Hewlett-Packard was AN 64, *Microwave Power Measurement*. Now, a completely rewritten note AN-64-1 *Fundamentals of RF & Microwave Power Measurements* is available to bring all of the pertinent power measuring principles up-to-date.

AN 64-1 explores in detail three of the most popular power sensing techniques, thermocouple elements, thermistors, and diodes including a comparison of the advantages and disadvantages of the three methods. A comprehensive error analysis section follows with particular emphasis on mismatch considerations. Included also are some pulse power measurement considerations.

For your free copy, check N on the HP Reply Card.

## How to configure your own automatic network analyzer



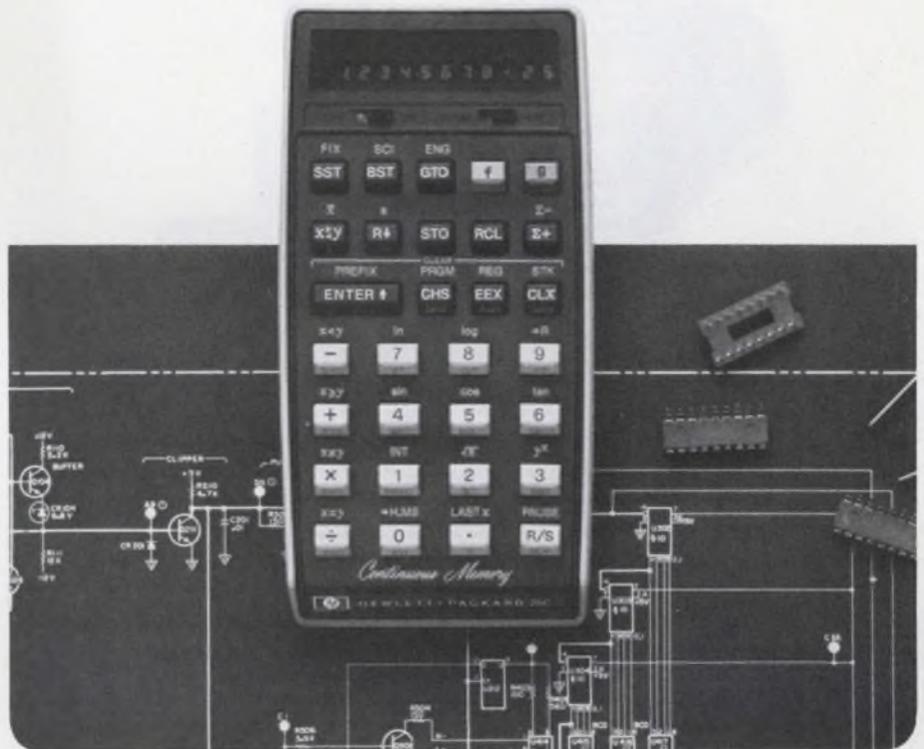
An economical method for semi-automatic, *error-corrected* microwave network measurements is described in Application Note 221. The HP-IB system uses the HP 8410 network analyzer and HP 9825A desktop computer, with 110 MHz to 18 GHz range.

Sources of error and the essentials of error correction are described. A sample 9825A program for calibration and measurement is listed along with annotations and flow charts. Results that demonstrated significant improvements in accuracy are presented.

If your work involves microwave measurements, be sure to send for your free copy. Check O on the HP Reply Card.

## Continuous memory retains your programs and saves your data—even when you turn it off

Continuous memory makes it possible to add functions to those already preprogrammed into the HP-25C, ready at the touch of a key.



The continuous memory capability of the HP-25C scientific programmable pocket calculator can provide tremendous values in time-savings and convenience to any scientist, engineer or student who uses a few long programs repeatedly. The 25-C not only retains the last program you used, it also retains all data in the registers. And now, with a reduction in the price, you can save money too.

Continuous memory in the 25-C is the only feature not found in the popular HP-25. Otherwise, both calculators offer the same powerful capabilities.

- 49-step program memory plus 8 addressable registers
- BackSTep and SingleSTep keys let you review the entire memory one step at a time, in either direction

- Conditional branching allows you to test relationships between values
- Pause feature allows you to momentarily interrupt program execution and display the results of the X register for evaluation or recording
- Trig and log functions plus rectangular/polar conversions
- Statistical capabilities: summations, mean and standard deviations
- Three display modes: decimal, scientific or engineering notation
- All memories available for register arithmetic.

Either calculator is a good choice for your professional needs.

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

# Build your own automated system around an HP computing controller



Shown above is an HP computing controller in a microwave test laboratory. The test limits can be set from the keyboard of the controller; the controller tests all parameters and makes NO-GO decisions. Data can be stored for later evaluation and analysis of quality control information.

A fast and inexpensive way to add data acquisition and analysis capability to your instruments is with HP computing controllers—the HP 9825A and 9815A. Each compact controller is a complete, one-package system with integrated keyboard, display, strip printer, easy-to-use language and tape storage. Interfacing the controller to your instrument is simple. Plug in the appropriate interface card, write a simple application program and your system is on its way up. Off-the-shelf interface cards and built-in software allow you to interface to BCD, 8 or 16 bit parallel, bit-serial and HP-IB (Hewlett-Packard Interface Bus)-compatible instruments.

## HP 9825A controller

The HP 9825A computing controller provides minicomputer-like speed and capability. It features buffered I/O and live keyboard. A built-in 250k-byte tape cartridge with a 3k-byte-per-second transfer rate and 90-inch-per-second search rate allows quick storage and retrieval of data. Using the HP-IB, the 9825A can control as many

as 14 instruments and peripherals with each HP-IB Interface card. Up to three cards may be connected. The programming language (HPL), designed for scientists and engineers, is easy-to-learn and, in combination with the keyboard's eight editing keys, is easy-to-use.

## HP 9815A controller

The HP 9815A computing controller with its 96k-byte tape cartridge can be anything from a simple data logger to a controller of a small automatic instrumentation system. Its 16-character alphanumeric thermal printer can be programmed to instruct the operator and provide labeled hard-copy results. Programming, for interfacing as well as data analysis, is fast and easy, using RPN. The AUTOSTART feature allows your program to begin executing automatically when the power is turned on.

*For your copy of a brochure illustrating automatic test systems with integral desktop controllers, check M on the HP Reply Card.*

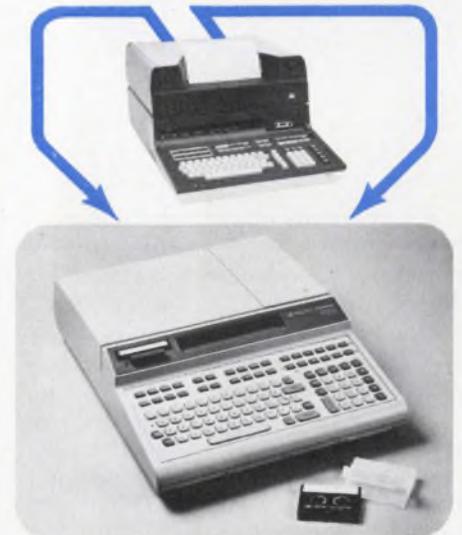
# Cut development costs when upgrading to a new desktop computer

For desktop calculator owners whose applications have outgrown their earlier HP 9800 series calculators, a simple way to move up to a more powerful data handling system is now offered.

The HP 98032A Interface Card allows accurate and swift transfer of data from the 9810A, 9820A, 9821A or 9830A/B to the newer 9825A and 9831A computing controllers. The same interface card also permits the direct transfer of data and programs used with the 9830A/B into the larger memory of an HP 9831A computing controller.

To perform the transfer, simply plug the interface card into your old calculator and connect the other end of the card to your new 9825A or the 9831A. In a fraction of the time it would take to manually re-enter the data or program, the interface card smoothly transfers it — unattended. In case an error is encountered in the transfer, an error message will be automatically recorded and prompt the user for a later correction.

*For additional information on upgrading to an HP 9825A or an HP 9831A, check L on the HP Reply Card.*



If your applications require larger storage and faster processing speeds than your earlier model desktop calculator can offer, consider upgrading to or adding a powerful new HP desktop computing controller. A new interface card will now enable you to transfer your data and/or programs simply, quickly, economically.

# Distributed System/3000 brings remote computers within your reach

For the first time, it is now possible to interconnect Hewlett-Packard 3000 Series II Computer systems in distributed processing networks. DS/3000 consists of new software developed as an extension of Multi-Programming Executive II, the computer's basic operating system. MPE provides for multiple interactive and concurrent batch operations. It also brings an accounting structure and file security that provide protection against unauthorized use of local or remote HP 3000 systems and their data.

When existing 3000 Series II computers are networked with DS/3000, the user's investment in application software is protected. That software will require no change because the MPE operating system was designed to accommodate such future developments as networking.

DS/3000 cuts the cost and slashes the time and effort needed to get a useful distributed data-processing system up and running. You can sit down at a terminal and use the programs, files and data resident in any interconnected HP 3000. You don't need a special program to do it, either. Simply identify the computer you want to talk to and you're on-line.

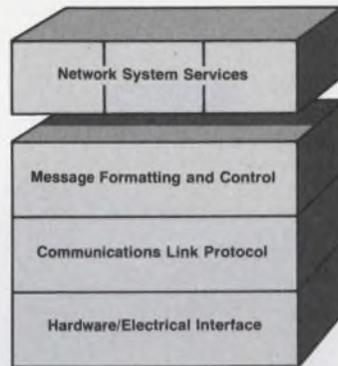
With the same ease, you can shift programs and files from one HP 3000 to another. All that is needed to interact with a remote system is to add the word REMOTE to some commands. Remote files are as easily accessible as those stored locally. Only seven simple new commands need to be added to the HP 3000 repertoire to accomplish program-to-program communication among systems. Remote peripheral devices are also at your command. Operation at this high level without a massive investment in special programming is a breakthrough in distributed processing.

## DS/3000's architecture is layered

DS/3000 has been implemented with a 'layered' architecture, so that user-created software will not become obsolete because of technological advances that may occur in communications.

Each layer to a large extent functions independently. In the future, network enhancements to DS/3000 could be

accomplished by providing a new software/hardware update to just one layer. This change would not affect either the structure or the usage of DS/3000 user commands and procedures.



*The layers.* The first layer, the electrical interface to external modems, meets EIA RS 232C and CCITT standards. Systems can be linked over common carrier facilities at speeds up to 9600 bits per second or over hardwired lines at speeds up to 2.5 million bits per second.

The next layer is concerned with link protocol in a point-to-point configuration. It currently multileaves data bidirectionally over half or full duplex common carrier facilities, using IBM-

compatible Binary Synchronous Communication (BSC) protocol.

The third layer automatically handles conventions of message formatting and manages the flow of messages between systems.

The top (fourth) layer is the most exciting for it represents the set of full, high-level system services available to the user on DS/3000. These include sharing of resources, remote command processing, remote file access and program-to-program communication.

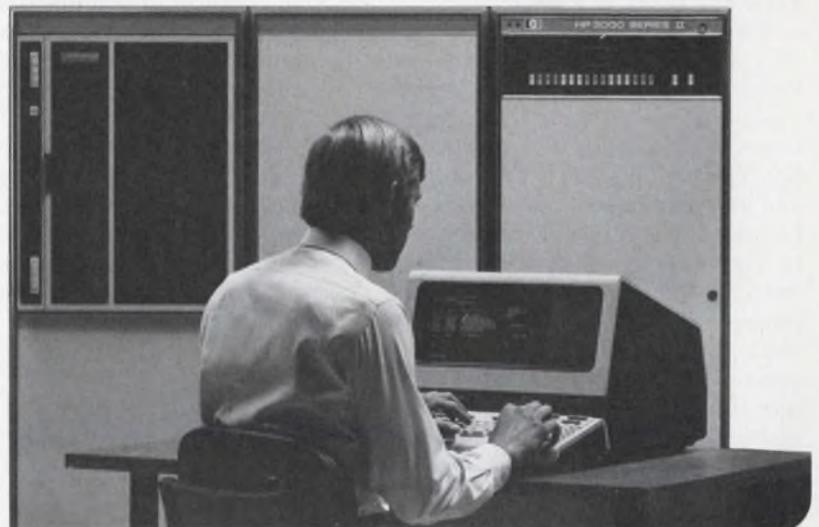
## The HP 3000 Series II Computer

The all-round performance of the HP 3000 makes it an ideal departmental computer for solving a wide range of problems such as order processing, inventory control, cost accounting and materials requirement planning.

With its versatile executive software, the HP 3000 offers speed and power. The built-in flexibility of the HP 3000 will allow you to take advantage of technological developments in distributed data processing.

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

Instantaneous information sharing between HP 3000 computers is now practical and economical. New software puts data and processing power of remote computers at your command—at your terminal. Just add the word "REMOTE" to the appropriate commands.



## Microprocessor in new LCR automates a wide range of measurements



While the microprocessor in the new HP 4262A LCR meter automates and simplifies component measuring and testing, the arrangement of the instrument front panel keyboard switches assures maximum operating convenience and error-free operation.

This new Hewlett-Packard 4262A Digital LCR Meter is a 3-1/2 digit microprocessor-based instrument that meets today's requirements for measuring capacitance, resistance and inductance of components in the laboratory, on the production line and in quality assurance inspection.

Because the 4262A is microprocessor-based, it features automatic operation and internal self-test capability to insure the instrument is functioning properly. For example, the operator simply selects the function and loss parameters, one of three test frequencies and inserts the device to be measured. The LCR Meter does the rest—automatically selecting the proper range and equivalent circuit mode. Deviation measurements are also provided for very useful comparisons when measuring the range of small trimmer or variable capacitors. Capacitance can be measured from

0.01 picofarads to 19.99 millifarads, inductance from 0.01 microhenries to 1999 henries and resistance from 1 milliohm to 19.99 megaohms. D and Q (loss) are also measured; D is measured from 0.001 to 19.9 and Q from 0.05 to 1000.

In addition to automatic measurement and wide range, the 4262A basic accuracy is 0.2 percent of reading. Measurement frequencies of 120 Hz, 1 kHz and 10 kHz are available. An HP-IB option allows the system-oriented user to easily interface the 4262A with a calculation controller or computer for increased speed, programmed measurements, automatic decision making and permanent hard copy records.

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

## A/D converter puts your analog voltages onto the HP Interface Bus

With the 59313A Analog to Digital Converter you can convert up to 4 channels of dc voltage sources to digital form for use in measurement or test systems structured around the Hewlett-Packard Interface Bus (HP-IB). A particularly useful application is in adapting, to systems use, instruments whose outputs are dc voltages.

The 59313A was designed specifically for systems use. It can perform 200 conversions per second on a single input channel or 50 per second on each of four channels. Selectable rates are 5, 10, 20, 50, 100 or 200 samples per second and are accurate to  $\pm 0.05\%$ . Resolution is 0.05% (10 bits plus sign), and the dual slope A to D converter has a linearity better than 1/2 least significant bit (LSB) and 4.75 ms conversion time.

The four jumper-selected voltage ranges can be screw-driver adjusted to values of  $\pm 1.0$  to  $\pm 1.3$ ,  $\pm 2.5$  to  $\pm 3.5$ ,  $\pm 5.0$  to  $\pm 7.0$ , and  $\pm 7.0$  to  $\pm 10.3$  volts, so as to maintain maximum resolution with a variety of voltage sources. The input can take 30 volts rms without damage, and input impedance exceeds 1 megohm.

The binary output code is readily converted to decimal form, or other codes, with a computing controller on an HP-IB system.

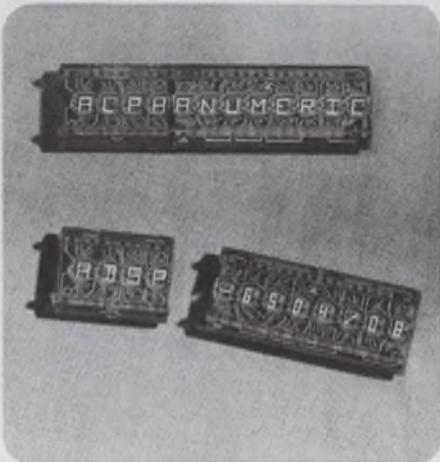
*For more information, check H on the HP Reply Card.*



The HP 9825A computing controller programs the HP 59313A for versatile, four-channel A to D conversion on an HP-IB system.

# HEWLETT-PACKARD COMPONENT NEWS

## Easier-to-read characters with new 16-segment display



HP now offers a 16-segment font in a new display for applications requiring lower power usage with ease of readability.

The first 16-segment solid state LED alphanumeric displays from Hewlett-Packard are now available. They are designed for use in computer peripheral products, automotive instrument panels, calculators plus instruments and systems requiring low power con-

sumption in an easy-to-read display. Magnification of the LED by an integral lens enhances the character intensity while keeping the power use at a minimum, and results in a character size of 3.8 mm. In addition to the 16 segments, the display has a centered decimal point and colon. Drawing as little as 1.0 to 1.5 mA average current per segment, they are easily read at a distance of more than six feet.

The new HDSP-6504 and HDSP-6508 four- and eight-character offer complete 64-character ASCII set capability. Both dual-in-line packages can be stacked end-to-end for applications requiring additional characters.

More rugged than standard PC board/lens type display packages, the new HP devices are well suited for demanding in-field applications such as in computer-based mobile units.

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

## New low $R_s$ beam lead PIN switches in just 2 ns



A new mesa process with glass backfilling is responsible for the performance of this new beam lead PIN. The mesa construction constrains the minority carriers thereby enhancing switching speed.

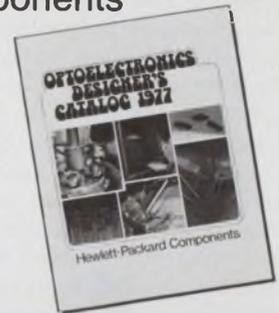
Representing a major improvement in beam lead PIN technology, the Hewlett-Packard HPND-4050 offers 1.3 ohms typical (1.7 max) series resistance at only 10 mA current. This low

resistance reduces power requirements and makes it ideal as a shunt switching element in stripline and microstrip circuits. The low current requirements make it suitable for use in portable, airborne or shipboard applications.

Reverse recovery time is typically 2 ns, which meets or exceeds switching time requirements for fast switches for high frequency modulator and attenuator component applications in EW systems. Capacitance of the HPND-4050 is 0.15 pF maximum and breakdown voltage is 30V minimum.

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

## HP offers wide choice of quality optoelectronic components

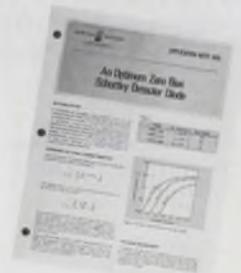


This new *Optoelectronics Designer's Catalog* contains detailed, up-to-date information on our complete optoelectronic product line. It is divided into five major product sections: solid state lamps, solid state displays, optocouplers, emitters, and PIN photodiodes.

Included in the 200 pages are product photographs, specifications, operating characteristics, and performance graphs.

*For your copy, check Q on the HP Reply Card.*

## New Schottky Technical Note



Application Note 969 addresses the theory behind a new line of Schottky detector diodes. Conventional Schottky detector diodes require a small amount of dc bias for low level detection to take place. Even though only a few microamperes are required, this is often difficult to supply. These new Schottky diodes (HSCH-3171 series) eliminate this need for dc bias and are more efficient as detectors compared with conventional Schottky detector diodes.

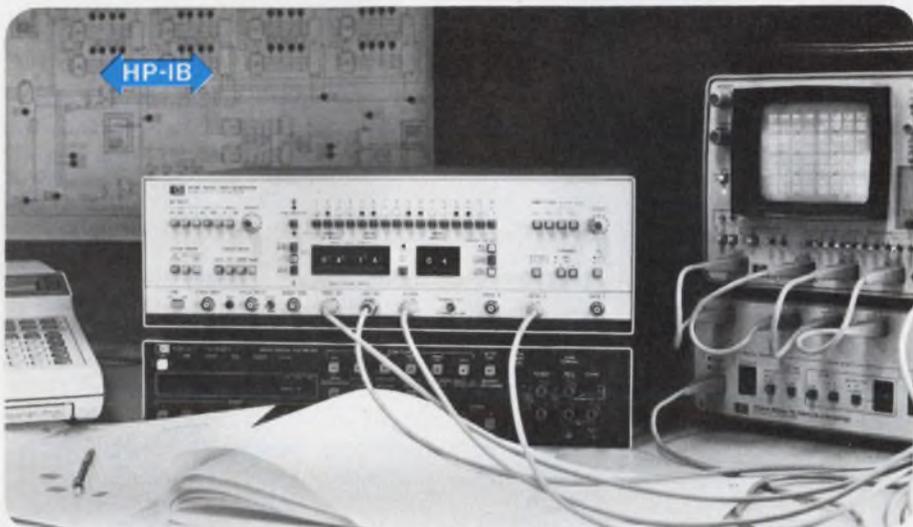
*For your free copy of this application note, check P on the HP Reply Card.*

# New 50 MHz serial data generator produces 2048 bit data streams plus PRBS

Now the HP 8018A provides the answer to all your requirements for serial digital stimulus. The 8018A includes two data channels, each with 1,024 bits of digital memory. Both word length and the number of words may be selected to exactly match your application. Serializing the channels, you can generate data streams up to 2,048 bits in length, sufficient for even the most complex data requirements.

Pseudorandom pattern generation is also included. With preset sequences from 511 to over 1 million bits long, you can easily produce worst case testing patterns or simulate actual traffic in a data network. An innovative new technique even lets you interleave PRBS and programmed data words in a single stream, perfect for simulating preamble—data message—postamble patterns.

The 8018A's high performance output amplifier delivers clean 5 ns pulses with amplitudes up to 15V. A switchable 50-ohm source minimizes reflections under various load conditions, helping you maintain pulse integrity right up to your circuit or system under test. A full complement of cycle modes



Suitable for bench and systems applications, the 8018A data generator is shown above. The logic analyzer displays the data pattern that has been generated for testing a serial digital interface. Both the data generator and the voltmeter are under programmed control using an HP desktop computer.

and trigger outputs simplifies synchronization with other instruments. An optional HP-IB programming interface enables you to rapidly load all 2,048 memory bits or integrate the 8018A's capabilities into automatic test systems.

This unmatched feature set has been

designed to shorten and simplify troubleshooting tasks wherever a source of serial data is required.

*To find out more about this powerful new digital performer, check J on the HP Reply Card.*

**East**-4 Choke Cherry Road, Rockville, MD 20850,  
Ph. (301) 948-6370.

**South**-P.O. Box 10505, Atlanta, GA 30348,  
Ph. (404) 434-4000.

**Midwest**-5201 Tollview Dr., Rolling Meadows, IL 60008,  
Ph. (312) 255-9800.

**West**-3939 Lankershim Blvd., North Hollywood, CA  
91604, Ph. (213) 877-1282.

**Europe**-7, rue du Bois-du-lan, P.O. Box, CH-1217, Meyrin-2,  
Geneva, Switzerland, Ph. (022) 41 54 00.

**Japan**-Yokogawa-Hewlett-Packard Ltd., Ohashi  
Bldg., 1-59-1 Yoyogi, Shibuya-ku,  
Tokyo 151, Ph. 03-370-2281/92.

**HEWLETT**  **PACKARD**

**MEASUREMENT** **news**  
**COMPUTATION**  
*product advances from Hewlett-Packard*

July/August 1977

New product information from

**HEWLETT-PACKARD**

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## Across the desk

(continued from page 8)

### Blame the moon

The moon must have been full when type was set for the product story, appearing on p. 160 of our June 21, 1977, issue, on Teledyne Philbrick's 1435—not 1453. It's a 1000-MHz op amp that settles to 1% in a mere 10 ns. What's more, Teledyne Philbrick is on Allied—not Alled—Drive.

CIRCLE NO. 319

### New Books

**Analysis and Design of Sequential Digital Systems**—L.F. Lind, J.C.C. Nelson, Halstead Press, 605 Third Ave., New York, NY 10016, 146 pgs. \$17.00

CIRCLE NO. 461

**Digital Computer Circuits and Concepts**—B. Deem, K. Muchow, A. Zepa, Prentice-Hall, Inc., Englewood Cliffs, NJ 07632, 487 pgs. \$15.95

CIRCLE NO. 462

**Microcomputer Handbook**—C.J. Sippl, Petrocelli/Charter, 641 Lexington Ave., New York, NY 10022, 480 pgs. \$19.95

CIRCLE NO. 463

**Optimum Systems Control**—A.P. Sage, C.C. White, Prentice-Hall, Inc., Englewood Cliffs, NJ 07632, 413 pgs. \$22.50

CIRCLE NO. 464

**Microprocessors: Fundamentals & Applications**—W.C. Lin, IEEE Press, Distributed by John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10016, 335 pgs. \$9.95

CIRCLE NO. 465

**Shock & Vibration Handbook**—C.M. Harris and C.E. Crede, McGraw-Hill Book Co., 1221 Avenue of the Americas, New York, NY 10020, 1322 pgs. \$47.50

CIRCLE NO. 466

**Handbook of Oscilloscope Waveform Analysis and Applications**—M. Ritter-Sanders Jr., Reston Publishing Co., Inc., P.O. Box 547, Reston, VA 22090, 200 pgs. \$15.95

CIRCLE NO. 467

**Electronic Designer's Handbook**, second edition—L.J. Giacoletto, McGraw-Hill Book Co., 1221 Avenue of the Americas, New York, NY 10020, 2344 pgs. \$47.50

CIRCLE NO. 468

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CIRCLE NUMBER 7

# If this ad doesn't don't know what

## A/D Converters

	Motorola's MC14433	National's ADD3501 (MM74C935-1)
Accuracy: 0° to +70°C	No spec	± 1 count max
Power Supplies Required	2	1 (+5V)
External Active Components Required	4	2
System Cost	Higher	Lower
Price @ 100 pcs.	\$9.97	\$9.95

National introduces its answer to the Motorola MC14433. The ADD3501 3½-digit A/D converter...manufactured using National's standard MM74C Series CMOS process.

As you can see from the chart, it offers more performance and requires fewer external components than Motorola.

Fewer components means lower system cost and greater reliability.

The ADD3501 uses pulse width modulation as a conversion technique, rather than

dual slope. Which means inherently better temperature and long term stability.

And our out-of-range indication is "OFL," not just a blink.

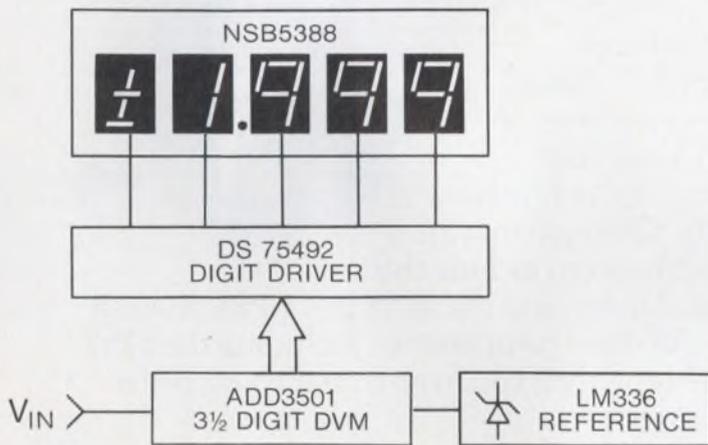
The ADD3501 is available now from National distributors. Pick up a few samples and give us a look-see.

**One-stop shopping for digital panel meter and digital multi-meter components.**

Another nice thing. You can fill your whole shopping list from National.

# convert you, we will.

The LM336 Reference, plus the other external components you might need for your panel meters and digital



DVM BLOCK DIAGRAM

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## Other ways to convert you.

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ED8/2

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# Intel delivers a unique the 8085. It's like the

Introducing the 8085, a unique new microcomputer that is part of a new Intel<sup>®</sup> microcomputer system—the MCS-85.<sup>™</sup>

The 8085 is both software and bus compatible with the 8080. So you can take

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Total system commitment. It protects your investment. And gives you the jump in a competitive world. Because MCS-85 is a complete and fully supported system, comparing Intel with any other microcomputer supplier becomes an apples to oranges comparison.

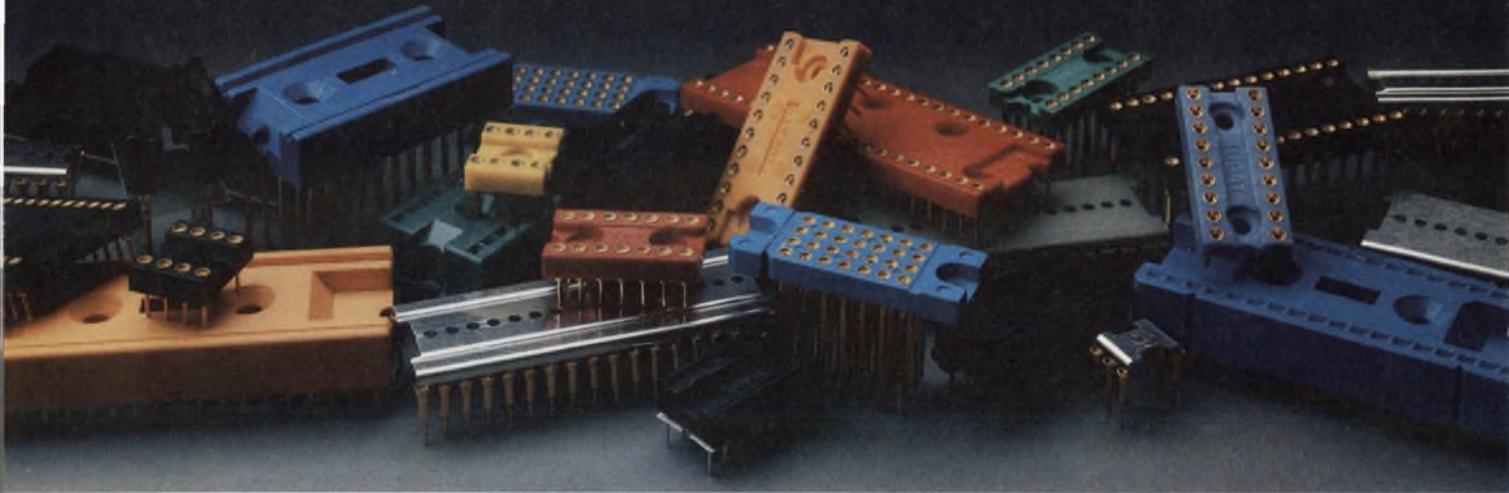
The fastest way to get started is to order MCS-85 products from your local Intel distributor. Almac/Stroum, Component Specialties, Cramer, Elmar, Hamilton/Avnet, Harvey Electronics, Industrial Components, Liberty, Pioneer, Sheridan, L.A. Varah, or Zentronics.

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Our Series 300 low-profile sockets excel over competitive types with their superior beryllium copper side-wipe contacts that handle all com-

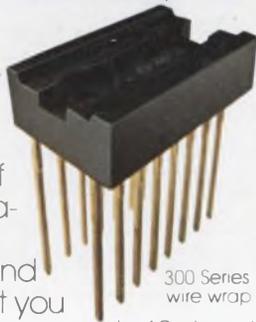


300 Series low-profile

ponent lead sizes with better retention and longer contact life. They are available in all sizes from 8 to 40 contacts.

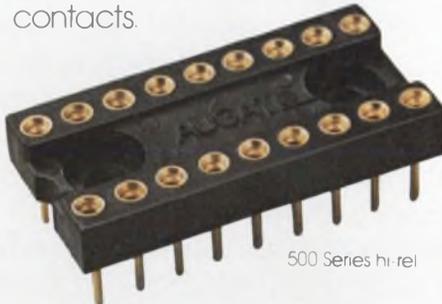
Our 300 Series wire wrap sockets are the best buy in the industry today. Their special pin taper locks them in place without bonding or soldering, and

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300 Series wire wrap

Our 500 Series sockets are the industry's "premium grade", the ones to use when high reliability and exceptional performance (at a reasonable price) are a must. They come in 12 sizes between 8 and 40 contacts.



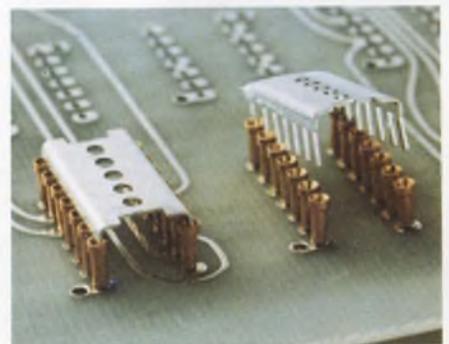
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Our 700 Series lead socket carrier is a new concept of growing popularity. The metal carrier holds the individual contacts in place through assembly and soldering, and is then removed. Advantages: improved airflow and complete topside accessibility for inspection and solder rework. Available in 14 sizes.

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## AUGAT<sup>®</sup>

Augat interconnection products, IsoTronics microcircuit packaging, and Alco subminiature switches.

## Be a gambler without losing—time, that is

An on-the wrist gambling casino is the latest feature to be packaged into an LCD digital watch. Based on a random-number generator in the watch circuitry, three games are available simply by pressing a Game and a Display switch: Jack Pot, Dice, and Roulette.

Jack Pot displays three random numbers, from 1 through 6, to simulate the three spinning wheels of a slot machine. Dice displays two random numbers from 1 to 6 to imitate the roll of a pair of dice. Roulette winds up with a number from 1 to 36, as in the spinning of a roulette wheel. The watch is appropriately named the Monte Carlo. Gaming, timing and other functions are controlled by four switches on the watch by Unitrex in New York City. One switch, the normal time display, is also used in playing the games. A second is the Game switch, which selects the three games but also returns the watch to the normal hours and minutes time mode. A Light switch turns on back illumination for night viewing, while a Set switch is used to set the time.

All three games use the same pseudo-random generator, observes Dwain Holst, president of Datatime, Sunnyvale, CA, designer and supplier of the watch IC chips. In the Game modes, the normal timing logic is locked out and the random numbers are displayed.

To play Jack Pot when the watch is displaying the time, the game switch is pressed once. To start the three Jack Pot numbers "rolling," the Display switch is pressed. As long as the display switch is held in, the three numbers continue to change rapidly.

Because of the flow response of the LCD, the individual numbers cannot be detected. Once the Display switch is released, the rate at which the random numbers are sent to the display begins to slow down—just like slot machine wheels. Finally, the right hand digit appears motionless, then the middle

digit and finally the left-hand digit.

If all three digits are the same, the Jack Pot is hit and four Js flash in the display. Pressing the Game switch twice selects Dice, while three times gives roulette. As with Jack Pot, the Display button is operated to set the Dice and Roulette numbers in motion and to stop them.

Pressing the Game switch a fourth time returns the watch to timekeeping. Pressing the Display button then shows the day and date. Pressing Display twice more within two seconds shows minutes and seconds. A final push on Display, brings back the hours and minutes digit to view.

## S/n up, phase distortion down in Hall playback

An 8-track record-playback head for magnetic tape recorders is the first Hall-effect consumer application. Incorporating thin-film Hall elements in the playback structure, the Hitachi head has lower cross talk, higher signal-to-noise ratio and substantially lower phase distortion than those of conventional magnetic coil playback devices.

Key to Hitachi's design is a 2- $\mu$ m, thin-film, indium-antimonide Hall element with a highly efficient magnetic structure. Microzone-melting the Hall element on a ferrite substrate reduces noise to present low levels. On this basic element, a ferrite pole piece is fastened and ground to form a playback head with a 3- $\mu$ m gap.

Signal-to-noise ratio of Hitachi's playback unit is 3 to 5 dB better than competitive conventional units, says Gentaro Miyazaki, director of Hitachi's Consumer Products Research Center in Lyndhurst, NJ. Cross talk is below -50 dB at 80 Hz. And phase distortion is so low that rectangular or square waves can be reproduced with excellent fidelity—a major requirement for hi-fi buffs.

In addition, the time lag between recorded and monitored voice or music is less than that for conventional heads. The physical distance between the recording head gap to the reproducing head gap has been reduced. The conventional distance is 3.2 mm. For the Hitachi device, it is 2.4 mm.

The first Hall-effect playback heads produced a few years ago not only had poor s/n ratios and frequency response, but were costly to boot—\$500 to \$600. Hitachi's method of fabrication produces low device cost—on the order of 9 dollars in large quantities, according to Miyazaki. The device is being mass-produced in Japan.

## Ovshinsky strikes again: amorphous solar cells

Even as the scientific community's attitude toward Stanford Ovshinsky's development of noncrystalline, amorphous semiconductors has begun to turn from skepticism to acceptance, the inventor has come up with a new application for the devices: solar cells that are claimed to be two orders of magnitude less expensive than conventional silicon cells.

Such devices can be made to produce electricity at a cost of 0.2 cents/kWh, compared with 25 cents/kWh for crystalline-silicon solar cells, according to Ovshinsky's firm, Energy Conversion Devices Inc. of Troy, MI. To be competitive with conventional sources, the company says, the cost must be 3 cents/kWh.

Amorphous semiconductors can cost less than crystalline devices because their materials can be mixed by a simple process and can contain fairly high amounts of modifiers—20% or more. On the other hand, silicon crystals must be extremely pure, and the small amounts of modifiers used in the doping process can be difficult to control.

To make amorphous-semiconductor solar cells, the basic material is chemically modified to increase its conductivity. Low conductivity, among other factors, had made amorphous materials unsuitable for converting sunlight to electricity.

Ovshinsky's work with amorphous materials, which began in 1958, has long been regarded with suspicion, in part because the materials' responses could not be explained simply. But in recent years, potential applications have begun to emerge.

Burroughs Corp. has been working on amorphous memory devices. Energy Conversion Devices has also developed an amorphous-material microfiche system that may soon be marketed in the United States by Minnesota Mining and Manufacturing.

## Biggest windmill to generate 2.5 MW

The largest windmill in history—a 2.5 MW system with blades spanning a circle 300 feet in diameter—will be built over the next two years in a test program conducted by the Energy Research and Development Administration. Although experimental, the wind turbine—the name for modern electrical generating windmills—will be located at a utility-company site and will supply electricity to a local electrical system for public use.

The program will investigate the economics and operating characteristics of large wind turbines when coupled with conventional power plants, according to an ERDA spokesman. Special emphasis will be on developing a wind turbine capable—if produced in quantities of up to 100 units—of providing electricity at a cost approaching that of conventional power plants.

ERDA and the National Aeronautics and Space Administration, which will manage the program, are negotiating a \$10-million contract with Boeing Co. of Seattle to design, build and install wind turbines at sites with a mean wind speed of 14 mph. Such sites are relatively common throughout the United States.

The largest currently operating wind turbine is the 100 kW, 125-ft diameter system built for ERDA by NASA-Lewis Research Center at its Plum Brook test area near Sandusky, OH.

## Million-hour life seen for GaAlAs lasers

Solid-state gallium aluminum arsenide lasers with average projected lifetimes of one-million hours—or 100 years—have been reported by Bell Laboratories.

These long-lived room-temperature lasers are essential for future optical communications systems.

“Aging tests have shown that these lasers now last so long, that it’s hard to determine their expected lifetime in a system application,” according to Barney DeLoach, head of the light-

wave-sources department.

“However, by operating groups of lasers at temperatures considerably higher than room temperature—90 C (194 F), 70 C (158 F), and 50 C (122 F)—we were able to cause them to fail in measurable times. Even so, some tests exceeded two years.”

By extrapolating these high-temperature results to lower temperatures, says DeLoach, Bell Labs was able to project room-temperature (22 C or 72 F) lifetimes of about a million hours.

Actual equipment-frame temperatures in operating lightwave systems exceed 22 C. Initially, thermoelectric cooling devices will be used to maintain near-room-temperature conditions for the lasers.

## Current limiters added to smallest LED lamps

On-chip current-limiting resistors have been added to red LED lamps that can be mounted on 0.1-in. centers—25% less spacing than in other available lamps with built-in resistors. The current limiters eliminate the need for an external resistor and make for a more compact and simpler design in such applications as digital status indicators, cameras, and portable equipment.

Because the LEDs from Hewlett-Packard Co., Palo Alto, CA, also contain reverse-protection diodes, the lamps can operate from 5-V sources without additional biasing components.

The Model HLMP-6600 requires a nominal forward current of 10 mA and typically emits 2.4 mcd of axial luminous intensity. The HLMP-6620 typically draws 5 mA and delivers 0.6 mcd. Both lamps go for \$.75 in quantities up to 99 and \$.53 in quantities over 1000.

CIRCLE NO. 318

## Testers can penetrate the surface of Mars

An instrument package that can be dropped from a satellite orbiting Mars can penetrate the surface of the planet and perform experiments as deep as 45 feet. Preliminary development and testing of the penetrators has been completed at Sandia Laboratories in Albuquerque, NM.

Funded by NASA’s Ames Research Center at Moffett Field, CA, the penetrators may become part of a geology mission to Mars in 1984. Tests of the

packages were performed in earth materials, loam and sand-covered lava, resembling the surface materials expected on Mars. The tests were conducted at McCook, NE, and Amboy Crater, CA.

In the proposed Mars system, the penetrators will be ejected from a spacecraft near the high point of an elliptical orbit, where orbital speed is lowest. The penetrators will decelerate through the Martian atmosphere, with a final descent by parachute, and strike the surface at roughly 500 ft/s.

A detachable afterbody containing an antenna, transmitter, and command receiver will be sheared off at impact and remain on the surface. At the other end of a 45-ft multilead umbilical cable, the main body of the vehicle will dig in anywhere from 40 in. to 45 ft, depending on the nature of the surface.

Instruments within the hollow projectile—about 3½ in. in diameter and 4 ft long—will record scientific data to be stored in an on-board memory and telemetered back to Earth via the orbiting spacecraft. The experimental package is expected to last at least 400 days.

Data-gathering begins on impact, with an on-board accelerometer generating a signal that will provide a vertical profile of the penetrability of the layers it passes through. This will also give an indication of the physical geology of the impact site. Other experiments have not yet been selected by NASA scientists, but may include thermal, seismic, and geochemical measurements to provide information on the structure, composition, and state of the Martian interior. Tests for detecting water and the past or present occurrence of life may also be included.

Several experiments could be conducted by opening a door in the side of the penetrator to expose a sample of the surrounding strata to analytical instruments. Power for the instruments and for data storage would come from two radioisotope thermoelectric generators located near the front of the penetrator. The RTGs would also recharge high-capacity batteries that provide power for data transmission.

Sandia has been conducting high-speed earth penetration studies for about 20 years as part of its nuclear weapons programs for the Energy Research and Development Administration. The Mars penetrator design is similar to a sea-ice measuring system developed by Sandia for the Coast Guard.

CIRCLE NUMBER 10 ►

# "BLUE MAX" DID IT!

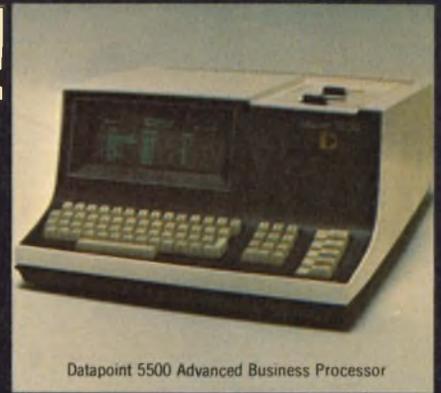
Do you need a capacitor that provides miniature size, maximum CV ratings, consistent quality at a competitive price?

Datapoint Corporation of San Antonio, Texas, manufacturers of advanced business processors did, and they chose the KEMET "Blue Max" dipped monolithic ceramic capacitor. This durable and reliable workhorse helps provide the quality consistent in all Datapoint processors.

Available in three dielectrics — COG Ultra-Stable, X7R Stable, and Z5U General Purpose — in six case sizes. Choose from more than 350 CV ratings, in capacitance values from 2.2 pF to 4.7 uF in 50, 100 and 200 voltage ranges.

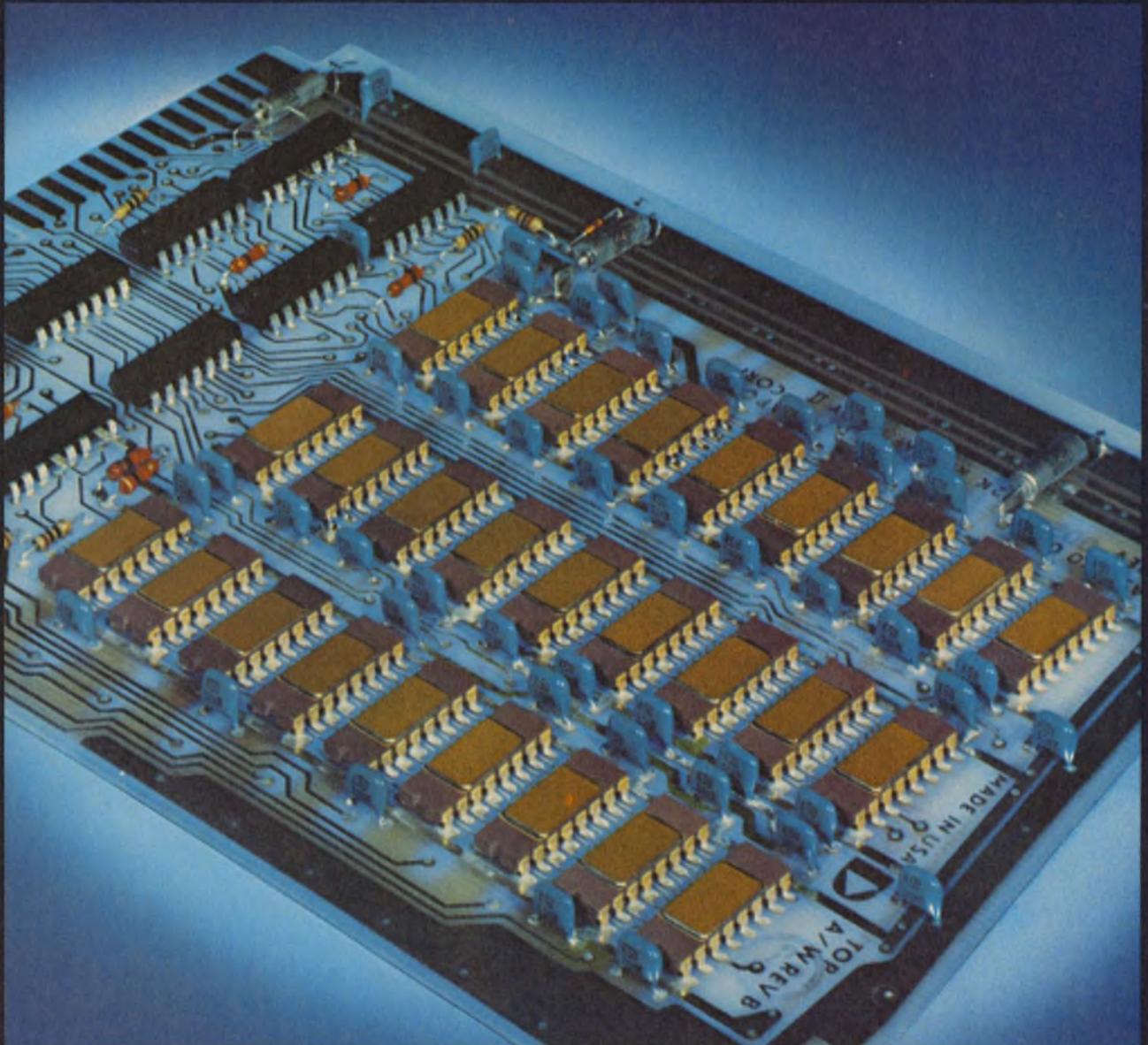
Want to know more? Write us: Components Department, Union Carbide Corporation, P.O. Box 5928, Greenville, SC 29606; phone: (803) 963-6300; TWX: 810-287-2536; Telex: 57-0496.

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**PMI's  
COMDAC™ companding  
D/A converter. When  
you think about what  
it can do, nothing  
seems very far-fetched.**

Not long ago, we ran a little contest in one of the electronics magazines. We asked engineers to come up with the most creative ideas they could think of to put PMI's unique COMDAC—the first and only companding D/A converter—to work. We got lots of responses with exciting ideas. But the interesting part is that no less than **five** engineers said they'd had terrific ideas—but they couldn't submit them because their corporate attorneys were starting patent searches.

That's the kind of brainstorming that COMDAC has generated since we first introduced it.

The reason is simple: nature is nonlinear. People, plants, animals, water, wind—we don't live in a straight-line world. We live in a world of curves, slopes, and human response systems (ears, eyes, touch) that do not follow straight-line paths. In trying to reduce these things to digital data, or to imitate them, we've always fallen short.

**Until COMDAC.**

With the help of COMDAC you can linearize analog signals. COMDAC can supply the shades of grey, the sweeping curves, the "vive la différence!" of the natural world. COMDAC uses logarithmically companded digital techniques for D/A conversion; with just eight bits, it provides the dynamic range of a 12-bit DAC—72dB or 4096:1. With that range, it can produce a convincing facsimile of the human voice, for example. Your watch radio can awaken you gently, with soothing, motherly tones, or shake you out of bed with a drill sergeant's scream—whichever is called for in your case.

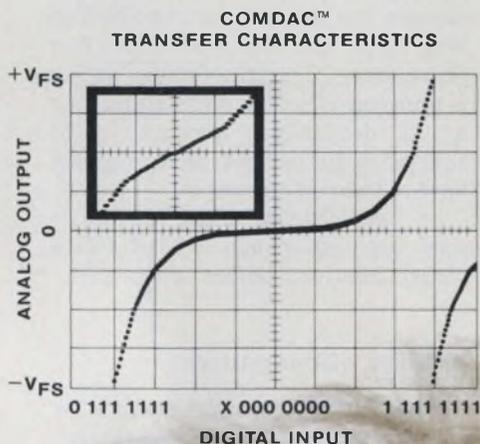
*It's six-forty — rise and shine. Squash at eight. Board meeting at ten.*



Consider these applications—some of which are already a reality:

- Digitized audio—music, sound effects, voice ( $\mu\text{P}$  controlled)
- XYZ positioning (automated drill presses, for example)
- Motor controls
- Echo/reverb devices (for electronic guitars, electronic organs, synthesizers)
- Voltage-controlled oscillators and filters
- Servo motor controls

- Altimeters
- Waveform generation (with PROM)
- VU meters (for better response)
- Voice recognition (imagine a typewriter you could dictate letters to!)
- Tone generators
- Voice encryption
- Voice warning systems (they're already using them in aircraft)
- LOG sweep generators
- Data acquisition
- Recording studios
- Verbal response systems (like, your car could give you the word when it's overheating)



Keep in mind that COMDAC is not just a concept. It's a working reality. In the last two years, we've delivered half a million and cut the price in **half**. And since the 8-bit COMDAC can do many things a

12-bit DAC can do, think of what you will save by using a low-cost 8-bit system to do the job of the expensive 12-bit approach.

With a little bit of thought, a creative engineer—that's you—can come up with some really dazzling ideas. The surface has just been scratched. If you'd like a copy of all our contest entries, circle the bingo number below. We'll send technical literature that will help you with your application. Want a sample COMDAC? Send us a request on your letterhead.

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CIRCLE NUMBER 11



## Intelligent memory holds the key to a limitless array of computers

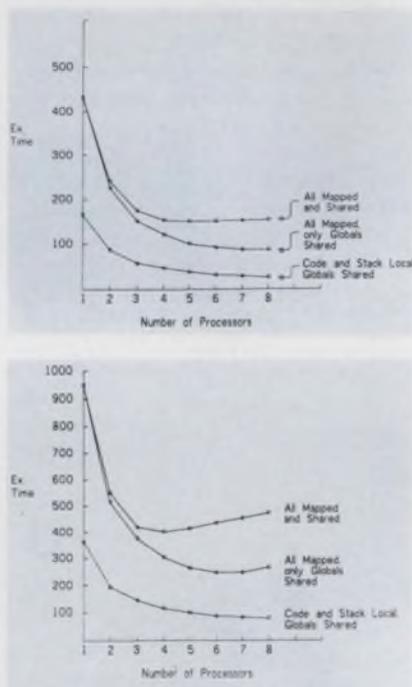
A scheme to connect hundreds of microcomputers into a potentially endless array of distributed intelligence has been developed by a research team at Carnegie-Mellon University in Pittsburgh. The processors would be connected into a common, intelligent memory that can accommodate  $2^{28}$  words of storage, or well over 250-million words.

"Cost is the crux of the problem in expanding a distributed processing system," notes researcher John Ousterhout, speaking at the National Computer Conference in Dallas. "In most cases, cost increases nonlinearly with size; it is proportional to the number of processors times the number of memory boxes. Extending a system from 16 processors and 16 memory boxes to 32 and 32 will square the cost, not double it." So the idea was to find a computer structure that can accommodate a very large number of processors—hundreds of them—and very large amounts of memory without reaching a point of cost-saturation.

### Too much waste

Currently, distributed microcomputer systems are structured so that each processor has uniform access to all parts of memory—an extravagant use of hardware since most programs don't require vast amounts of storage at all times. According to the Carnegie-Mellon approach, the interconnection between processors and memory is distributed, packet-switching techniques are used to shuffle data around and each processor has quick access to its own local memory. A "unit of memory" is associated with a "unit of processing" and the boundaries are highly flexible. Each processor has access to all the other processors' memories and vice versa.

**Dick Hackmeister**  
Western Editor



Two different programs have been debugged and run on the Carnegie-Mellon distributed-processing system; one solves partial differential equations (PDE) and the other is a sort routine (Quick Sort). These graphs show the decrease in execution time for an increasing number of processors sharing the job. The degree of task-sharing is optimized when the program code and subroutine stack reside in local memory and all the working computers have access to common global commands (macroinstructions).

Local memory-access time is about  $3 \mu\text{s}$  and the remotest data can be accessed in about  $25 \mu\text{s}$ . When any processor needs data from afar, it is accessed by the intelligent memory and delivered in packets—so data are never "deadlocked." This problem occurs when each data stream needs the bus to travel in the opposite direction at the same time and they impede each other.

Routing data in packets of 16-bit

words side-steps deadlocking much like railroad trains passing each other on sidings. One packet is held in a buffer, away from the bus while the other passes freely. Then the shunted packet is returned to the bus and continues on to its destination, perhaps to be shunted again or have another packet buffered out of its way.

By "leapfrogging" data, the bus is used just long enough to send a data packet from one buffer to the next.

### Clusters of computers

When the data packet reaches its destination, it is latched into a buffer, which is also the input port to a cluster of as many as 14 processors.

Each of the processors in a cluster has its own local memory. Processors and memory are connected through a switch, which is controlled by the buffer—an intelligent port. The switch can be set to connect the processor to either the input port/buffer memory or the processor's own local memory.

The switch, buffer, port and intercluster bus are all invisible to the local processor.

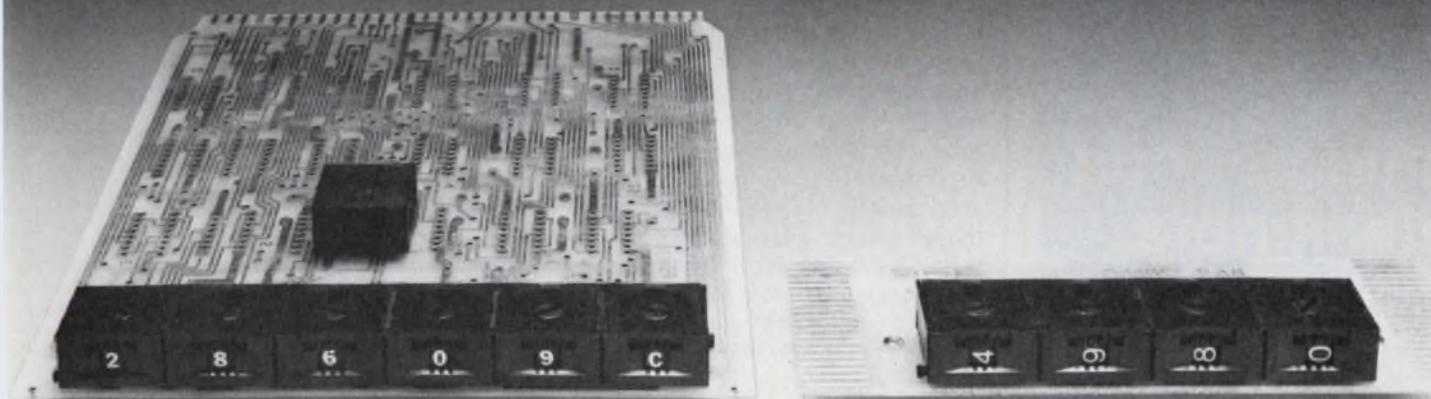
The key to the Carnegie-Mellon system's extensibility, says Ousterhout, is its modularity, which allows hundreds of processors to be added to the system cheaply.

Even though each processor has only a single, 16-bit address bus, it has access to virtually  $2^{28}$  memory locations. What's more, as a result of clever indexing and mapping, no bus in the system has more than 16 lines.

The local switches, detecting an address generated by the local processor, connect it to either the local memory or the input port (from the intercluster bus), depending on the four most-significant bits.

Those four bits serve as a page number; the remaining 12 bits are the

*(continued on page 32)*



# SNAPPY LITTLE NUMBERS

Save time and money with SAE Strip-Pak™ rotary PCB switches. These snappy little numbers come in a wide range of output codes, and are the most reliable PC board rotary switches you can buy.

The unique modular design of Strip-Pak switches lets you snap them together in strings. You can even mix output codes within the same gang. And Strip-Pak switches can be placed individually, too, either horizontally or vertically, any place on a board.

Additional versatility is provided by a choice of three operating methods: by thumb pressure, with a screwdriver, or with an optional snap-in knob.

SAE Strip-Pak switches are every bit as tough as they are versatile. We use a beryllium copper detent spring instead of plastic teeth or gears, for an operating lifetime of 500,000 detents. And that's a snappy *big* number.

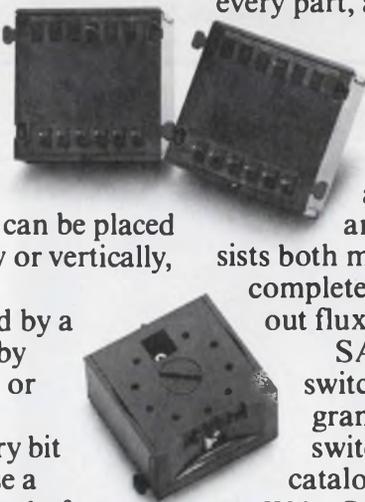
More reliability comes from total in-house manufacture. SAE makes every part, inspects every part, and controls every detail of assembly.

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Preformed, heat-treated terminals are made from 30 percent thicker stock, and the glass filled polyester housing resists both moisture and solvents. The terminals are completely sealed so you can wavesolder without flux wicking.

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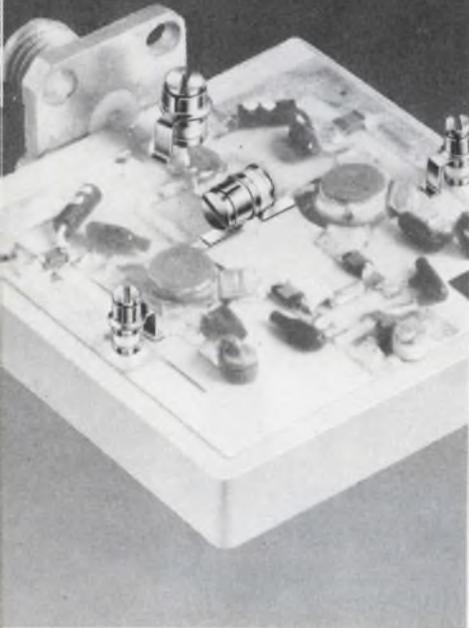
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The OEM Connection

CIRCLE NUMBER 12

# giga-trim capacitors for microcircuit designers



Giga-Trim® (gigahertz-trimmers) are tiny variable capacitors which provide a beautifully straight forward technique to fine tune RF hybrid circuits and MIC's into proper behavior. They replace time consuming cut-and-try adjustment techniques and trimming by interchange of fixed capacitors.

Applications include impedance matching of GHz transistor circuits, series or shunt "gap-trimming" of microstrips, external tweaking of cavities, and fine tuning of crystal oscillators.

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(continued from page 30)

offset. If the address calls for the processor's local page, the switch connects the processor directly to its local memory. If not, it may get connected to *another* local processor's memory, to the intercluster bus port's buffer, or even back to its own local memory, though this last alternative is unlikely.

Besides being a buffer, the intercluster bus port is a mapping processor that controls the relationship between the generated address-page number and the rest of the system.

## Four bits per page

The four-bit page numbers define one of 16 words in a look-up table residing in the local switch. The higher-level mapping processor/buffer memory/input port defines those relationships, and loads the co-relating addresses that are in the look-up table. For this reason, the mapping processor can detect an overabundance of remote memory references. And, though not yet programmed to do so, the mapping processor can relocate that remote data into the processors' local memory. All this is invisible to the user.

In short, the local processor generates a memory address of 16 bits. The switch interprets the top four bits as an indirect address. The indirect address is defined as another location somewhere within the realm of  $2^{28}$  locations. (The limit of  $2^{28}$  is arbitrary

and can be increased with very little effort.)

Beyond flexibility of addressing and memory sharing, all processors can communicate directly with all other processors through a memory-location "window"—any two processors address the same location and communicate bidirectionally through it. This is similar to a DMA (direct memory-access) operation.

All processors can interrupt each other, diagnose each other, single-step each other, and more. And they all run asynchronously.

The Carnegie-Mellon project is currently in "Phase 2," an evaluation phase. To date, 10 processors in three clusters have been implemented and two applications programs have been debugged. One is a quick sort routine, the other solves partial differential equations.

Experiments that partition programs into different parts of memory while monitoring the execution time as a function of the number of computers actually working have lived up to the team's expectations. "Phase 3" of the project will expand the number of processors in the system to several hundred. It will take several years, though, to accomplish, says Ousterhout.

The Carnegie-Mellon work was funded by the National Science Foundation, the Advanced Research Projects Agency and the Air Force. Digital Equipment Corp. supplied the hardware. ■■

## A signature verifier

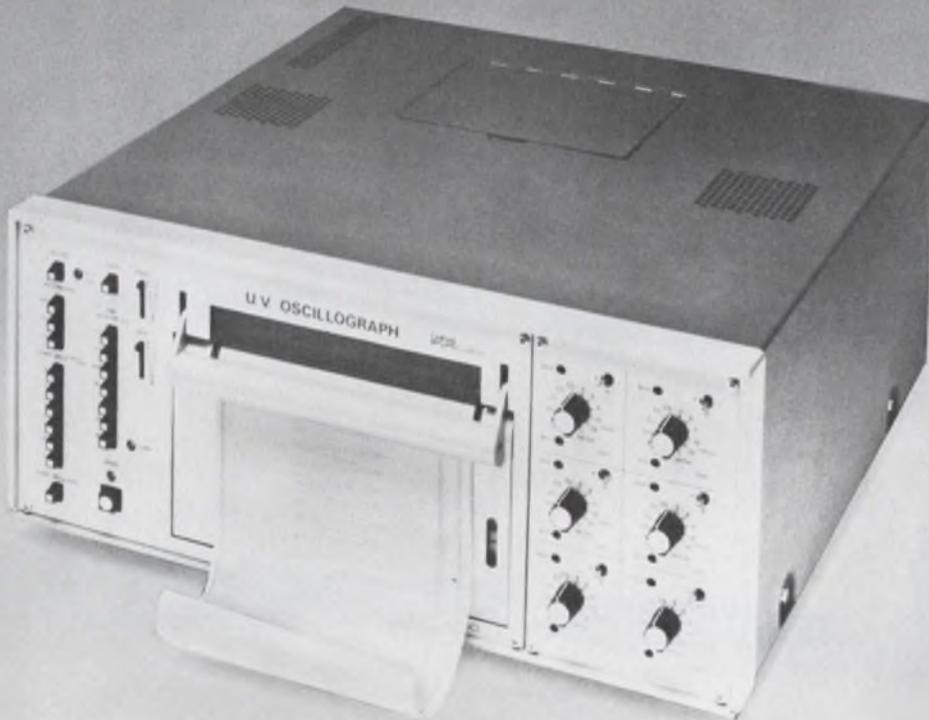


A ballpoint pen and writing tablet incorporating piezoelectric transducers converts handwriting movements into electrical impulses.

Developed at Sandia Laboratories, Albuquerque, NM, the pen and tablet instrument can be incorporated into signature verification systems to help control access to areas where personnel have to identify themselves.

The pen produces electrical signals that reflect the unique horizontal and vertical motions occurring as a signature is written. The tablet produces signals from handwriting pressures.

# SE6150: More than an oscillograph.



## An Innovation.

The innovation is built-in signal conditioning. And it pays off in time and convenience.

With EMI's new SE6150 ultra-violet oscillograph, you can move from one test to a completely different test without changing or adjusting the set up. Six channels are pre-conditioned to record up to 2 KHz fsd from high or low impedance voltage sources ranging from 500 mV to 500 V. Six additional channels provide direct galvanometer entry for high output

type transducers. Connection can be made instantly via any or all of these versatile inputs.

The SE6150 also offers an easy-to-read display, trouble-free ultra-violet recording and a price that's hundreds of dollars below less capable instruments.

Best of all, it's from EMI, a world leader in quality instruments. A name that means innovation. EMI Technology Inc., Instrumentation Division, 55 Kenosia Avenue, Danbury, CT 06810. Phone: (203) 744-3500, TWX: 710-456-3068.



EMI Technology Inc., Instrumentation Division  
A member of the EMI Group. International leaders in music, electronics and leisure.



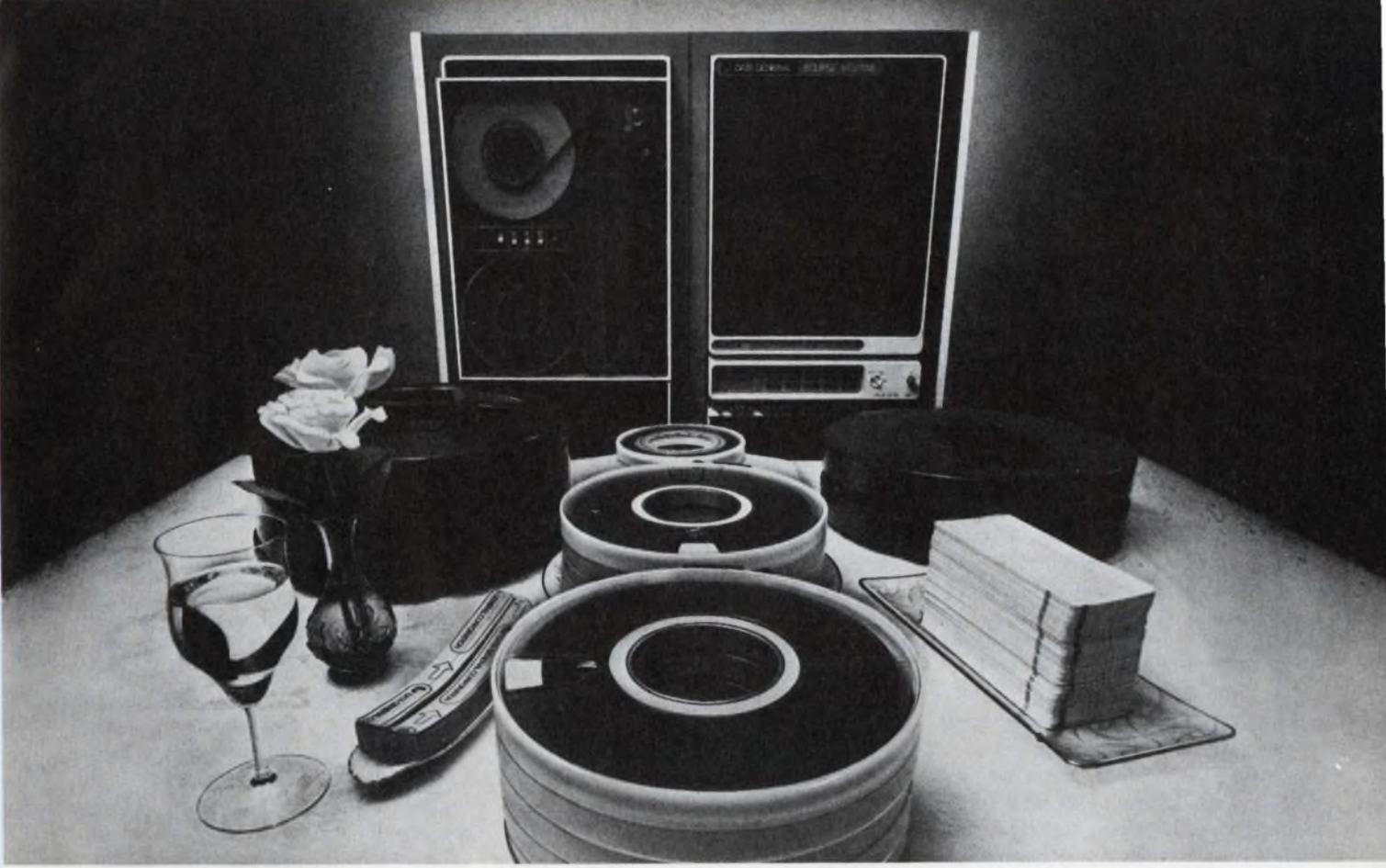
# UBIQUITOUS . . . . .

The Ballantine 3028A; at home in Bryce Cañon, on shipboard, or in your maintenance shop and laboratory. In one fine instrument Ballantine has combined features otherwise found only in a number of lesser multimeters. It is another new Ballantine with full performance and top quality.

- DISPLAY:** 3-1/2 large LED
- FUNCTIONS:** AC, DC Volts  
AC, DC Amps  
 $\Omega$  low power  
 $\Omega$  high power  
Display Test  
Battery Check
- RANGES:** 32
- ACCURACY:** To  $\pm 0.05\%$   $\pm 1$  digit
- FREQUENCY:** 15 Hz to 110 kHz  
rms responding
- MODEL 3028A: \$279**

- Fully EMI shielded
- No fuses; circuit breaker protected
- AC RMS response for accuracy with distorted inputs
- One year calibration interval
- Safety compliant
- Uses only standard parts
- Optional:* battery pack, analog meter, 20 amp range, 40 kV dc and 700 MHz detector probes, full complement of accessories

## Ballantine



# Introducing the hungry ECLIPSE.

Data General's new ECLIPSE S/130 computer has a bigger appetite for work than any other mid-range mini. And enough speed and versatility to wolf down any kind of data you have to dish out.

The hungry ECLIPSE computer is built around the same powerful architecture as our super high-speed ECLIPSE S/230. Added to that is a host of special features that make the hungry ECLIPSE unique. Like our fast micro-coded floating point and efficient character string instruction sets. And our second-generation WCS general-purpose user microprogramming ability that results in unmatched throughput in demanding applications. To top it off it also includes AOS, our amazing new heuristic multi-programming advanced operating system, and of course the full range of Data General's economi-

cal big-computer peripherals, software and worldwide support.

Now, you don't have to skimp along with an undernourished mini that's too limited for your work. Or splurge on one that's too fat just to get the performance you need. Just order an ECLIPSE S/130 computer. It will make your work load a lot leaner. Want more food for thought? Send for our brochure.

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ED 8/2

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CIRCLE NUMBER 16

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# 1977 Career and Salary Survey

Like almost everyone else, U.S. design engineers make more money than they did five years ago. But many think they should be making even more. According to an ELECTRONIC DESIGN career and salary survey conducted five years ago (ED No. 9, April 27, 1972, p. 42), nearly 60% of the respondents made \$15,000 or more. According to a survey conducted in June of this year, nearly 60% make at least \$20,000. But close to 40% make no more than \$24,999. Another 30% make \$25,000 and more.

Half the respondents to the 1977 survey consider themselves underpaid.

According to this survey:

- Almost half (44%) are project engineers, senior engineers and group leaders; one-third are technical-staff members, scientists, physicists or engineers.

- Nearly one of every four works on computers and data-processing equipment; one of every five works on communications, navigation or guidance equipment. Slightly fewer work on aircraft, aerospace, ground-support or oceanographic equipment.

- Virtually half have no more than a bachelor's degree, while another 30% have Master's degrees. About 4% have PhDs. (Five years ago, 33% had Master's degrees, and 5% had PhDs.)

- Close to 60% of the respondents are between 25 and 39, and 27% between 40 and 49. (One out of five is at least 30 and at most 34.)

- Just about everybody has been unemployed (99%) during his engineering career, but the overwhelming majority (88%) have been out of engineering work less than 1% of their professional time.

- Seven out of 10 work from 36 to 45 hours a week, but fully 19% work as many as 49 hours a week.

- Very few (3%) have suffered from wage busting—salary cuts due to contract bidding.

- Almost half participate in civic activities.

The paychecks may be healthier, but over half the respondents in two higher-priced groups consider themselves underpaid. Almost 65% of the chief/principal engineers and division heads think so. So do 55% of the section or department heads.

In addition, the largest salary bloc to complain of being underpaid makes \$20,000 to \$24,999 (Table 1). One out of four chief/principal engineers and division heads can be found there—as well as 43% of the project engineers, senior engineers and group leaders.

## From the mountains. . .

A majority of those respondents living in New England (63%) believe they deserve more in their paychecks. An even greater majority in the Mountain region (70%) do *not* consider themselves deprived. The Middle Atlantic and Midwest respondents considering themselves underpaid fall slightly below 50% and likeminded respondents from the South, Southwest and West Coast land slightly above.

By education, the best paid are PhDs, the tiniest population. And 77% of them don't feel underpaid. They stand the best chance of making at

least \$35,000. In addition, engineers with Master's degrees have been able to jump slightly ahead of those with bachelor's degrees. While 61% of the latter make \$15,000 to \$24,999, 64% of the former make \$20,000 to \$29,999. Interestingly, 42% of those with no degree—and according to the responses, there are many more of them than PhDs—make \$20,000 to \$24,999.

Respondents working on industrial controls and medical equipment make the lowest salaries, with half the former and 60% of the latter making less than \$20,000. It was even worse five years ago. Then, only one of every four in medical equipment was making at least \$15,000. Now, nine of every 10 makes that much. But no one gets as high as \$25,000.

In 1972, half those in industrial controls made at least \$15,000, but only 18% made at least \$20,000. In 1977, 43% make over \$20,000.

The largest percentage of respondents, by product category, to make over \$30,000 works in consumer electronics (Table 1). Five years ago, only 15% made over \$25,000. Now 47% make over \$25,000.

Engineers in the consumer industry are better educated than they were five years ago. At that time, none of the respondents had a Master's degree. Five years later, half the respondents in consumer electronics have one (Table 3).

How long one has been working affects how much he makes—but subtly. Almost as high a proportion of respondents with five to nine years' experience makes between \$20,000 and \$24,999 as the percentage of those with 10 to 14 years under their belts. And both percentages are high, according to Table 1. But after that, the former group falters, while the latter group gives respondents with 15 to 19 years behind them a run for the money at the \$25,000-to-\$29,999 level. The 15-to-19-year veterans, in turn, almost match the proportion of respondents with up to 24 years' experience making between \$30,000 and \$35,000. As Table

## Something about the survey

In May, 1977, a career and salary questionnaire was sent to 1000 engineers and managers randomly selected from ELECTRONIC DESIGN's domestic circulation. As of July, this circulation comprises 88% of ED's total circulation.

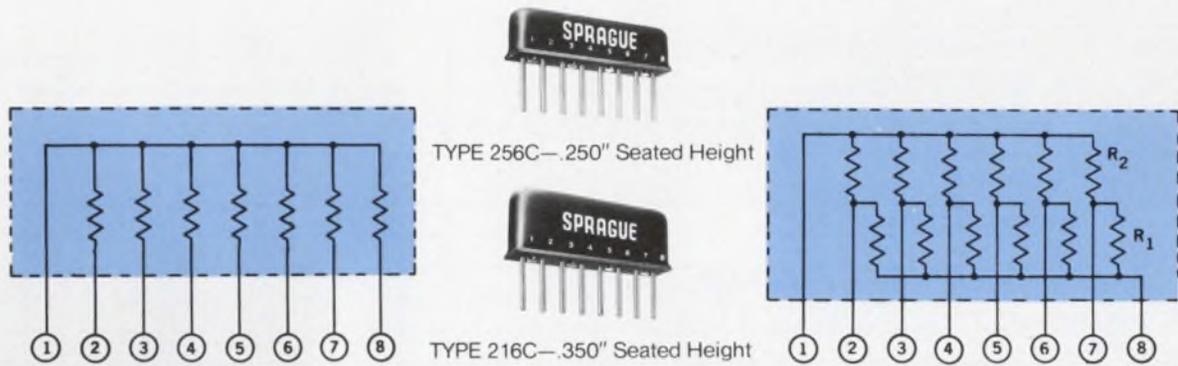
The response was both quick and overwhelming. Two days after the questionnaires were mailed, eight surveys came back, filled out. By the cut-off date, 406 questionnaires had been filled out and returned.

Special thanks go to Elaine Acquire, without whose typing and mailing help there would have been no survey.

James Keane  
Associate Editor

(continued on page 38)

## **NOW!** SINGLE IN-LINE RESISTOR NETWORKS WITH IMPROVED PERFORMANCE



# BOARDABLE AND AFFORDABLE

### **Low Cost and High Density Configuration**

are only two of the features of Sprague Type 216C and 256C Metanet® Resistor Networks. Now, you can also enjoy the benefits of improved power dissipation, better temperature coefficient of resistance, and closer standard resistance tolerance.

**Save Board Space.** Single in-line design permits vertical installation, which allows more units to be seated in less space. This mounting style also results in improved high-frequency performance and significant in-place cost reduction. (Metanet Resistor Networks are also available in 14 and 16 pin DIP packages.)

**Better TCR.** Typical temperature coefficient of resistance is within  $\pm 200$  ppm/°C, cutting previous allowable limit almost in half.

**Up-graded Power Dissipation.** Individual terminating, pull-up/pull-down, and interface networks are capable of dissipating 250 mW per resistor at 70°C, an increase of 100% over previous designs.

**Closer Resistance Tolerance.** Standard resistance tolerance for each resistor is  $\pm 2\%$ , with other tolerances between  $\pm 1\%$  and  $\pm 5\%$  available on special order. (Resistor-Capacitor networks are also available. Standard Monolythic® capacitor tolerance is  $\pm 20\%$  and resistor tolerance is  $\pm 2\%$ . Tighter tolerances are available on special order.)

**Proven Product Line.** Sprague has more than fifteen years of experience in the development and manufacture of precision thick-film resistor networks, which include individual terminating, pull-up/pull-down, interface, and dual terminating designs.

For complete technical data, write for Engineering Bulletin 7041B to:  
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**THE BROAD-LINE PRODUCER OF ELECTRONIC PARTS**

CIRCLE NUMBER 17



**Table 1. Salary Profile** (All the number responses denote %)

	Under \$10,000	\$10,000-\$12,499	\$12,500-\$14,999	\$15,000-\$19,999	\$20,000-\$24,999	\$25,000-\$29,999	\$30,000-\$34,999	\$35,000 and over
<b>Titles &amp; (% of total response)</b>								
President or Vice President (1)	—	—	—	—	33	33	33	—
Technical or research director (1)	—	—	—	—	—	67	—	33
Chief engineer, principal engineer or division head (6)	—	—	9	9	26	26	17	13
Section head or department head (15)	—	—	2	16	31	27	19	5
Project engineer, senior engineer or group leader (44)	1	1	2	22	43	20	7	4
Member of technical staff, scientist, physicist or engineer(33)	1	4	9	41	30	9	5	1
<b>Products &amp; (% of total response)</b>								
Computers & data-processing equipment (24)	1	1	4	27	40	20	5	2
Instrumentation (13)	—	4	10	22	31	23	10	—
Communications, navigation or guidance equipment (20)	—	1	4	27	33	17	14	4
Consumer electronics (4)	—	7	—	—	46	13	27	7
Industrial controls (10)	—	—	10	43	17	17	10	3
Components, subassemblies, hardware or materials (7)	—	4	—	18	48	15	4	11
Aircraft, aerospace, ground support or oceanographic equipment (19)	1	—	4	23	39	19	9	5
Medical equipment (3)	—	10	—	60	30	—	—	—
<b>Company location &amp; (% of total response)</b>								
New England (14)	—	2	7	19	40	21	9	2
Mid Atlantic (24)	—	2	3	18	31	23	16	7
Midwest (17)	1	3	6	33	37	13	6	1
South (6)	4	—	8	20	40	12	8	8
Southwest (9)	—	3	—	32	46	8	8	3
Mountain (3)	—	—	20	50	10	20	—	—
West Coast (27)	—	1	4	32	34	22	6	1
<b>Highest level of education &amp; (% of total response)</b>								
No degree (9)	—	6	3	33	42	11	5	—
Associate degree (10)	—	2	15	37	29	10	7	—
Bachelor's degree (47)	1	1	7	30	31	19	7	4
Master's degree (30)	—	1	—	18	41	23	14	3
PhD (4)	—	—	—	6	44	19	12	19
<b>Electronic work experience &amp; (% total response)</b>								
4 years and under (15)	3	5	24	45	19	2	2	—
5-9 years (24)	—	2	2	46	41	9	—	—
10-14 years (16)	—	—	—	25	44	20	8	3
15-19 years (19)	—	3	4	13	35	30	11	4
20-24 years (10)	—	—	—	15	36	28	13	8
25-29 years (11)	—	—	—	3	37	28	23	9
30 years and over (5)	—	—	—	14	27	18	32	9
<b>Ages &amp; (% of total response)</b>								
Under 25 (3)	14	7	29	50	—	—	—	—
25-29 (16)	—	2	16	51	28	3	—	—
30-34 (20)	—	3	1	36	44	11	5	—
35-39 (19)	—	3	4	25	40	18	5	5
40-44 (16)	—	—	2	6	37	37	14	4
45-49 (11)	—	—	—	12	34	36	14	4
50-54 (7)	—	—	—	14	43	22	14	7
55-59 (5)	—	—	—	15	25	20	30	10
60-64 (2)	—	—	—	—	33	—	50	17
65 & over (1)	—	—	—	50	—	—	50	—
<b>Feel underpaid? &amp; (% of total response)</b>								
Yes (50)	1	2	5	32	37	15	5	3
No (50)	—	1	5	20	35	22	13	4

(continued on page 40)

CIRCLE NUMBER 19 ►

# Just as you can count on water to freeze at 32° F,



## you can count on Synchron motors.

When you buy a motor for installation in your product, the last thing you want is a troublemaker. You want to install it and forget it.

Despite many similarities, all synchronous motors aren't the same. Not by a long shot. No matter what anyone may claim.

You can't judge performance and dependability by data sheets alone. Or by price. Or delivery. Or the flip of a coin. The big difference often is the brand name. And what's behind it. The integrity of the company that makes the motor. The expertise



of the designer and the people who put it together and test it.

We make Synchron motors as if our name were on your product. Total quality, total dependability. Designed right and built right, to do the job right. That's the only way we do business.

Call or write for our specification sheets and the name and location of our representative in your area.

Choose from five principal styles of Synchron motors—60 or 50 Hz—from one revolution per week to 900 rpm—from 8 thru 98 oz-in torque at 1 rpm—from hundreds of different outputs.



**HANSEN MANUFACTURING CO., INC.**

Princeton, Indiana 47670

a subsidiary of IMC MAGNETICS CORP.

We make every Synchron motor as if our name were on your product

(continued from page 38)

1 further illustrates, the race doesn't stop there.

Salary may be a thorn in many sides, but it doesn't seem to sour many outlooks on the profession itself. Even though half consider themselves underpaid, the majority are satisfied that they chose to be an engineer. Only 22% express dissatisfaction. The most dissatisfied are the project/senior engineers or group leaders—and only one of four feels that way.

Not only that, but an even greater majority—almost nine of every 10—indicate they like their job duties in general.

How one feels about his job isn't always affected by how many hours he works per week. While 28% of the respondents who indicated they like their duties work 36 to 40 hours a week, 39% of the respondents feeling the same way work as much as 45 hours a week. Then the good feeling starts to wear off. Only 21% of the enthusiastic respondents work up to 49 hours a week, while as low as 9% work at least 50 hours a week.

What's more, with half the respondents complaining of lack of money, only one out of 10 moonlights. (Five years ago, one out of five indicated they were moonlighting.) In addition, 30% of the respondents indicate that their spouses work.

Ironically, the salary range in the most satisfied area—the Mountain region—runs far behind that in all the other regions. As Table 1 further illustrates, the biggest chance of making at least \$30,000 seems to be in the Middle Atlantic region, while the best chance of making close to \$25,000 is in the Southwest.

### Where is everybody?

Salary aside, an engineer's geographic location can certainly help or hurt his career. For example, if he works on computers and data-processing equipment, his best bet for work is the West Coast, which contains over one-third of that industry (see Table 2). His next bet is the Middle Atlantic—only a continent away.

As Table 2 also illustrates, the Middle Atlantic region is slightly better than the West Coast for communications, navigation or guidance equipment. New England is where a

(continued on page 42)

**Table 2. Products by location (top); Location by products (bottom)<sup>1</sup>**

Note: All the number responses denote %

Products worked on	Location						
	New England	Middle Atlantic	Midwest	South	South-west	Mountain	West Coast
Computers & data-processing equipment	13	20	19	6	7	1	34
	25	21	27	24	19	10	30
Instrumentation	23	17	11	6	10	4	29
	23	10	9	12	14	20	14
Communications, navigation or guidance equipment	13	30	17	6	8	1	25
	19	25	19	20	16	10	18
Consumer electronics	27	13	21	13	13	—	13
	7	2	4	8	5	—	2
Industrial controls	12	20	46	7	3	5	7
	9	8	27	12	3	20	3
Components, subassemblies, hardware or materials	11	29	15	4	15	4	22
	6	8	6	4	11	10	5
Aircraft, aerospace, ground support or oceanographic equipment	6	30	6	6	10	3	39
	9	24	7	20	21	20	27
Medical equipment	10	20	10	—	40	10	10
	2	2	1	—	11	10	1

<sup>1</sup>The top numbers are the % reported of the products worked on in a certain geographic region, while the bottom numbers are the % reported of a certain geographic region devoted to each product category.

**Table 3. Education** (All the number responses denote %)

	No degree	Associate degree	Bachelor's	Master's	PhD
<b>Titles</b>					
President or Vice President	—	—	33	67	—
Technical or research director	—	—	100	—	—
Chief engineer, principal engineer or division head	4	4	57	22	13
Section head or department head	15	15	35	35	—
Project engineer, senior engineer or group leader	9	9	44	33	5
Member of technical staff, scientist, physicist or engineer	8	12	52	24	4
<b>Products worked on</b>					
Computers and data-processing equipment	9	13	42	32	4
Instrumentation	6	17	46	27	4
Communications, navigation or guidance equipment	14	6	44	32	4
Consumer electronics	—	14	29	50	7
Industrial controls	15	12	54	17	2
Components, subassemblies, hardware or materials	15	7	52	15	11
Aircraft, aerospace, ground support or oceanographic equipment	4	8	52	34	2
Medical equipment	—	—	70	20	10
<b>Locations</b>					
New England	10	11	43	34	2
Middle Atlantic	6	8	43	37	6
Midwest	11	11	50	23	5
South	—	4	56	32	8
Southwest	5	14	49	24	8
Mountain	30	—	50	20	—
West Coast	11	12	46	29	2

What's TRW up to now?

# Metal film with muscle.

Our Metal Glaze™ resistors are rated 2 to 4 times mil spec power, yet retain precision resistor characteristics.

Now, with both strength and precision, you can take advantage of these thick film resistors and standardize on one size. Or benefit from an improved safety factor. For example, our 1/8W 1% device will handle 1/2W @ 70°C, or up to 40W pulse.

What's more, we've added a new 2W standard.

It takes 50% of the board space of the old 2W, yet is rated 3W @ 25°C. We're also in the process of substantially increasing resistance well into the megohms.

TRW metal films with muscle are available from 1/8W to 5W, 200V to 15KV, with 1, 2 and 5% tolerance. For standards in all types of resistors, contact your local TRW distributor. Or TRW/IRC Resistors, 401 N. Broad St., Philadelphia, Pa. 19108. (215) 922-8900, Dept. G.

## **TRW** IRC RESISTORS

ANOTHER PRODUCT OF A COMPANY CALLED TRW

™ Metal Glaze is the TRW trademark for its thick metal film resistors.

CIRCLE NUMBER 20

**Table 4. Work Week** (All the number responses denote %)

	Hours per Week							
	Less than 20	20—30	31—34	35	36—40	41—45	46—49	50 and over
<b>Titles</b>								
President or Vice President	—	33	—	—	—	—	33	33
Technical or research director	—	—	—	—	—	33	—	67
Chief engineer, principal engineer or division head	—	—	—	—	26	22	30	22
Section head or department head	2	3	—	—	16	26	40	13
Project engineer, senior engineer, or group leader	1	1	1	1	29	45	16	6
Member of technical staff, scientist, physicist, or engineer	1	2	1	1	40	38	11	6
<b>Products worked on</b>								
Computer and data-processing equipment	—	1	—	1	24	45	14	15
Instrumentation	—	—	—	—	27	42	25	6
Communications, navigation or guidance equipment	1	—	—	1	35	38	17	8
Consumer electronics	7	13	—	—	33	14	33	—
Industrial controls	—	—	—	—	32	29	32	7
Components, subassemblies, hardware or materials	—	4	—	—	30	44	15	7
Aircraft, aerospace, ground support or oceanographic equipment	1	3	1	—	39	35	15	6
Medical equipment	—	—	10	10	20	40	10	10
<b>Underpaid ?</b>								
Yes	1	1	1	—	30	36	20	11
No	1	2	1	2	31	39	18	6

good part of consumer electronics can be found, while the Midwest, with 48%, is clearly the place to be for industrial controls. (Five years ago, only 27% of the industry was located there.)

Almost 30% of those working in components, subassemblies, hardware or materials are situated in the Middle Atlantic region. Close to 30% of those in instrumentation work on the West Coast. The biggest chunk of the medical equipment industry lies in the Southwest. Almost 40% of those working on aircraft, aerospace, ground-support or oceanographic equipment reside on the West Coast.

No matter what degrees have or haven't been attained or how many hours are logged, all the respondents keep themselves up-to-date with various educational tools. They were asked to rate several ways to keep up to date.

The highest point gatherer is trade magazines, with 17% of the total score. Not too far behind is manufacturers' literature, with 15%. Books take third with 14%, while manufacturers' sales or applications engineers, at 12%, nudge past trade shows and college courses at 11%. Correspondence courses bring up the distant rear at 8%.

**On the move. . .**

One trait many respondents share is mobility. Half the respondents reveal

**Table 5. Relocation** (All the number responses denote %)

To	From							
	Same region	New England	Middle Atlantic	Midwest	South	Southwest	Mountain	West Coast
New England	61	—	39	0	0	0	0	0
Middle Atlantic	41	19	—	19	13	0	2	6
Midwest	69	5	12	—	7	5	2	0
South	50	18	13	13	—	6	0	0
Southwest	26	5	21	26	5	—	0	17
Mountain	29	0	29	0	14	14	—	14
West Coast	60	10	6	8	2	7	7	—

that they relocated to work for their present companies. Money seemed a factor at the high end of the salary scale. Seven out of 10 respondents making between \$30,000 and \$34,000 relocated. Indeed, eight of 10 making \$35,000 and beyond had to "move" into their current jobs.

One of the least affected groups makes between \$25,000 and \$29,999. "Only" 38% had moved. But just about half those making slightly less—\$20,000 to \$24,999—relocated to their present jobs.

The two least affected groups are at the bottom of the salary scale—"only" 29% of those earning between \$10,000

and \$12,499 and 32% of those getting \$12,500 to \$14,999 made a move.

In relocating, job level plays an uncertain role, at best. While two-thirds of the technical or research directors moved to their present jobs, not nearly as great a proportion of chief/principal engineers or division heads had to pack their bags (35%). Over 40% of the section/department heads pulled up stakes, while for the rest of the respondents, it was virtually 50-50.

Interestingly, the groups most likely

*(continued on page 44)*

# Safety. Long life. Reliability. Pour it on.



Now there's an all-purpose encapsulant that gives you silicone performance at the price of organics. Dow Corning Sylgard<sup>®</sup> 170 A&B silicone elastomer. A two-part liquid encapsulant that cures at room temperature or can be heat accelerated to increase production rates.

Sylgard 170 carries the UL 94VO rating, the very highest rating for flame retardancy for this type of product.

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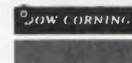
reversion resistant at high temperatures. And that means greater reliability and longer product life under the most severe environmental conditions.

Sylgard 170 has great dielectric properties, too. So it's perfect for general potting and encapsulating jobs like modules, relays, power supplies, amplifiers, ferrite cores and connectors. At a price that'll let you keep a margin of profit in your product as you build in an extra margin of safety.

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## **DOW CORNING**



(continued from page 42)

to relocate, in terms of experience, are at opposite ends of the spectrum. Nearly 60% of those with at most four years' experience have relocated to take their present job. But almost 70% of those who have been working at least 30 years have relocated to get where they are now.

For that matter, over half the respondents with 25 to 29 years on the job have made a move. The least likely to go are the respondents who have rung up 10 to 24 years as engineers. And even their percentages are in the low-to-mid-40s.

The industry with the most movers is components, subassemblies, hardware or materials—over 60%. The second most affected product group is computers and data-processing equipment—55%. The least affected industry is industrial controls—39%.

### . . .but not far

Where did everybody go? The answer, basically, is "Not too far." Impressive majorities in New England, the Midwest and the West Coast moved, but stayed in those regions. The Middle Atlantic and Southern regions as well were the scenes of considerable movement within their boundaries (Table 5).

When the respondents did decide to break regional ties, they pretty much went no farther than a neighboring region. Or regions.

For example, if the relocaters in New England didn't come from somewhere else in the region to begin with, they came from the Middle Atlantic. Those leaving New England stayed primarily on the East Coast.

Very few relocating Southerners made it all the way to the West Coast. They stopped at the Mountain region on one side or the Midwest and Middle Atlantic regions to the north.

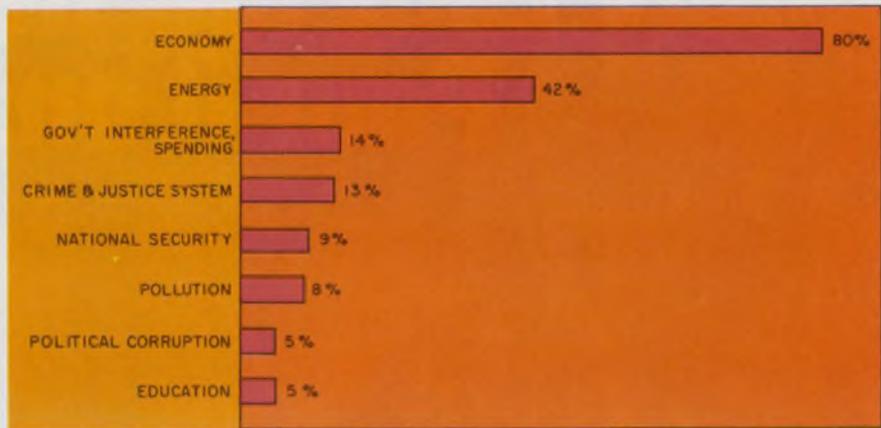
Respondents departing the Midwest took advantage of their central location to push out primarily into the adjacent Middle Atlantic and Southern regions and then as far as the Southwest.

In keeping with the over-all pattern, mobile respondents from the West Coast basically didn't get past the Southwest and Mountain regions.

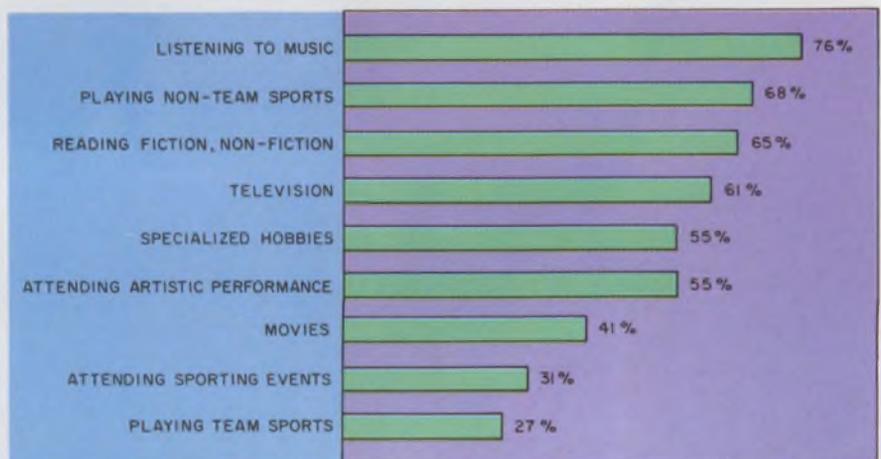
Very few made the long haul from coast to coast.

Almost half of those who have relocated participate in civic activities.

## 1. What national issues especially concern you?



## 2. Which leisure activities do you enjoy?



Indeed, over 47% of all respondents are active in community affairs. Approximately seven of every 10 who are civic-minded are between the ages of 30 and 49.

About 36% of the civic-minded work as many as 45 hours a week. About 30% work 36 to 40 hours a week.

Above and beyond community interests, the respondents concern themselves with national issues—but only a few really grab their attention. When asked to name the national issues (not necessarily one) that especially concerned them, eight of every 10 picked the economy (see Fig. 1). But "economy" is an umbrella term that covers several worries. To many, economy means inflation, to others it means taxes. To a small group, it means unemployment.

Of course, other national issues got attention. Energy—how to get it, how to save it—is on 41% of the respondents' minds. Big Government interference and spending are a distant

third. Crime and the justice system concern a smaller group, as do national security, pollution, declining morality and political corruption. But such controversial topics as equal rights and abortion are of little concern to most of the respondents.

One question that provoked a fragmentary response was "Whom do you trust?" The biggest fragment, 21%, didn't respond. Another 7% said they trust no one.

No single answer was dominant. Only 13% indicated they trust themselves, while 26% revealed that they trust their wives and families. Even here, one respondent qualified his answer: "My wife and one of my two children." God received 16%, and 4% stipulated "everyone until proven otherwise." Some 3% made a point of announcing they do *not* trust politicians.

One respondent unequivocally stated he trusts "me, ELECTRONIC DESIGN and God (in that order)." ■

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MCM4027C4*	250 ns	\$6.60

\*Ceramic device prices are equally attractive

## Profile of an industry standard.

The MCM4027 is designed to provide high performance at low cost in main-frame memories, buffer memories, and peripheral storage. Three versions provide a choice of speeds from 150 ns to 250 ns. Power dissipation is very low, just 27 mW (max) in standby, and 470 mW (typ) while active. It's in the standard 16-pin packages, plastic and ceramic, with power supply pins on the corners to assist in optimizing system layout. All inputs are TTL compatible and the output is 3-state TTL compatible. It's also compatible with other popular 4K RAMs like the 2104, 4096 types, and the MCM6604. Latches for Address, Chip Select, and Data In are all on the chip.

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CIRCLE NUMBER 23

# Washington report

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## B-1 demise benefits cruise missiles

President Carter's decision to cancel the B-1 bomber will accelerate development of cruise missiles to be carried on existing B-52 bombers—and later on a new family of cruise missile-carrying aircraft based on current wide-bodied jets such as the Boeing 747.

One of the first steps in the quickened cruise-missile program will be to increase the commonality between the guidance systems of the Air Force's Air Launched Cruise Missile (ALCM) and the Navy's Tomahawk cruise missile, according to Navy Capt. Walter Locke, manager of the Pentagon's Joint Cruise Missile Project Office. Greater commonality is needed, according to Locke, because the next ALCM flight tests aren't scheduled until early 1979 while the Navy has about 20 flights scheduled for its Tomahawk over the next two years. Although each missile has the same guidance system, McDonnell Douglas's terrain-contour-matching (Tercom) system, the two services had been drifting apart on guidance requirements. Commonality, estimated as high as 30%, had dipped to 10% when the Air Force and Navy began engineering development of their missiles in January. Locke now puts it at about 50% and says it can go higher.

Common guidance will enable the Air Force to capitalize on the extensive flight testing of the Navy's Tomahawk—19 successes in 22 attempts. The results can be applied to the ALCM, which is not as far along in development. It has only been flown six times, and two of the flights crashed.

Although McDonnell Douglas makes the same guidance system for both missiles, the Navy permits the company to do all the systems integration before turning the system over to Tomahawk's prime contractor, General Dynamics. On the other hand, ALCM prime contractor Boeing receives all the subsystems separately and does the systems integration job on the vehicle, including the preparation of the guidance algorithms.

As part of the commonality requirement, both cruise missiles will carry the Litton P-1000 series inertial platform (also used on the F-15, F-5E and F-18 fighters) and the Litton LC 4516 navigation computer modified (modified from the computer on the F-5E). An improved Litton navigation computer, the 4516C, will go on the later models of the cruise missiles.

Before the President announced his decision, both cruise missiles were supposed to have achieved an initial operational capability by June, 1980. But now IOC will be pushed forward to improve strategic defenses, says Defense Secretary Harold Brown.

Each B-52 will be able to carry up to 20 cruise missiles—12 mounted on the wings and eight on an internal rack. With 250 B-52s, that adds up to 5000 cruise missiles that could be ordered. Defense officials estimate privately each missile will cost \$1-million (with inflation).

The B-1 program would have cost \$24.8-billion if the President had ordered construction of all 244 aircraft requested by the Air Force. Now, only four developmental aircraft will be built, and total spending will be slightly more than \$4-billion. The first three are currently in flight test and the fourth, designed to test the defensive electronic countermeasures (ECM), is due to begin flying in early 1979.

Another victim of the B-1 decision was a new version of the Short Range Attack Missile, the SRAM-B, which was to have been carried on the new bomber. The

B-52s are currently equipped with SRAM-A air-to-ground missiles. Boeing is the prime contractor for both versions.

## **Navy examining new sighting system on F-14**

A gyro-stabilized closed-circuit television system being tested on the Navy's F-14 fighter is expected to increase the range at which pilots can identify enemy aircraft. Using their eyes, they currently have to get to within three miles to positively identify Soviet MIG fighters.

But the television sight unit developed by Northrop is supposed to be good to at least 10 miles. If an enemy fighter can be identified outside 10 miles, the F-14 can fire a Sidewinder or Phoenix missile before it gets within range of the enemy aircraft's missiles.

TVSU is slaved to the F-14's radar and AWG-9 Phoenix missile's fire control system. The "gimballed" telescope-TV system has two fields of view. Images are displayed in both the front and rear cockpit while TVSU maintains an optical lock-on and track of the target through ground clutter, evasive maneuvers and electronic countermeasures. All four TVSUs being tested at Nellis Air Force Base, NV, have operated without failure.

## **New attack system's future up to Congress**

A team of electronics companies headed by Lockheed Missiles & Space Co. has been selected by the Air Force to develop a new system for locating and attacking enemy air defenses. But the program's future hinges on Congress appropriating \$30-million for development.

Known as the Precision Location Strike System (PLSS), the program includes IBM on weapons guidance, E-Systems on airborne sensors and aircraft installation, and Rockwell International's Collins Government Telecommunications Div. on ground communications. Lockheed also is negotiating with Harris Corp., Control Data Corp., Sperry Univac and Motorola to be subcontractors.

The development phase is expected to take four and a half years with the last year devoted to testing prototype hardware. The total contract is estimated to be worth \$120-million. A team headed by Boeing was the losing bidder.

## **Airborne radios to use MNOS circuits**

Magnavox is using MNOS memories developed by the Air Force Avionics Laboratory and based on earlier commercial development at NCR Corp. to provide channel selection in the ARC-164 airborne radio.

The circuits, which store 16-bit channel frequency codes in each of 20 present channels, are more reliable and less expensive than the core memories used in previous airborne radios, according to the Air Force. The MNOS circuits can be expanded to 32 channels. The Air Force is also looking at applications in satellites requiring long lifetime in orbit.

**Capital Capsules:** Two spacecraft to orbit Mars and drop roving vehicles on the planet's surface comprise a major new program planned by NASA for next year's budget. Launch is planned for 1984 from the Space Shuttle and cost is expected to be in the billion-dollar class....Control Data has delivered the first two models of its **AYK-14 standard airborne Navy computer** to McDonnell Douglas for installation in the F-18 fighter. The computers are designated the XN-2A configuration and include dual 32-k core memory modules....One of the electronics research tasks proposed by the Defense Advanced Research Projects Agency (DARPA) is to **improve III-V materials for higher-power solid state sources.**

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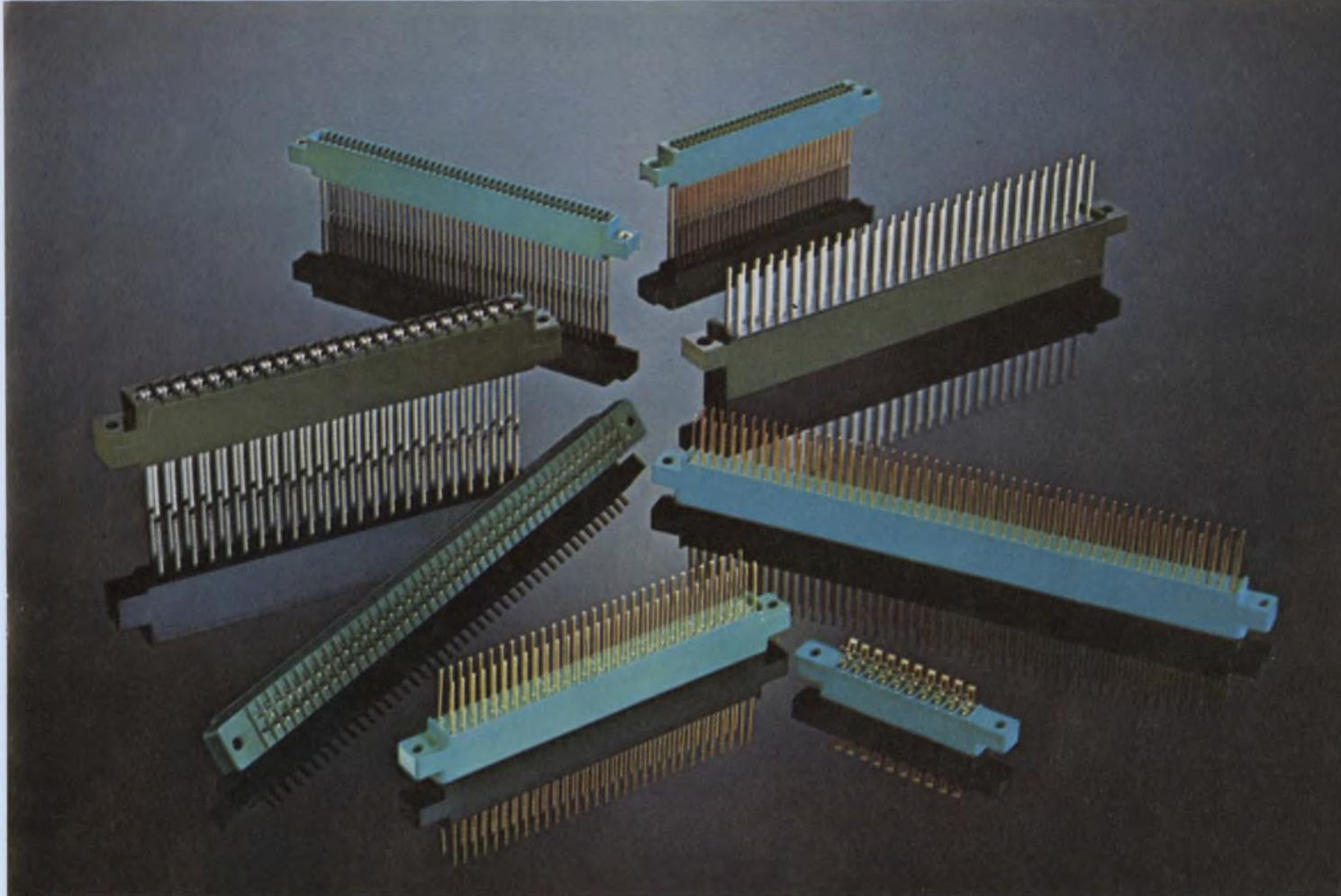
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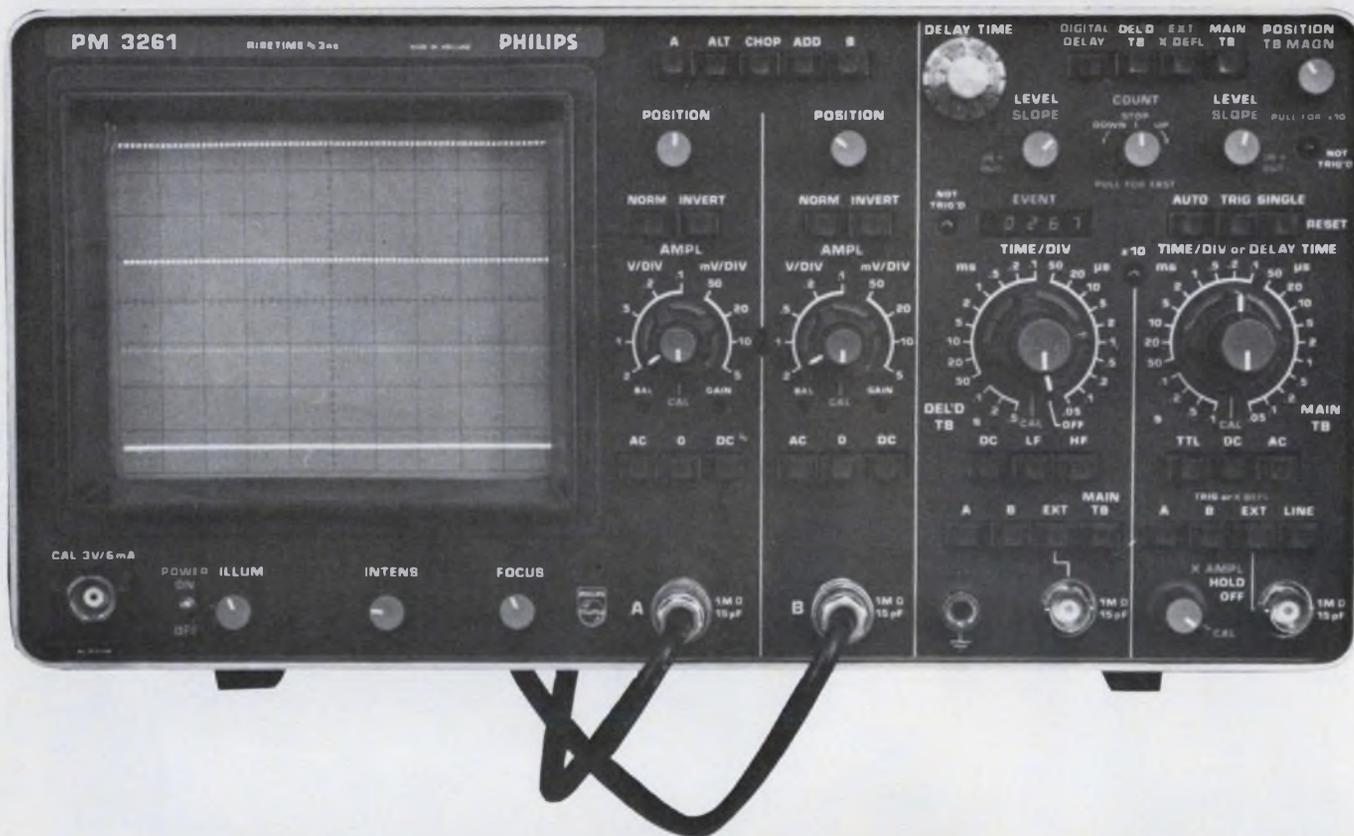
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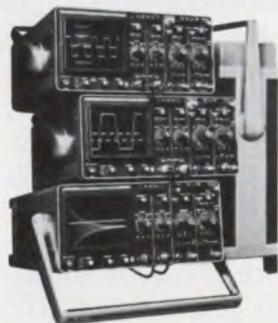
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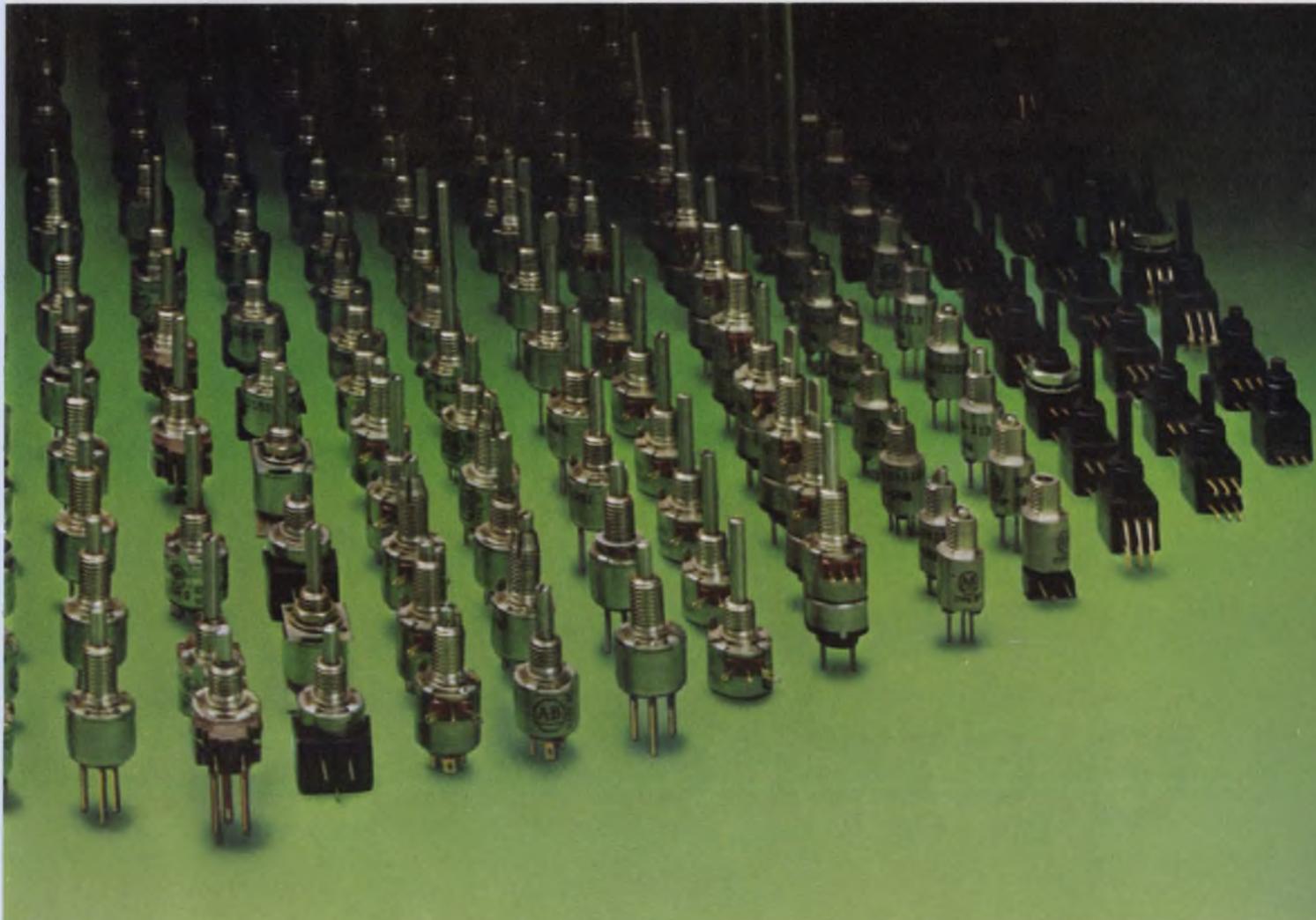
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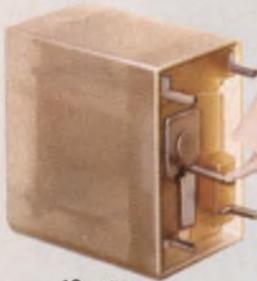
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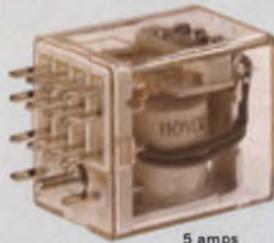


# The answer is 1300

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SPST-NO or NC, SPDT



5 amps  
4PDT



13 amps  
DPDT



5 to 50 amps  
SPST, SPDT, DPDT

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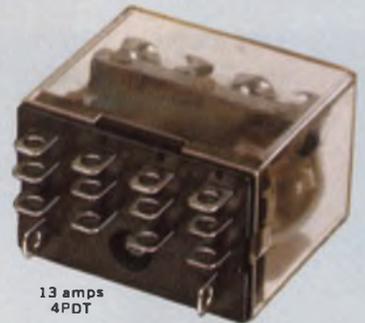
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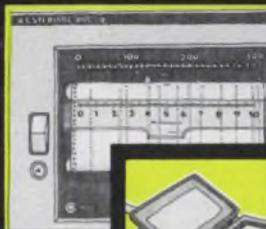
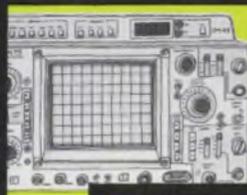
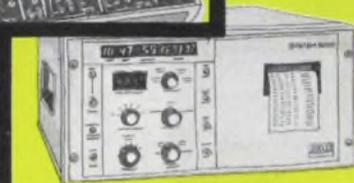
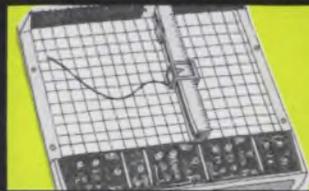
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The SN75125 and SN75127 are monolithic seven-channel line receivers in a 16-pin package that meet the IBM 360/370 I/O specification. Special low-power design and Schottky-clamped transistors allow for low supply-current requirements while maintaining fast switching speeds and high-current TTL outputs. Both operate from a single 5V power supply. The SN75127 has standard  $V_{CC}$  positioning.

The SN75128 and SN75129 are eight-channel line receivers with many of the features of the 125 and 127 plus common strobes for each group of four receivers. The SN75128 has an active-high strobe while the SN75129 has an active-low strobe.

## RS-422 dual differential drivers.

The SN55/75158 and SN75159 are dual differential line drivers designed to meet EIA Standard RS-422. They require only a single 5V power supply and offer balanced-line

operations, TTL and DTL input compatibility, short-circuit protection and high output impedance in the power-off condition. Typical propagation delay times are 16 ns. Input clamp diodes provide transient voltage protection.

The SN75159 offers all of the features of the SN75158 driver plus 3-state outputs for bus-organized systems.

## Dual line receivers.

To the SN55/75140 Series are added the 141, 142 and 143 dual single-ended line receivers with TTL-compatible strobes and outputs. Each features single 5V supply requirements,  $\pm 100$  mV sensitivity, reference voltage adjustable from 1.5 to 3.5V for maximum noise immunity, and a high input impedance for data-bus applications.

Like the existing SN55/75140, the new 141 offers a common reference pin and common strobe but adds an input-protected diode for the power-off mode. The 142 and 143 line receivers have individual reference pins, individual strobes and an internal 2.5V reference available. The 143 receiver has a diode-protected input stage.

## General-purpose line drivers with 3-state outputs.

The DS78/8831 and DS78/8832 can be used as either single-ended or dual differential drivers. They operate on a single 5V power supply and are ideal for party-line applications. All offer very low output impedance with high drive capability, also 40-mA sink and source capability. Typical propagation delay times

are 15 ns. The drivers are differentiated by the output clamp diode to  $V_{CC}$  on DS78/8831.

## Single-ended transceiver.

The SN75136, a functional pin-for-pin replacement for the Signetics N8T26, is a quad transceiver using Schottky-clamped transistors and a single 5V power supply. Both the driver and transceiver have 3-state outputs for data-bus operations. PNP inputs minimize input loading (200  $\mu$ A max.).

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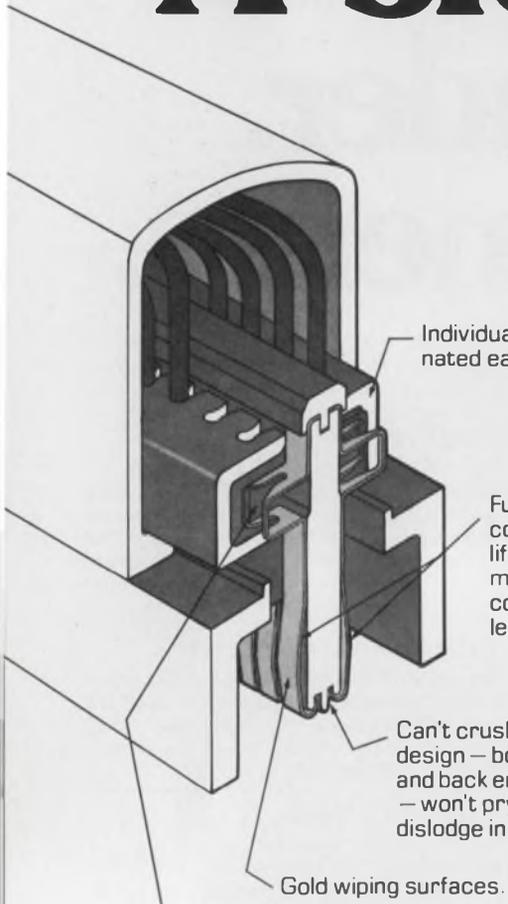
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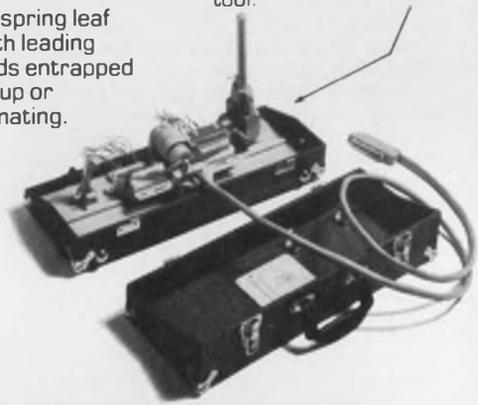
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## Unlucky in love

Jack was in love again. He had met this beautiful lady who radiated excitement, enchantment and warmth. She had everything he wanted and she apparently wanted him; she repeatedly invited him to call.

And call he did. Often. But each time he telephoned, she was unavailable—always with profound regrets and a perfect reason. She had to entertain her folks who had unexpectedly arrived from out of town. Or she had suddenly developed a terrible cold. Or her boss, without warning, had demanded that she work incredibly long hours, and she was dreadfully tired. But still eager.

In time Jack quit calling. This was a love that the fates were against. Conspiring with the fates was the fact that the lady had another love, and she found time-sharing difficult.

In a sense Jack had another love, too. If ever a man could feel something like love for a supplier, Jack could. For a new vendor had everything an engineer could pray for. Or so the salesman assured him. This vendor had the industry's broadest line, the best state of the art in product sophistication, the highest reliability, the lowest prices and the quickest delivery. Who wouldn't love a vendor like that?

So Jack started placing orders. But things didn't work out quite right. Though the vendor had the broadest line, he seemed never to have just the part that Jack needed. He had 0.02- $\mu$ F capacitors, but not 0.01  $\mu$ F. He had polystyrenes, but not Mylars. The high failure rates Jack encountered were peculiar to that line alone. And the prices—they were much better on the parts Jack didn't need. Delivery, too, was better on the other lines.

In time, Jack quit placing orders with this vendor. It seems that the vendor had another love—an older and larger customer whose requirements always took priority.

Jack wasn't always lucky in love.



GEORGE ROSTKY  
Editor-in-Chief

# AMP research discovered Bonded Lubrication 5 years ago.

## It's now today's better way to extend contact life without compromising performance.

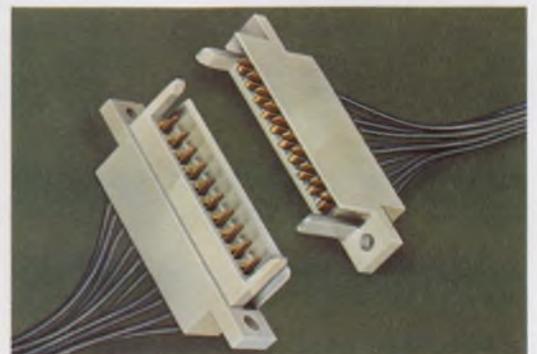


Through the electron microscope, the dramatic improvement AMP Bonded Lubrication makes in contact life and performance is clearly evident.

With the popular DUALATCH connectors, Bonded Lubrication has reduced plating thickness requirements and more than doubled the previously accepted cycle life of 10,000 insertions and withdrawals.

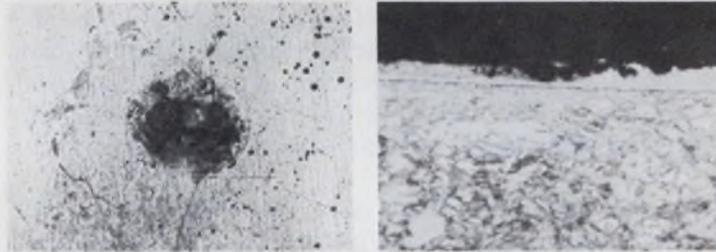
For example, look at the effect on the connector contact shown. Not only is wear to the plated surface greatly reduced by the permanent lubrication but it

Dramatic difference in wear between contacts utilizing the unique AMP Bonded Lubrication Process and ordinary contacts is shown by these scanning electron microscope images.



significantly lowers the insertion forces when mating high-pin count connectors. Now Bonded Lubrication can be applied to a variety of contact geometries without compromising electrical performance.

Or consider what AMP lubrication leadership has done for contacts used in our tin-plated products like surface mount ZIF connector and Bifurcated Leaf types. Their lubricated contact surfaces are protected from the detrimental effects of oxidation and fretting corrosion. Indeed, there are now applications where high performance tin-plating, with the correct contact design and Bonded Lubrication, can be used in place of noble metals.

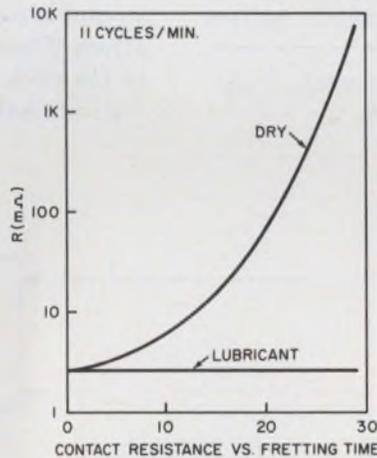
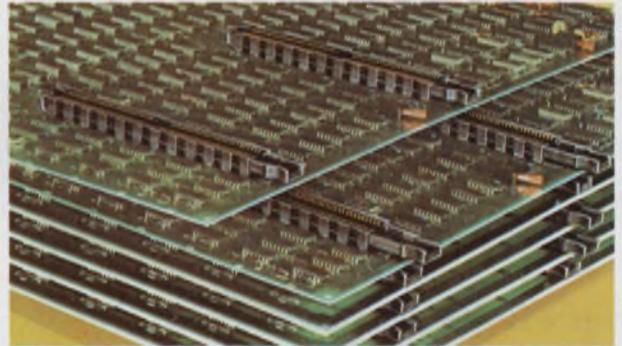


AMP's Materials Research Laboratory pictures of surface oxidation and fretting corrosion on non-lubricated contacts.

AMP lubricated contacts are today's answer to extended contact life and performance, and together we can search out better ways to assist your designs.

For more information on the products mentioned, circle the reader service number. For more technical information on lubrication just call Customer Service at (717) 564-0100, extension 8400. Or write on your Company letterhead to AMP Incorporated, Harrisburg, PA 17105.

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## Design your own data terminal.

Interface a dot-matrix printer to your processor and get printouts faster than with off-the-shelf units.

General-purpose data terminals work into most computers. But if you design a data terminal around a dot-matrix printer, you can tailor the terminal's interface to the system and improve throughput. Where data terminals double as message switchers efficiency can improve dramatically.

Begin your data-terminal design by selecting a printout device—for example, Victor Comptometer's IMP 130 dot-matrix print mechanism. Generating a printed line takes 800 ms, and a line feed 200 ms when not preceded by data. The print head, containing seven print solenoids, uses an optical gate to generate a print strobe signal from a slotted metal comb. The line feed also uses an optical gate, but this one operates from a disc containing an index slot.

### Store and read with separate clocks

To mate efficiently with the printer, let a system clock store the data in intermediate output buffers

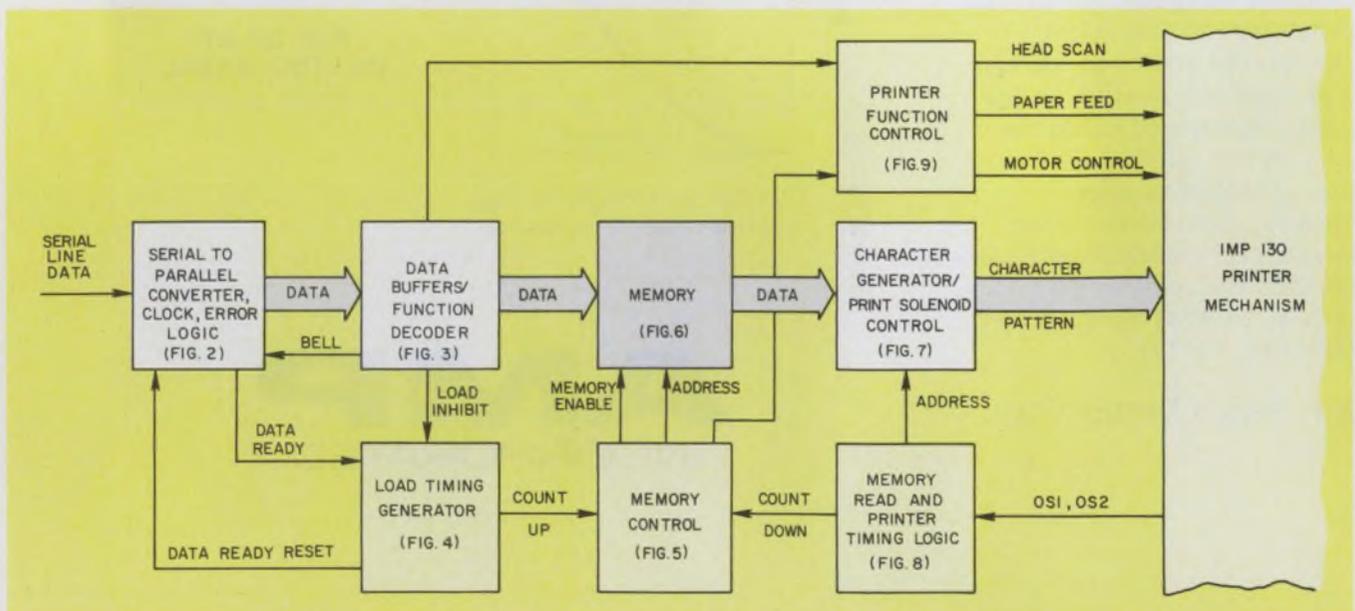
**Robert J. Stetson**, Engineer, Storage Technology Corp., 222 S. Riverside Plaza, Chicago, IL 60606.

at the system's data rate. Then, with an output clock, shift out the data at 9600 baud. Pause for 800 ms after each line feed containing data, and for 200 ms after each line feed that isn't preceded by data. For example, when a message is followed by four line feeds (to place the message above the tear line on the platen), insert a 200-ms pause between each line feed.

Going from the output to the input side of the terminal's interface, the most popular input data format is serial 6-bit American Standard Code for Information Interchange (ASCII) code. The logic for mating an IMP 130 printer mechanism to serial 6-bit ASCII-coded data is summarized in the block diagram of Fig. 1. The following are the major functional components of the terminal's processing and control logic:

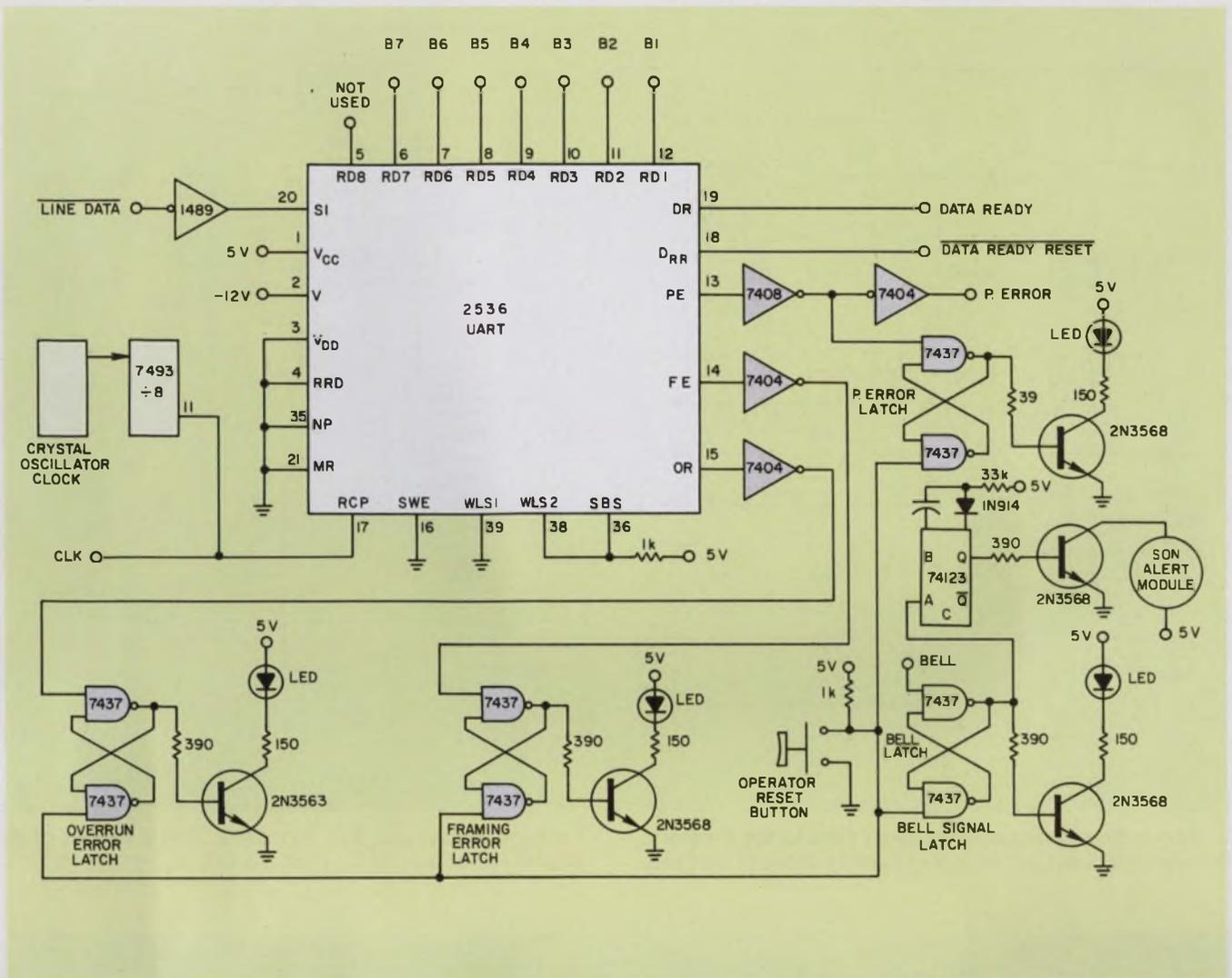
- A serial-to-parallel (s/p) converter, clock and error logic (Fig. 2). The s/p converts serial input data to a parallel-bit format. In addition, the input data stream is monitored for parity, framing and overrun errors. These data input operations are synchronized to the clock.

- Data buffers and a function decoder (Fig. 3). The



1. **Memory matches input to output data rates.** Serial-input data are converted to parallel, then buffered, de-

coded and read into memory—all at the system's clock rate. Stored data generate printer-control signals.



2. The UART converts serial input to parallel, at up to 16 times the baud rate, under control of the system clock.

Flags indicate parity, framing and overrun errors. Data Ready indicates that outputs are stable.

data buffers present parity-checked data to the memory, while the function decoder channels the decoded printer functions to dedicated lines.

- A load-timing generator (Fig. 4). Actuated by the Data Ready signal, this generator develops signals to load a line of characters into memory.

- Memory-control logic (Fig. 5). This logic generates the addresses for loading and unloading memory. The memory is loaded by the Count Up signal from the load-timing generator, the Count Down signal from the memory-read. Printer-timing logic unloads the stored characters to the printer.

- A memory (Fig. 6), which consists of six chips, each capable of storing 16 four-bit words. Pairs of chips are accessed together—one chip stores four bits and the other stores two bits—for a total of six bits per word.

- A character generator and print-solenoid controls (Fig. 7). This circuitry converts the 6-bit ASCII characters from the memory into the appropriate sequence of print-head control signals. The print head forms a character in reverse, that is, the head moves from

right to left across the platen.

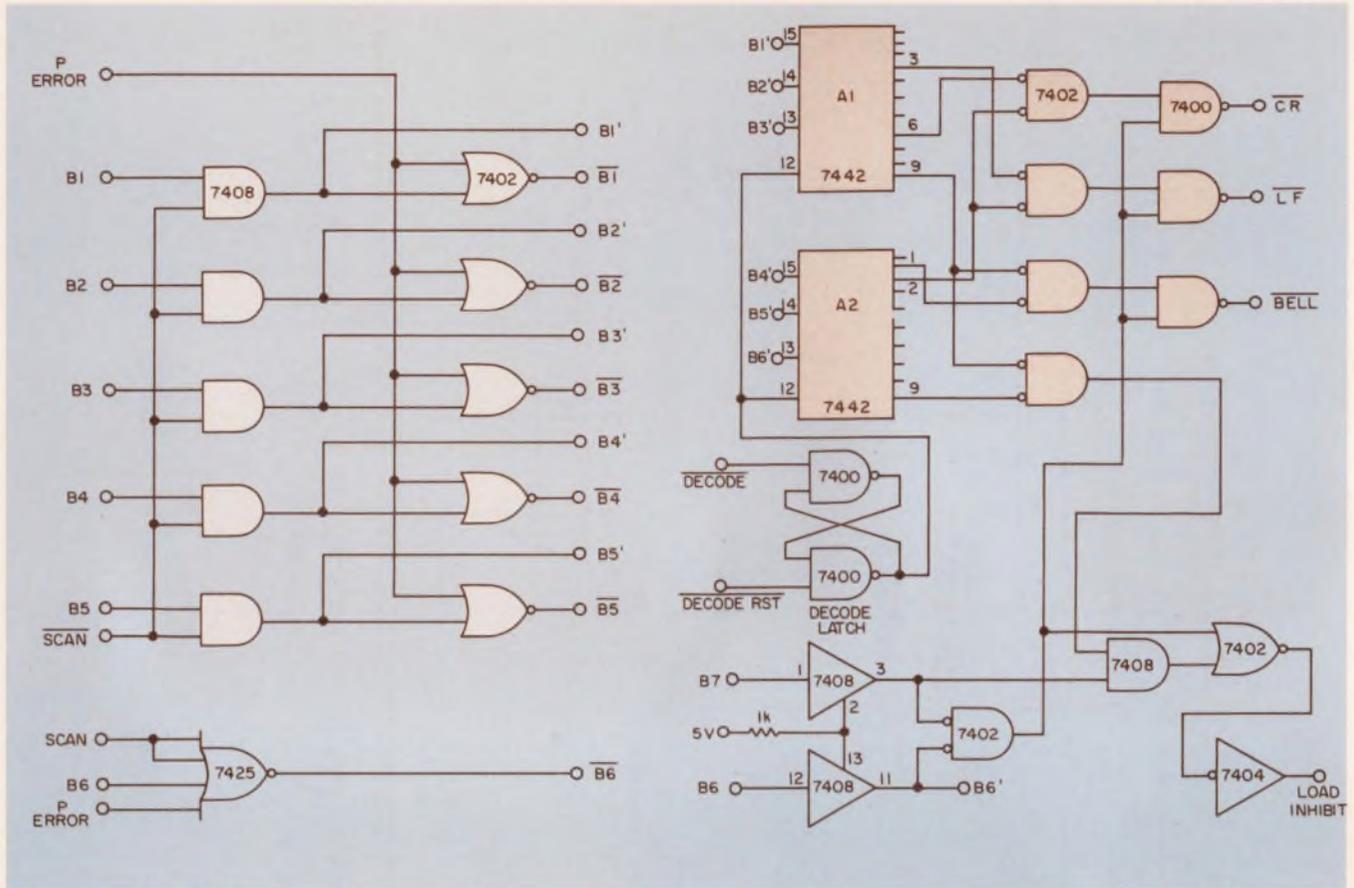
- Memory-read and printer-timing logic shown in Fig. 8. This logic generates the address sequence for the character generator.

- Printer-function control (Fig. 9). This consists of the gating and timing circuits that control the printer's motor, paper feed and head scanning.

### Choose circuits for performance and cost

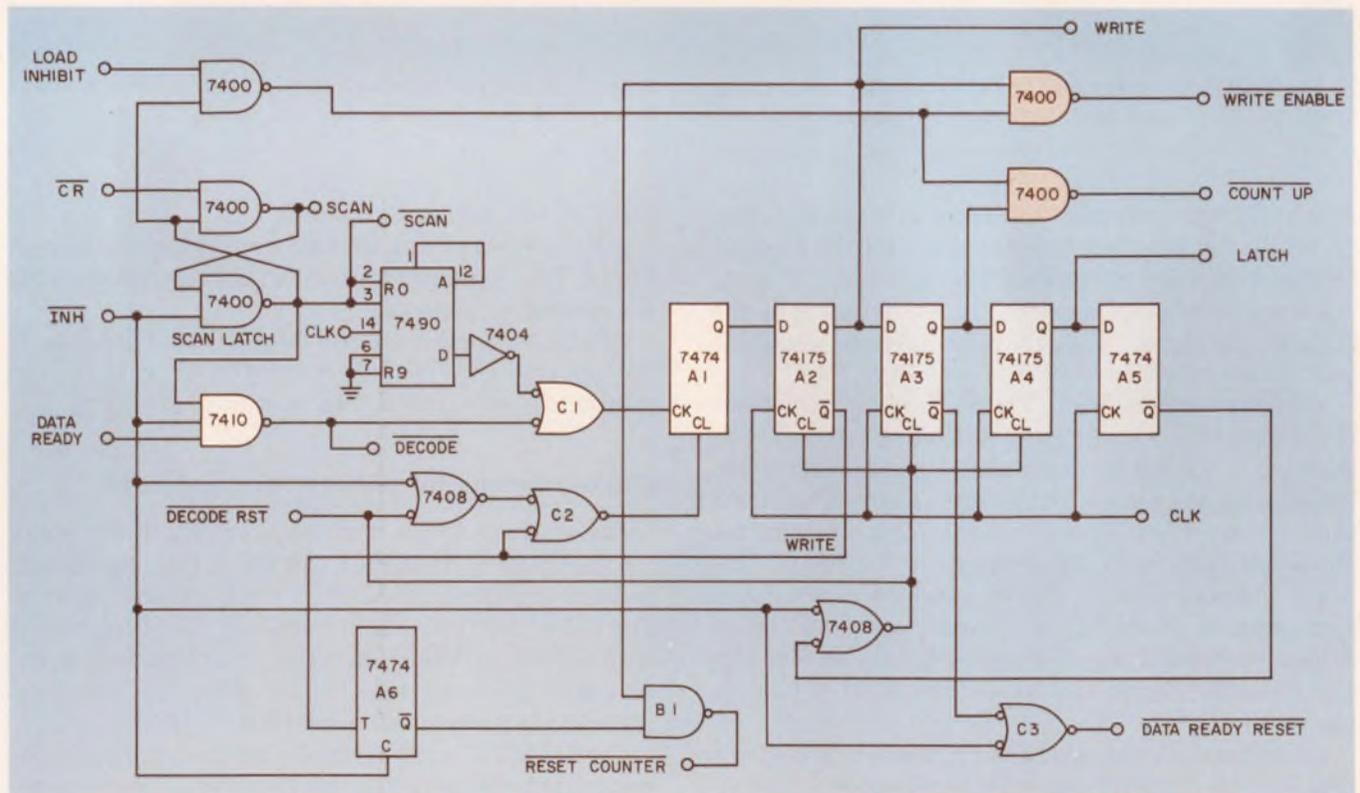
For stability at low cost, use a crystal clock. Make the oscillator's frequency the baud rate times 128, because crystals in the 1-MHz range are inexpensive. Then, for the final clock frequency, divide by eight with a 7493 counter. The result is a clock frequency, 16 times the baud rate, required by the universal asynchronous receiver/transmitter (UART).

The UART (Fig. 2) performs serial-to-parallel conversion both reliably and inexpensively. What's more, you get error flags—use them to monitor incoming data. Note the 1489 line receiver at the UART's input. It converts EIA standard data voltages



3. The buffers gate parity-checked data to the memory. Binary-to-decimal converters efficiently decode Line Feed,

Carriage Return and Bell functions. The 6 output of A<sub>1</sub> plus the 2 output of A<sub>2</sub> produce CR.



4. Load-timing logic develops the Write Enable, which loads a line of characters into the memory. When the UART signals that data are ready, A<sub>2</sub> through A<sub>5</sub> connected as

a shift register, generate the Count Up signal in synchronism with the system clock. The Write, Write Enable and Latch signals are produced similarly.

to logic levels for the system.

Each time data are available in the output buffers of the UART, Data Ready goes high. It remains high until Data Ready Reset is pulsed, which indicates that the data were read. This repeats for each character.

When a parity error is detected, have the output set the parity-error latch (Fig. 2) and gate the data buffer (Fig. 3). The resultant output, from the data buffer to memory, is a question mark (6-bit ASCII), and the erroneous character is deleted. If the character is a function, it is executed.

Gate the data buffers with Scan. This gating inhibits loading the UART's output character. You disable the 7408s and force the buffers to output a B6, which loads a Space into memory. Divide the outputs of the data buffer into  $B_n'$  signals, that drive the function decoder and  $B_n$  signals, which are the memory inputs.

Every time you access the load timing generator, pulse Decode to set the decode latch (Fig. 3). As a result, the decode circuit can convert the 6-bit ASCII character to its decimal equivalent.

Detecting characters that represent functions with gates on the outputs of the 7442 b/d converters is much less cumbersome and uses fewer chips than employing individual sensing circuits for each character.

### There's no secret to decoding

Decoding both characters and functions is straightforward and reliable. On the input,  $B_1'$ ,  $B_2'$ ,  $B_3'$  have binary weights of 1, 2 and 4, respectively. The output of the decode latch is connected to the binary-8 inputs of both converters. Unless the decode latch is set, no function can be detected. When a character from the UART is ready to be detected, Data Ready goes high (Figs. 2, 3). Decode then sets the decode latch, which in turn enables the decode circuit.

If the character is a Carriage Return (CR),  $B_1'$  is low and  $B_2'$  and  $B_3'$  are high. The resultant decimal value is 6. Connect the decimal-6 output of converter  $A_1$  to one input of the AND gate to detect a CR.

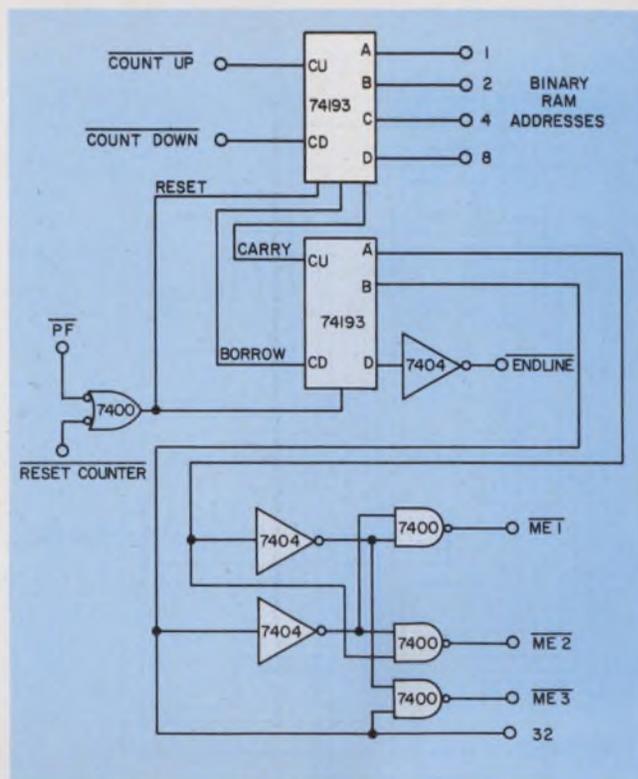
Now do the same with bits 4, 5 and 6. The signals  $B_4'$  and  $B_6'$  are low and  $B_5'$  is high. The result is a decimal 2. The decimal-2 output of converter  $A_2$ , connected to the other input of the AND gate, decodes a CR.

When a rubout is detected, all inputs are high and the result is a decimal-9 output from both  $A_1$  and  $A_2$ . These outputs are ANDed and the result is ORed to Load Inhibit to prevent a rubout from loading into memory.

Null is also inhibited from being loaded into memory. The gate used to detect Null senses  $B_6$  and  $B_7$  and its output is ORed into Load Inhibit.

### Load the memory when data are ready

After decoding, read the characters into the system's memory under the control of the load-timing



5. The Count Up signal generates RAM addresses, in ascending order, for loading data. Unloading addresses are produced in the reverse order from the Count Down signal. The first 16, second 16 and the last two characters in a line are enabled by the  $ME_1$ ,  $ME_2$  and  $ME_3$  signals.

generator (Fig. 3). The load cycle begins with Data Ready. When the unit is out of the print cycle, and the scan latch is reset, Decode starts the decoding process. Flip-flop  $A_1$  begins the load-timing cycle. The shift register made of  $A_2$  through  $A_5$  is clocked at 16 times the baud rate, which generates Write Enable to the memory and Write to the function generator.

Because  $A_6$  is not reset until the printer scans, Write for the first character only passes through  $B_1$ . With this arrangement, you zero the memory address counter, which in turn addresses a line's first character into memory.

At the next clock, Count Up advances the memory-address counter (Fig. 4) so that memory addressing moves to the next RAM location. Meanwhile, Data Ready Reset goes to the UART, which means that the character has been read and stored.

A subsequent clock generates Latch. When coincident with address 34, Latch sets the head-drive latch. The next clock pulse resets  $A_1$  through  $A_4$ . At the same time, Decode Reset resets the decode latch in the function decoder.

One clock pulse later,  $A_5$  is reset. This cycle repeats for each character (except when the address counter resets), until a CR is detected.

A detected CR sets the scan latch. Scan enables the 7490 decode counter to divide the clock frequency by eight. Spaces, therefore, load into memory at twice the rate of data, until the total of characters in the

memory equals 34. Then Inhibit resets the scan latch and other associated circuits in Fig. 4.

### Three memory areas store a line of print

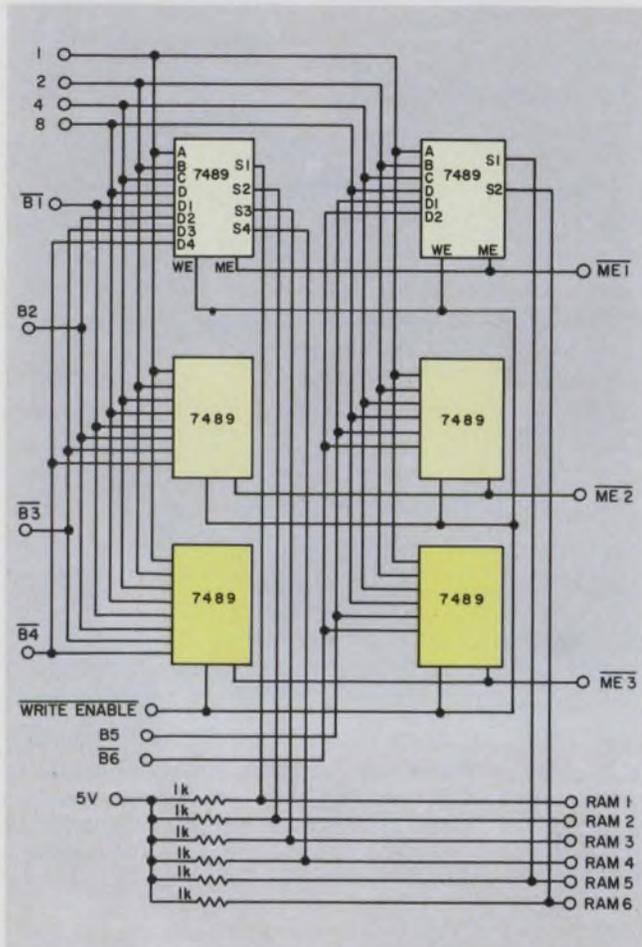
The memory-address counter generates 16 addresses from either the Count Up or Count Down signal. Decoders, shown in Fig. 5, steer the first, second and third group of characters to the memory areas enabled by ME<sub>1</sub>, ME<sub>2</sub> and ME<sub>3</sub>, respectively. The memory is loaded, a byte at a time, until it is full (34 bytes).

Once a full line of characters is stored, the head scans. Since the memory-address counter then decrements, stored data are accessed in reverse (right to left) of the order in which the line of characters was loaded. This reverse addressing is controlled by Count Down (Fig. 5).

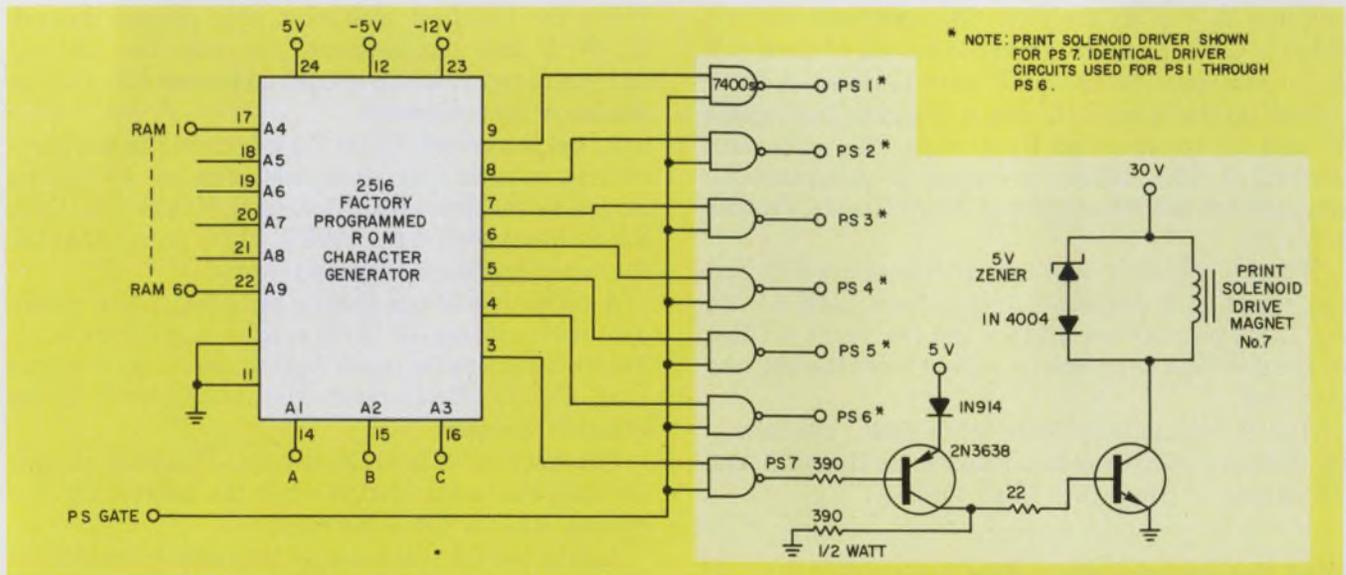
The memory's contents are printed on the platen from right to left, with left-margin justification. The head-scanner comb (OS<sub>1</sub>) has an excess of slots, which cause the address counter to count down past zero to address 255, which then generates End Line. End Line, ORed into the paper-feed circuit, provides the paper feed each time the head scans.

The memory is shown in Fig. 6. Binary inputs 1, 2, 4 and 8 provide addressing for 16 memory locations common to all chips. The six memory chips are enabled two at a time. Memory addresses 00 through 15 are each scanned twice on the first two cycles (ME<sub>1</sub>, ME<sub>2</sub>). Only addresses 00 and 01 are scanned on the third cycle (ME<sub>3</sub>).

Three of the six chips store bits 1, 2, 3 and 4 while the other three chips store bits 5 and 6. Although you can receive 8-bit ASCII incoming data, the memory stores only 6-bit ASCII. When working with 8-bit



6. The memory contains six chips—each capable of storing 16 four-bit words. Chips are accessed two at a time by the ME<sub>1</sub>, ME<sub>2</sub>, or ME<sub>3</sub> signals, with one chip storing four bits and the other, two bits. The Write Enable signal determines whether the memory is activated for storage or readout. Four-bit binary signals from the memory-address counter locate each data byte.



7. The character generator is a preprogrammed ROM that sequences character-pattern signals for the print heads. Its inputs are parallel 6-bit-ASCII-coded characters from

the memory and the sequenced A, B and C address signals from the printer-timing logic. The PS Gate strobes each ROM output into its solenoid driver.

character printers, only the character generator need be modified. Both the existing memory and UART can handle 8-bit characters.

Select a well-ventilated location for the 7489 memory chips—they run hot. Try to place temperature-sensitive components away from these chips in your mechanical layout of the system.

### One chip generates the characters

Availability and economy make using the 2516 character-generator ROM a smart move for the designer. The preprogrammed chip gives you a character that is 7 dots high by 5 dots wide, with a gap width between characters of one dot location.

Address inputs A, B and C count down from 05 to 00 for each character presented at the input. This counting sequence causes the print head to form the character in reverse, with the head moving from right to left (the A, B and C addressing is binary).

Do not use the outputs of the character generator to drive the print solenoids. The print solenoids should not be activated for more than 420 or less than 390  $\mu$ s. When the solenoids are operated for too long, the pins on the scan head snag the ribbon and damage the head. Solenoids active for less than the proper time

produce light and uneven printing.

To ensure the correct pulse width for the solenoids, use the PS Gate to time the driver's output. The PS-Gate signal is generated by a phototransistor and a LED with a slotted-comb interrupter (Fig. 9). The comb remains fixed as the head passes from one end of its travel to the other.

The output of the operational amplifier in Fig. 9 is a sine wave that is clipped by the diode to ground and squared by a 74123 Schmidt trigger. The resulting clean square wave triggers the timer (Fig. 8) that generates the PS Gate. Use low-tempco precision resistors and capacitors for the PS-gate circuit.

### The circuits work—if you're careful

As illustrated in Fig. 7, the print signals are gated to the drivers through 7400s. There may be a temptation here to use 7437s, with a fan-out of 30. But due to the driver-input configuration used, this isn't necessary. The sink-current capabilities of the 7400 are quite adequate.

The solenoid drivers in Fig. 7 have a superior record. The 2N5192 transistor is rated at about 7 A at 30 V and the solenoid coils draw a mere 2 A.

Keep the 30-V circuits isolated as best you can from all sensitive circuitry. Noise is always a problem when you switch high currents. Use filters around the preamps to the drivers and a separate ground return for the +30 V. The amount of bypass-filtering required depends on your layout.

The character generator is addressed by the counter in Fig. 8, which stays reset until the memory is fully loaded. A bypass capacitor on the output of B<sub>1</sub> eliminates ringing.

The printer-function control consists of timers and drivers (see Fig. 9). Every cycle of the timing generator produces a Write signal that starts the motor timer. Once started, the motor operates for one second.

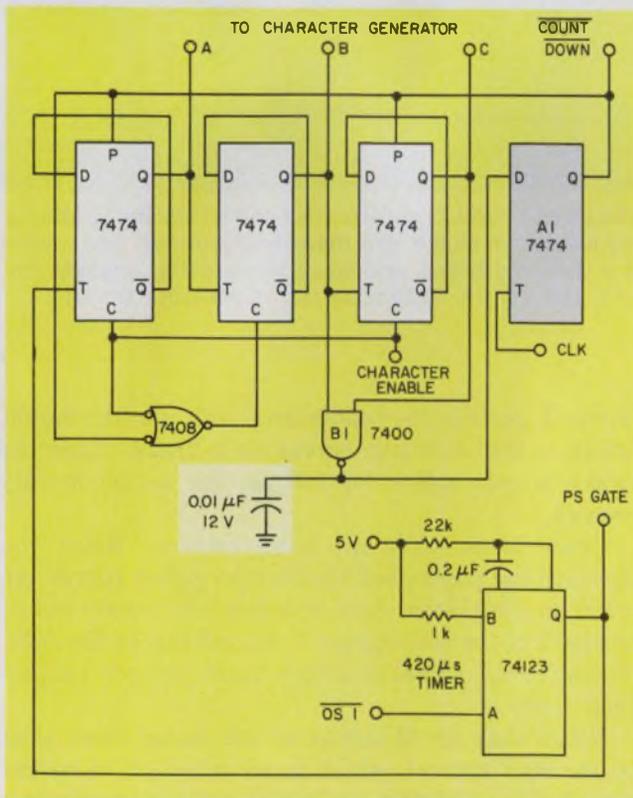
### Don't lose Line Feeds

Because Write is not generated by a function, you can lose some Line Feed signals, when the motor stops at the end of a message. To avoid losing these, let Line Feed also activate the motor.

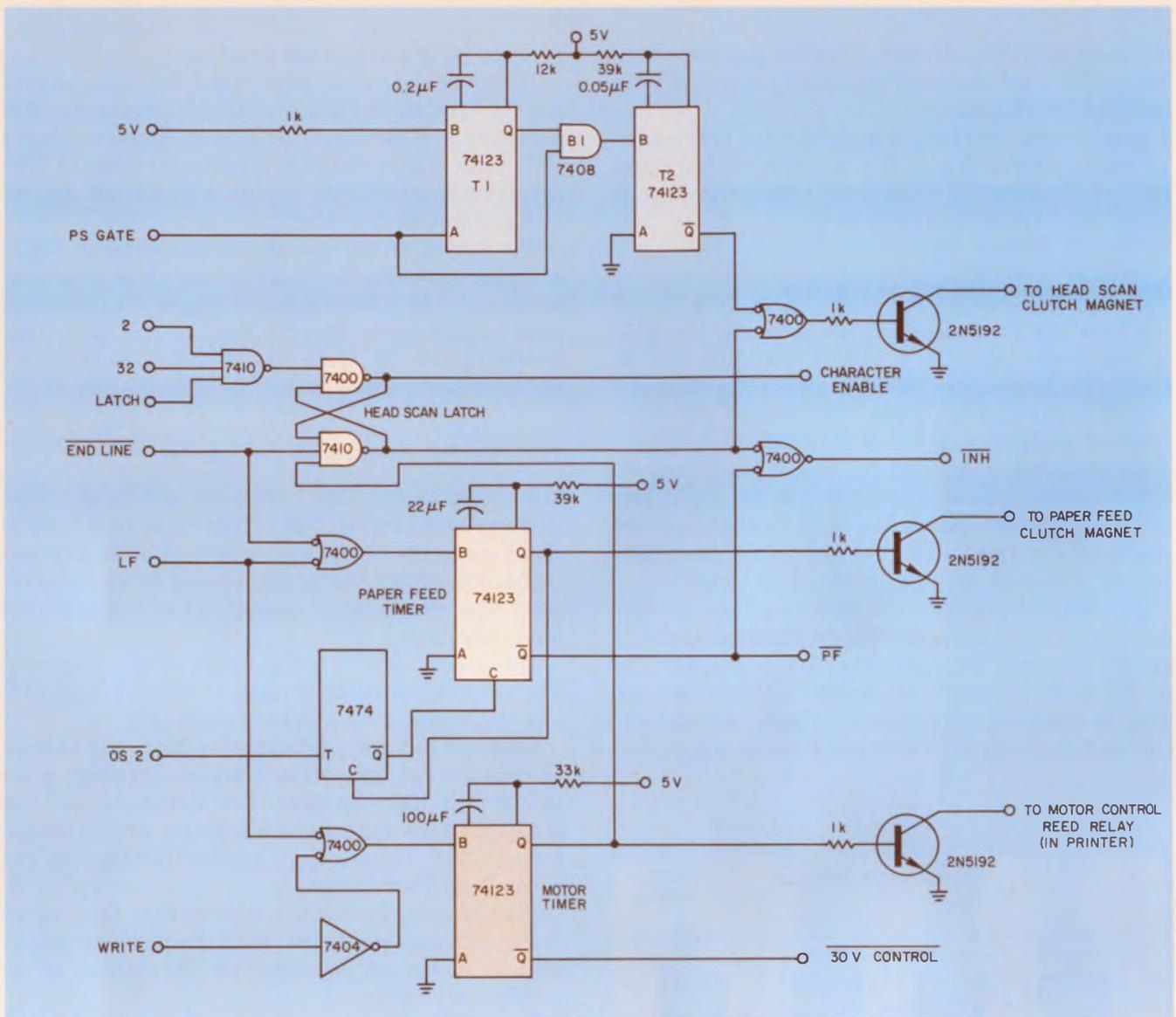
Connect End Line to the paper-feed timer to provide a Line Feed after a printed line. When preceded by data, the Line Feed is lost because Data Ready Reset is driven low by the first space inserted in memory after a CR.

When the address counter reaches 34 and Load is high, set the head-scan latch and enable the character generator's address counter in Fig. 8. Also, prevent additional loading of the memory as well as decoding of control characters by driving Inhibit low.

When its latch is active, the head drives across the platen. At the conclusion of the scan, End Line resets the latch. But what if the latch isn't reset? As a backup,



8. Character Enable toggles the 3-bit counter to generate the A, B and C address signals that sequence the character generator. Flip-flop A<sub>1</sub> produces the Count Down signal that decrements the memory address counter. The damping capacitor at B<sub>1</sub>'s output squelches ringing.



9. Function-control timers clock the printer. Paper feeds while the printer head returns. Once started, the motor operates for one second. When shortened time between PS Gate signals indicates that the head is moving too fast,

one-shots  $T_1$  and  $T_2$  control the head's velocity by pulling the head-scan clutch into the running motor. The motor is a dynamic brake, and since the braking engages for only 100  $\mu$ s, the head-scan action remains smooth.

the motor timer times out and releases the clutch by resetting the latch.

When the clutch releases, the head begins its return travel powered by a spring. To prevent the head from slamming against the right-side stop you must control the head's velocity. Tie the PS gate to the A input of timer  $T_1$  and to one input of  $B_1$  and the result is a simple velocity control.

### Two timers control head speed

Each time a PS-gate signal is received,  $T_1$  fires on the negative transition (trailing edge) of the signal and enables  $B_1$ . If  $T_1$  times out before the next PS gate,  $T_2$  is not triggered. However, if the head is moving too fast, the next PS gate comes sooner, so the signal will be gated through, because  $T_1$  is still enabled.

Timer  $T_2$  pulls in the head-scan clutch, and the motor, which is still running, serves as a brake. Since the brake is only active for 100  $\mu$ s, the action is very smooth.

Paper feeds while the head returns. When you activate the paper-feed clutch, the paper moves upward on the platen. Also, the disk slot moves out of the path of the optical gate ( $OS_2$ ) and blocks the light. When the  $OS_2$  signal goes high again, clear the paper-feed timer.

Notice that the Q output of the motor timer goes to the 30-V control, which is an interlock to reduce the likelihood of damage to the printer mechanism or print solenoids, should the logic fail.

Use a 1488 line driver at the output of the system to convert the logic levels directly to line voltages consistent with EIA RS-232C data specifications. ■

# MOTOROLA OMNIBUS



Rollin' along the routes to right design\*

## Superpower\* Schottkys unprecedented performance at high temps.

Motorola's new state-of-the-art MBR7545 power Schottky rectifier is rated for 150 A peak, 50% duty cycle square wave output, 20 kHz 150° junction (90°C case), AT RATED REVERSE VOLTAGE!

The 20 to 40 V MBR7520 series of Schottky barrier devices employs epitaxial construction with oxide passivation, and has AVALANCHE characteristics for transient immunity! Lower leakage current allows no derating for reverse power.

Motorola offers the broadest line from 0.5 A to 75 A and at highest  $V_R$ —45 V—for larger ranges of input  $V$  from off-line supplies. Extremely low  $V_F$ , as much as 0.1 V less, can save you up to 20% in power at 100 A over other types. Super-high case and junction temperature capabilities (175°C peak) afford smaller heat sinks, higher reliability... up to twice the amount of heat dissipation than also-rans.

Even  $dv/dt$  is upped... 1,000 V/ $\mu$ s for the '7545. And  $\theta_{JC}$ . It's just 0.8°C/W instead of the usual 1.0 for more reliability and efficiency.

And that's what Schottkys are all about—efficiency in high-frequency switching. The new MBR7520—7545 units will be the new standards in those designs. Price for the prime MBR7545 is \$7.95, 100-up.

Send for data sheets and spec-by-spec, side-by-side comparison of this new standard with the SD51. A real eye-opener.

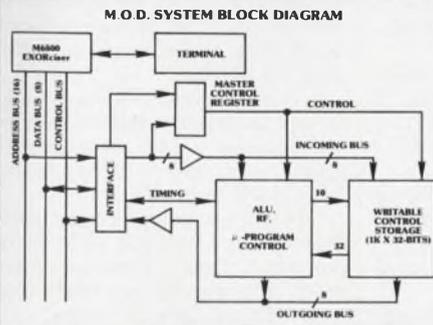
Also available are new 35 A DO-4s and 60 A DO-5s with similar capabilities. □ A

## M.O.D. Adventures in processing with MECL 10800 LSI

Nowhere is the number-crunching power and flexibility of microprogramming more aptly demonstrated than in this high-speed, bipolar LSI processor.

Called M.O.D. for Microprogrammed On-Line Demonstrator, it's an 8-bit arithmetic processor built from the MECL 10800 family.

Slave to an M6800 MOS EXORciser\* system, the M.O.D. has a 1K x 32-bit writable control store, extensive micro-instruction set (including BCD), and 17 working registers. Operating with a 10-MHz clock rate, a single precision binary floating point multiply requires 37.6  $\mu$ s. The M6800 system allows a user to read, load and dump WCS as well as run microprograms.



There's a new handbook describing the M.O.D. in detail and it's available only through your local Motorola Field Applications Engineer. It shows processor structure, gives microprogramming techniques and examples as well as lots of other nitty-gritty. Just call him on the phone and fork over \$1.50.

\*Trademark of Motorola Inc.

## Motorola Announces NE592/SE592 Diff Amp

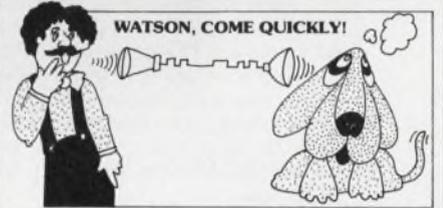
Here's a linear gem for magnetic memories, communications, display and video recorder systems: the NE/SE592—a monolithic, two-stage, differential output, 90-MHz, wideband video amplifier.

It has fixed gains of 100 and 400 without external components and adjustable gains from 400 to 0 with one external resistor. The input stage has been designed so the circuit can function as a high-pass, low-pass or band-pass filter with the addition of a few external reactive elements between the gain select terminals.

Available in plastic and ceramic DIPs or metal can versions and in two temperature ranges (0° to 70°C and -55° to 125°C) it's particularly useful in magnetic tape or disk file systems using phase or NRZ coding and in high-speed thin-film or plated wire memories.

Prices are good, \$1.10 to \$2.95, 100-up, delivery's excellent. □ B

## Let's talk about digitizing voice with I<sup>2</sup>L Interface ICs



How'd you like an interface IC that multiplexes many voice channels on a single pair of wires, switches telephone PBX and scrambles for secure communications?

Try a continuously variable slope delta modulator, or CVSD. It's a simple alternative to more complex conversion schemes in systems requiring digital communication of analog signals.

S/N ratios of the recovered signal do not vary with distance when using digital transmission; and multiplexing, switching and repeating hardware is more economical and easier to design. The CVSD A-to-D is well-suited to digital communications and is an economical, efficient means of digitizing inputs for digital transmission.

The MC3417L military version and MC3418L telephone-quality CVSDs are firsts. They'll soon see use in telephone, PBX, military and commercial security, because they provide a breakthrough into practical, mass-producible telephone codes.

Features include one-chip encode and decode functions with digital input for selection... compatible I<sup>2</sup>L-linear bipolar technology... CMOS-compatible digital output... input threshold selectable. The '3417 has a 3-bit algorithm for 16 kHz and below clock rates and the '3418 4-bits for 32 kHz and higher.

The loop offset and current matching of the '3418 have been laser-trimmed to allow outstanding idle channel performance in commercial telephony.

'3417, 100-up, \$6.95; '3418, \$7.95.

Send for an applications-oriented data sheet and complete technical article. □ C

# The lowest-cost 4027

challenges the 4K RAM field

Of all the 4K dynamic RAMs that have achieved popularity, our 4027 is the industry standard. And priced better than 40% below competitive types at current prices. The challenge for 4K memory leadership is on.

Motorola's highly reliable N-channel silicon gate technology results in a 4096 x 1 organized RAM designed for high-performance, lowest-cost applications in mainframe memories, buffer memories, and peripheral storage. It's a second source for the MK4027.

Three speeds are presently offered, each in plastic and hermetic 16-pin dual in-line packages. The first has a maximum access time of 150 ns, and the second and third are 200 ns and 250 ns versions. The first has maximum Read and Write cycle times of 320 ns, and the others are 375 ns. The low-power dissipation is 27 mW max, standby, and 470 mW typical, active.

Each of the 64-row addresses is refreshed every 2.0 ms in this one-cell design. All inputs are TTL-compatible, and the output is three-state TTL-compatible. Power supply pins are at the corners of the standard 16-pin packages for optimized board layout. Our 100-up prices for the fast, faster, and fastest MCM4027Ps are \$6.60, \$6.90, and \$8.20. □ D



## MCM6670

### newest ROM character generator

The MCM6670 is mask-programmable, a horizontal scan (row select) character generator with 128 characters in a 5 x 7 matrix. It complements our broad line of 128c x 7 x 9 and 128c x 9 x 7 character generator ROMs.

A static 8K ROM in an 18-pin package, with diagonal corner supply pins, it operates at a max access time of 500 ns from a single +5 V power supply. It's TTL-compatible.

You specify the content of the 6670 by programming a single photomask. Photomask encoding is computer-aided for quick, economical, and efficient implementation of the bit pattern.

In operating the 6670, a seven-bit address code selects one of the available characters, and a three-bit row select chooses the correct row to appear at the outputs. The rows can be sequentially selected to provide a seven-word sequence of five parallel bits per word for each selected character.

In plastic, the MCM6670 is \$8.15, 250-up (minimum quantity), after a one-time mask charge. □ E

MPS6172  
complements  
MPS5172

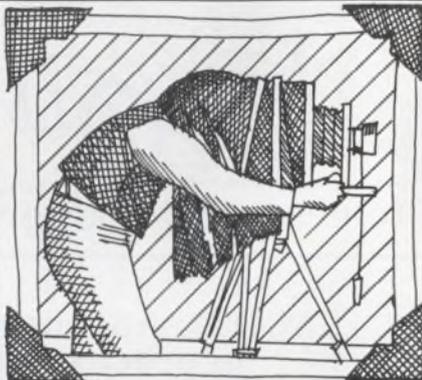


for 11.5¢

The lowest-priced industry-standard plastic transistor now has a PNP complement . . . and it's equally low-cost!

The MPS6172 is a true, spec-for-spec matchup with the '5172 . . . hFE range of 100 to 500 at 10 mils . . . 0.25 volts  $V_{CE}$  (sat) max . . . one-piece, injection-molded Unibloc\* package . . . etc.

Use it for general-purpose, low-level amplifier applications where you don't want to spend much more than a thin dime or so, 100-up. For either one. □ F



## Get a better picture

with 1,400 V Horizontal Darlington

Wide-screen advantages are here with the 8A MJ10011—brilliantly conceived to combine output transistor with damper diode, provide an order of magnitude increase in gain and equal the performance of discretes, such as the BU208, in all critical parameters such as  $t_f$ , SOA,  $V_{CE}$  (sat) and thermal stability.

It does all that plus furnishing better-than-discrete cost effectiveness.

This new unit allows options never before available. The transistor has nominal hFE of 40 at 5 A compared to 3 for the discrete BU208. This allows sat V typically less than 2 V at 4 A with only 200 mA of base drive whereas a discrete needs 2 A drive for comparable sat V. This modest demand greatly simplifies drive circuitry and is well within IC technology needed to produce an integrated driver plus oscillator which would direct-drive the MJ10011.

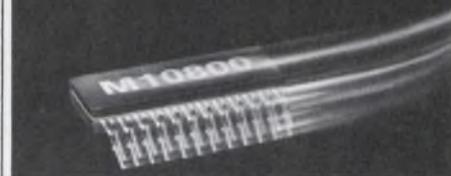
The integrated diode section functions as well as existing discrete damper diodes and provides a path for the yoke current during negative swing of the scan cycle with about 1.2 V drop at 4 A.

And an ac coupling capacitor from the driver to the Darlington input offers built-in protection from excessive current flow which otherwise destroys the output if the horizontal oscillator locks up.

Thermal stability is ensured through proprietary glass passivation and specially-constructed TO-3 packaging providing high voltage and low thermal resistance capabilities. Large glass insulators around B-E pins maximize creepage paths and resist arcing. Header thickness is optimized for typically 0.6°C/W  $\theta_{JC}$  without sacrificing strength.

100-up is just \$3.50. □ G

## M10800 IS MECL LSI!



Recently introduced is one of the best-conceived, high-performance bipolar processor functions available today . . . the MC10803 memory interface. It's the communication or interface link between main system processor and main memory or peripheral section.

It controls bidirectional flow of data to and from the main processor and, in parallel with data transfer, it generates or formats memory addresses. The latter is accomplished with an on-chip ALU. By placing an ALU at the processor, peripheral port memory addressing can be done in parallel with the main ALU complex operations.

Introductory price for the '10803 is \$40 in quantities of 100. Of course, it's in the new 48-lead quad in-line QUIL\* package.

### ALU to you

If you haven't heard of the MC10800M 4-bit ALU, listen up.

Fully characterized over the MIL range of -55° ambient to 150°C  $T_J$ , you can use it in applications from space satellites to the Alaskan oil field. Or, if you're not into stuff that heavy, use the standard MC10800 ALU characterized from -30° to +85°C ambient just like the standard MECL 10K series logic family.

Whichever you do, you've got the MECL heritage behind you, developed over years to its present level of LSI sophistication and performance. Speed—performance—system density. MECL LSI.

### And militarily speaking

. . . we're the only ones with JAN MECL! The six units found on MIL-M-38510/60 are now available from Motorola . . . the first and only source to be drafted!

JM38510/06001BEB	10501 Quad NOR Gate
JM38510/06002BEB	10502 Quad NOR Gate
JM38510/06003BEB	10505 Triple OR/NOR
JM38510/06004BEB	10506 Triple NOR Gate
JM38510/06005BEB	10507 Triple EXOR/EXNOR
JM38510/06006BEB	10509 Dual OR/NOR

### MECL Memory magic . . .

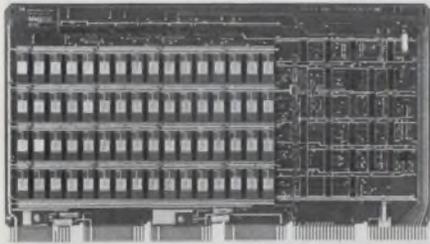
Memories complete MECL's magnificent story. There's a new 256 x 1-bit memory with a max access time of 15 ns available in sample quantities—the MCM10152 RAM. Pinouts and function are the same as the popular MCM10144. And the MCM10139 is a new 32 x 8 programmable ROM. It too is accessed in 15 ns and is sample-available.

Others in the MECL memory production bag are:

MCM10143	8 x 2 Multiport Register	10 ns
MCM10144	256 x 1 RAM	26 ns
MCM10145	16 x 4 Register File	15 ns
MCM10146	1024 x 1 RAM	29 ns
MCM10147	128 x 1 RAM	12 ns
MCM10149	256 x 4 PROM	25 ns

Do it with MECL. It's quicker! □ H

# Standard add-in, add-on and microcomputer memory systems expand the capability of popular mini's and micro's



Board and cabinet level memory systems are relatively new in the product mix of the Motorola Semiconductor Group but Motorola's memory system people are old hands in the field. It's not so surprising then, that in a short time our line of add-in, add-on, and microcomputer memory systems has grown to nine standard board-level systems, a selection of chassis, and a creative custom capability.

**MMS80810**—Here's a high density 32K x 8 or 16K x 8 memory that's designed for 8080A systems, so it's SBC80/10-compatible. It's fast, with a max access time of 450 ns. A refresh cycle is generated by on-board logic, asynchronous to the MPU, and it has on-board address select jumpers for locating 32K words in a 64K word memory map in independent 8K segments. Even the SBC80/10's originators don't have this one.

**MMS1110**—This one's a 16K x 16 LSI-11† compatible memory that mounts directly into the H9270 backplane slot. All timing, control and bus interface logic are included. It's compatible with the DEC Q Bus†. It's fast, low power, and at \$790 in the 25 quantity, low cost. An 8K x 16 version is \$420 and a 12K x 16 board is \$650 in the same 25 lots.

**MMS1116**—A high speed, fully expandable 16K x 16 PDP-11 add-in memory. The MMS1116 mounts directly into the MF11 backplane used with PDP-11/05, 11/10, 11/35, 11/40, and 11/45. Complete hardware and software compatibility. With DEC's memory management, this system can provide up to 124K words of main memory. Maximum access time is 400 ns. At \$1,100 in quantities of 25, it's very economical, too.

**MMS1118**—Another PDP-11 add-in memory, this one 16K x 18. It's designed for the PDP-11/04 and PDP-11/34, and plugs into the modified UNIBUS†. The MMS1118 is fast, with a max access time of 550 ns, compact, and low cost, with a 25 quantity \$890 price tag. It has short circuit memory protection, too.

**MMS3400**—The 3400 is a 64K x 9 or 32K x 18 building block memory for large systems. It combines high-speed access time of 450 ns max, low P<sub>D</sub> of only 30.6 W continuous DMA operation and modular expandability—configuration for up to 256K words per system is practical. Asynchronous or Handshake refresh modes are options and either word or byte mode may be selected with use of an on-board jumper. The 3400 also provides short circuit memory protection.

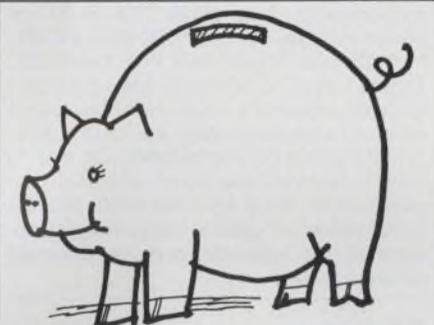
## M6800-based systems benefit, too

**MMS68100**—This 16K x 8 memory was designed to provide a fast, low-cost, high-density board to simplify the design of M6800-based systems. "Hidden Refresh" relieves the MPU from time wasting refresh cycles. Refresh is transparent to the system. Address select jumpers on the card permit user defined addressing. Cost of the 16K x 8 system is only \$465 in quantities of 25, and there's an 8K x 8 version for just \$285.

**MMS68102**—Non-volatility is the key to this 16K x 8 EXORciser\* compatible memory. Battery backup circuitry consumes only 0.3 W @ +12 V in the backup mode. A multi-layer card makes the MMS68102 very compact. Access time is only 350 ns. Prices are surprisingly low; \$735 for the 16K x 8 and \$465 for the 8K x 8, in quantities of 25.

**MMS68103**—Here is a 16K x 8 memory with edge connector pin assignments just like both EXORciser and Micromodules. On-board refresh makes the system look static and improves throughput by reducing MPU overhead. It, too is fast, yet inexpensive.

**MMS68104**—Call this one the kit companion. It's an ultra low cost, \$395 each, 16K x 8 memory design to provide the maximum amount of memory at the least expensive price for hobbyists and users of the MEK6800DII kit. □ | †Trademark of DEC



## 50A, 500 V Switchmode\* Darlingtons

### Save Blood, Sweat, Tears & \$\$

How about saving at least 25% in bucks and an infinite amount of wear and tear on yourself in switching regulator design? The fastest, highest-current, highest-voltage power switching transistor around can do it for you!

The MJ10015-16 SuperPower\* Darlingtons are designed for high-voltage, high-speed power switching in inductive circuits where fall time is critical . . . regulators, inverters, solenoid/relay drivers and motor controls.

Where they really shine is in large switching regulators by eliminating, or drastically reducing, paralleling. With these, the paralleling and matching is already done—all you do is plug 'em in and watch 'em go: 180 ns typical fall time . . . 1 μs inductive storage time . . . 25 min gain at 20 A . . . 450 and 500 V BVCEO! □ | \*Trademark of Motorola Inc.



## Lock in your frequencies with these PLL frequency synthesizers

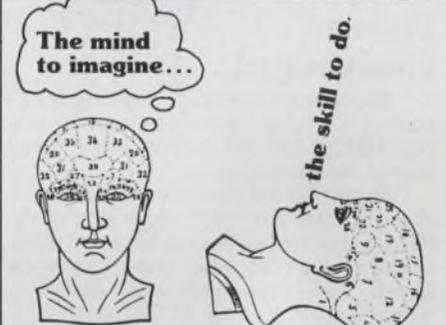
Motorola has taken the industry standard phase-locked loop frequency synthesizers and made them for operation over a wider voltage range and to higher temperatures. They are the MC145104, 06, 07, 09, and MC145112.

The MC145106 is the full pinout star performer in this family of monolithic CMOS devices designed for applications in equipment such as CB and FM transceivers. The other units are all limited pinout versions. The operating temperature range is -40° to +85°C, the full standard industrial range. A single supply in the +4.5 to +12 V range is all that's required.

The device includes an oscillator/amplifier, a 2<sup>10</sup> or 2<sup>11</sup> divider chain for the oscillator signal, a programmable divider chain up to 2<sup>9</sup> for the input signal, and a phase detector. The phase detector controls a voltage-controlled oscillator.

Our replacement chart works this way:

MC145104 for SM104, MM55104, MM55114  
MC145106 for MM55105, MM55116  
MC145107 for SM5107  
MC145109 for SM5109  
MC145112 for SM5106 □ | K



## —in every mainstream technology.

Technology in ECL. Technology in TTL. Technology in MOS.

That's what we've got, and in every processor, logic and memory category.

We've been around a long time in ECL and MOS logic, we've innovated with 6800 and 10800 processors and we've intro'd some great RAMs, ROMs and PROMs.

Last, but not least: 54/74LS . . . we've turned raw silicon into fine-tuned LS TTL product in just 2 months. The circle (or square matrix) is now complete. Motorola is a leader in every mainstream technology.

Put it all together with our overwhelming discrete capability and our leadership in linear interface and you've got what Motorola is all about—the most complete semiconductor technology from here to there. And no other can make that claim.

### LINEAR INTERFACE AND DISCRETES

	ECL	TTL	MOS
MPU	10800	2900	6800
LOGIC	10K	LS	CMOS
MEMORY	1K RAMs PROMs	4K, 8K PROMs 1K RAMs	4K Static RAMs 4K, 16K Dynamic EARAMs - ROMs

## 8K EPROMS

— 450 ns or 300 ns



'77's new 8K EPROMs provide two different speeds: 450 ns for the MCM68708/MCM2708 and a faster 300 ns for the MCM68A708/MCM27A08. All are pin-compatible with our MCM65308 and MCM68308 mask-programmable 8K ROMs, and upward compatible with the 16K MCM65317 and MCM68316E mask-programmable ROMs, for low cost and high volume applications. The 68708 and 68A708 are bus compatible with the M6800 micro-processor family.

They are organized as 1024 bytes of 8 bits and use three power supplies. These highly reliable 8K EPROMs are available now in 24-pin ceramic packages specified for a 0° to +70°C temperature range. The 450 ns 68708 and 2708 are \$32.00, 100-up; \$37.50, 100-up, for the 300 ns parts. □ L

### Alterable Automotive Speed Controller Resumes Speed

## On Simple Driver Command

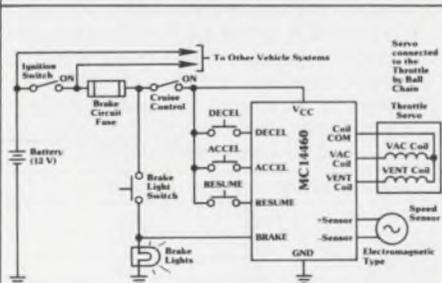
Sophisticated vehicular highway speed control is now as simple as designing in a new CMOS LSI component with a speed sensor and throttle servo.

Motorola's MC14460 is an automotive speed control processor which continually trims a throttle positioning servo for maintenance of an alterable stored reference speed. The stored reference speed is trimmed up or down by ACCEL or DECEL commands from the driver.

A brake input interrupts the processor's control, but a simple RESUME command from the driver returns the vehicle to the most recent stored speed.

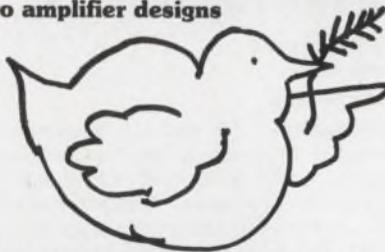
The MC14460 has both master oscillator and pulse oscillator on the chip, and all inputs are diode protected. It features internal redundant brake and minimum speed checks, and uses low frequency speed sensors. No throttle position feedback is required.

TYPICAL AUTOMOTIVE CRUISE CONTROL APPLICATION



□ M

## Peace & quiet return to amplifier designs



with 0.5 dB NF 2N6428-29A TO-92

If you're familiar with audio devices, you know you can't get much below 1 dB NF at about 100  $\mu$ A without creating an uproar in design compromise.

## Wideband RF Amps

Offer Ultra-Linearity & Response Flatness



A series of 4 wideband RF modules covering 1 to 250 MHz and 10 to 400 MHz ranges provides state-of-the-art linearity.

Designed for radio and cable communication systems plus RF instrumentation and operating from either 13.6- or 24-volt power supplies, the MHW590-93 amps offer  $\pm 1.0$  dB gain flatness over their bandwidth. Typical  $G_{P\epsilon}$  is 36 dB and the units are spec'd for high-performance systems with a source and load impedance range from 50 to 100  $\Omega$ .

Performance and reliability is due to hybrid, high-rel type construction of gold metallization on alumina substrate, fluxless solder reflow process for component attachment to the substrate, and laser-trimmed resistors. □ o

## Master Semi Selection

with a Master Semi Selector Guide



Here's the new-edition cornerstone of our exclusive Update System . . . 250 pages of up-to-date perspective on all available Motorola components—from Micro-Ts to memories.

It lists, in alpha-numeric sequence, every standard product in the vast Motorola inventory and divides this total offering into a variety of major product categories, with sufficient technical info to permit an intelligent, first-order evaluation. Preferred devices are highlighted.

Master your semi selections now . . . find out the most suitable device for your specific application.

Check the proper box on the coupon. . . then check your local OEM sales rep or distributor for the very best of semiconductors. Motorola's. □ P

Well, we've got the new '6428 series and it offers 0.5 dB typ at 100  $\mu$ A and 5 V. It's quietly taking over the low-level, low-noise amplifier world.

A major technological breakthrough made it possible. Without shooting off our mouth on too many secrets, we use virtually defect-free material—no voids or displaced lattice. Then we employ nitride-passivated die with improved designs. Then we use epoxy-packaging with greater moisture resistance which also affords long-term reliability.

And we'll sell it to you for just 40¢-55¢, 100-up.

They've just been JEDEC-registered and are available in any quantity from the Quiet Zone of your Motorola distributor or sales office. Ahhhhh . . . □ N

## Beep Beep

for HV Ignition Darlington



Make way for MJ10012 400 V silicon power . . . it's designed specifically for the high-voltage, high-current, harsh environmental needs of automotive applications.

With a rated operating temperature range from -65°C to +200°C, the 10 A metal TO-3 extends by 50°C the limits of previous high-SOA Darlington for demanding auto markets. Nobody else can touch that. It's also useful in switching regulators and motor control.

Nobody else can touch the SOA either—3.5 A at 50 V; or the power dissipation—100 W; or the  $h_{FE}$ —300 at 3 A. Even PD is double the competition—100 W at 100°C.

Or the price—just \$2.75, 100-999. That's just HALF what others ask. Oh, there is a similarly-priced unit . . . in plastic. But with only HALF our specs. □ q

## TTL RAM

has the speed you need to write/read.



Bipolar, has intro'd another fast-access RAM with all the features you need for high-performance applications. You can get to it in 30 ns, typical.

The MCM93415 and MCM93425 are 1024-bit read/write RAMs organized 1024 words by 1 bit.

They're made with full decoding on-chip, separate data input and data output lines and an active filter chip select. Both are fully compatible with standard DTL and TTL logic families and the '425 has a three-state output to drive bus-oriented systems and/or highly capacitive loads. The '415 is open-collector.

Both provide non-inverting data output, 15 ns typical chip select, 500 mW typical PD and replacement of F-troop's 93415 and 93425.

You'll want 'em for buffer control storage, high-performance main memory, bipolar bit slice and high-speed microprogram control memory storage applications.

Just \$9.75 for the plastic DIP and \$11.00 for the ceramic, 100-up. Send for the data sheet. □ R

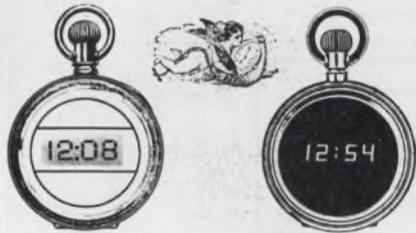


# Keeping Time

## LED or LCD

Whichever way the digital timepiece market eventually goes, Motorola has the standard CMOS circuits and custom capability to match.

The better established LED timepieces are ideally served by the fully integrated 6-function, 4-digit MC14470 circuit. It's fabricated with our low threshold metal-gate technology and designed to interface easily with LED alphanumeric displays of 9-segment first and second digits. Display segment and digit drivers are on-chip. Other chip features include a four-year calendar, interdigit blanking and switch-contact debouncing. Functions include hours with minutes and seconds, day-date and month-date.



LCD displays have been steadily claiming greater support in the marketplace, and Motorola has kept pace with the trend with a raft of new offerings. Of these the MC14482 is the most versatile. It's a fully integrated 6-function, 4-digit circuit with 5-function options. Because the versatility of the circuit allows operation with four different function options, it can be a real inventory reducer. The different display formats are 6-function, Slant-R, 6-function Bar-a, 5-function standard U.S., and 5-function European.

Other LCD timepiece circuits available include the MC14480, a 5-function, 4-digit circuit that replaces the S1424A, TP0232/0233, MM58118/58120, and the MM58117/58119. Our MC14479 is a mirror image of the MC14480. The standard 6-function, 4-digit circuits are rounded off with the MC14481, which interfaces with a 3-1/2- or 4-digit display with an additional segment above and one below the colon.

Motorola's keeping time with the way the world keeps time. □ s



## Challenge of the month!

— Our TO-220 vs Anybody's.

We tested. We compared. We documented. We published.

We know, for instance, we had no failures at all after 750,000 device-cycles of 1 minute on/1 minute off at  $\Delta T_J = 75^\circ C$ . Try that with others.

We know we had less than 1% failure after 8-1/2 million device-cycles at  $\Delta T_J = 100^\circ C$ . The best of our "competitors" had twice that many failures.

We know Motorola TO-220s have orders of magnitude less failures than others in temp cycling, pressure cooker, high-temp reverse bias and thermal shock. Because we tested and compared.

Our new TO-220s have the nitty-gritty. 2-1/2 times stronger, lead-free, die-attach solder. Cross-hatched die bond areas that control solder thickness and minimize bond degradation. Moisture barrier moats around bond area. Ultrasonic wire bonding. Glass passivation. Heavier, rugged, flat copper leads. Industry-proven mold compound. In-process QA controls at all critical points. Etc., etc., etc.

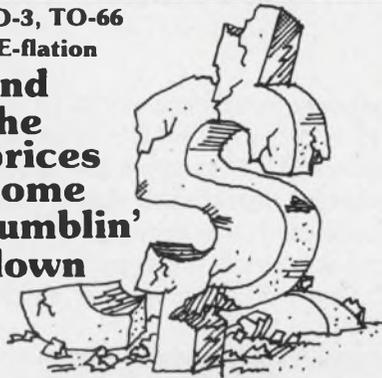
Motorola TO-220 is designed better than anyone else's to last longer.

Prices are lower, too. Series-by-series and quantity-by-quantity. And even though we 100% test all spec'd electrical parameters INCLUDING SOA, they're still lower than others. (continued)

We've even got Switchmode\* units ready to take over your high-voltage needs from 350 to 400 V. Included are all the specs you need to design and characterize high-frequency, 100°C inductive applications.

2N-, TIP- and MJE-types are available now from distributor or factory from 1 A to 15 A, EpiBase\* and diffused mesa with more types arriving constantly. A special brochure can be had including rel-report, data sheets, selector guide and . . . the lowest prices around. □ T \*Trademark of Motorola Inc.

## TO-3, TO-66 DEflation and the prices come tumblin' down



An average 12-1/2% price cut on seven commodity power transistors now brings Motorola prices about 10% lower than others!

We've cut the 2N3055 and its PNP complement MJ2955 6¢ apiece . . . the 2N6569 and its complement 2N6594 6¢ apiece and the 2N3054 driver and its complement 2N3740 7¢ apiece.

And you'll notice we price NPNs and PNP's equally. We're the first and only source to give you this advantage!

Close on the heels of this cost-saving are decreases in 40 other TO-66 prices—at an average of 45%!

75 additional TO-3 standards have been cut an average of 35%, too. You can now get all the quality, reliability and delivery you want in a TO-66 and TO-3 at the lowest prices in town:

Part	Description	100-Up	
		Old	New
2N3738	225 V/2 A Power Switch	\$1.25	\$1.14
2N3441	160 V/3 A Amplifier	2.50	0.75
2N5430	100 V/7 A Amplifier	6.65	2.10
2N5052	200 V/2 A Power Switch	3.35	2.50
2N3442	140 V/10 A Gen'l Purpose	1.75	1.10
2N6228	140 V/6 A Gen'l Purpose	4.28	1.10
2N6338	100 V/25 A Switch	7.15	3.75

Move up to Motorola quality—and low price!

## All Aboard! Motorola Omnibus • Rollin' along the routes to right design.



(Coupon Missing?) Send inquiries to: Department LDC, Motorola Semiconductor Products Inc., P.O. Box 20912 Phoenix, AZ 85036

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- ⊠ H MCI1883
- ⊠ I MCI1884
- ⊠ J JAN MECL
- ⊠ K MCM10143
- ⊠ L MCM10144
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## Multi- $\mu$ P systems combine the efficiency of dedicated microcomputers with the throughput of minis. And their modular structure makes expansion a snap.

The trend away from the powerful CPU, and toward multiple  $\mu$ Ps is not only a matter of economics. Multi-microprocessor (MMP) systems also offer the advantages of graceful degradation and a flexibility that greatly simplifies system growth. Modular expansion permits gradual growth increments, and there is less software interaction than with a single, high-performance CPU.

Because processing modules (PMs) execute tasks simultaneously, processing bottlenecks are minimized; and because each PM can be designed for its specific job, throughput is high. The detailed configuration of a multi- $\mu$ P system depends on its specific tasks. Such factors as the number of users, devices to be controlled, input types, processing load, and real-time response must be analyzed before you design the PMs and the system that holds them together.

Nevertheless, many multi- $\mu$ P systems share enough requirements to make the design of a general-purpose system practical. Such a system can provide office-building security, collect data and control terminals or parking lots. You can also use it to sense and control remote, and quite diversified equipment.

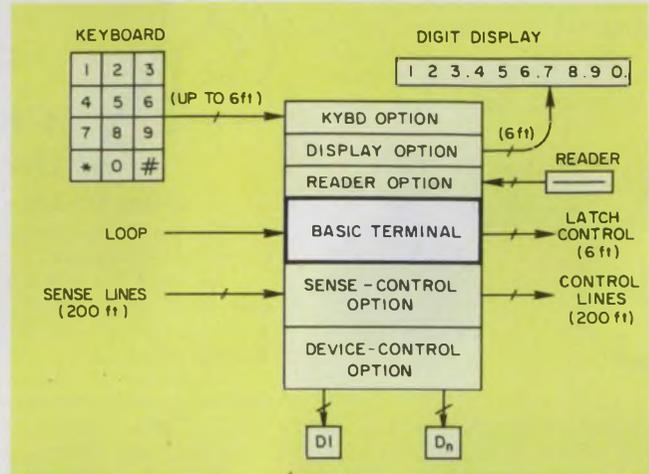
If used for security, a terminal-control unit (TCU) of the system (Fig. 1) can read a uniquely encoded card that permits the user entry into a secured area (building, factory, garage, hotel room, or parking lot). The TCU can check authorization, note the time, monitor traffic, and, if there is an entrance fee, keep financial records. The system's data base is centrally located and may be interrogated by many TCUs, which may be placed simultaneously on one full-duplexed communications line (Fig. 2).

Central-site functions include communication control, file management, hard-copy output or interactive CRT use. Sensors at remote sites may perform such environmental measurements as air quality and smoke density. Or they may monitor energy load, burglar alarms or highway traffic, and transmit results to the central site for processing and storage.

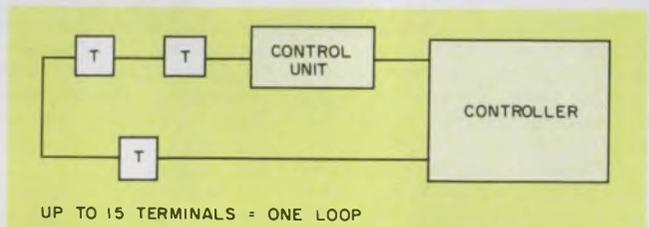
### Which $\mu$ P is best?

Before you can begin designing a multi- $\mu$ P system in detail, check the available  $\mu$ Ps, and study their

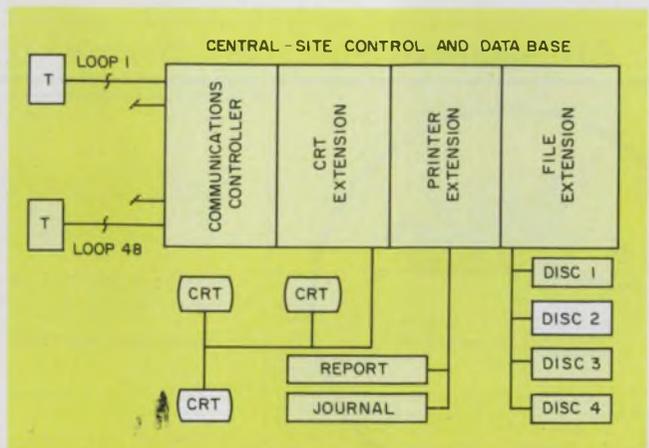
**Ted Burton**, President, SECOM, P.O. Box 2074, Culver City, CA 90230.



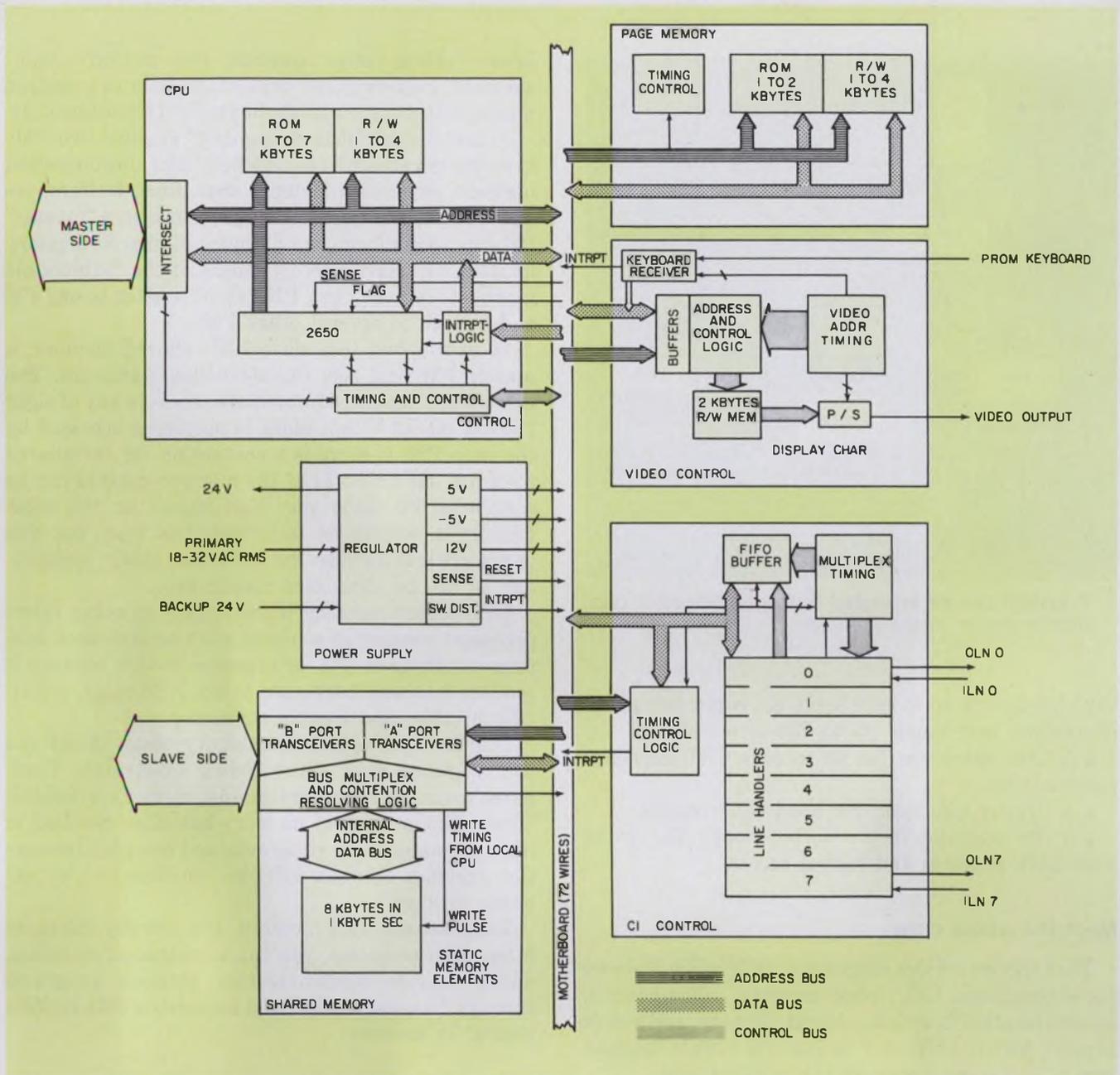
1. A terminal control unit can serve many functions. In this case, the card reader monitors access to a secured area by scanning an ID card.



2. The communications loop control unit can handle up to 15 terminals per loop.



3. The complete system consists of a central-site unit and peripherals. With 48 communications controllers, this system accommodates 720 terminals.



4. Processing modules consist of six submodules. Each is built on a PC board measuring 7 × 7 in.

impact on system engineering, software design, and system cost. The Signetics 2650, for instance, offers a good mix of instruction-set power, hardware-interfacing simplicity and cost for the system shown in Fig. 2.

The 2650's wide variety of addressing modes, particularly indirect and indexed addressing, coupled with a minicomputerlike instruction set and an impressive register complement make programming extremely efficient. As shown by benchmark programs written for different  $\mu$ Ps, this efficiency reduces memory needs.

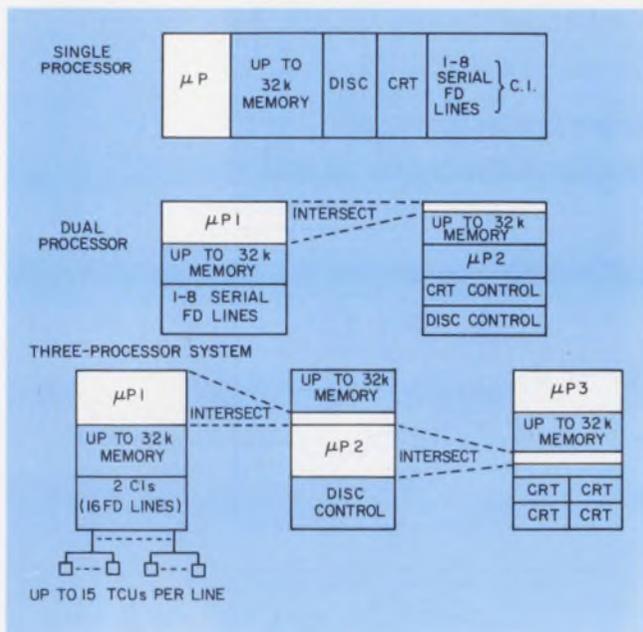
The 2650's interrupt structure permits multiple vectored interrupts to service routines located any-

where in addressable memory, and you can exploit this feature when servicing interrupts from the communications interface, CRTs, or floppy disc.

A single 5-V supply, single-phase TTL clock and static operation are all advantages: The 2650 can be suspended indefinitely while resolving access contention, and can easily be single-stepped during system debugging.

Each PM in the system consists of a 2650 microprocessor, up to 32 kbytes of local memory, 8 kbytes of shared memory, and generally one or two I/O controllers. The interfaces (Fig. 3) include:

- A communications controller handling up to eight full-duplex lines with up to 15 terminals per line, at



5. A system can be expanded from one processor (top) in increments of single modules.

variable speeds up to 2400 baud. Six communications controllers can handle up to 720 terminals.

- A CRT extension for up to four CRT/keyboard combinations.
- A printer extension for hard copy reports.
- A file extension for up to four floppy-disc drives with both physical and logical access.

### Meet the whole crew

The functional block diagram of a PM in Fig. 4 shows six submodules: CPU, page memory, video control, communication interface, shared memory, and power supply. All are built on 7 × 7-in. PC boards inserted into a 72-pin connector on the motherboard.

A CPU submodule contains the 2650 microprocessor, up to 7 kbytes of PROM memory for program storage, up to 4 kbytes of RAM for data storage and programs loaded from a floppy disc, timing and control for system synchronization, interrupt logic for interprocess communication, and an "intersect" feature for the shared-memory interface. The "page memory" provides additional program and data storage: up to 7 kbytes of ROM and 4 kbytes of RAM, in 1-k increments.

A video control unit (VCU) is the brain of a custom terminal consisting of a keyboard and a 20-line CRT with 64 characters per line. The VCU provides the system with a man-to-machine interface by enabling an operator to interrogate the central data base. The operator may search for a name in a file, call up a blueprint or examine a report.

Through the  $\mu$ P-resident program, the communication interface (CI) controls up to eight full-duplex

lines. Polling, error control, line protocol management, buffering and converting data to standard message formats are implemented in this submodule.

A dual-ported "shared memory" enables two PMs to communicate with one another. Information passed between processors includes data files, buffers, request blocks and queues. The processor in a "master" PM can access from 1 to 8 kbytes of shared memory located in a "slave" PM by means of the "submodule intersect" feature. Any PM can be master to one PM and a slave to several other PMs.

To gain access to a slave PM's shared memory, a master PM first sets the 2650 Flag status bit. The master PM is granted immediate access to any of eight 1-kbyte blocks if that block is not being accessed by the local PM. If there is a contention for the shared memory, one (or both) of the microprocessors can be suspended by using the Wait signal on the 2650. Usually, a suspension lasts less than 5  $\mu$ s, but this is not critical because the 2650 uses static memory, and so can be suspended indefinitely.

Dual-ported memory is preferable to other inter-processor connection schemes such as dedicated bus, time multiplexed bus, or crossbar switch because it reduces intersect hardware to six MSI chips, a flat-ribbon cable, and a cable connector.

Dramatically decreased memory costs have freed the programmer of many coding constraints. Compared to the cost of programming, memory is, indeed, "free." The low cost of memory has often resulted in huge, unmanageable programs and complex interaction schemes between software modules, which are prone to bugs.

To isolate software modules, and thereby minimize interaction problems, you can use structured tables, which provide communication between programs through "request blocks" and associated data buffers located in memory.

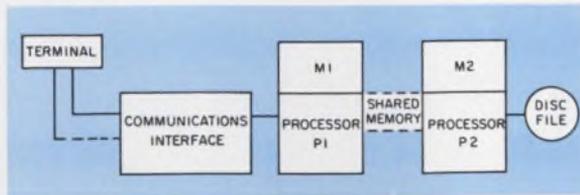
### Software is king

In this multi- $\mu$ P configuration, the operating system is a floating real-time executive (REX) that resides in a 1-k PROM in each PM. The subroutines of the interrupt-driven REX are specifically designed to run in a real-time multimicroprocessor system, and it has three important features:

1. All application requirements for I/O are made through the REX in software rather than hardware. So the multi- $\mu$ P system's physical resources can be changed without affecting application software.
2. Floppy-disc memory is supported by the REX through an overlay control system that permits the system's features to be extended and facilitates off-line processing.
3. The REX's modular design permits such features as utility routines, diagnostics and simulation, debug or report-writing capability to be added easily.

The REX program is divided into two logical sec-

## Message flow within a two-processor system



1. Terminal has keyed message into buffer and "message complete" button is pressed.
2. Terminal sets traffic flag, ready to deliver message to communications line when polled.
3. Terminal service routines of P<sub>1</sub> polls terminal.
4. P<sub>1</sub> receives message from the communications interface through terminal service routines. Message is formatted to standard.
5. Upon detection of "end of message," the message is queued by REX to the proper base-level process for service.
6. Application program (base level) formulates the proper response to the terminal, and queues the response.
7. Application program formulates I/O request block and queues it to "log-in."

8. When base-level program is done, control returns to REX. Base level is now free to process additional messages.

9. While base level was completing steps 7 and 8, the return response to the terminal was in process at the interrupt level. Upon completion, the base-level routine is notified.

10. Intersect-software in REX passes log-in message to P<sub>2</sub>.

11. P<sub>2</sub> intersect software in REX routes message to appropriate application.

12. LOG routine composes disc I/O request block, and queues request to disc.

13. Disc processes request and routes completion signal to base-level LOG routine.

14. LOG routine completes transfer to disc.

In this example the message paths are direct. In a more complex operation the message paths needn't be sequential. As more processors or functions are added to the system, the number of routing paths increases, but does not become more complex for any given processor in the system. Therefore, each processing module may be viewed as a distinct building block, and modular development of the system is practical.

tions, the unprotected "base level" section where interrupts are enabled, and the "interrupt level" section, where they are disabled. Applications programs typically execute in base level on a first-in, first-out basis. I/O handling routines and certain operating-system tasks execute at interrupt level. A base-level applications program that is executing at the time of an interrupt is saved until the operating level is changed back to base level and execution resumes.

For base-level task control, the operating system uses a 4-byte prefix to message buffers or control tables. The prefix is organized as follows:

THREAD	+0	Link Address, high-order byte
	+1	Link Address, low-order byte
TADD	+2	Task Address, high-order byte
	+3	Task Address, low-order byte

The first two bytes (THREAD) are used to link the packet to the base level task queue. When the 4-byte prefix reaches the head of the queue, control passes to the program whose start address is in the TADD field.

### How PMs can pass the buck

Tasks are passed from one program to another in the form of software tables called "I/O request blocks." If the program resides in a different PM from the one that's executing it, I/O request blocks and

associated data are passed through restricted data buffers in shared memory.

Each 2650  $\mu$ P can service up to eight interrupts, with another eight available as options. They act as follows:

- System reset: a jump to the initialization routine.
- Real-time clock: When any of the decrement counters has reached zero, a jump is made to its associated program.
- CRT interrupt: The CRT keyboard is checked for "character present" and, if true, the character is queued to the routine specified in the device control block of the CRT for base-level processing.
- CI half-full interrupt: Normal processing of the CI buffer includes message routing and polling.
- Fault time: Should a module fail, system clean-up routines are called.

Except for system reset and fault time, all interrupt routines must save and restore the base-level program they interrupt. All interrupt routines must use the interrupt-level entries to subroutines of the REX.

If you design a multi- $\mu$ P system properly, expansion becomes easy. Upgrading from a two-processor system to a three-processor system may become necessary because of increased CRT activity, a larger traffic load between the communications system and the disc, or the need to accommodate high-level languages. Representative configurations for system expansion are shown in Fig. 5. ■■

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## Multiprocessing can marry a radar that detects only moving targets to a large air-traffic-control computer inexpensively—and with high reliability.

Microprocessors can often simplify knotty interface problems—such as marrying an advanced radar system to a large air-traffic-control (ATC) computer. Thanks to the flexibility of  $\mu$ P-based logic (see box), three microcomputer boards can do the job much more economically than a minicomputer: The parts cost for all three boards is \$1500, and a system of this complexity can be developed by a couple of engineers in a few months. What's more, the microprocessors' ability to test themselves, as well as the whole interface, strengthens system integrity.

The moving-target-detector (MTD) radar maintains surveillance of several hundred moving targets, in the presence of clutter like terrain and weather echoes, generating massive data. But the ATC computer requires a special input data format, and an interface is needed.

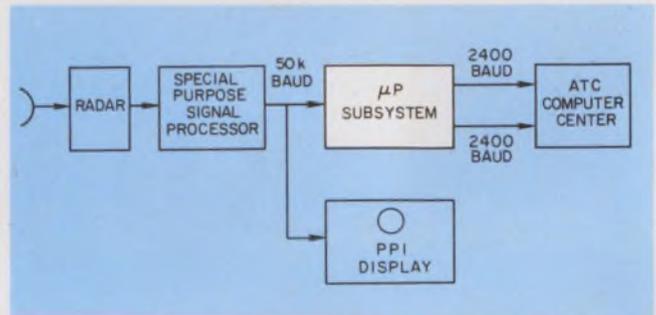
The interface (Fig. 1) has to accept 50,000 bit/s of "threshold-crossing" data, translate them into standard FAA target report messages, and transmit those messages over two (redundant) communication lines to the ATC computer center. Five basic functions must be performed by the microprocessor-based interface system:

1. Receive individual range-gate threshold-crossing data.
2. Make individual crossings coalesce into potential targets.
3. Apply acceptance criteria to extent of range and azimuth.
4. Format target report and radar-status messages.
5. Buffer messages and transmit them over redundant communication lines.

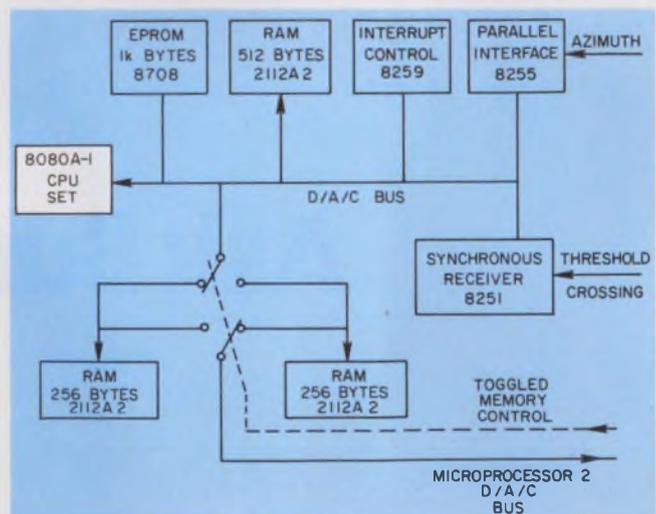
### Microprocessors share the load

In addition to inputting range-gate threshold-crossing data and outputting target-report messages, the microprocessor must combine individual threshold crossings into a single target report. And these target reports must also be checked to establish that the data are credible. Since a timing analysis of these functions

**Dr. Thomas Gabriele**, Supervisor, Computer-Aided Design, Bendix Communications Div., Baltimore, MD 21204



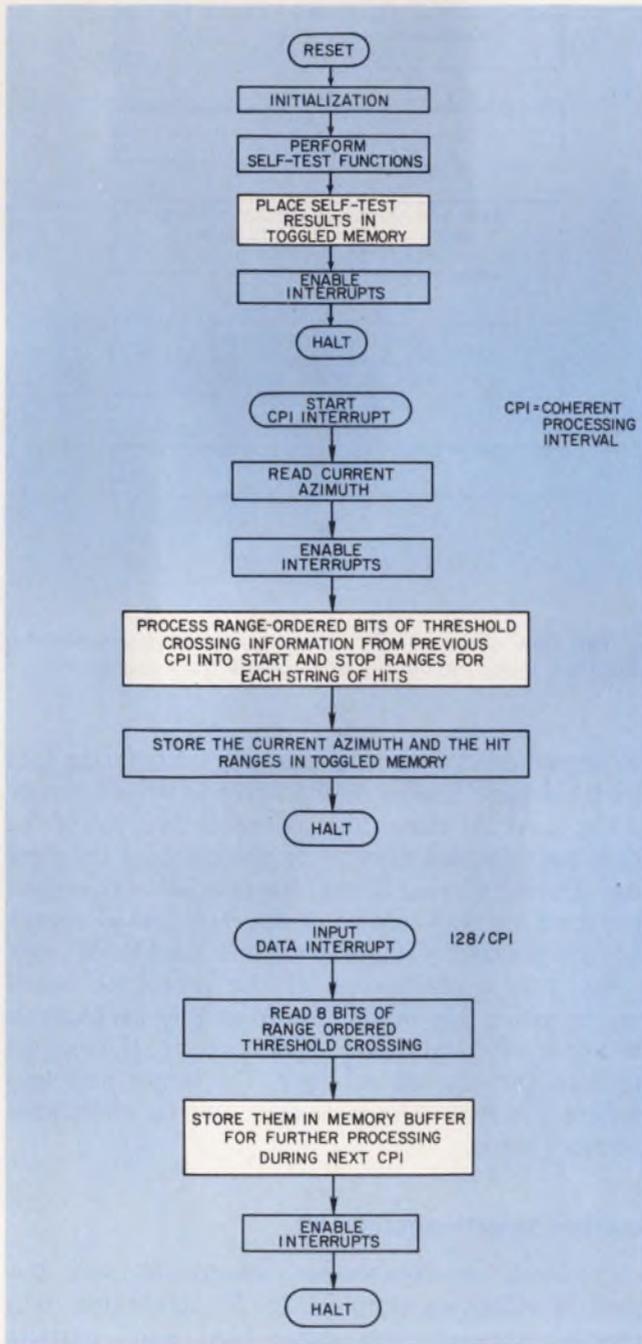
1. A moving-target detecting radar uses signal processing to extract the target data from the clutter. Microprocessors interface the MTD system with the large air-traffic-control computer.



2. One of the three  $\mu$ Ps used,  $\mu$ P<sub>1</sub>, processes incoming target information and stores it in a "toggle" memory.

indicated that a single microprocessor cannot accomplish everything in the allotted 25-ms interval, the tasks are divided among three microprocessors. One microprocessor ( $\mu$ P<sub>1</sub>) accepts the input data, performs some preliminary processing and stores the data in microprocessor memory.

Another microprocessor ( $\mu$ P<sub>2</sub>) performs the bulk of the actual data processing and only outputs range and azimuth data of acceptable quality, which are then



3. During alternate coherent processing intervals (CPI)  $\mu P_1$  processes and stores target data.

### Multiprocessing: wave of the future

Microprocessors are adding a new dimension to data processing. You can now break down a system's overall requirements into specific tasks, and assign a separate microprocessor to each of them. Such distributed systems offer many advantages.

For instance, you can employ multiple microprocessors within a single system and by providing surplus processing capacity you can boost system reliability. In the event of failure of a particular processing element, you divert processing tasks from that element to the others in the network. Such dynamic reallocation provides a much higher level of virtual redundancy than the mere number of processors indicates.

A multimicroprocessor system design can also be used simply to reduce over-all system cost, if you dedicate separate microprocessors to different major system functions. A design based on several microprocessors may be more cost effective by a factor of 10 than a single conventional minicomputer.

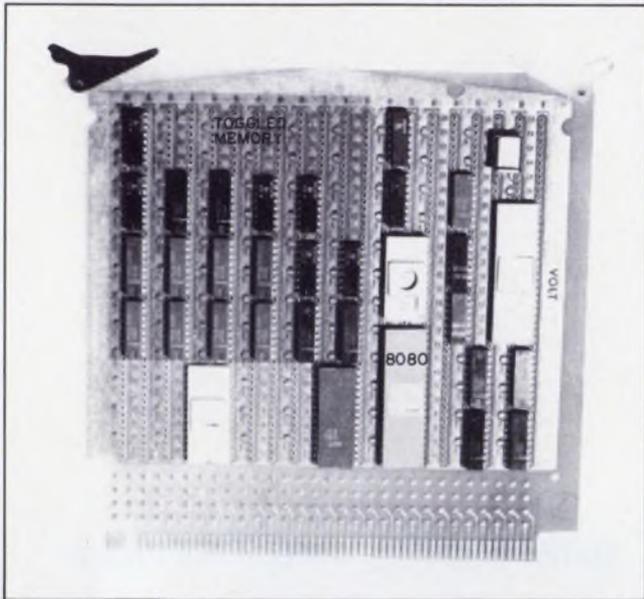
In addition, the system's idle time can be used by the microprocessor to test itself—often by adding only a few instructions to the program. For example, reading fixed values from memory, performing simple computations with those values, and comparing results with other fixed values in memory, tests memory addressing, CPU-instruction execution, and control-bus operation. With some additional hardware, the microprocessor can even perform built-in test functions of other subsystems.

Because microprocessor chip sets can easily multiplex a variety of data over a single serial communication line, they reduce the amount of wiring required in a large system. One day microprocessors may significantly reduce the cost of large avionic systems by multiplexing signals onto single transmission lines.

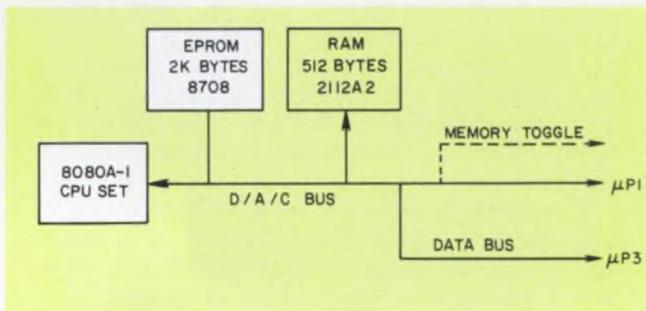
reported to the ATC center.

A third microprocessor ( $\mu P_3$ ) is responsible for handling the dual (redundant) communication lines. It formats all output messages and gives the ATC computer the operational status of the remote radar.

Of course, using these three microprocessors in this way cannot reduce the total processing time of the



4. The three microcomputers each take up a PC board. The toggle memory resides at the top left of the  $\mu P_1$  board. The rest is occupied by the 8080 and its support chips.



5. Most of the signal processing is handled by  $\mu P_2$ , which gets data from toggle memory, and passes results to  $\mu P_3$ .

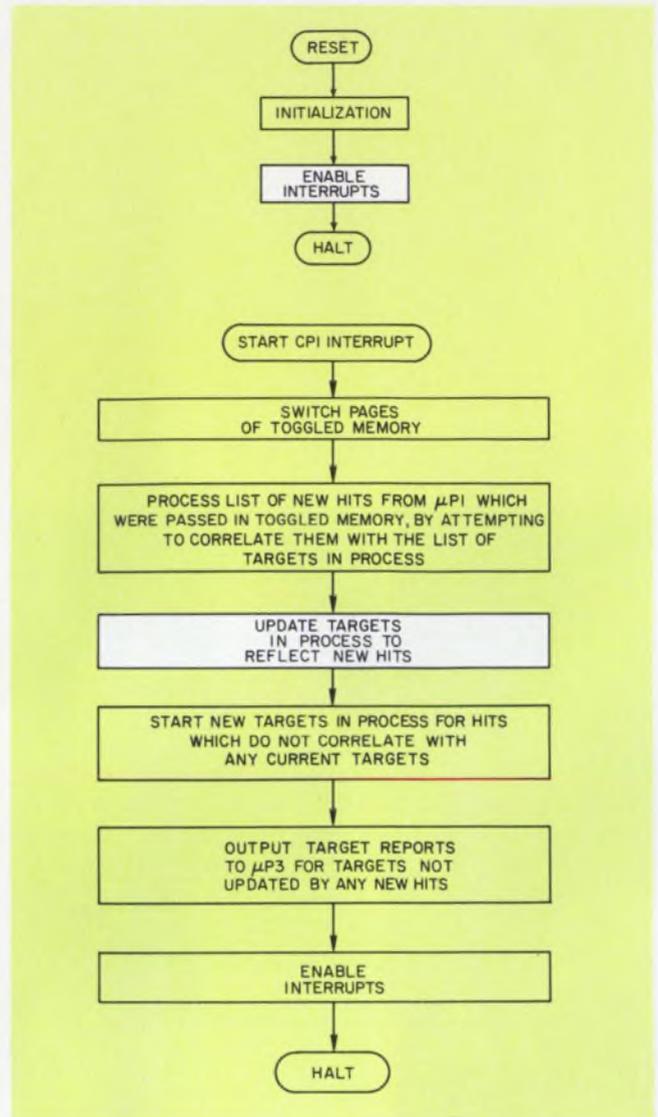
data. But  $\mu P_1$  can start working on the next data batch while the other two are still busy with the previous one.

Using several microprocessors also makes it possible to tailor the architecture of each  $\mu P$ 's subsystem to the particular tasks that are assigned to it. Fig. 2 outlines the functional organization of  $\mu P_1$ . It receives threshold crossings through a serial interface, while azimuth data are inputted over a 12-bit parallel interface.

### Enter the toggled memory

Processing time is divided into "coherent processing intervals" (CPI). As the flow chart for  $\mu P_1$  (Fig. 3) shows, the threshold crossing and azimuth data are converted into range limits, which have to be passed to  $\mu P_2$ . The resulting heavy information flow between the two microprocessors must be handled without disrupting the actual processing tasks.

The problem can be solved by a "toggled" memory.



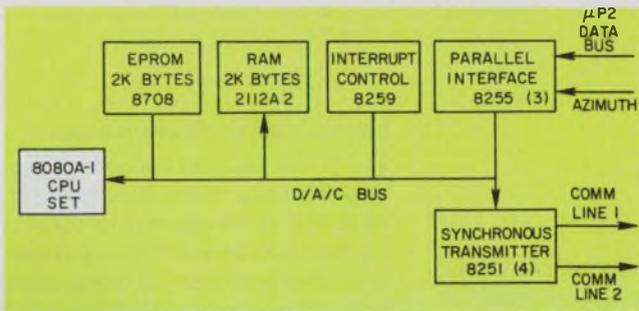
6. The flow chart of  $\mu P_2$  shows how the processor determines from individual hits where the targets are.

During all odd 25-ms intervals,  $\mu P_1$  writes data into the RAM page located in the lower left-hand corner of Fig. 2. At the same time,  $\mu P_2$  reads data out of the RAM page located directly to the right of the first page. During all even 25-ms intervals,  $\mu P_1$  writes data into the RAM page located on the right and  $\mu P_2$  reads the data previously stored in the left-hand RAM page.

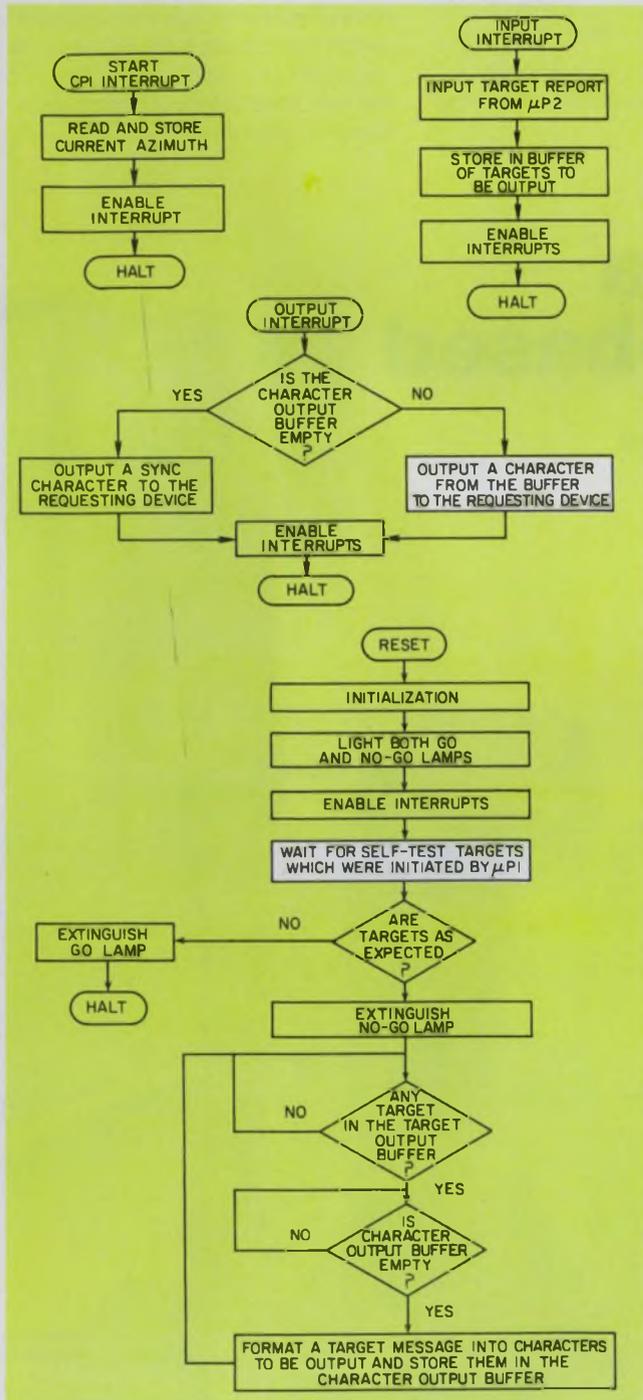
Fig. 4 is a photograph of the prototype board implementing this design. The 18 smaller packages in the upper left-hand corner of the board are the toggled memory and bus control logic. The larger packages contain the 8080 microprocessor and its associated interface chips.

### Another target—another hit

The second microprocessor's functional block diagram is relatively simple (Fig. 5). It obtains data directly through its data bus and outputs range/azimuth pairs of reported targets to  $\mu P_3$ . But as the flow chart (Fig. 6) shows,  $\mu P_2$  also identifies



7. Communications with the ATC system are handled by  $\mu P_3$ , which uses two redundant data lines, but switches to a single line if one becomes defective.



8. The normal operation of  $\mu P_3$  is traced in these flow charts. The bottom one includes the self-test feature.

new targets. It does so by comparing the "hit list" of  $\mu P_1$  with previously identified targets. The updated target data are now ready for transmission to  $\mu P_3$ .

The third microprocessor,  $\mu P_3$ , is in charge of this transmission (Fig. 7). It has a rather large 2-kbyte RAM to store as many as 200 target reports until they can be sequenced onto the two output lines. The  $\mu P$  controls two 8251 serial-communications interface chips for each communications line. Each of the 8251s can handle up to 8 bits.

But the message words to the ATC computer must be 13 bits long. So, in response to interrupts,  $\mu P_3$  outputs eight bits on one communications chip, and five bits on the other. The clocks to these chips, and the data from them, are hardware-steered so that the 13 bits appear consecutively on the communications line (Fig. 8). To improve system reliability, the two lines share the message load except when  $\mu P_3$  discovers that one of the lines is out of order. In this event, all messages go over the good line.

### Get a free bonus

As a result of using microprocessors for the radar interface, an extra feature is available—a self-test capability that guarantees over-all system integrity. Whenever the system is turned on, the microprocessors test themselves automatically. The operator can also initiate a test at any time. Instead of listening to the radar,  $\mu P_1$  accesses "canned" data stored in its ROM memory, and treats them as if they came from the radar. After performing its preliminary processing,  $\mu P_1$  passes the results on to  $\mu P_2$ , which processes the test data as it would any other data.

The test data are designed to produce four acceptable targets. Accordingly,  $\mu P_3$ , which is aware of the test, doesn't compose output messages for the first four target reports it receives from  $\mu P_2$ . Instead, it goes to its read-only memory and retrieves copies of the four correct target reports. It compares these with what it receives from  $\mu P_2$ . If they agree, it turns on a Go light. If they do not correspond, it turns on a No-go light. In this manner the operator knows positively whether the system is performing all functions properly.

Each of the microprocessors and their associated circuitry are assembled on 6 × 6 in. standard logic prototype boards. They consume a total of 18.5 W and are easily integrated with the rest of the radar's signal processing hardware. The need to handle 32 separate targets at the same azimuth simultaneously dictates the use of 3-MHz 8080s, rather than the conventional 2-MHz versions. The parallel interface between  $\mu P_2$  and  $\mu P_3$ , the toggled memory, and the aforementioned output-communication line interface are unique to this 8080 application. ■■

### Acknowledgment

The radar interface was constructed by the Bendix Communications Division, under internal funding, in cooperation with the FAA.

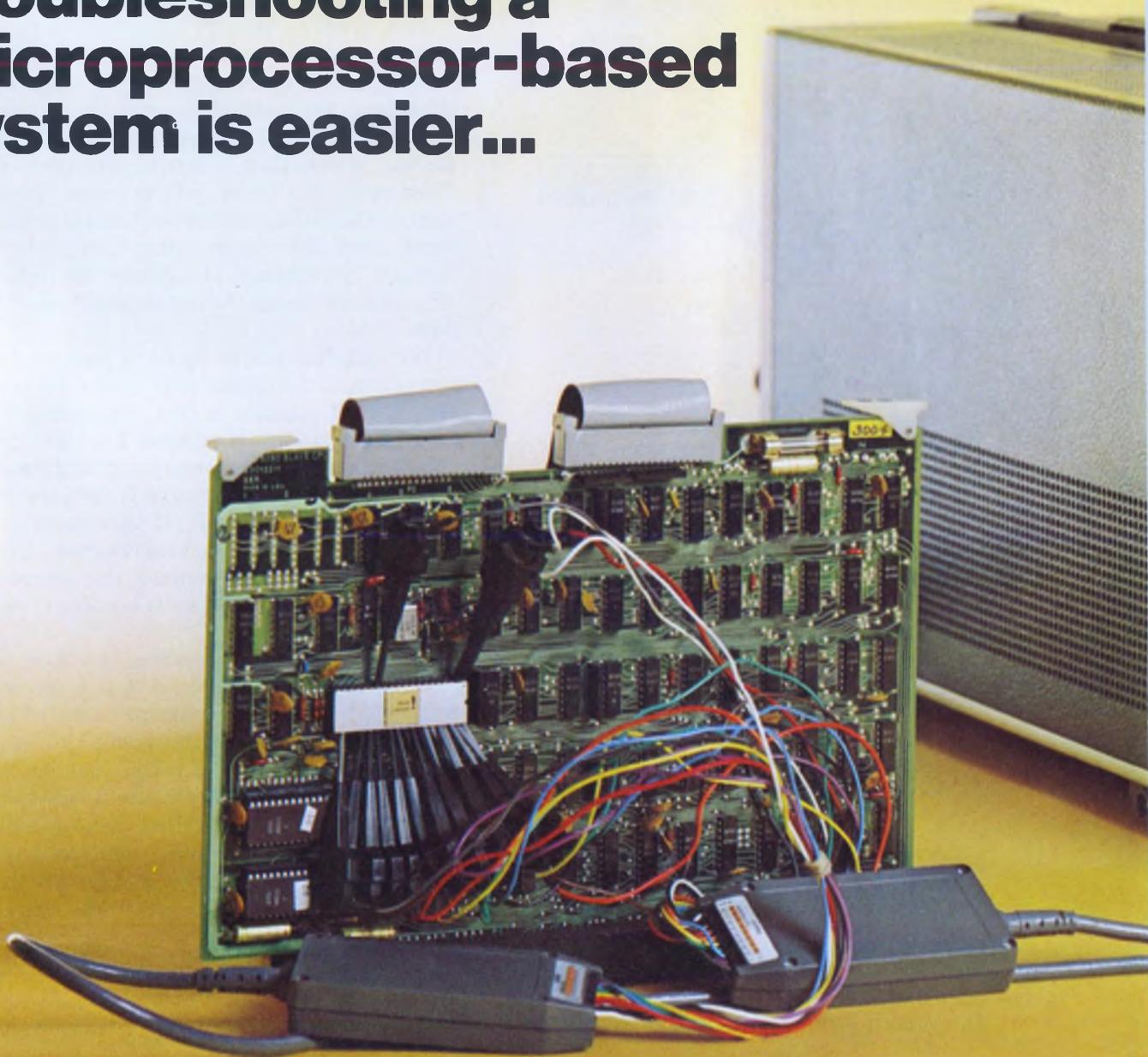
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# Troubleshooting a microprocessor-based system is easier...



**Compare known good data with new data.**

The 7D01F features two comparison modes which facilitate in-depth software/hardware debugging. The EXCLUSIVE-OR and RESET-IF modes speed up what would otherwise be a very tedious process: checking the program flow chart against what falls out when the program is run.

For an EXCLUSIVE-OR comparison, simply verify known good data, store it in reference memory; acquire new data, and select a table comparison mode. The reference table and the compared table (which may be in hex, octal, or binary) will be displayed side by side, and the differences between the two will be highlighted for ready identification.

Use RESET-IF to track down an intermittent fault. In this mode the 7D01F can automatically acquire and compare up to 4096 bits of new data to 4096 bits of reference data. Data is continually reacquired until a mismatch occurs. If there is a mismatch, the instrument holds the display, highlights the differences, and displays the number of resets that occurred. This frees the operator from continually monitoring for wandering programs, intermittent loops, or ragged-edge timing problems.

**Analyze system and interface timing.**

The 7D01F offers synchronous data acquisition at speeds up to 50 MHz. But it is sometimes necessary to view microprocessor operation with increased timing resolution, as well as to locate timing discrepancies in the system's interface with the outside world. You may, for example, need to asynchronously examine data coming into the I/O port before you can determine whether incorrect information is coming from the I/O port itself or the hardware on the other side. The 7D01F offers asynchronous data acquisition at sample intervals of up to 100 MHz.

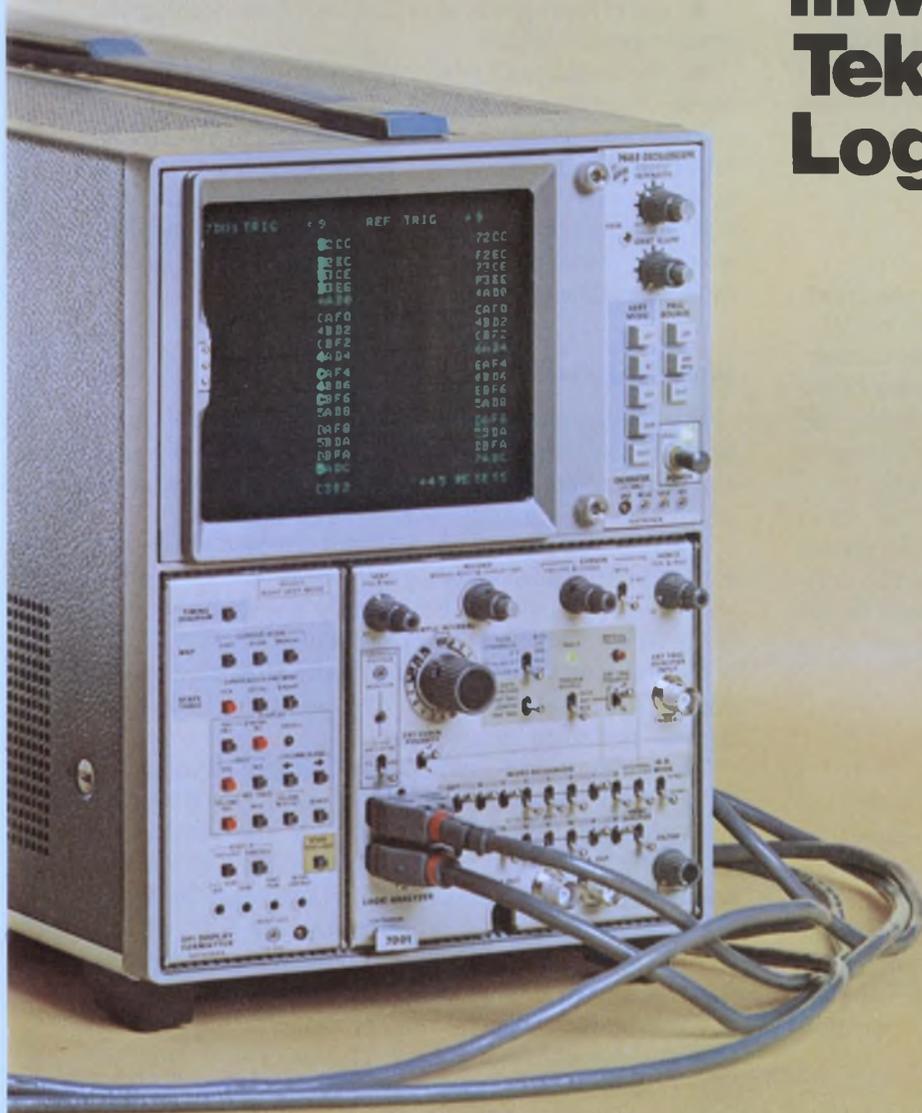
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Preserve microcomputer-system data—during shut-downs or input-power failures—by using a battery-powered CMOS RAM to store the contents of essential registers and selected memory locations. When used with simple CMOS logic, a CMOS RAM like RCA's 1824CD draws so little current that a relatively small and inexpensive battery can sustain most systems for weeks.

At the expense of only 500  $\mu\text{A}$ , the 1824CD RAM lets you store 32 eight-bit words. Using CMOS throughout, the interface logic and RAM can operate for a month from a single small NiCd battery like GE's five-volt 04B111AGT1. Just one day of line-powered operation will give the battery enough charge to operate for a week.

### It's polite to interrupt

The key to the power-transfer system is the Interrupt feature of an 8080 microprocessor. The battery-powered CMOS logic generates a Power-down Interrupt signal to the 8080 when line voltage drops below the critical level of 90 V ac and remains below 100 V ac for a predetermined interval. This PDI signal leads the 8080 system into a nonactive state.

To prevent false writing into the RAM during power transients, a latch circuit makes the RAM inaccessible until normal input power is restored. During the shut-down procedure, the 8080 sets a CMOS latch in the interface logic. The  $\mu\text{P}$  pulses this latch via one of its output ports.

### The logic is vigilant

To prevent the PDI from causing data to be written partially, the processor executes a Disable-Interrupt instruction before loading data into the battery-powered RAM. When writing is complete, an Enable-Interrupt instruction makes the 8080 system responsive to the Power-down Interrupt signal. The power-down condition must be detected early enough so that the system's power supply can maintain operation

during the transition to battery power.

To ensure early power-down detection, logic monitors the voltage across the storage capacitor ( $V_{\text{cap}}$ ) inside the power supply. As a result, the Interrupt is generated a few tenths of a second before power drains from the system's supply.

In addition to generating PDI, the battery-powered CMOS logic monitors the power status. When power is down, the status can be either

- Intentional power-down, caused by switching the system power off, or
- Nonintentional power-down, caused by a PDI while the power switch is off.

These two power-activity states are presented as input bits to the 8080, which checks them when the system is powering-up. If the previous powering-down was intentional, nothing more happens. If not, however, the system informs the operator that a power failure has occurred.

### Everything stays orderly

During system operation, a brief power failure sends the system through an orderly shut-down and start-up sequence. The system alerts the operator to what otherwise would seem erratic behavior.

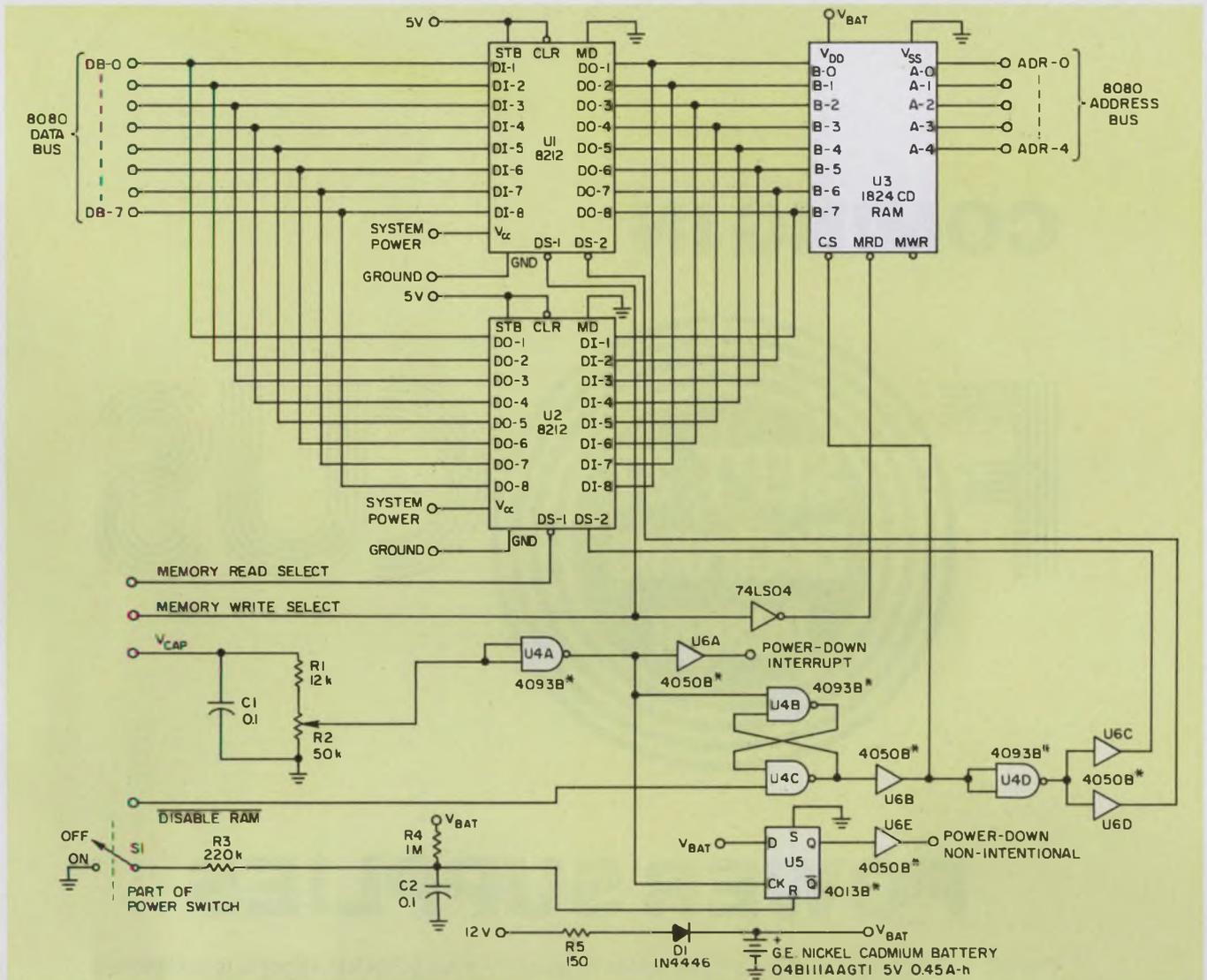
While powering-up, the system can also check the contents of preselected RAM addresses that are loaded with known words. If these tested words prove out, the system commences its operational program. If the test data aren't correct, the system indicates to the operator that memory wasn't retained correctly during the power-on/off cycling.

The system's line-operated 12-V supply charges the battery, and series resistor  $R_5$  limits the charging current to the recommended 45 mA<sup>1</sup> (one-tenth the battery capacity) for the 0.45 A-h battery. From the schematic, in which an asterisk marks each battery-operated element, you can see that the logic draws so little current that it has practically no effect on the charging.

When power fails, the storage capacitor discharges almost linearly through the regulator—so long as  $V_{\text{cap}}$  remains more positive than the sum of the regulator voltage and the load voltage.<sup>2</sup> Potentiometer  $R_2$  develops the PDI signal when  $V_{\text{cap}}$  drops below +6 V (and the ac input goes below 90 V rms). At this

---

Larry Bruni, Senior Associate Engineer, Kimball Systems, 151 Cortlandt St., Belleville, NJ 07109



The CMOS RAM, U<sub>3</sub>, stores 32 eight-bit words. This backup memory stores the contents of critical registers or totals from daily operations in the event of line-power

failure or during intentional shut-down. The all-CMOS logic draws so little current that the small battery can support the system for a month.

level, the capacitor still has enough power to operate the system for at least 0.1 s.

### Interrupt waits for power to return

PDI stays active until  $V_{cap}$  rises to +7 V (and the ac input goes above 100 V rms). So, the system has an added advantage: The ac-line voltage is monitored at power turn-on. In systems with motors, this sensing can prevent burn-out due to low voltage. The CMOS Schmitt-trigger circuit, U<sub>4a</sub>, monitors  $V_{cap}$ .

In response to PDI, the microprocessor generates the Disable RAM signal, which toggles the latch consisting of gates U<sub>4b</sub> and U<sub>4c</sub>. The latch, in turn, isolates the RAM from the system. This same latch also deactivates the 8212 buffers, U<sub>1</sub> and U<sub>2</sub>, which normally operate between the data bus and the RAM. Once set, only power restoration can reset the latch—it drives the PDI signal low.

Flip-flop U<sub>5</sub> indicates whether or not a power-down was intentional. For nonintentional power-down, the leading edge of the PDI signal sets U<sub>5</sub>. If the power switch is on, U<sub>5</sub> remains set after the leading edge passes. When power is restored, the  $\mu$ P examines the state of U<sub>5</sub> and sees that the power removal was nonintentional—a failure.

The only way to reset U<sub>5</sub> is to turn the power switch off. So, once the operator knows that power has failed, he turns the system off. Then, when power is restored, he simply restarts the system.

The combination of R<sub>3</sub>, R<sub>4</sub> and C<sub>2</sub> filters the power-switch line from noise. ■■

### References

1. *Nickel-Cadmium Battery Application Engineering Handbook*, Second Edition, General Electric, Gainesville, FL, pp. 5-1, 5-2.
2. Watson, C. A., Jr., "Power Supply's VC Product Sets Interrupt Capability," *Electronics*, Oct. 14, 1976, pp. 117-118.

# COMING IN



## POWER SUPPLIES

The 8th in *Electronic Design's* 1977 series of award-winning FOCUS reports is scheduled for the September 27 issue. The Topic: Multiple-output DC Power Supplies.

There is growing interest in power supplies that deliver more than one voltage. These units have all the problems of ordinary power supplies, plus special ones of their own. The report will help engineer-readers avoid pitfalls in specification, application and use. It will look at questions like:

- *Why should you select one supplier over another?*
- *What special features do companies offer in their products?*
- *How do they obtain these features?*
- *What specs are deceptive, ambiguous or omitted?*
- *Where is confusion most apt to occur?*
- *How do you select a power supply most appropriate to your needs?*

As usual, the FOCUS will dig beneath the surface to tell it like it is.

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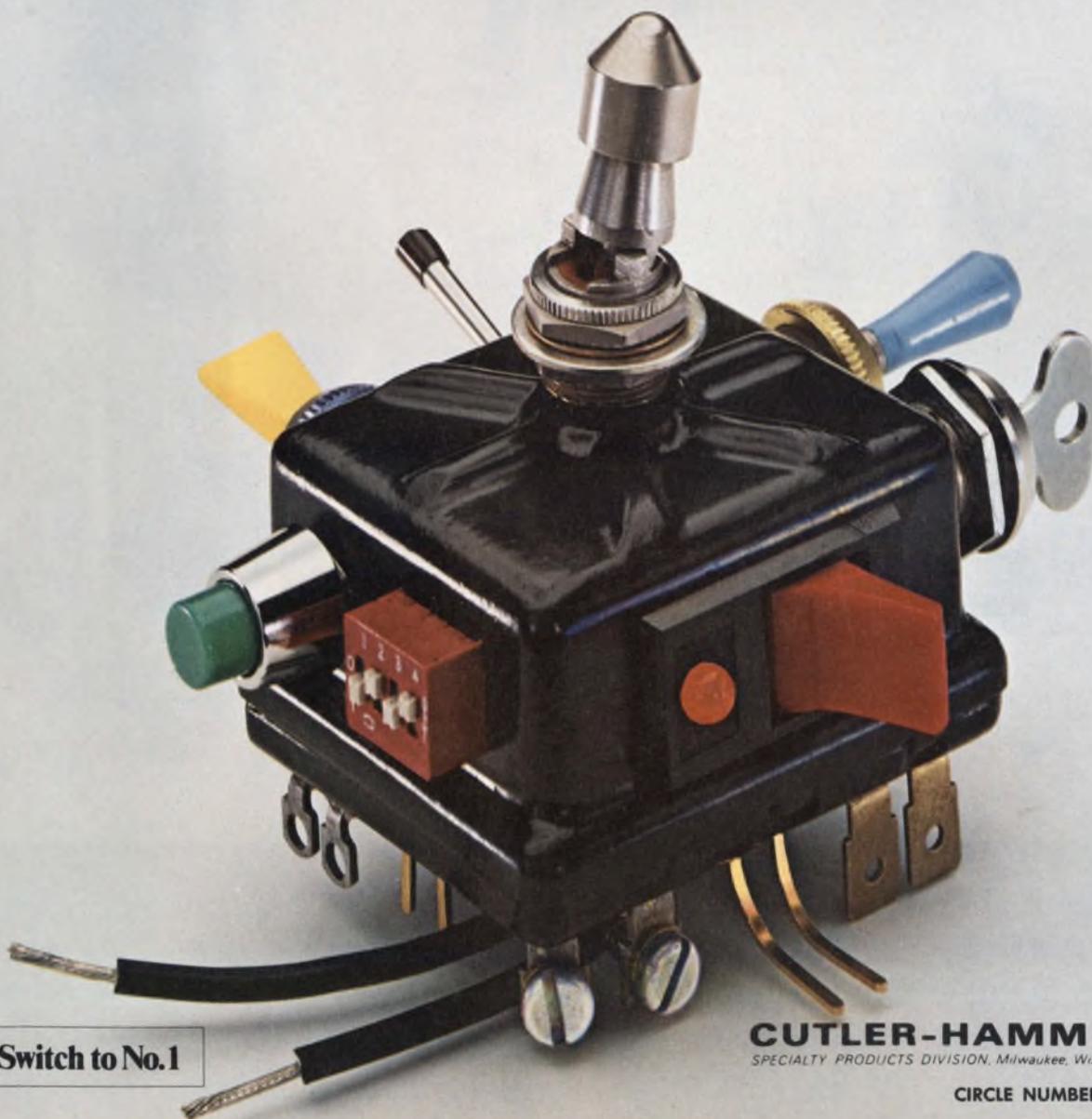
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CIRCLE NUMBER 131



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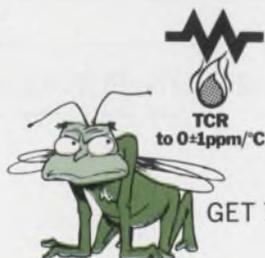
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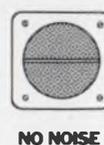
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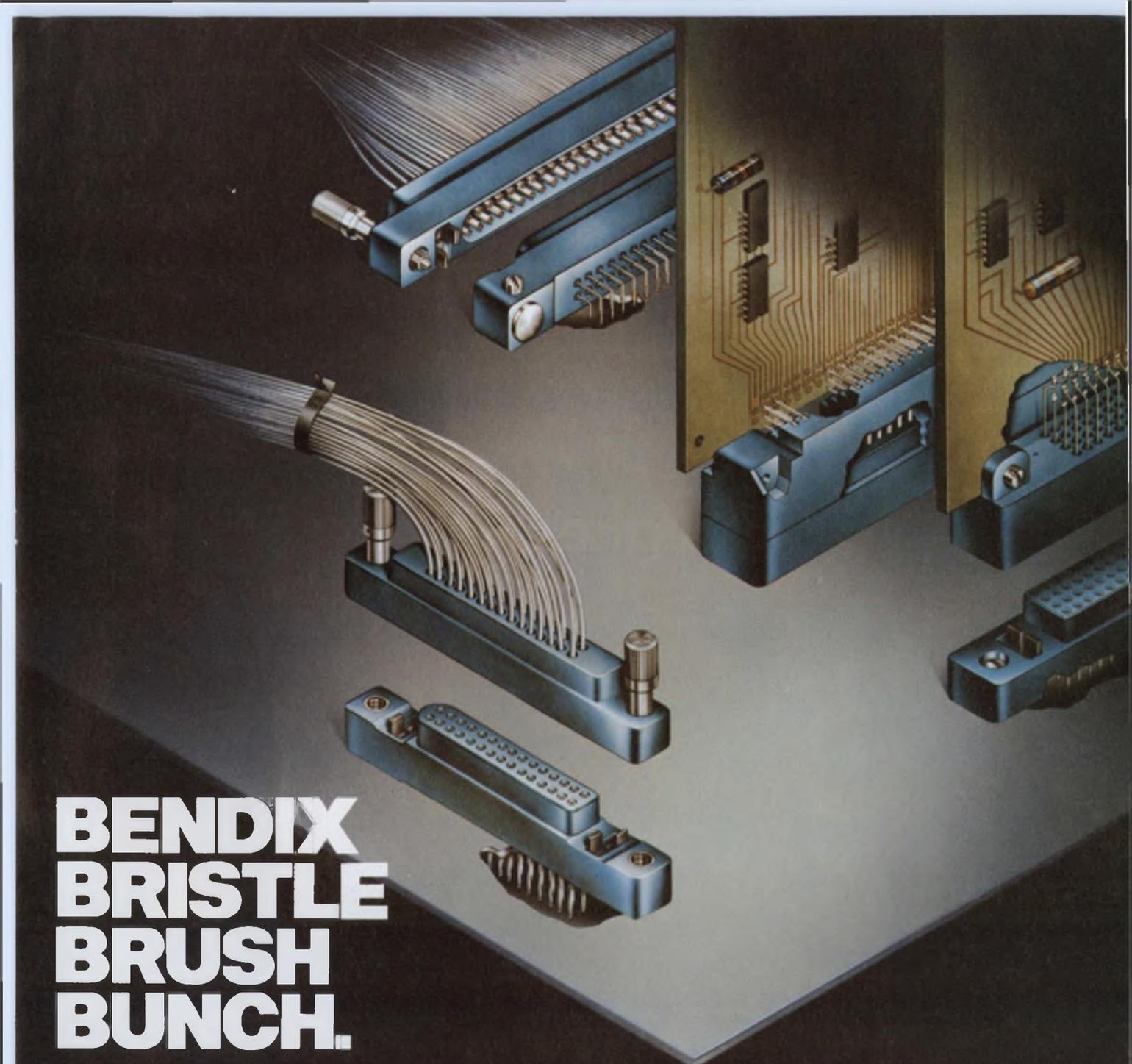


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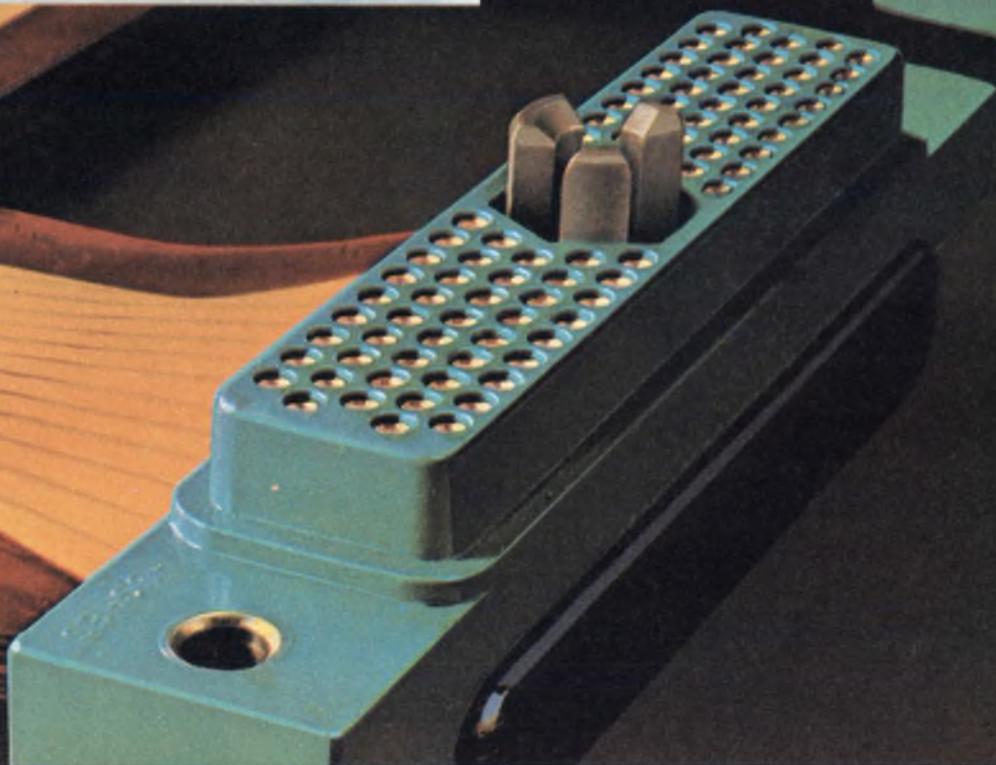
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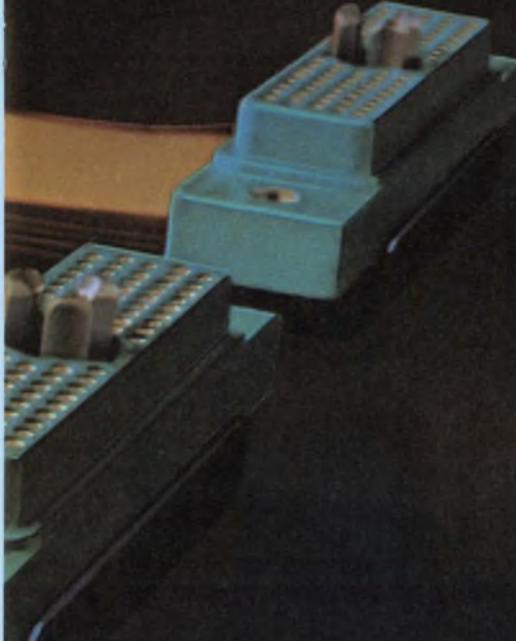
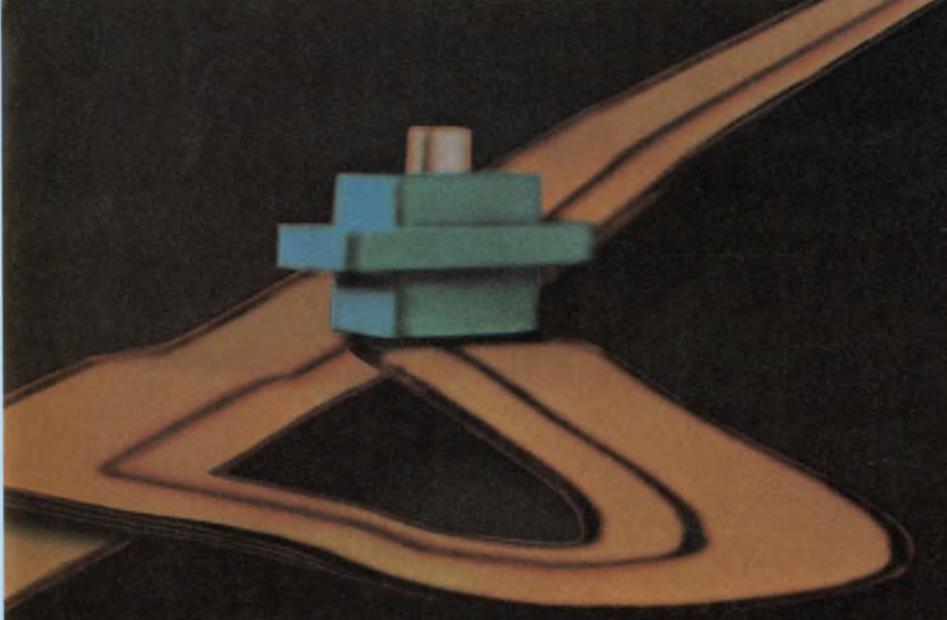
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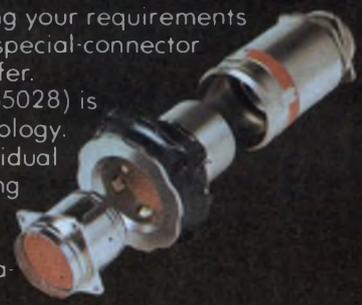
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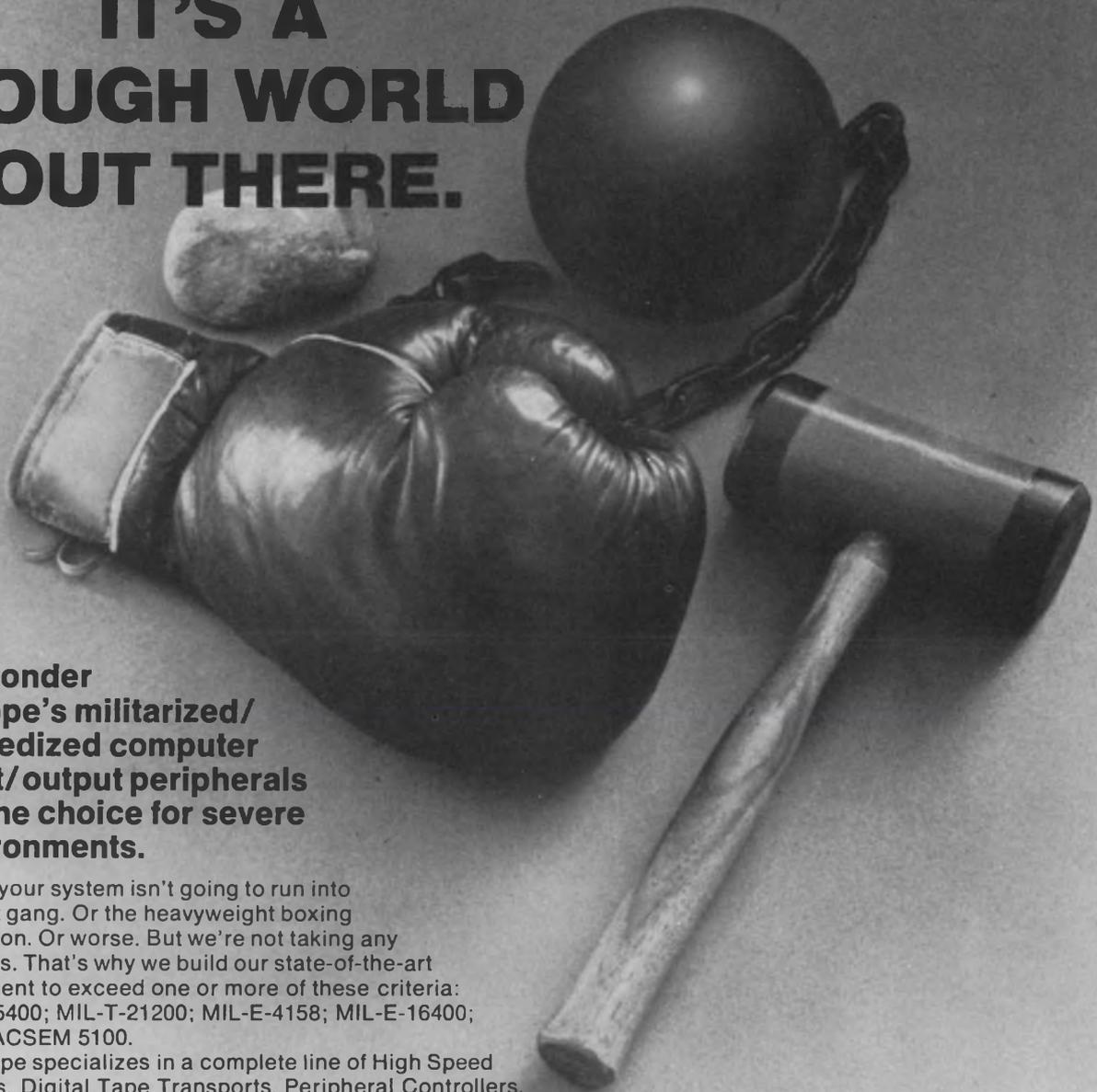
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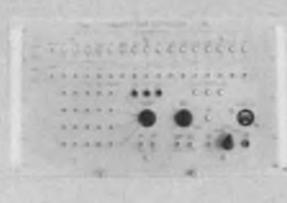
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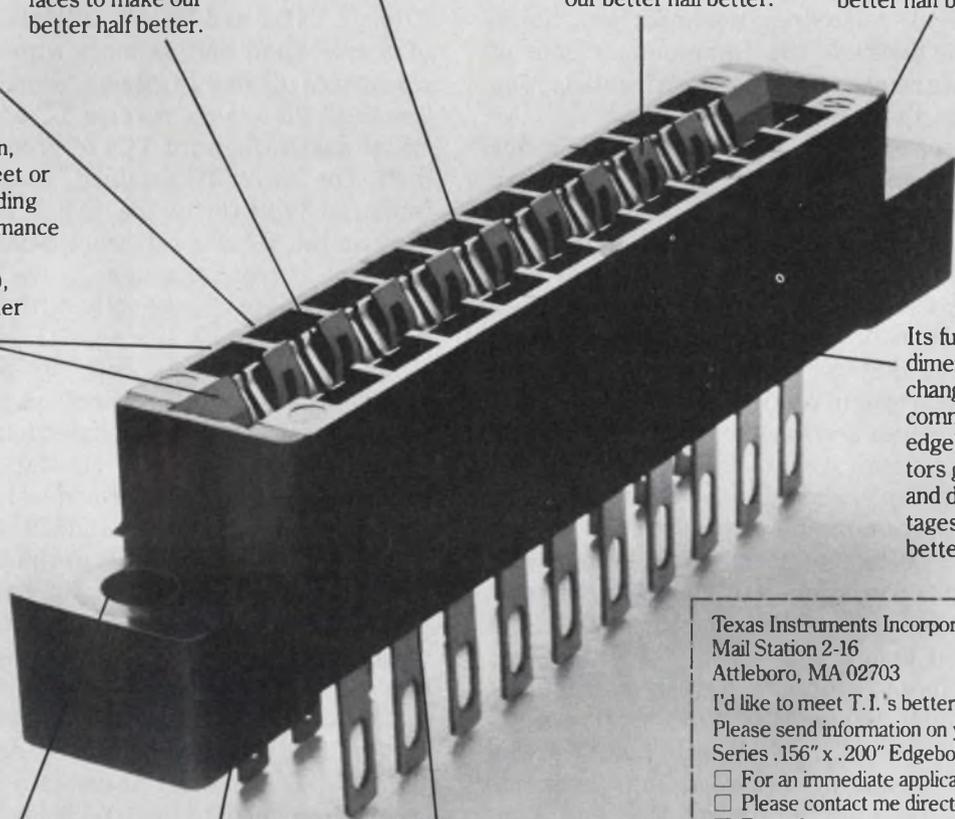
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## Voltage references determine accuracy, ultimately, of many precision circuits. Several techniques are used to stabilize reference sources: Which is best?

The performance of d/a and a/d converters, digital voltmeters, regulated power supplies and many other circuits ultimately relies on the accuracy of their voltage (or current) references. It's important, therefore, that you understand the numerous methods of deriving accurate references and the performance you can expect from them.

Simple reference circuits can be built from a few discrete components, or precision IC references can be purchased (see table). For high performance—temperature coefficients of 10 ppm/°C or less and comparable long-term drifts—hybrid-packaged IC references approach the best attainable within the state of the art. Monolithic circuits provide a little less performance, but they cost less, too.

No matter which type of reference you use, you must make sure it provides accuracy and stability greater than those of the circuit it controls. Since a 12-bit a/d converter, for example, should resolve 0.025% of full scale, a major portion of this capability will be lost if the reference doesn't perform much better. And when temperature variations are included, the temperature coefficient (TC) of the reference can be the largest source of error.

Therefore, reference-regulation errors as small as 0.001 to 0.01% (10 to 100 ppm), TCs of 1 to 20 ppm/°C and long-term drifts of 10 to 20 ppm/month aren't unusual. And often such specifications must be maintained with several milliamperes of load and wide input-voltage and temperature variations.

Several varieties of reference diodes are listed in the comparison table—from the simplest (class A) to the more sophisticated devices, such as the LM329 and LM399 series (class B and C).

### Stabilized diodes make simple references

The simplest reference source uses a temperature-compensated diode.<sup>1</sup> It consists of only one series resistor between a voltage-supply line and the reference diode (Fig. 1). The output voltage is taken across

the diode. Best results are attained when load-current variations are minimum.<sup>2</sup>

Two series of simple reference diodes—types 1N821 through 1N829 and 1N4611/4611C—are combinations of a zener and one or more conventional forward-conducting diodes in series. Such an arrangement "cancels" the zener's reverse TC against the conventional diodes' forward TCs to produce a low over-all drift. The lowest TC attained, about 5 ppm/°C maximum, is typified by the 1N829 and 1N4611C. But because the TC of a reference diode depends heavily upon the current through it, the current must be closely regulated—especially with the 1N821 series; somewhat less with the 1N4611 series.

Represented schematically by the familiar zener symbol, these diode references are packaged in standard outlines with the specs listed (class A) in the table.

For a lower dynamic impedance than a simple compensated zener can provide—typically less than 1  $\Omega$ —you can use the LM329 temperature-compensated reference (class B in the table). It comes in four grades—10, 20, 50 and 100 ppm/°C—which are suffixed A, B, C and D, respectively. While less dependent on current than the class A diode—in the class B, the TC is poorer. Nevertheless, the zener diode in the LM329 is a so-called subsurface type, with greater long-term stability than the surface zeners of the class A devices. Packaged in a TO-92 outline, the schematic symbol of the LM329 is still that of a zener, although the integrated circuit in the package has many parts besides the subsurface zener.

Because of its very low dynamic impedance, the LM329 in Fig. 1a minimizes error from input-voltage variations, load variations and series-resistor drift. The major error results from the LM329's TC.

Fig. 1a tabulates the major worst-case errors for a  $15 \pm 1$ -V supply and a 0.5-mA  $\pm 25\%$  load. The TC error causes about 90% of the total error. The resulting over-all error of about 0.1% restricts this circuit to use for converters of eight bits or fewer.

For both low impedance and low TC, active temperature-stabilized reference diodes such as the LM399A, LM399 and LM3999 (class C) are recommended. These class-C diodes are similar to the LM329, but incorporate heaters that keep the internal

---

Walter G. Jung, Consultant, Pleasantville Laboratories, Forest Hill, MD 21050.

# Comparison of reference sources

Device	Manufacturer	Class*	Output voltage	Load current	Output impedance	Temp. coeff.	Input voltage	Long-term stability
1N821-829 series 1N4611-4611C series	Many Sources	A	6.2 ± 5% V	7.5 ± 0.01 mA	15 Ω	5ppm/°C (max) (1N829A)	↑ determined by user	—
		A	6.6 ± 5%	2.0 ± 0.2	75	5 (1N4611C)		—
LM329 (suffixes A, B, C, D)	National Semiconductor	B	6.9 ± 5%	1	0.8	0, 20, 50, 100	↓	20ppm/1000hr (typical)
LM399A		C	6.95 ± 5%	1	0.6	1		20
LM399		C	6.95 ± 5%	1	0.5	2		20
LM3990		C	6.95 ± 5%	1	0.5	5		20
AD580M	Analog Devices	D	2.50 ± 1%	10	1 (max)	10	4.5 to 30 V	10
MC1403A	Motorola	D	2.50 ± 1%	10	0.91 (max)	25	4.5 to 40	
REF-01E	Precision Monolithics	D	10.00 ± 0.3%	10	0.8	8.5	12 to 40	—
REF-02E		D	5.00 ± 0.3%	10	0.8	8.5	7 to 40	—
LH0070-2	National Semiconductor	E	10.00 ± 0.01%	5	0.2	4 **	13 to 33	500 (max)***
LH0071-2		E	10.24 ± 0.01%	5	0.2	4	13 to 33	500 (max)
AD2700L,U	Analog Devices	E	+10.00 ± 0.025%	10	0.05 (max)	3	+13 to +18	100/1000 hr (max)
AD2701L,U		E	-10.00 ± 0.025%	10	0.05 (max)	3	-13 to -18	
AD2702L,U		E	±10.00 ± 0.025%	5	0.05 (max)	3	±13 to ±18	

\* A = Temperature-compensated reference diode.  
 B = Active temperature-compensated reference diode (IC).  
 C = Type B, with thermally stabilized substrate.  
 D = Three-terminal monolithic IC.  
 E = Hybrid IC, actively trimmed to high accuracy.  
 \*\* Approximated for comparison. Actual spec is 0.04% @ -25 to 85 C.  
 \*\*\* Over life of unit, period unspecified.

### Typical performance

Temp. range (25 to 70 C):	20 ppm/°C (max) @ 45 C	900 ppm
TC:	425 μV/V	62 ppm
Input regulation:	0.0035 (ΔIL ≤ 25%)	35 ppm
Load regulation:	20 ppm	20 ppm
Long term stability:		1017 ppm
		or about 0.1% suitable for 8 bits
TC:	5 ppm/°C (max) @ 45 C	225 ppm
Input regulation:	4.7 μV/V	70 ppm
Load regulation:	0.0037% (IL ≤ 25%)	37 ppm
Long term stability:	20 ppm	20 ppm
		352 ppm
		or about 0.035% suitable for 9 bits
TC:	1 ppm/°C (max) 45 C	45 ppm
Input regulation:	280 μV/V × 0.15 V	6 ppm
Load regulation:	0.00087% (IL ≤ 25%)	26 ppm
Long term stability:	20 ppm	20 ppm
		97 ppm
		or about 0.0097% suitable for 11 bits

1. A temperature-compensated zener (a) is a simple low-cost reference source. Improved performance and lower impedance can be obtained with a built-in heater that

maintains the unit at 85 C (b). The heater is electrically isolated from the diode in some thermally regulated references (c), which allows greater flexibility.

substrate at 85 C. This achieves a 1 to 5-ppm/°C TC combined with about 0.5-Ω impedance.

The LM3999, like the LM329, is contained in a TO-92 package. Its heater has one lead in common with its diode, and the heater operates on 9 to 36 V, consuming about 360 mW in 25 C of still air. The heater's initial surge current is typically 140 mA, and warm-up time is 5 s.

To electrically isolate the heater from the diode, the LM399 and LM399A are packaged in insulated TO-46 housings with four leads. For both units, the heater typically consumes 255 mW at 25 C, and takes 3 s to warm up.

Calculations for the LM3999 show better precision than with the LM329 (Fig. 1b)—an over-all error of 352 ppm, or 0.035% vs 0.1%. This precision is suitable for converter resolutions of 9 bits. The circuit in Fig. 1c, however, is optimized to perform even better with the LM399A and its TC of 1 ppm/°C. To take advantage of this low TC, the supply voltage must be restricted to ±1% variations and a stable 100-ppm resistor must be specified for R<sub>1</sub>. A worst-case error analysis of the circuit results in an over-all error of less than 100 ppm (0.01%), which is suitable for 11-bit accuracy.

Not included in those error analyses are the initial voltage tolerances of the diodes and all possible load effects. In practice, the initial tolerances can be trimmed with divider resistors, but then the divider errors have to be included in the over-all error budget.

Current references can easily be constructed by feeding load resistor R<sub>L</sub> (in Figs. 1a, 1b or 1c) into an op-amp summing point instead of to ground. However, the TC of R<sub>L</sub> would then become part of the error budget. Many popular IC converters, such as the 1408 or DAC-08, operate with such current references.

### Bootstrapping the diodes lends flexibility

While the unbuffered diode-reference circuits in Figs. 1a, b and c suffice for many applications, often voltage adjustability is needed and current levels of several milliamperes must be supplied—usually beyond the capabilities of the unbuffered circuits. Buffered circuits, like those in Fig. 2, are popular because of their simplicity and good performance.

Because the op-amp buffer operates with a single supply voltage, the output has the same polarity as the supply, and start-up is positive. When the reference diode breaks down, the negative-feedback loop sets the output voltage at

$$V_0 = V_{ref} \cdot \frac{R_2 + R_3}{R_2} \quad (1).$$

To build a negative-output reference circuit, reverse the diode, ground pin 7 of the op amp and apply the unregulated negative supply voltage to pin 4. If used,

R<sub>5</sub> is returned to pin 4.

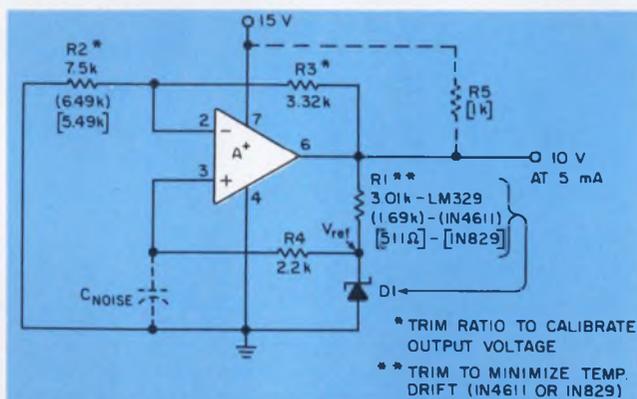
From Eq. 1, resistors R<sub>2</sub> and R<sub>3</sub> determine V<sub>0</sub>. Resistor R<sub>1</sub> determines the current in the reference diode, D<sub>1</sub>, which remains constant because V<sub>0</sub> and V<sub>ref</sub> are constant. The diode should have the desired TC, while R<sub>2</sub> and R<sub>3</sub> should have low tracking TCs. For minimum bias-current errors, R<sub>4</sub> should be equal to the value of R<sub>2</sub> and R<sub>3</sub> in parallel. The op-amp drift should be about 5 μV/°C, computed at 1 ppm/°C for a 6-V reference diode.

Resistor R<sub>1</sub>, whose selection is governed by the reference diode, yields nominal currents of 1, 2 and 7.5 mA for the LM329, 1N4611 and 1N829 diodes, respectively. For 7.5 mA use, additional current is supplied by R<sub>5</sub> to ease the burden on the op amp. For best results, R<sub>1</sub> can be trimmed to set the over-all TC of the circuit nominally to zero at 25 C.

However, to attain maximum TCs less than 10 ppm/°C over a wide temperature range, the total circuit must be considered as a single thermal system, both mechanically and electrically. This approach accounts for the superior performance of hybrid and monolithic IC references.

### Hybrids for high performance

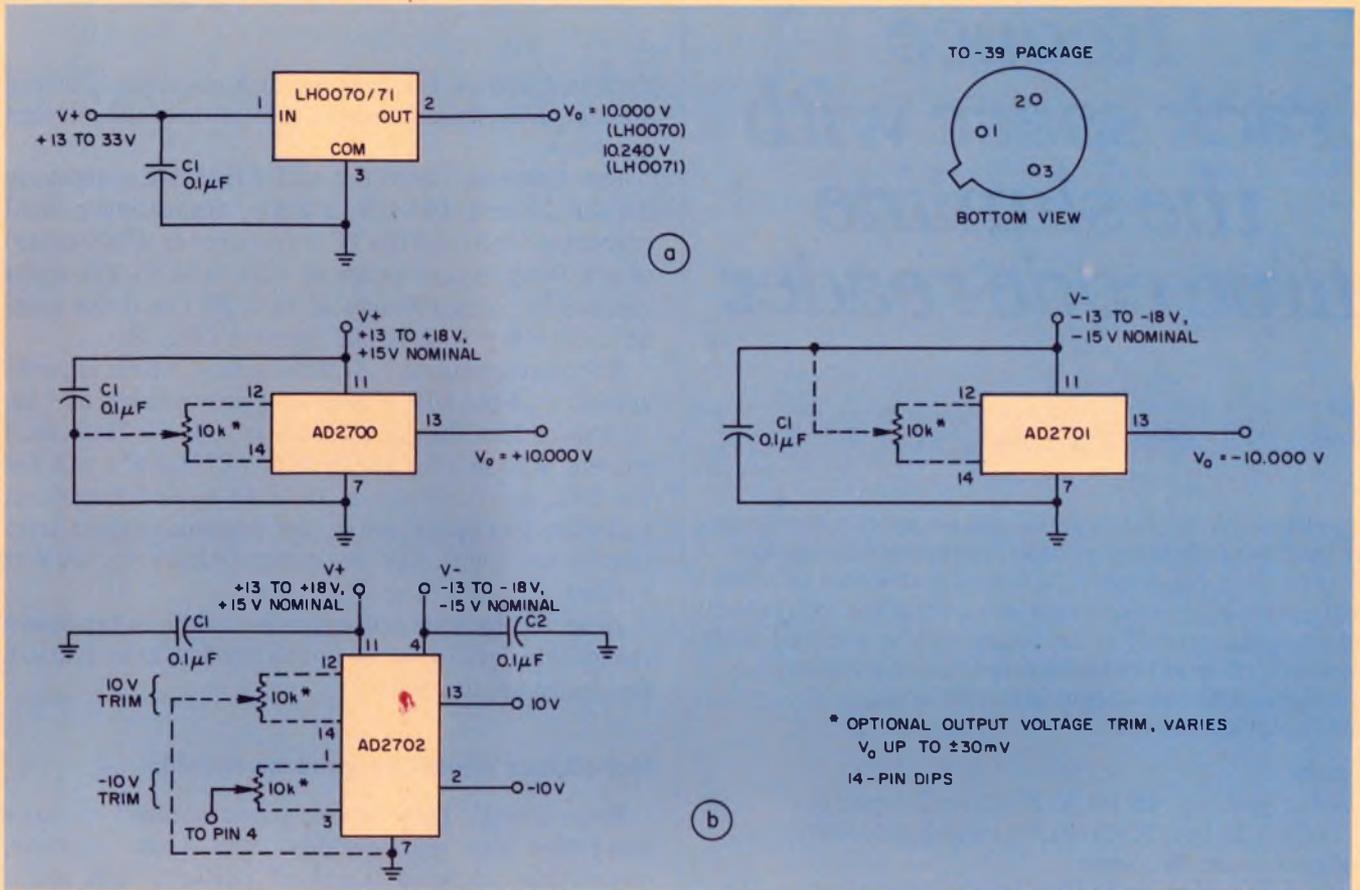
Hybrid and monolithic references are usually trimmed with a laser under operating conditions to adjust the output voltage and minimize the TC. Hybrid



### Suitable component combinations

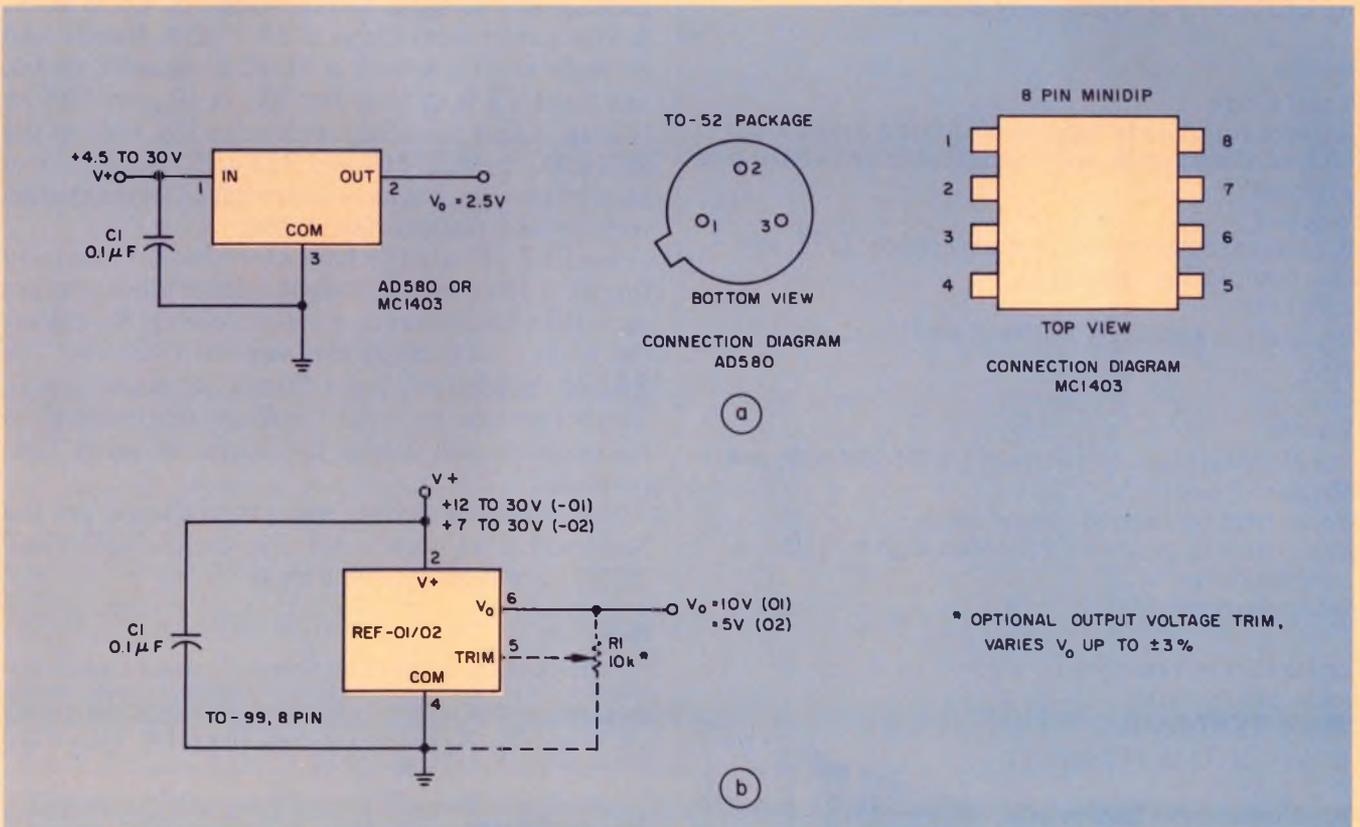
Over-all TC	D <sub>1</sub>	A <sub>1</sub>	R <sub>2</sub> /R <sub>3</sub>	R <sub>1</sub>
<50 ppm	329B	741	10 ppm/°C tracking	100 ppm
<25 ppm	1N4611B or 1N827	301A	5 ppm/°C tracking	↑
10-15 ppm	1N4611B or 1N827	AD741L, OP-02E	2 ppm/°C tracking	optimize (see text)
≈ 5 ppm	1N4611C or 1N829	*	1 ppm/°C tracking	↓

2. An op-amp booster can be used to obtain voltages different from the reference diode and to handle larger current loads than a simple zener diode.



3. Voltage references in hybrid packages provide the highest "as-delivered" accuracy. They are trimmed for

precise output voltages (a), and some versions allow further external trimming as well (b).



4. Monolithic voltage-reference ICs can be cheaper than hybrid circuits, but some performance is sacrificed. As

with hybrids, both fixed (a) and externally trimmable versions (b) are available in various voltage ratings.

# Reduce rack space with the slimline time code reader.



The Model 8395 reads serial time code outputs from time code generators or tape reproducers, displays time in days (optional), hours, minutes and seconds, and optionally provides serial and parallel outputs to other equipment. The unit may also be ordered with forward/reverse reading option, error by-pass, multiple-code input, and input filtering. Specifications follow.

## Inputs

**Code Options:** IRIG A, B, E, or G (specify)

NASA 36 Bit, XR3/2137 (switch selected)

**Impedance:** 4K ohms

**Level:** 50 mVpp to 10 Vpp (wider range optionally available)

**Frequency:** 100 Hz to 250 KHz

**Modulation Ratio:** 2:1 to 6:1

**Input Filtering:** Optionally available

## Outputs

### Serial Code

Buffered input code capable of driving a minimum of 200 feet of unterminated coaxial cable or twisted pair (optional).

### Parallel

BCD days, hours, minutes and seconds, DTL and TTL compatible (optional).

### Isolation

All outputs separately buffered and short-circuit proof.

## Physical

The physical characteristics of the Model 8395 are:

**Weight:** 8 pounds

**Mounting:** Standard 19 inch rack

**Size:** 19 inches wide x 1.72 inches high x 13.25 inches deep

**Temperature:** 0°C to -60°C

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CIRCLE NUMBER 36

devices, however, can provide the highest as-delivered accuracy, and they demand a minimum of user design attention.

For example, LH0070-2 and LH0071-2 references deliver 10 and 10.24 V  $\pm 0.01\%$ , respectively; load current is 5 mA; and the TC is specified as 0.04% (max) over a temperature range of -25 to 85 C. The units can handle input voltages of 13 to 33 V and the long-term stability spec is 500 ppm/yr (Fig. 3a).

Another hybrid, the AD2700 series, which is packaged in a 14-pin DIP, delivers output voltages of +10, -10 and  $\pm 10$  V. Initial accuracy is 10 V  $\pm 0.025\%$ ; load current is 10 mA for the 2700 and 2701 and 5 mA for the 2702; input voltage is 13 to 18 V; and long-term stability, 100 ppm/1000 h. An optional output trim can be used with the devices to adjust the output voltage  $\pm 30$  mV (Fig. 3b).

However, hybrids are expensive, and less expensive monolithic devices, while not as precise, are adequate for many applications.

## Monolithics almost as good as hybrids

Even though they can be manufactured in large quantities for considerably less than hybrids, monolithic reference ICs don't perform that much poorer. In monolithics, initial tight calibration and some maximum specs might be poorer. For example, the three-terminal AD580M contained in a TO-52 package can accept a voltage range of 4.5 to 30 V, deliver a reference voltage of 2.5 V  $\pm 1\%$ , handle load currents to 10 mA with a TC of 10 ppm/°C (max), and provide a long-term stability of 10 ppm/1000 hr (Fig. 4a). Other monolithic reference ICs, such as the MC1403A, the REF-01E and REF-02E are also three-terminal devices, but have somewhat different characteristics and features (see table).

The REF-01E and 02E have a terminal for trimming (pin 5). If left open, the output voltage tolerances are as in the table; however, a potentiometer,  $R_1$ , can set the output  $\pm 3\%$  about the nominal (Fig. 4b). The REF-02, in addition, has a "Temp" terminal (pin 3), which provides an output voltage proportional to temperature, and allows the device to sense temperature.

New reference devices, not yet available, are the National LM336, a 2.5-V unit, and the Analog Devices' AD581, a programmable unit. ■■

## References

1. "Temperature Compensated Voltage Reference Diodes," Application Notes - 2, *Zener Diode Product Catalog*, Siemens, Scottsdale, AZ, pp. 7-14.
2. Jung, W.G., *IC Op Amp Cookbook*, Howard W. Sams & Co., Indianapolis, IN, 1974, pp. 139-143.

## Acknowledgement

This article is adapted from the author's forthcoming book "IC Converter Cookbook," to be published by Howard W. Sams & Co., Indianapolis, IN.

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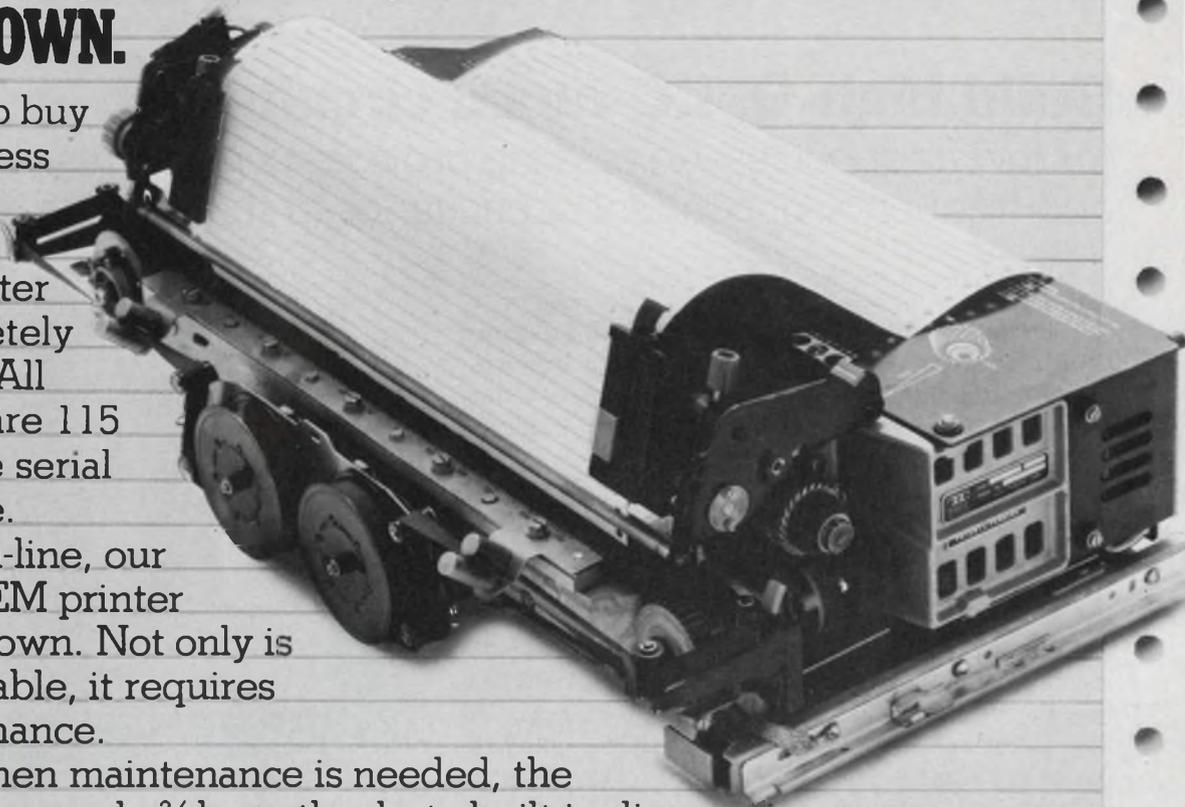
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## Build high-Q, LC-tuned circuits

for low frequencies. An op amp provides negative resistance and frequency-dependent capacitance to sharpen the response.

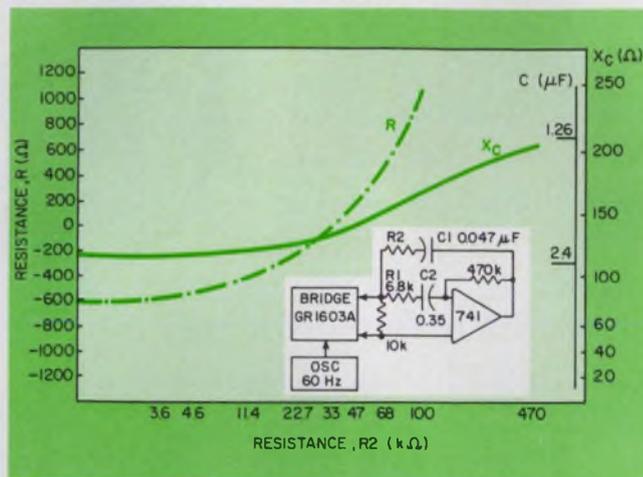
The trouble with trying to design high-Q, LC-tuned circuits for frequencies below 100 Hz is that even with the best magnetic materials, you cannot make inductors and transformers with high Q. But by combining conventional inductors and transformers with an operational amplifier you can obtain a sharply tuned active LC circuit. The op amp improves selectivity in two ways: Negative resistance cancels core losses, and frequency-dependent capacitance resonates with the inductors to produce steep skirts in the response.

Although replacing LC networks with active circuits is commonplace for small-signal, low-frequency filtering, the technique has not previously been extended to applications that require you to detect feeble low-frequency signals while retaining the common-mode isolation of coupling transformers. Though the circuits described are designed for ground-fault-current-interrupter (GFCI) applications, you can extend their use to such applications as current probes and instrumentation for bioelectric measurements.

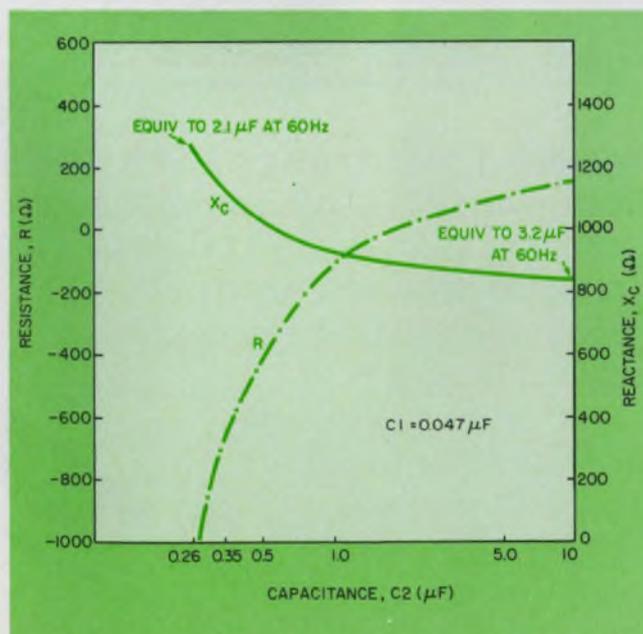
### How the circuits work

Obviously, if inefficient inductors are connected to negative resistances that supply the coil and core losses, they will exhibit high Q. Then if such inductors, along with their negative-resistance sources, are connected in series or in parallel to a capacitor, you should be able to build resonant circuits. In reality, however, the attainable Q will be limited by variations in inductor losses with temperature and signal level. And, of course, if too much negative resistance is supplied, the circuit will become unstable.

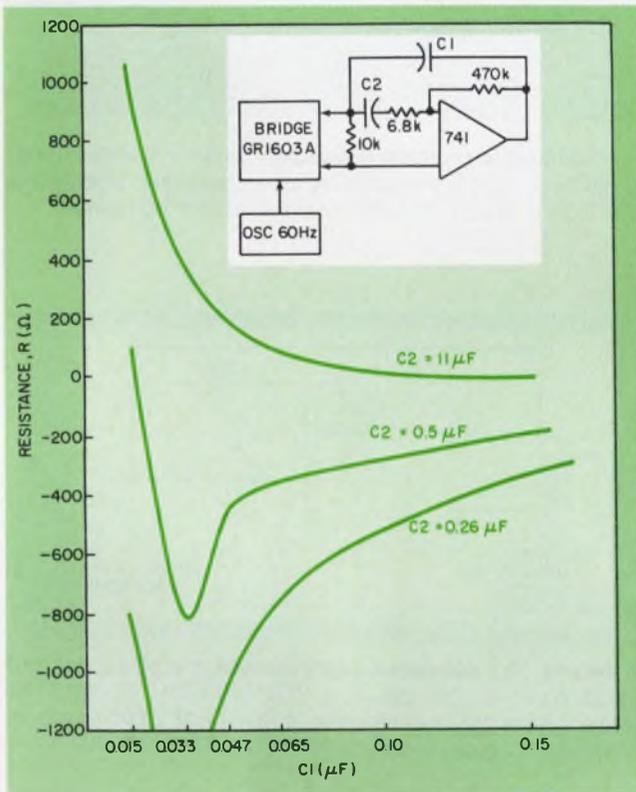
The frequency selectivity of LC circuits can be augmented even further by making the capacitor frequency-dependent. If the capacitance increases with increasing frequency, the skirts of the response curve on both sides of resonance will be steeper than the usual 12-dB/octave that characterizes individual LC sections of conventional design.



1. Large reactance changes can be obtained with an op-amp circuit that has a handful of extra components in its feedback loop (a). As  $R_2$  increases, the capacitive reactance increases and the resistance goes positive.



2. Large changes in generated capacitance for the circuit of Fig. 1 occur as the reactance of  $C_2$  shifts. The curves shown are for 60-Hz operation.



3. Rapid shifts in resistance, as seen by the impedance bridge, occur when  $C_1$  and  $C_2$  change.

Fig. 1 depicts an active circuit developed for a 60-Hz GFCI. The leads from the bridge are usually connected to an inductor or transformer winding, which is to be resonated. As resistor  $R_2$  is varied, this circuit generates a capacitive reactance ranging from 2100 to 1100  $\Omega$ , which corresponds to 1.24 to 2.4  $\mu\text{F}$ . An interesting advantage of this circuit is that it generates large capacitances—a real economic plus in low-frequency LC networks.

For smaller values of  $R_2$ , the circuit also supplies negative resistance. (Note that the circuit presents a positive resistance of 10 k $\Omega$  when  $R_2 = \infty$ ).

Things really begin to happen when  $C_2$  changes (Fig. 2). The generated capacitance increases with a drop in the reactance of  $C_2$ —caused either by an increase

in  $C_2$  or the signal frequency. The effect of  $C_2$  on the resistance is even more pronounced. To achieve stability at low frequency under a variety of conditions, you often need to supplement the inductor losses with a fixed resistor (10 k $\Omega$ , in this example). Without the decreasing susceptance of  $C_1$ , however, the negative resistance would tend to “run away” with decreasing frequency in spite of the damping resistor.

The somewhat complicated interdependence of  $C_1$  and  $C_2$  upon the generated resistance is shown in Fig. 3. Again you can see that resistance becomes a positive 10 k $\Omega$  when either  $C_1$  or the frequency becomes zero.

### Active circuit outperforms passive

Compare the performances of a miniature ferrite-core transformer in passive and active tuned circuits (Figs. 4a and 4b, respectively). To ensure stable operation with the transformer over a wide range of temperature and signal amplitudes, the active circuit is damped with the 3.3-k $\Omega$  resistor. The circuit generates 0.57  $\mu\text{F}$  by multiplying the 0.059  $\mu\text{F}$  of  $C_1$  almost tenfold. The transformer sees the same capacitance in both the active and the passive circuit.

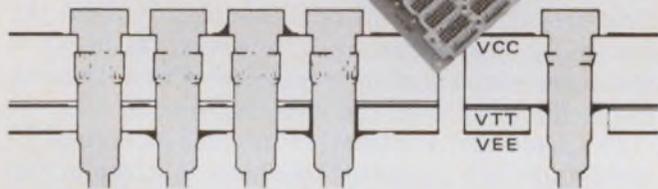
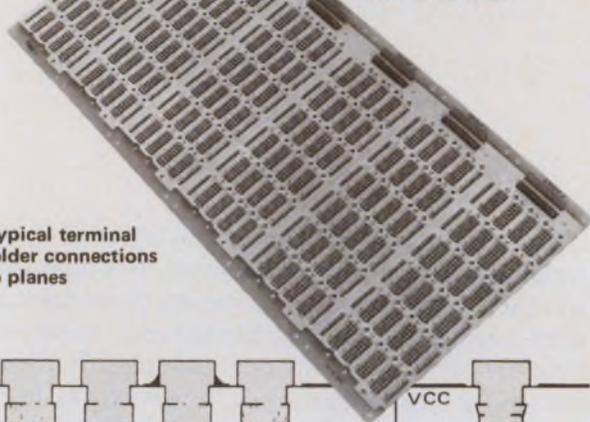
The difference in the secondary voltage,  $E_s$ , is due to absorption of the transformer losses by the negative resistance. While the op-amp provides additional gain, this is a side benefit compared to the large bandwidth reduction—from 44 Hz to 3 Hz.

The use of an LM3900 Norton quad in the circuit of Fig. 5 not only permits you to work with a single-ended power supply but also leaves three amplifiers for other purposes. The transformer design is non-critical and inexpensive. It has a 2100-turn secondary of 42-gauge wire on a silicon-steel EI-187 core.

In a passive configuration, this transformer resonates with a low-loss, 3- $\mu\text{F}$  capacitor, and the circuit has a 6-dB passband of 36 to 127 Hz. However, using the circuit of Fig. 5, the new passband turns out to be 54 to 67 Hz. Paradoxically, since one stable 3- $\mu\text{F}$  capacitor is more expensive than all of the components in Fig. 5, the improvement in signal-to-noise ratio is accompanied by a cost reduction.

Note that, though it's usual to ground pin 7 of the LM3900, you can actually ground either V+ or V-.

# ECL\* Packaging Panels



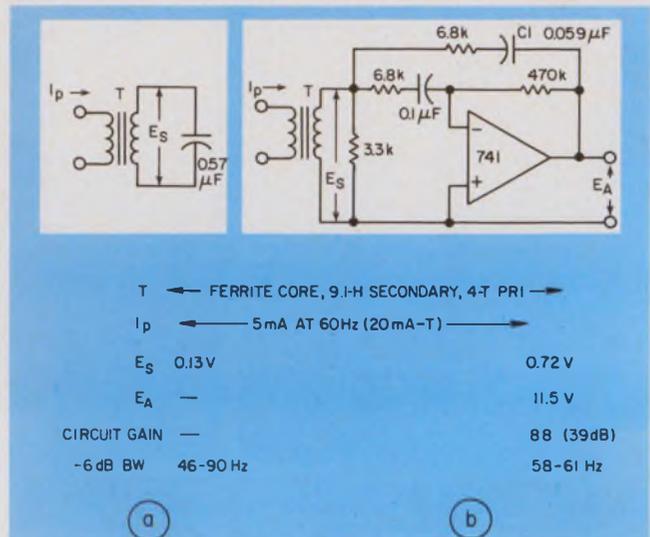
EMC's co-axial plated-thru and non-plated-thru hole design. Competitor's solder joint-in-the-hole. Potential flux contamination.

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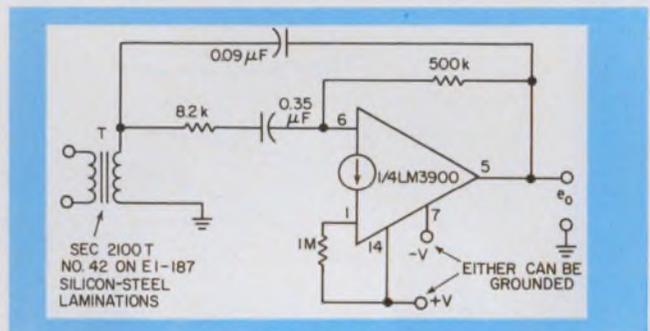
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4. Passband is reduced drastically when a conventional tuned circuit (a) is replaced by an active tuned circuit (b). The 3.3-k $\Omega$  shunt resistor ensures stable operation.



5. Nearly 10:1 passband improvement in a 60-Hz current transformer is obtained in a GFCI with this circuit. The secondary of the transformer consists of 2100 turns of 42-gauge wire on EI-187 silicon-steel laminations.

In the circuit's GFCI application, grounding V+ will avoid false triggering of an SCR during a start-up transient. With V+ grounded, the op amp cannot go positive when the power-supply voltage is applied.

Although determining component values for the circuits described will require some trial and error, the following procedure will make it easier:

1. Calculate the capacitance needed for the desired resonant frequency. The circuit will generate a capacitance of  $C_1$  multiplied by the closed loop gain—which you can assume to be 10.
2. Start with  $C_2 = 5C_1$ ,  $R_1 = XC_2$ ,  $R_2 = 0$ .
3. If your circuit oscillates, add a shunt resistor and/or increase  $R_2$ .
4. To increase the effects of frequency change, reduce  $R_1$  and/or  $C_2$ .
5. Check circuit stability over the required temperature and signal-level range. ■■

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# Carl Korn Of Dynascan Speaks On

## Training Real-World Engineers

Engineers are supposed to be objective, realistic, practical, down-to-earth people. They are supposed to design real products for real markets. And they are supposed to design them for manufacture on real production lines with real components obtainable from real vendors.

And frequently they do.

But very often, engineers—especially younger, unscarred engineers—fall into traps. It's one of the roles of engineering management to help these engineers avoid these pitfalls, as they can be terribly costly.

**The first thing you have to fight is the idea that you can get something for nothing—or almost nothing. The something-for-nothing syndrome hits many engineers.**

A fellow reads about a new component and he charges in with: "Wow, they've just introduced this brand new device and we can now add this function and it will cost us almost nothing."

Whenever I hear that, I shudder. It's happened to me often enough so that I know that when an engineer tells me we can get something for nothing, or almost nothing, we have to be careful.

When we go along with one of these brand new components, we often find that our testing cost shoots

up. Or the number of rejects we encounter during incoming inspection soars. Or reliability drops. It's quite possible that the incremental cost of the part itself may be negligible, but the total cost of putting in the function may not be adequately considered.

New devices must be greeted with great caution. I recall a new semiconductor many years ago. We bought thousands. In the first five lots of production parts, each time the manufacturer produced them they came out different. The manufacturer, in fact, gave each lot a different part number.

Because we were in a hurry to use this exciting new part, we had to re-design our unit each time to make the new part fit because the vendor couldn't make the new one like the old one. Mind you, these were not hand-produced models; we had thousands of production parts.

**Now this raises another problem, one of the most important problems we face—relationships with suppliers.**

We don't make basic components. We make equipment using components provided by other people. So we write specifications around their components. But we frequently have a hard time getting suppliers to produce to their own standards.

Sometimes we have to reject 25% of the parts in a lot. This tends to drive our prices up and to drive us in the direction of hopping from supplier to supplier. That's not desirable. I think they have a better system in the Far East, where an equipment manufacturer gets in bed with his component supplier. So the supplier tries his darnedest to take care of his customer. That practice is less prevalent here. There is too much concern with squeezing the last tenth of a cent out of the cost of a component.

To save money the engineer may decide that he can make a design that will do very nicely using parts with the specifications shown on the manufacturer's data sheets. But he had better find out if the manufacturer's parts are like his data sheets.

If you're designing something that's not achievable in production because of component limitations, then you're kidding yourself. You have to make sure that you're buying real parts that you can actually get instead of parts that look great on a data sheet.

Even worse than buying from a data sheet is buying from samples you get from a salesman. A salesman brings in a few parts and they test out beautifully. Unfortunately, they may represent the best that a production line has ever produced.

Let's talk for a moment about this business of component specifications. Say you need a part with 1% tolerance. You would expect a bell-curve distribution of parts around that tolerance. You'd expect a lot less at the limits than at the center. But when you actually make tests and take a distribution curve, you find that there's a hole in the middle. You are getting only the limits. Someone else paid a premium for the stuff in the middle.

Unfortunately your design may have been based on the bell curve. If everything you receive is at the limits then your design is wrong. So it may be necessary to specify the distribution of the new parts you require.

But new parts are not the only problem. You can run into snags with old components, too. You decide that you can add this new function and all you'll have to do is add a potentiometer to the front panel. But that added pot may change the size of the front panel and change the size of the entire instrument, requiring a major redesign.

That's an easy trap to fall into because, at first, all you see is the cost of a front-panel pot. And that's not much. So it's necessary to teach your engineers to live in a world with real components.

### **It's also necessary to teach your engineers that their lab is not necessarily the real world.**

When an engineer designs a product, he must remember that production units won't be tested in the lab under the conditions in which he tested his prototype. They will be tested on a production line by people who don't have his skills. These people may not be using—and may not need—the test equipment

he used in the lab. There are many sophisticated tests that the engineer may need that don't have to be made on the production line.

The production line, in fact, should be a major concern for the engineer. Usually he tends to overlook how things will go together mechanically. He may not realize that a new part, even one that might be slightly more costly, might save money in the long run because it might make it easier to manufacture the entire equipment.

At this stage the engineer has already laid out his PC boards and he's reluctant to make a change. He feels that the cost of a change is very high. He may lock himself in because he doesn't want to change his boards. And he may be right.

So it's important, as soon as your engineers start laying things out, that they be involved with the people from production. At this stage they should be deciding how the product will be manufactured and how it will be tested. You don't want a situation where certain parts can't be tested because you can't get at them. The link between design engineering and production engineering should be made at the earliest possible stage.

### **But something else should be done even earlier. You have to decide what the product is going to be. That's not as trivial as it seems.**

You have to be wary of the temptation to redesign your equipment for broader or different markets. I can show you an example in some of the CB test equipment we recently introduced. We could have done all sorts of things to make the equipment useful for the two-way radio business or for a broad range of lab applications in addition to CB testing. But by focusing on the requirements of CB testing, we were able to cut the cost of the equipment substantially, and thus expand its market, though we did not expand its capabilities.

We want our engineers to design for a market we've defined. We want to avoid the trap of: "Gee, if I add these two functions I'll expand my possible market another 5%." The engineers have to learn that we may not be able to sell that additional market because we don't have the right kind of sales organization. Or maybe the rest of the equipment won't adequately meet the needs of the additional market.

Deciding what the product should be can be one of the most challenging problems of all. You have to decide, not only what market you will serve, but how. This means that you have to decide, among other things, what goes on the front panel and what goes inside. You have to determine which features can be automatic, and therefore kept behind the panel, and which features should be brought out for user convenience or even for cosmetic reasons.

Here you have to resist the temptation to do everything in the most sophisticated way. It may not be desirable to make everything automatic, for exam-

## Who is Carl Korn?



It began with the TV-repair and installation business that he started from his apartment in 1947. That was three years after he got his BEE from City College of New York, and just a year after he left the Navy and married Frances Ban, whose brother, Phil, was to become his business partner.

As his TV business began to mushroom, Carl Korn knew it would be extremely useful to be able to test vacuum tubes quickly and accurately in people's homes. So he started Dynascan to produce tube testers. These quickly became popular with the entire TV-service industry. That was when his own TV business was six years old and he was 32.

The next important product of what was to become B & K (for Ban and Korn) Precision, the electronic test-equipment group of Dynascan Corp., was an on-site CRT tester. By 1976, B & K accounted for about 17% of the \$100-million revenue of Dynascan, with the remainder in CB radios and radio remote-control systems. While Dynascan is still moving rapidly, so is Carl Korn, a man with boundless energy.

Though he seems to work 25 hours a day as president of Dynascan, he finds time to play a respectable game of golf (his handicap is about 15) and a mean game of tennis.

The Korn family has three children—Cheri Meisels, 26, Peter, 22 and Rhonda, 20.

ple. Sometimes you want lots of controls on the front panel because it conveys an impression that a piece of equipment is extremely powerful.

**Now how do you go about teaching the younger engineer about the real world? You can't just stand there and lecture. Yet you want to teach him things you've learned from years and years of scars. How can you get that talent into a young engineer without having to wait all those years?**

You have to structure your organization so that the key people who supervise the younger engineers fully understand that part of their function is education. One of the project leader's defined roles should be to teach the younger engineers things they haven't learned in school. And there's a lot.

One of the problems with school is the fact that many of the people teaching there never worked in industry. They so enjoyed the academic atmosphere that they went right from school to school—starting as student and finishing as teacher. Too often these people have zero conception of what the real industrial world is like. As students they were the cream of the crop. They did so well that the professors offered them assistant professorships.

But it's not easy to get senior people to educate the younger ones because you have an unusual situation. The old-timer doesn't know a lot of the things the newcomer has just learned in school. The older fellow, who has been working in industry for many years, may not be so well educated in the latest digital techniques, for example. So when the kid out of school comes around just brimming with information on digital design, the older engineer tends to be overawed.

He's reluctant to teach the new fellow. He feels he should be learning rather than teaching. He may feel that what he can impart is too trivial. An that's a danger.

It's particularly bad because the newer engineer may be unfamiliar with old technology that can sometimes provide a better solution than newer technology. I'll show you an example.

Some years ago we were designing a CRT tester that called for driving the CRT with high-voltage pulses having brief current peaks. The vacuum tube (remember the vacuum tube?) offered the best solution at that time, as the tube is very forgiving. It could take brief peak currents that would destroy many semiconductors.

But our young engineer didn't even know what a tube was. He had never used one, had never seen one. The old-timer was able to provide an old solution that turned out to be best.

With all these warnings, you can run into a problem created by the warnings themselves. You don't want to stifle creativity. You want to be innovative and you want to be a leader. So you want your people to think way out. This means they have to make mistakes. The only way to avoid mistakes is to avoid doing anything. And you want your people to do things.

If a guy has no failures, he is not trying enough. So you have to let him know he's expected to make mistakes. You must be prepared to accept some failures. This means you must welcome new ideas. But you must be careful with them, too, as they can often prove costly.

Getting your engineers to design *in* the real world, *for* the real world isn't easy. But it's of paramount importance. ■■

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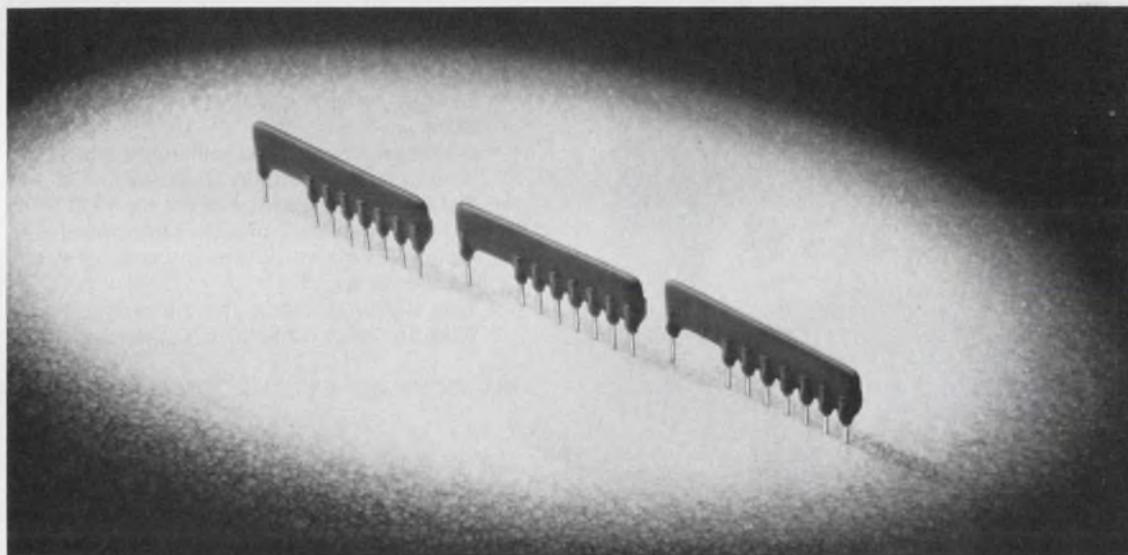


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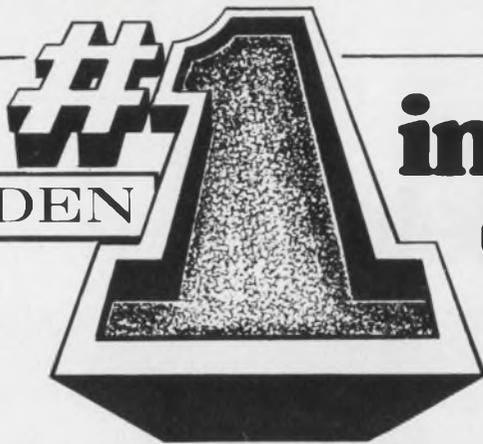
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## Pulsing a PROM's supply voltage greatly reduces the energy used

You can save energy by switching a PROM on only when needed. This mode is especially important in battery-operated equipment where bipolar PROMs have been avoided, because they consume a great deal of power.

A typical case is decoding a pocket-calculator's seven-segment output to BCD with a PROM. The supply current to the PROM is considerably higher than that drawn by a MOS calculator, but fortunately the PROM is needed only when a digit appears at the calculator's output.

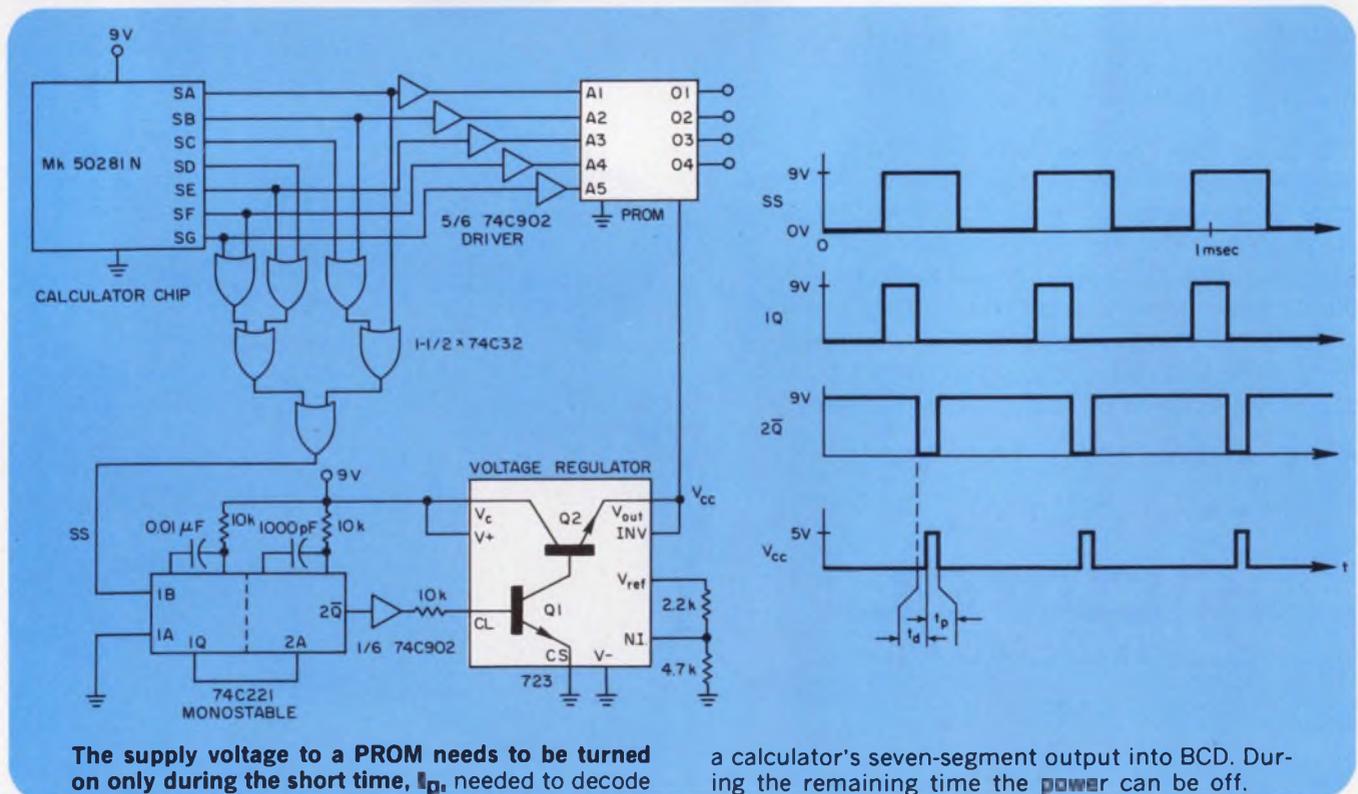
In the figure, segment outputs SA through SG are ORed together into signal SS, which is a pulse train with a 1:1 mark/space ratio and period of 350  $\mu$ s. Transients at the leading edges of SS are "cleaned" by half a 74C221 dual one-shot, which then triggers the other half to provide negative-going pulses at its

$2\bar{Q}$  output. When  $2\bar{Q}$  is HIGH, series-pass transistor  $Q_2$  of the 723 voltage regulator is turned off via transistor  $Q_1$ . Note that  $Q_2$  is off most of the time.

When  $Q_2$  is on, the output voltage,  $V_{cc}$ , rises to a predetermined value of 5 V after a delay,  $t_d$ , of about 1.5  $\mu$ s, and allows PROM operation for time  $t_p$ , which is also very short. The average power consumption of the decoding circuitry is, therefore, mainly in the 3 mA current drain of the voltage regulator. Since PROM operation draws 35 mA, pulsing saves more than 90% over continuous operation.

*Peter A. Ernst, Institut für Regelungstechnik Universität Erlangen-Nürnberg, Cauerstrasse 7, 8520 Erlangen, Germany*

CIRCLE NO. 311



The supply voltage to a PROM needs to be turned on only during the short time,  $t_p$ , needed to decode

a calculator's seven-segment output into BCD. During the remaining time the power can be off.

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## Ideas for design

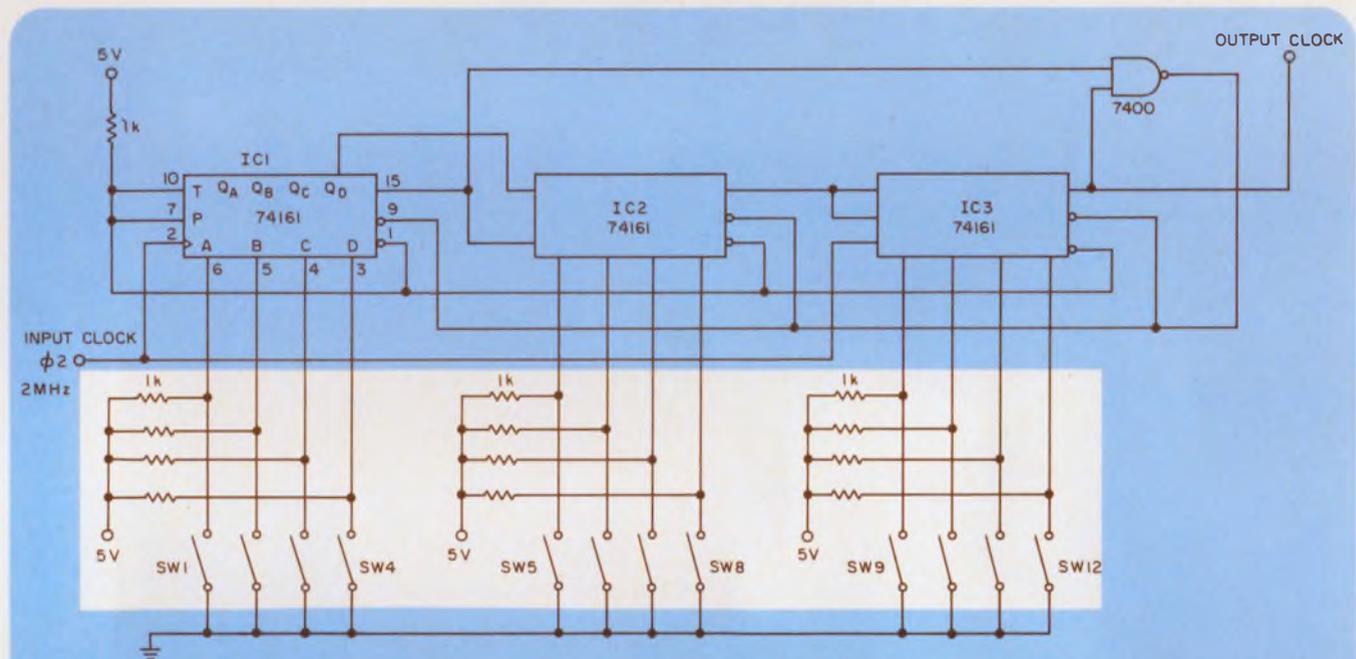
# Programmable baud generator for an 8080 works off the system's clock

Just three synchronous, presettable 4-bit binary counters and a NAND gate are needed to build a programmable baud-rate generator. The generator can give you virtually any baud rate, plus it uses the clock in your system, instead of a special crystal needed by off-the-shelf baud generators. Of course, the accuracy of the baud rate depends on the accuracy of the system clock.

The circuit in Fig. 1 uses the  $\phi 2$  clock of an 8080-microprocessor system, which has a frequency of 2

MHz. A look-ahead-carry cascades the three counters, IC<sub>1</sub>, IC<sub>2</sub>, and IC<sub>3</sub>. The 2's complement of the number, by which the master clock needs to be divided, is set up on the switches. With these set-up data, the ripple-carry overflow from the last counter stage, IC<sub>3</sub>, presets the counters.

With an input clock period of 500 ns, the output, Q<sub>D</sub>, of IC<sub>1</sub> produces a pulse width of 4  $\mu$ s, which enables the input, T, of IC<sub>2</sub>. This pulse width assures an output clock of 4  $\mu$ s, which meets the minimum worst-case



Baud rate	UART frequency 16X baud rate	Divisor	Switch settings											
			SW 12	11	10	9	8	7	6	5	4	3	2	1
50 b/s	0.800 kHz	2500	0	1	1	0	0	0	1	1	1	1	0	0
75	1.2	1667	1	0	0	1	0	1	1	1	1	1	0	1
110	1.760	1136	1	0	1	1	1	0	0	1	0	0	0	0
134.5	2.152	929	1	1	0	0	0	1	1	0	0	1	1	1
150	2.4	833	1	1	0	0	1	0	1	1	1	1	1	1
300	4.8	417	1	1	1	0	0	1	0	1	1	1	1	1
1200	19.2	104	1	1	1	1	1	0	0	1	0	0	0	0
1800	28.8	69	1	1	0	0	1	1	0	0	1	0	1	0

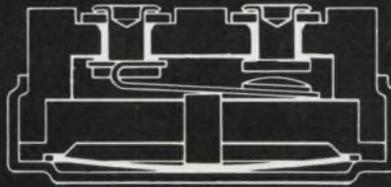
1. A programmable baud-rate generator driven by an 8080  $\mu$ P's clock can be programmed by setting

switches SW<sub>1</sub> through SW<sub>12</sub>. The switch combinations in the table provide eight selections.

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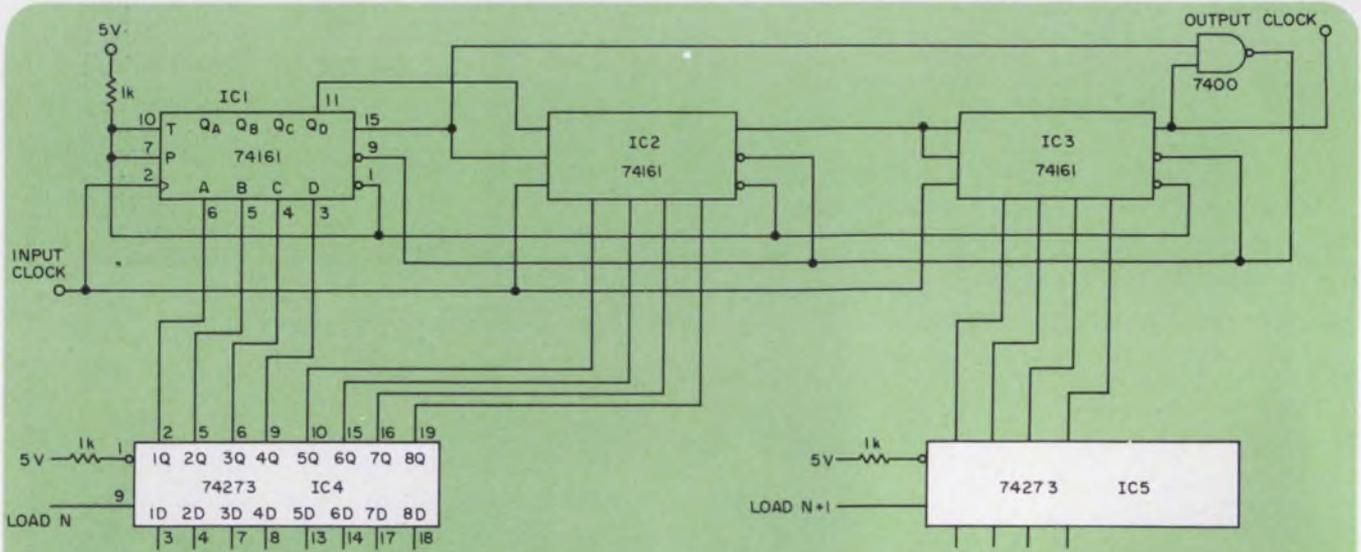
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2. Software can set the baud-rate if the programming switches are replaced with two registers, IC<sub>4</sub> and IC<sub>5</sub>.

pulse-width requirement of 2.5  $\mu$ s, needed for most UARTs. The table summarizes switch settings for baud rates of 50 through 1800.

Two registers, IC<sub>4</sub> and IC<sub>5</sub>, in Fig. 2 allow software selection of the baud rate.

*Naresh K. Batra, PE, Electronic Engineer, A. B. Dick Co., Information Products Div., 2200 Arthur Ave., Elk Grove Village, IL 60007.*

CIRCLE NO. 312

## Reduce ground-loop problems in safety-grounded instruments

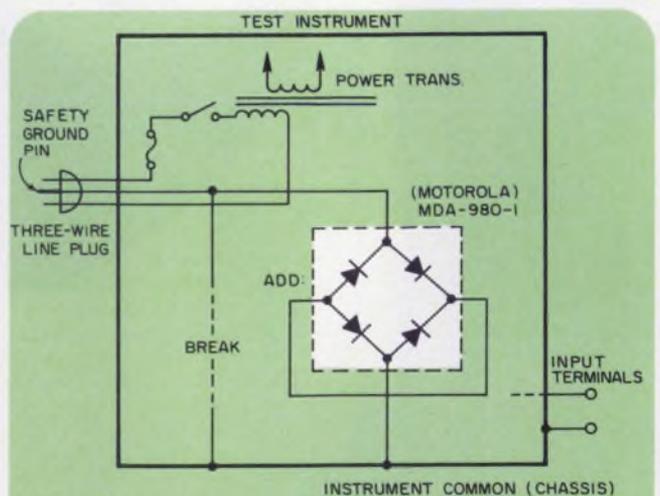
Do current loops in your instrument's power-plug safety connection cause noisy or erroneous measurements? Consider the following solution before reaching for that three-prong to two-prong line-cord adapter.

The addition of a single high-current rectifier bridge allows the instrument's common to float at least  $\pm 1$  V away from the power-line safety ground to accommodate the few hundred millivolts of typical ground difference (see figure). But under fault conditions, the diodes fully conduct with a shock-free  $\pm 2$  V maximum drop, which preserves the protective function of the power ground.

The bridge must be able to carry the maximum fault current. However, since reverse voltage on each diode is less than 1 V, the bridge's voltage rating is unimportant.

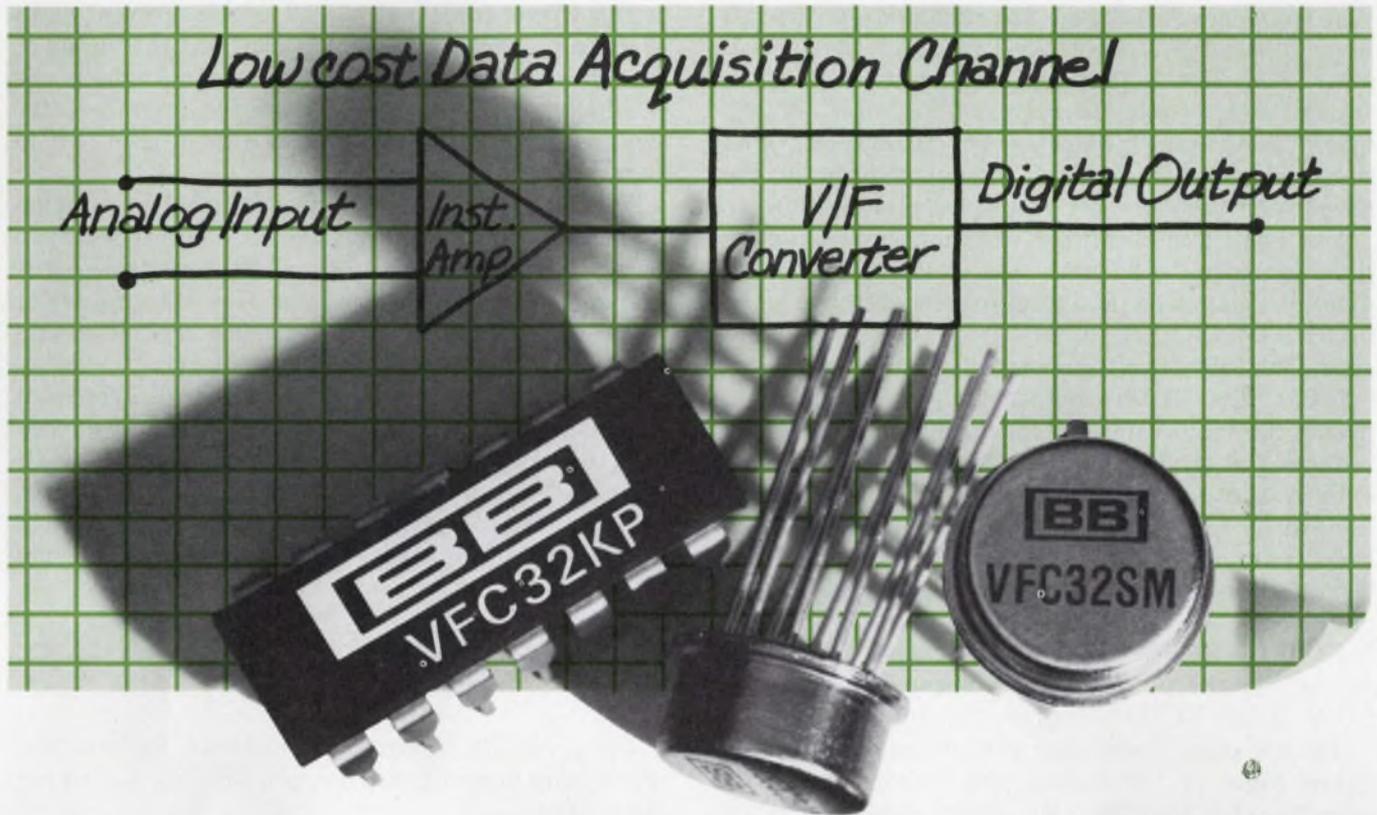
*Durward Priebe, Principal Engineer, R&D Laboratory, Hewlett-Packard, 5301 Stevens Creek Blvd., Santa Clara, CA 95050.*

CIRCLE NO. 313



A bridge rectifier between an instrument's safety-ground pin and the chassis' common ground preserves the safety feature of the ground and also reduces ground-loop problems.

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In high-speed Schottky logic systems, the clock frequencies are usually well beyond 10 MHz. But ordinary IC phase-locked-loop chips can't perform at such frequencies. However, you can build—with readily available ICs—a Schottky-TTL compatible phase-locked-loop (PLL) that requires no special supply voltage levels—only the regular TTL +5 V. What's more, the circuit produces very little jitter, and remains near its nominal frequency even in the absence of the reference frequency (see figure).

The PLL, a conventional second-order configuration, includes both input and feedback-frequency dividers that feed a digital phase detector.<sup>1</sup> The detector's output, after filtering, is an error signal that controls a 54S124 voltage-controlled crystal oscillator (VCXO). The VCXO's output frequency "seeks" to match the input-reference frequency, which thereby reduces the error signal to a minimum.

Both the reference and VCXO frequencies are divided by four with two 54S112 flip-flops to bring them within the phase-detector's operating range. Therefore, with a 20-MHz input reference and VCXO output, the phase-comparator inputs operate at 5 MHz. If the VCXO's output is less than the reference frequency, the phase-detector output (pin 13) goes LOW; if the VCXO is higher, pin 2 goes LOW.

The low-pass filter circuit suppresses noise and the sharp edges of the output pulses from the phase detector. In addition, the filter determines the dynamic performance of the loop—a second-order loop

with a damping factor of 0.8 and a natural frequency of 4.5 krad/s.

The RC-filters at the input of the LM108 op amp, with a corner frequency of 82.3 krad/s, prevent high-frequency components from overdriving the inputs of the op amp. The LM108 operates with a single +5-V supply, draws low input-bias current, so the filter exhibits little drift, and provides high dc gain to help with initial acquisition.

The 54S124 VCXO is a dual-unit Schottky voltage-controlled oscillator, designed to be used with an external capacitor (pins 12 and 13) to establish the center frequency of the oscillator. However, the device becomes an excellent VCXO when a crystal is substituted for the capacitor.

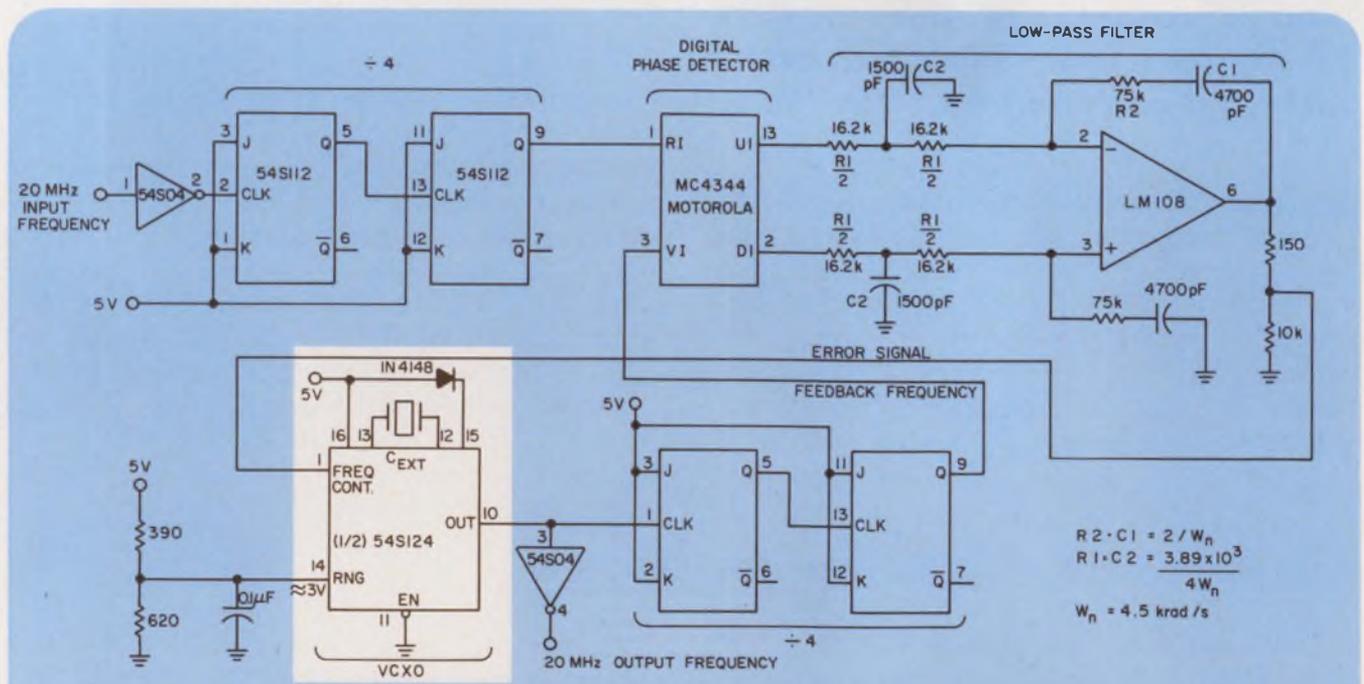
The crystal should be cut to obtain a series-resonant frequency slightly above the desired center frequency—in this case, 20.03 MHz. Such a crystal allows VCXO frequency variation between 19.965 and 20.035 MHz, with a 0-to-4-V change on the input control (pin 1). For the best results, the 54S124 range-control bias (pin 14) is set near 3 V.

## References

1. Gardner, F. M., *Phaselock Techniques*, Wiley, New York, NY, 1967.

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CIRCLE NO. 314



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3M Company—Dept. DLR-87  
St. Paul, MN 55101

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CIRCLE NUMBER 48

## Ideas for design

# Variable-delay circuit built with multivibrators preserves pulse width of the input signal

A TTL variable-delay circuit that preserves the input pulse width may be constructed with two DM9602 multivibrators (see figure). The circuit provides time delays ranging from 100 ns to several hundred microseconds. The input-pulse period, however, must be equal to or larger than the desired time delay.

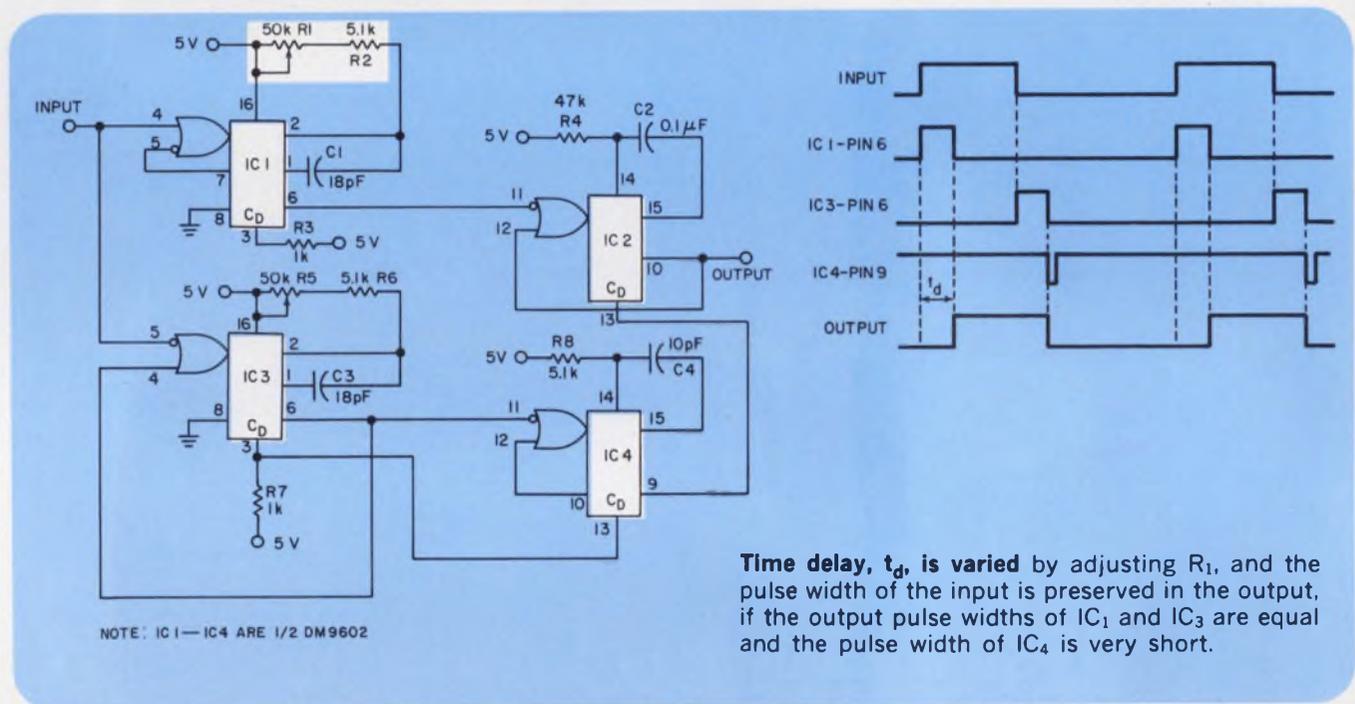
Multivibrator  $IC_1$  triggers on the leading edge of the input pulse, and  $IC_3$  on the trailing edge. If the time

constant  $R_4C_2$  is much larger than  $(R_1 + R_2)C_1$ , and  $(R_1 + R_2)C_1$  is equal to  $(R_5 + R_6)C_3$ , the output will be a delayed replica of the input pulse.

For the values shown in the figure, the time delay, determined by  $IC_1$ , may be varied from 100 ns to 1  $\mu$ s.

*John Keller, Advanced Development, Texas Instruments, Dallas, TX 75022.*

CIRCLE NO. 315



Time delay,  $t_d$ , is varied by adjusting  $R_1$ , and the pulse width of the input is preserved in the output, if the output pulse widths of  $IC_1$  and  $IC_3$  are equal and the pulse width of  $IC_4$  is very short.

### IFD Winner of March 29, 1977

Gerald Buurma, National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051. His idea "Simple CMOS Keyboard Encoder Circuit Programs Voltage Source In 1-V Steps" has been voted the Most Valuable of Issue Award.

**Vote for the Best Idea in this issue** by circling the number for your selection on the Reader Service Card at the back of this issue.

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New from Centralab...

# IMPS PUSHBUTTON SWITCHES

A new miniature modular building block system that offers microprocessor control designers more of what they need.

To meet the special digital and analog needs of today's  $\mu$ P-based controls, Centralab offers design engineers a whole new system of modular pushbutton switch building blocks. We call it IMPS — Integrated Modular Panel System. IMPS saves PC board and panel area and simplifies front panel design, cuts assembly costs, reduces back-panel space requirements, and meets the digital-analog needs of  $\mu$ P-based controls. Check these space saving, cost-cutting features.

## Simplify front panel interface.

All IMPS switches regardless of function, are uniform in size, simplifying design and selection of front panel hardware. They have high volumetric efficiency, occupying .505" x .388" PC board area and require only .608" of space between PC board and front panel.



Cut assembly costs.

IMPS switches may be mounted on the front panel, and are designed for automatic wave soldering installation and PC board cleaning. Insert molded terminals prevent flux and solder wicking and contact contamination. Integral PC board stand-offs provide for efficient board cleaning.

## Meet analog and digital needs.

IMPS switches are available with momentary, push-push and interlocking actions, with a long-life contact system that switches both digital and analog signals. To accommodate critical signal requirements, housings are high-insulation molded plastic with UL 94V-0 rating.

## Available options.

Optional installations include ganged assemblies, front-panel mounting and wire-wrapping.



All IMPS pushbutton switches are built to Centralab's highest quality standards (see specifications at right). They're priced as low as 41 cents in 1,000 quantity. For full technical details, samples and quotation, call (515) 955-3770, or write to the address below.



**CENTRALAB**

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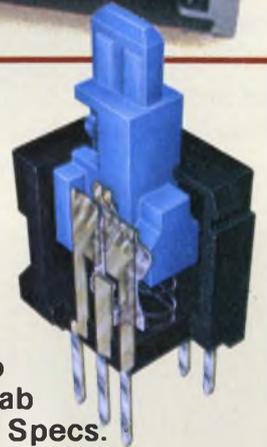
CIRCLE NUMBER 49



## Built To Centralab Quality Specs.

IMPS Pushbutton Switches combine compact size, low cost and highest quality throughout.

- Silver or gold inlay wiping contacts for long-life and low-contact resistance.
- Less than 2 milliseconds contact bounce.
- SPST, SPDT, DPST, and DPDT switch contacts.
- Printed circuit, DIL socket or wire-wrap terminations available.
- 2.5 to 3.5 oz. actuation force (momentary).
- Choice of button interface — square or blade shaft (shown) — permits use of a variety of Centralab and industry standard buttons and keycaps.
- 10, 15, 20 or 25mm center-to-center spacing.



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Our 550 Mu powder cores bridge the gap between 300 Mu cores and nickel laminations. Compared to 300 Mu cores, they pack 1.8 times more inductance into the same space. These toroids offer you less d.c. copper resistance, minimum distributed capacity, greater temperature stability than laminations and economies in assembly.

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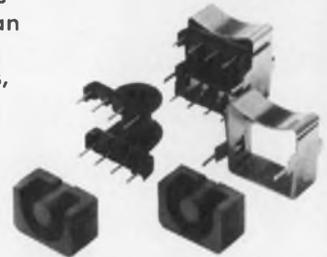


CIRCLE NUMBER 141

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CIRCLE NUMBER 142



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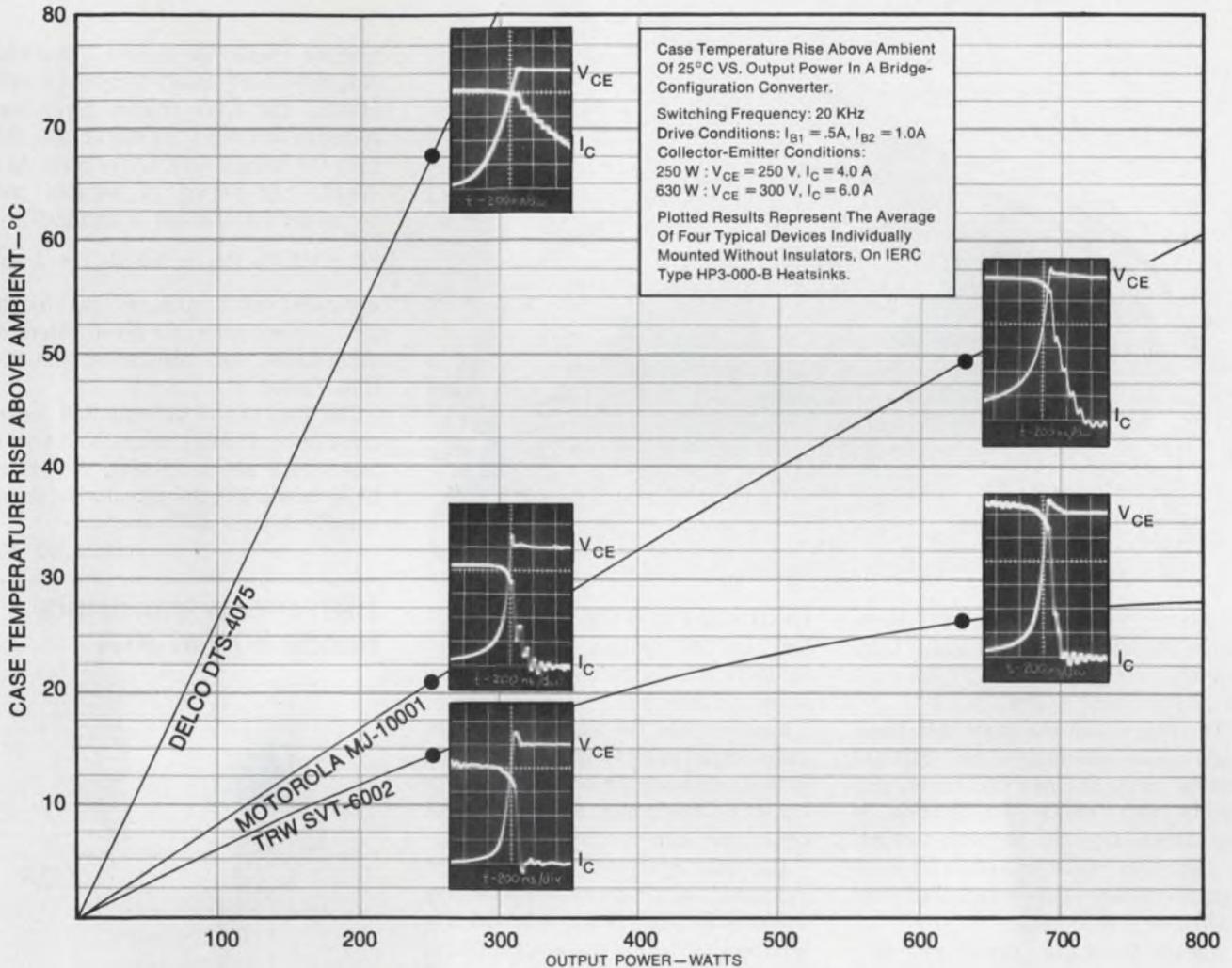
**Hoffman**  
ELECTRICAL ENCLOSURES

CIRCLE NUMBER 50

# Pure logic and hard facts

1. In high-frequency power switching, heat is a prime factor in Darlington failure.
2. Turn-off time is the dominant cause of destructive temperature rise.
3. The faster the turn-off, the cooler the Darlington, the greater the reliability.

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**TRW operates at the lowest temperatures for the greatest reliability in high-frequency Darlington off-line switching regulators**

And when you're working with high-power, fast-switching Darlings that's no small thing. When you need reliability at high frequencies, the best combination of switchoff and energy capability add up to greater efficiency and longer life. And what circuit are you about to design that doesn't deserve the best? Particularly when TRW Darlings are not only competitively priced, but are also immediately available in any quantity.

To get all the facts on TRW's high-frequency Darlington, use coupon or phone John Power at (213)679-4561.

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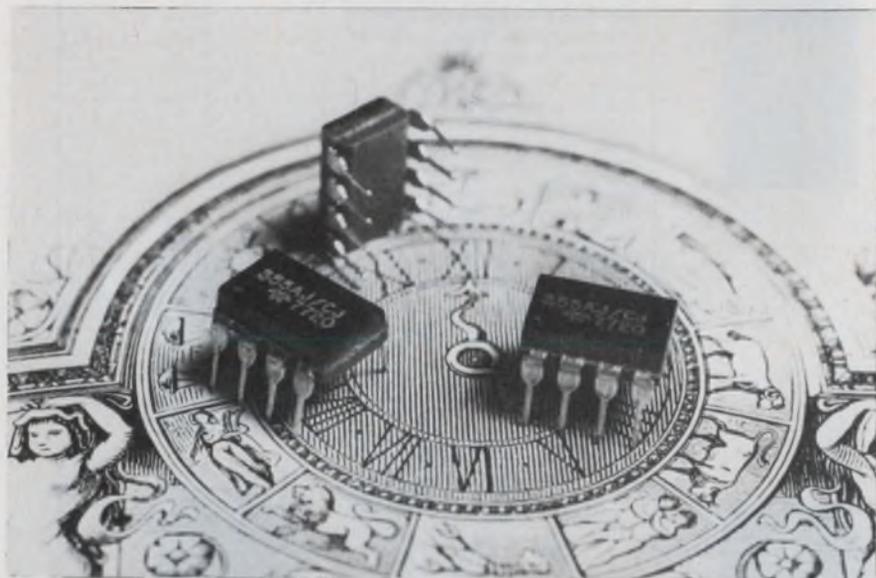
ED

## TRW POWER SEMICONDUCTORS

ANOTHER PRODUCT OF A COMPANY CALLED TRW

CIRCLE NUMBER 51

## Popular IC-timer in DIP is compatible with high-noise immunity logic



Teledyne Semiconductor, 1300 Terra Bella, Mountain View, CA 94040. (415) 968-9241. 100 qty price: \$1.10 (plastic), \$1.43 (ceramic); 2 wks.

The ubiquitous 555 timer now has a high-noise-immunity-logic (HiNIL) sibling rival. The new 355 timer, pin-for-pin and function-for-function, is the same as the 555—but with decidedly improved behavior and more compatible voltage specs when used with HiNIL or CMOS logic.

Industrial-control designers, who have tried using the 555 with HiNIL or CMOS-logic systems, have experienced a raft of problems.

Every time a 555's totem-pole output switches, the power supply can virtually short out. This problem is well known to computer logic designers, but often comes as a surprise to industrial-control engineers. The well-regulated and highly filtered 5-V supplies used for TTL usually can suppress with barely a quiver surges generated by a 555. But a HiNIL power supply usually ends up with a 300-mA, 200-ns spike on the supply line, when the 555's output goes HIGH.

HiNIL and CMOS logic aren't supposed to need tight regulation and heavy filtering. Consequently, when

HiNIL and CMOS flip-flops and counters in the system "mysteriously" change state, they are wrongly blamed as being unstable.

Furthermore, the trailing edge of the same output pulse from the 555 can put a 50-mA spike on the power-supply line—not as upsetting as the 300-mA surge, but still formidable.

The 355, specifically designed for industrial applications—with supply voltages ranging from 11 to 16 V—produces switching-transient spikes of only about 1 mA. Also, its reset threshold has been increased to be compatible with HiNIL. Like the trigger levels, this is proportional to the supply voltage. At 40% of the supply voltage, the reset voltage is between 4.4 and 6.4 V—to guarantee high noise immunity and still produce positive reset.

Of course, some compromises in performance are necessary. The 355 operates only at levels above 10 V; therefore, allowed current loads are reduced—100 mA source or sink current compared to 200 mA for the 555. And the 355 can't be used with TTL.

To eliminate the potentially heavy spikes of the 555, the 355's output stage is slowed. But in industrial work this

slowing should go almost unnoticed. And to be more closely compatible with HiNIL, the 355's trigger levels are raised to 45% of  $V_{CC}$  instead of 33%; this puts the trigger level above reset. As a result, the period of astable performance for the 355 is changed to

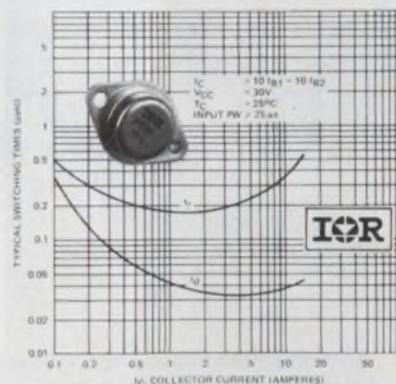
$$T = 0.5 C_T (R_A + 1.8 R_B) + 1 \mu s,$$

compared to  $0.7 C_T (R_A + 2 R_B)$  for the 555. Consequently, for given values of capacitance and resistance, the 355 runs faster.

The  $1 \mu s$  in the 355 equation represents internal delay, which isn't significant until about 20 kHz. A similar delay in the 555, though shorter, is not usually a published number.

CIRCLE NO. 301

## High energy transistors handle 80 V at 30 A

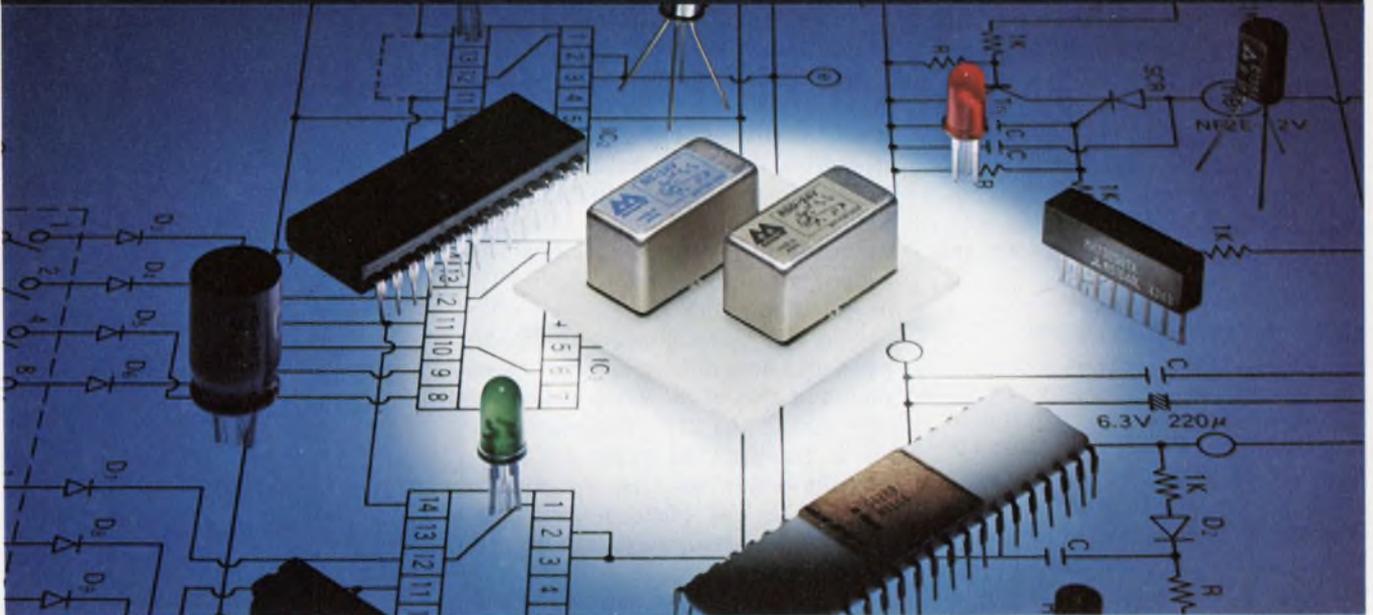


International Rectifier, 233 Kansas St., El Segundo, CA 90245. (213) 678-6281. From \$1.95 (100 qty); stock.

The 2N5879-82 series of complementary npn and pnp high-energy power transistors can handle 30 A of peak collector current. Transistors have  $V_{CE}$  or  $V_{CB}$  ratings of up to 80 V. The 2N5879 and 80 are pnp units and 2N5881 and 82 are npn. Units in the series all offer maximum dissipation ratings of 160 W and dc current gains of up to 35 at 4 V and 2 A. Switching rise time is  $0.7 \mu s$ , storage time is  $1 \mu s$  and fall time is  $0.8 \mu s$ . TO-3 case.

CIRCLE NO. 302

# Arrow-M R Relays

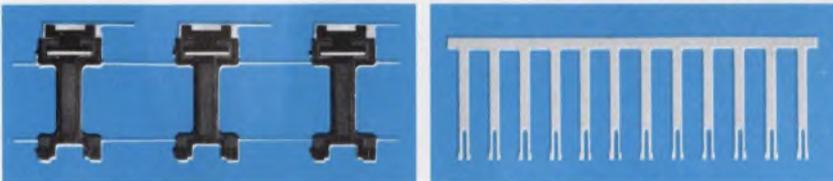


The many advantages and unique capabilities of Arrow-M's R Relays are far too extensive to be covered here. Therefore, we'd like to whet your creative appetite with a few outstanding facts:

1. Arrow-M R Relays are available in 1 Form C contacts which can carry a high current capacity of 1 Ampere 20 watts, and are capable of resisting welding at higher inrush currents. The dry circuit type which can switch current as low-level as 100uA is available in addition to the power type.

2. *High Speed:* Arrow-M R Relays can be operated at 500 cycles/sec.

## The tiny power memory reed



3. Greater reliability and lower cost, due to simultaneous automatic fabrication of coil bobbin, contact and terminal.

4. In addition to the standard there are 1 coil and 2 coil latching types, which are useful for logic circuit design as a memory component.

5. Not only can they be automatically wave soldered on PC boards with a high density of electronic parts, but they are simple to clean with most degreasers and detergents without affecting maximum contact reliability.

6. *High Sensitivity:* Minimum operating power:  
Single Side Stable 80 mw/Bistable 40 mw

7. *Longer Life:* Mechanical: More than  $10^9$  operations.  
Electrical: More than  $10^6$  operations.  
(1A 20vdc, 0.3A 110vac)

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CIRCLE NUMBER 52

**Opto-isolator couples HNIL with TTL**

*Hamamatsu, 120 Wood Ave., Middlesex, NJ 08846. Ralph Eno (201) 469-6640. \$1.44 (1000 qty); 30 days.*

Capable of coupling HNIL with TTL logic, the P1063 opto-isolator offers a rise time of 2  $\mu$ s. The device employs a GaAs LED and a silicon phototransistor. Isolation between input and output is 1500 V ac. DIP housing.

CIRCLE NO. 303

**Line drivers/receivers work at 10 Mbaud**

*Advanced Micro Devices, 901 Thompson Pl., Sunnyvale, CA 94086. E. Sopkin (408) 732-2400. See text.*

Models Am26LS31, Am26LS32, and Am26LS33 form a set of quad line drivers and receivers designed for driving long lines at rates in excess of 10 Mbaud. The Am26LS31 is a quad differential line driver having a propagation delay of 12 ns and capable of driving a 50- $\Omega$  terminated line. The Am26LS32 is a quad line receiver having an input sensitivity of  $\pm 200$  mV over an input range of  $\pm 7$  V. The Am26LS33 is a similar quad receiver for high-noise environments and features an input sensitivity of  $\pm 500$  mV over a  $\pm 15$  V common-mode range. The devices are available in 16-pin molded and ceramic-hermetic DIP and flat packages. Prices start at \$2 for the molded package in quantities of 100.

CIRCLE NO. 304

**CMOS decoder demuxes 4-digit BCD for LCDs**

*Siliconix, 2201 Laurelwood Rd., Santa Clara, CA 95054. Jim Graham (408) 246-8006. \$6.49 (100 qty); stock.*

Containing all the circuitry needed to decode up to four digits of multiplexed BCD information, the DF411 can also create the ac signals required to drive four LCD display digits. The DF411 is made from CMOS and its output signals are 50% duty cycle square waves and thus contain no dc component which could degrade display lifetimes. Only one external component, a small oscillator capacitor, is required for the DF411 to operate. Power consumption is 1.5 mW with outputs loaded. 40-pin DIP, 0 to 70 C.

CIRCLE NO. 305

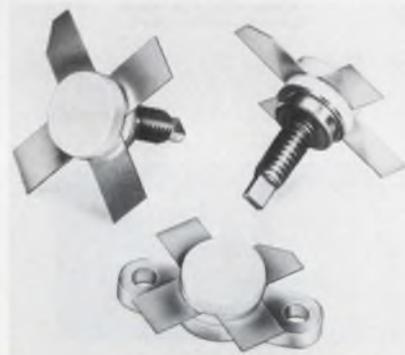
**NMOS 1-k static RAMs access at bipolar speeds**

*American Microsystems, 3800 Homestead Rd., Santa Clara, CA 95051. Ray Creech (408) 246-0330. See text.*

With a minimum access time of just 45 ns, the 4015-3, a 1-k static NMOS RAM, competes with most bipolar memories. The RAM, organized as 1 k  $\times$  1, is pin compatible with competing units such as the 2115 from Intel and the 93415 from Fairchild. Only a 5-V supply is required for the 16-pin DIP device. Made with the company's V-groove NMOS technology, the RAM has a chip area of only 4400 mil<sup>2</sup>—less than half that of the 93415 and about 60% that of the 2115. And, since the die is smaller, the yields are theoretically higher and thus the price is lower than the other devices—just \$6.20 for the plastic version in 100 qty lots. Stock.

CIRCLE NO. 306

**Uhf power transistors deliver up to 10 W**



*Amperex Electronic, Hicksville, NY 11802. Marty Burden (516) 931-6200. From \$5.25 (unit qty); stock.*

Uhf power transistors, the BLW79, 80 and 81, have power gains of 10, 9 and 7 dB with power outputs of 2, 4 and 10 W, respectively. All three transistors use gold metallization and gold wire bonding. Diffused emitter ballasting enables the transistors to withstand VSWRs of 50:1 with high line voltage and a 20% overdrive at a heat-sink temperature of 70 C. All units are characterized for 380 to 512-MHz operation at a collector voltage of 12.5 V. They are available in either the .380SOE flange or stud package.

CIRCLE NO. 307

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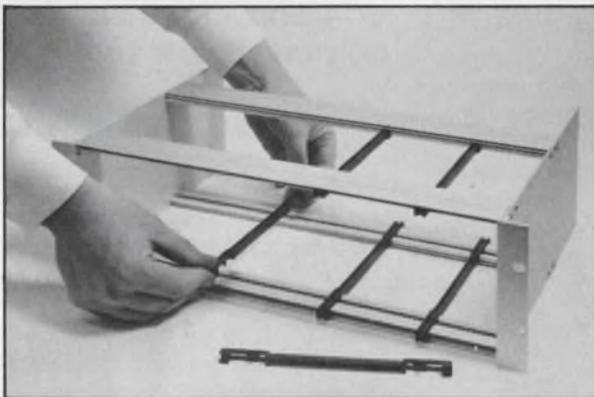
**"BET YOU CAN'T  
BEAT THE  
SYSTEM!"**

**AND HERE ARE FOUR REASONS WHY:**

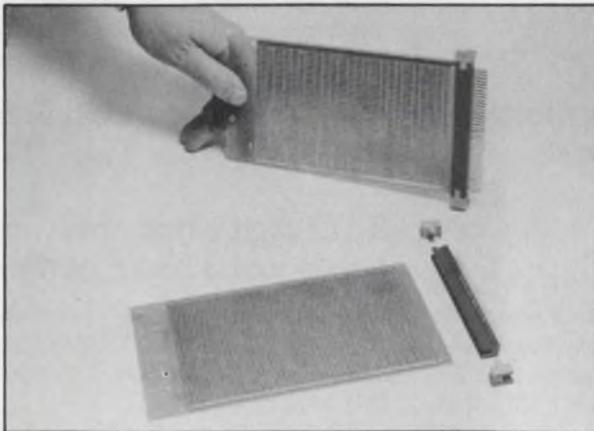
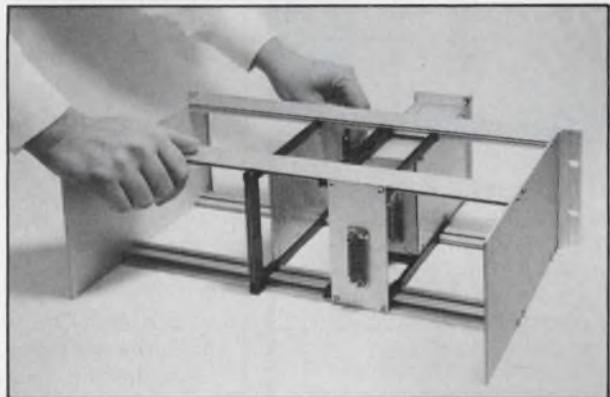
Bud's Modular Electronic Packaging System gives you options. Options to use circuit boards; to use full-enclosed modules, to use all of one, or a combination of both to develop an electronic package for a variety of applications. Equally important, the Bud System gives you the flexibility to alter your original circuit board/module arrangement for subsequent applications. The options are yours.



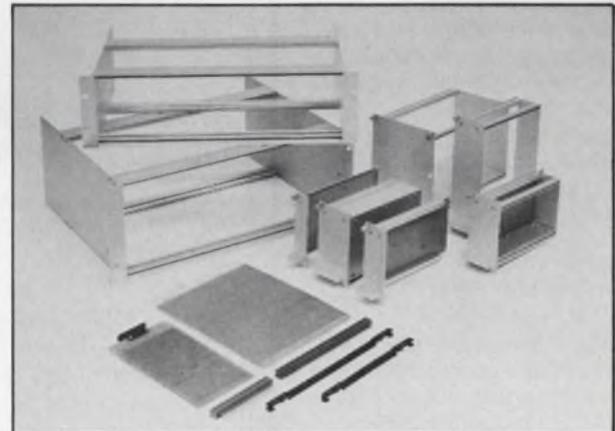
**1 Movable Snap-in Guides.** One reason for the System's flexibility are full-length, impact-resistant guides. You can move them, snap them in and out -- adjust them to a basic pitch of 0.2" to accommodate circuit boards and modules -- without dismantling the System's outer frame. The System will house up to 42 circuit boards; however, even when densely packed, maximum ventilation is assured.



**2 Perfect Alignment Between Connector and Circuit Board.** The System's distortion-free guides offer packaging flexibility, and also provide the means for positive alignment. All edge connectors, plus panel-type connectors mounted to socket-mounting panels are securely attached at the rear of the guides. Insert circuit boards into the System and they slip directly into the edge connectors. Slide in larger modules and they make perfect contact with the panel-type connectors.



**3 Board Profiling is Eliminated.** A uniquely designed end foot, easily attached at the end of each guide, not only "leads" circuit boards into edge connectors, but also positions edge connectors so they will accept the full height of the boards. This eliminates board profiling and, in turn, results in maximum contact. Keep in mind the Bud System is designed to utilize a wide universe of circuit boards and edge connectors to give you maximum flexibility.



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We could mention unconditional stability, instantaneous failsafe provisions and absolute protection from overloads and transients, but that's what you expect from any ENI power amplifier, and the 440LA is no exception!

Our catalog contains complete specifications on the 440LA as well as the entire line of ENI amplifiers, and is available without obligation, of course.

For further information or a demonstration, contact ENI, 3000 Winton Road South, Rochester, New York 14623. Call 716-473-6900, or Telex 97-8283 ENI ROC.

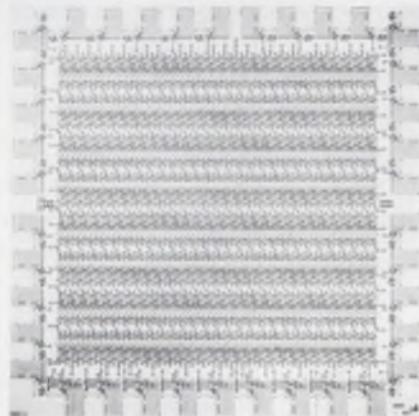
# ENI

The World's Leader  
in Power Amplifiers

CIRCLE NUMBER 54

## ICs & SEMICONDUCTORS

### Uncommitted NMOS array yields up to 262 gates



Interdesign, 1255 Reamwood Ave., Sunnyvale, CA 94086. Robert Townley (408) 734-8666. P & A: See text.

An NMOS uncommitted cell array, dubbed the digital Monochip, contains the equivalent of 262 gates on a 138 x 138-mil chip. The digital Monochip allows any electronic engineer, regardless of specification, to design a custom IC in a few days. Each cell can be connected into NAND or NOR logic and the levels are directly TTL and CMOS compatible. The tooling charge for either the digital or any of the linear Monochips is a constant \$2800, and the first 50 prototypes take four weeks.

CIRCLE NO. 308

### MOS static RAMs match bipolar counterparts

Intel, 3065 Bowers Ave., Santa Clara, CA 95051. William Regitz (408) 246-7501. See text.

The 2115A/2125A and 2115AL/2125AL are 1024-bit static MOS RAMs. They are 30% cheaper and consume 20 to 50% less power than the 93415 and 93425 bipolar RAMs they replace. All four units have an access time of 45 ns max. The supply current for the "A" versions is 125 mA and for the "AL" versions is only 75 mA. Also available are low-power "-2" versions of the above models, with a maximum access of 70 ns. All units come in a 16-pin DIP and operate on a single 5-V supply at TTL levels. Prices (100 qty) are as follows: 2115AL/2125AL, \$7.40; 2115A/2125A, \$6.90; 2115AL-2/-2125AL-2, \$6.90; 2115A-2/2125A-2, \$6.15. Stock.

CIRCLE NO. 309

### Multiprotocol USRT works at 2 Mbaud

Standard Microsystems, 35G Marcus Blvd., Hauppauge, NY 11787. (516) 273-3100. \$61.40 (500-999 qty).

The COM 5025 is a programmable multiprotocol controller that operates at speeds up to 2 Mbaud. A general-purpose universal synchronous receiver/transmitter, the 5025, can implement all major protocols including the bit-oriented SDLC, HDLC and ADCCP as well as the byte-oriented BISYNC and DDCMP. The unit is processor (8 or 16-bit) and TTL compatible. Data lengths from one to eight bits are individually selectable for both receiver and transmitter.

CIRCLE NO. 310

### V/f/v converter needs only one power supply

Intech, 282 Brokaw Rd., Santa Clara, CA 95050. (408) 244-0500. \$12 (unit qty); stock.

Using only one +5 to +18-V supply, the Model A-8404 voltage-to-frequency converter provides linear conversion of 0 to +10-V analog signals to a digital pulse train whose repetition rate is proportional to the analog signal. The unit can also perform frequency-to-voltage conversion. Specifications include operating range to 1 MHz and linearity at 1 MHz of  $\pm 0.4\%$ , max. Output is DTL/TTL and CMOS compatible. 14-pin DIP.

CIRCLE NO. 320

### 3-1/2-digit clock chip needs just 3 more parts

General Instrument, Microelectronics Div., 600 W. John St., Hicksville, NY 11802. Sonny Sellars (516) 733-3120. \$6 (100 qty); stock.

The CK3500, an I<sup>2</sup>L 12-hour digital clock circuit, requires only a 3-1/2-digit display, an inexpensive 3.58-MHz crystal and a small trimming capacitor. Able to be driven directly from a car battery and operate over a wide voltage range the circuit has both a normal and a standby operating mode. In the standby mode, the current drain is typically 4 mA. When on, each segment output can sink 20 mA. Housed in a 40-pin DIP, the CK3500 operates over -20 to +70 C.

CIRCLE NO. 321

## A/d converter chip runs on 25 mW

Siliconix Inc., 2201 Laurewood Rd., Santa Clara, CA 95054. Jim Graham (408) 246-8006. \$9.10 (100 qty); stock.

Using only 25 mW of power, the LD131 a/d converter offers a 3-1/3 digit (1500 count) system on a single CMOS chip. This TTL-compatible device has on-chip scaling resistors and clock. Nonlinearity is less than 0.1% of the analog input. Typical tempco is 15 ppm/°C. The unit has automatic zero and polarity. Temperature range is 0 to +70 C. 18-pin plastic DIP.

CIRCLE NO. 322

## Bus transceivers sink up to 48 mA

Advanced Micro Devices Inc., 901 Thompson Pl., Sunnyvale, CA 94086. E. Sopkin (408) 732-2400. From \$5.50 (100 qty).

The Am2915A, Am2916A and Am2917A are bus transceivers built with Schottky technology. They sink 48 mA at 0.5 V at each terminal. Bus-to-receiver speed is 18 ns and clock-to-bus-delay is 21 ns. A three-state output with a 4-bit latch and a 4-bit register on the inputs are standard. Specifically, the Am2915A is a quad two-input device with three-state outputs on both driver and receiver; the Am2916A is a quad two-input device with three-state driver outputs and a 4-bit parity checker/generator; the Am2917A is a quad device with three-state driver and receiver outputs and a parity checker/generator. The Am2915A and Am2916A come in 24-pin DIPs; the Am2917A comes in a 20-pin DIP.

CIRCLE NO. 323

## Power Schottky provides low $V_f$ at high current

TRW Power Semiconductors, 14520 Aviation Blvd., Lawndale, CA 90260. John Power (213) 679-4561. \$6.75 (100 -999); stock.

By eliminating stored charge, the SD-51 power Schottky diode allows a forward voltage of only 0.6 V at a forward current of 60 A. The DO-5 housed device features a maximum forward current of 120 A at a 50% duty cycle with reverse leakage current of 200 mA. The dc blocking voltage is 45 V dc. The junction operating range is -55 to +150 C.

CIRCLE NO. 324

# GE miniature lamps offer you gigantic design advantages.

### With 11 new wedge base GE lamps, you have more choices than ever.



Enjoy new design freedom with this expanded line of GE all-glass wedge base lamps. And keep enjoying the inherent benefits of the line: savings in weight, space, time and costs. GE now offers more than 30 wedge base lamps in three sizes: miniature lamps T-3/4 (10 mm diam.) and T-5 (15 mm diam.); subminiature lamp T-1/4 (6 mm diam.). Voltages range from 2.5 V to 28 V. Candlepower from 0.03 to 21 cd.

Use GE wedge base lamps with confidence for indicator, marker and general illumination applications, especially where space is at a premium. You may enjoy lower systems cost than with metal-based lamps and LED's. They're easy to insert and remove; have no soldered connections to corrode or break; and the filament is always oriented the same in relation to the base.

To start saving with GE wedge base lamps now, send for the latest bulletin on GE's expanded line. Order #3-5259R2. It's free.



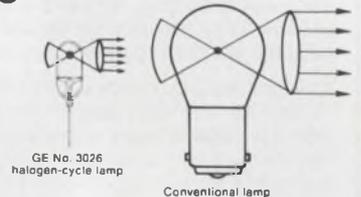
## For whiter, brighter light use GE halogen-cycle lamps.

GE halogen-cycle lamps offer you very high light output from a very small package. They can provide better light efficiency because the bulb doesn't blacken and because of accurate filament placement. Many have uniform bulb tops (no tip).

You get a whiter light than from comparable incandescent lamps because of higher color temperature operation. And they maintain their high initial output level for virtually the life of the lamp.

Because of their lower electrical power requirements, you also save on operating costs vs. comparable incandescent lamps. Some halogen lamps have long design life for low maintenance costs, too.

You can use GE halogen-cycle lamps with confidence when your design needs call for a lot of light in restricted space. For greatly expanded information on GE halogen-cycle lamps, send for your free copy of the new GE bulletin #3-5257-R.



## How to order lamp samples and important new free catalogs.

For catalogs and information on how to get lamp samples, call your local GE Miniature Lamp Products Representative or write: General Electric, Miniature Lamp Products Department #3382, Nela Park, Cleveland, Ohio 44112.

GENERAL  ELECTRIC

CIRCLE NUMBER 55

# BUILDING YOUR OWN POWER SUPPLY?

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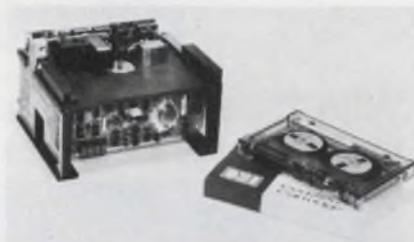
## ARNOLD MAGNETICS CORPORATION

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CIRCLE NUMBER 56

## MICRO/MINI COMPUTING

### Cartridge drives pack 11.5 Mbytes onto tape

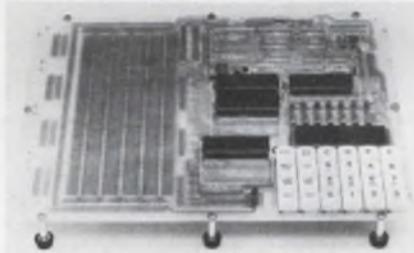


Data Electronics, 370 N. Halstead St., Pasadena, CA 91107. S. Thompson (213) 351-8991. \$1150 (100 qty); stock.

Complete with read/write electronics, the CMTD-3400S2 cartridge drive fits in just a 4.25 × 6.9 × 5.7-in. space. The drive can handle a 300 ft. 3-M cartridge and pack up to 11.5 Mbytes onto the tape. Data transfer rates of 192 kbits/s are possible. Optional cards for the drive include an interface card and an encoder card.

CIRCLE NO. 325

### Prototyping kit eases 8085 system development



Intel, 3065 Bowers Ave., Santa Clara, CA 95051. Rob Walker (408) 246-7501. \$250; stock.

A system design kit for the 8085 microprocessor, the SDK-85, contains the CPU, memory and I/O. The kit includes system monitor software in ROM, an interactive keyboard-display and a comprehensive design library. With the monitor, programs can be entered in hex, executed, single-stepped and debugged. The monitor also supports serial data communications via a teletypewriter interface. Spaces are available on the board for components to build a buffered bus expansion interface and a separate breadboard area. Components included are an 8085 CPU with a typical instruction cycle of 1.3 μs; an 8155 RAM, I/O and timer; an 8355 ROM and I/O; an 8279 keyboard/display interface; and an 8205 decoder. The entire system operates from a 5-V supply.

CIRCLE NO. 326

## Mini performance boosted with cache bus



General Automation, 1055 S. East St., Anaheim, CA 92803. (714) 778-4800. P & A: See text.

The GA-16/550 multiprocessor computer combines two high performance processors with dual cache bus and half a megabyte of error correcting memory. Costing less than \$50,000, the system provides the designer with high throughput, increased system integrity and the redundancy needed for today's critical networking applications. The dual cache bus structure connects up to eight very high performance processors to a large shared memory facility. A single cache bus can transfer data between as many as four processors and four memory banks at rates of up to 8 Mbytes/s. A parity-per-byte system protects the integrity of all data transfers. The GA-16/550 is a microprogrammed computer with a 240-ns microcycle time and a repertoire of 145 basic instructions.

CIRCLE NO. 327

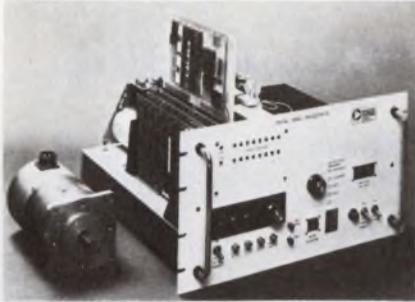
### Program converts 8080 assembly to Z80 code

MicroTec, P.O. Box 60337, Sunnyvale, CA 94088. Paul Greenfield (408) 259-8372. \$300; stock.

An 8080 to Z80 conversion program, written in standard ANSI Fortran, converts standard Intel assembly language statements to the equivalent Z80 statements. All required mnemonics, reserved names, and syntax conversions are performed. Other features include detection and flagging of certain errors present in the 8080 input statements; control of the formatting of the fields in the Z80 output statements; and output listing control statements.

CIRCLE NO. 328

## Programmable servo runs under $\mu$ P control



Torque Systems, P.O. Box 588, 225 Crescent Street, Waltham, MA 02154. Dick Matz (617) 891-0230. Typical system prices range from \$1000 to \$5000; stock to 6 wks.

The DS2200, a programmable digital servo control card, uses an F-8  $\mu$ P to control velocity, acceleration and position. A phase lock speed control regulates the constant velocity of the motor. Inputs to the system consist of parallel 8-bit data, a 3-bit address and three 8-bit words for position, another 8-bit word for velocity and one more for acceleration. The output is a serial pulse train at 10 kHz, maximum. Power requirements for the card are  $\pm 15$  V at 150 mA and 5 V at 1 A. Positioning accuracy is  $\pm 1$  bit.

CIRCLE NO. 329

## 8080-based computer has room for floppy disc



Vector Graphic, 790 Hampshire Rd. A-B, Westlake Village, CA 91361. Carol Ely (805) 497-0733. From \$369; stock.

The Vector 1+, an 8080-based micro-computer, can include a Shugart mini-floppy or equivalent in the same case. The designer cabinet contains an 18-slot, fully shielded S-100 motherboard, six connectors, and a power supply capable of delivering 18 A at 8 V and 2.5 A at  $\pm 16$  V. The 8080-based CPU board can be optionally ordered with eight-level vectored interrupts and a real time clock. A unique PROM/RAM board with 1 k of RAM and room for 2 k of PROM with a 512 byte resident monitor programmed on two 1702A PROMs is also available.

CIRCLE NO. 330

## Micro disc drive drops access time by 80%

Micro Peripherals, 2900 Cordura Lane, Los Angeles, CA 90049. Keith Ullal (213) 472-6067. \$224 (100 qty); 10 wks.

The Series B51, a micro floppy disc drive, uses a unique band-drive that allows the head to be moved at a fast rate—claimed to be almost five times faster than its nearest competition.

Access time for 15 tracks is 75 ms. Data are transferred at 125 kbps in FM encoding and 250 kbps for double density. Standard capacity is 109.4 kbytes on 35 tracks, or 124.7 kbytes for a 40-track double density drive with single side recording. The drives use MFM, M<sup>2</sup>FM and GCR encoding techniques and 5.25-in. diskettes. Dimensions are 3.25 x 5.55 x 8 in. and weight is 3 lb.

CIRCLE NO. 331

**No. 2**  
IN A SERIES  
**LOW NOISE TRANSISTOR**  
MICROWAVE TRANSISTOR  
UPDATES FROM AVANTEK

**$G_{NF}$ : 9.5 dB**

**$NF_{opt}$ : 3.0 dB**

**$I_c$ : 5 mA**

**Frequency: 4.0 GHz**

**Avantek AT-4690**

### Guaranteed Specifications

Type	$NF_{opt}$ dB (max)	$G_{NF}$ dB (typ)	$I_c$ mA	$G_{max}$ dB (min)	$I_c$ mA	$f_{test}$ GHz	$f_T$ GHz (typ)
AT-4690	3.0	9.5	5	12	15	4.0	8.5

### Excellent Noise Figure, Gain and Dynamic Range

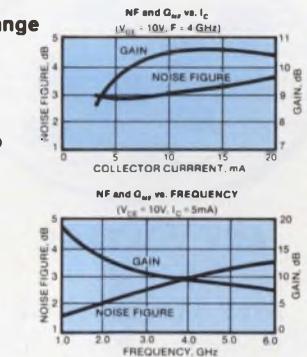
The designer need only look to the typical performance curves of Avantek's AT-4690 to determine its exciting potential. High gain and low noise figure, even at current levels up to 20 mA! Now you can design amplifiers with fewer stages and get more usable power.

The Avantek 70 mil stripline package is as dependable as the 4690 it contains. All Avantek transistors feature superior gold metallization and hermetic sealing to ensure consistent, reliable performance.

Availability? Of course! Remember Avantek is only a phone call away. Orders placed by noon will normally ship the same day.

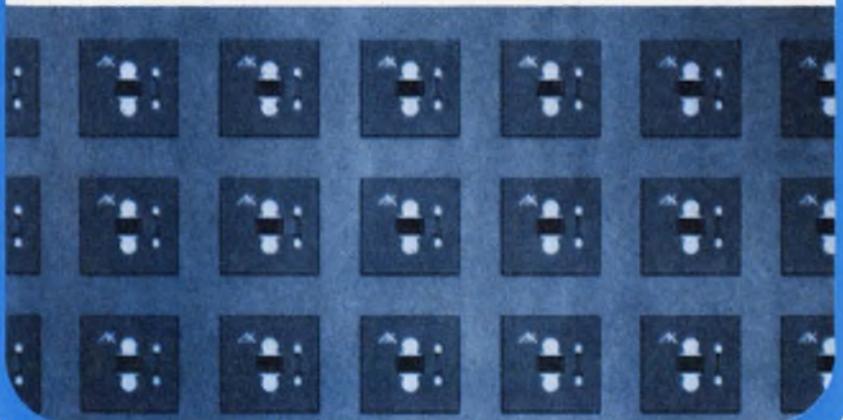


**Fast Delivery**



Contact: Avantek Transistor Applications Engineering  
(408) 249-0700

3175 Bowers Ave., Santa Clara, CA 95051 TWX 910-339-9274 Telex: 346 377



CIRCLE NUMBER 57

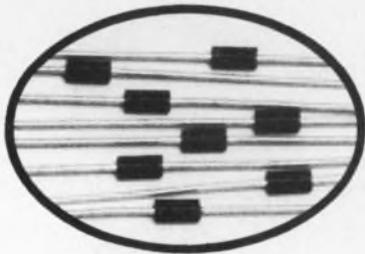
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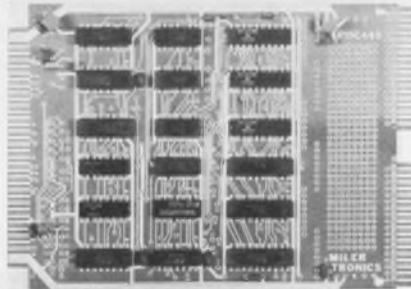
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CIRCLE NUMBER 58

## MICRO/MINI COMPUTING

### Interface card gives SC/MPs three 8-bit ports

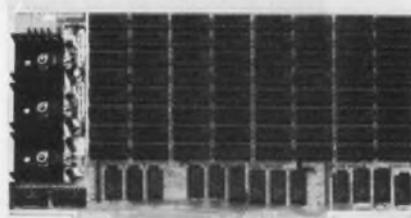


*MilerTronics, 303 Airport Rd., Greenville, SC 29607. Michael Webb (803) 242-9232. \$195 (unit qty); 4 wks.*

The PDC-440 is a 24-bit I/O card, bus and card-size compatible with the National ISP family of cards. It contains three 8-bit latched I/O ports, asynchronous data transfer input and output handshake controls and interrupt controlled data transfer capability. The card address is programmable, permitting multiple PDC-440 cards per system. A breadboard section is included for user supplied interfaces, and two 36 pin I/O connectors with user-definable pinouts are on the board.

CIRCLE NO. 332

### Static memory card holds up to 32 kbytes

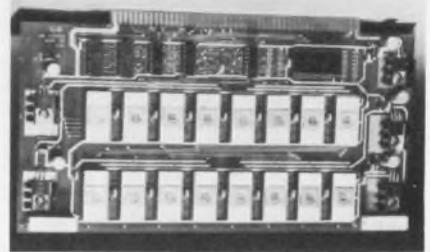


*Artex Electronics, 605 Old Country Rd., San Carlos, CA 94070. Robert Jones (415) 592-2740. See text: stock.*

A 32 kbyte static memory board, the 32K-100, is compatible with the S-100 microcomputer bus and speed-compatible with Z80-based systems. The basic board with all support circuits, power regulator, 8 k of RAM and assembly manual costs \$290. Additional 8 k chunks of RAM cost \$255, and a full 32 k memory board costs \$1055. The 32K-100 requires 8 V at 3 A, maximum, and has an access time of 250 ns. The board has buffering on all address and data lines, permits battery back-up and contains a bank select provision.

CIRCLE NO. 333

### PROM board holds up to 16 2708 PROMs

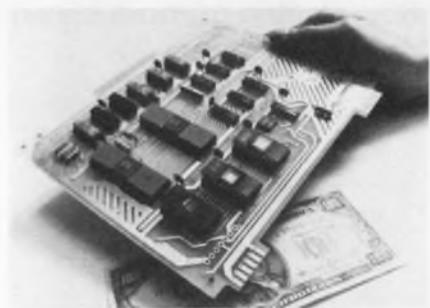


*IBEX, 1010 Morse Ave., Suite 5, Sunnyvale, CA 94086. (408) 739-3770. \$85 (unit qty); stock.*

Designed to plug into 8080-based Altair-compatible buses, a 16-k PROM board can hold up to 16 2708 PROMs. Unused 4-k sections can be disabled to allow RAM to exist within the board's address space. The board also has provisions for a wait state to allow it to operate with the faster Z80  $\mu$ Ps. Available as a kit, sockets are included for all ICs.

CIRCLE NO. 334

### Microcomputer boards intended for OEM use

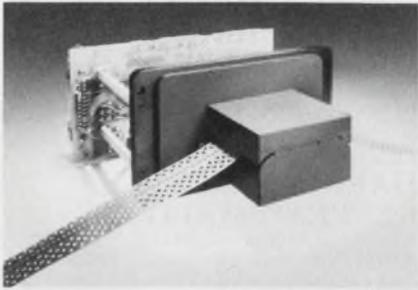


*Intel, 3065 Bowers Ave., Santa Clara, CA 95051. Rob Walker (408) 246-7501. P&A: See text.*

With a cost of \$99 in OEM quantities, the SBC 80/04 single board computer is claimed to be the lowest-cost computer ever offered. The SBC 80/04 operates from a +5-V supply, is based on the 8085, and includes provision for an on-board 5-V regulator. Also available are a directly compatible, more powerful version priced at under \$200 in OEM volumes, the SBC 80/05—and a prototyping package for both computers—the SBC 80P05, which costs \$895. The SBC 80/04 has a typical instruction execution time of 2  $\mu$ s. The board comes fully assembled and tested and measures 6.75  $\times$  7.85 in.

CIRCLE NO. 335

## Paper-tape reader accepts tape at 150 cps



*EECO, 1441 E. Chestnut Ave., Santa Ana, CA 92701. Bob Crum (714) 835-6000. \$290 (1 to 4 qty); stock.*

The 2001-2 paper tape reader can handle punched tape at 150 cps. TTL compatible, the unit reads any commercially available punched tape. The read head opens wide for easy loading. Constructed of a high wear-resistant material, the read head will not build up static electricity which can cause data errors. The reader measures 3.16 × 6.44 × 3.88 in. (80.3 × 163.6 × 98.6 mm) and the read head extends 2.1 in. (53.3 mm) in front of the panel.

CIRCLE NO. 336

## 8080-based micro has octal front panel



*Parasitic Engineering, P.O. Box 6314, Albany, CA 94706. Howard Fullmer (415) 547-6612. P & A: See text.*

The Equinox 100, an under-\$700 8080-based microcomputer kit, features a 12-pad keyboard and numeric 7-segment LED display. Addresses and data on the S-100 bus computer are displayed in octal on the LEDs. The front-panel keyboard and display lets the operator monitor or alter any register, register pair, memory location or I/O device in the system. Equinox 100 can single-step through programs, step slowly at a programmable rate from 1 to 64-k steps per minute, or Halt at predetermined points without "going to sleep." Inside the microcomputer is a 20-slot busboard which is fully shielded by interlaced ground lines and has active termination on every bus line.

CIRCLE NO. 337

# MEET OUR family of high VOLTAGE TEST PROBES

In 1967 we introduced the first high voltage test probe with a built-in meter. It became so popular that we have been adding new models ever since. Now there are five different versions to satisfy the demands of radio, television, appliance, audio, and electrical repair men in a wide variety of high voltage testing applications.

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Negative ground.

**MODEL 3157**—15,000 volts DC.  
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Positive ground.

**MODEL 3163**—6,000 volts DC.  
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**MODEL 3200**—10,000 volts AC.

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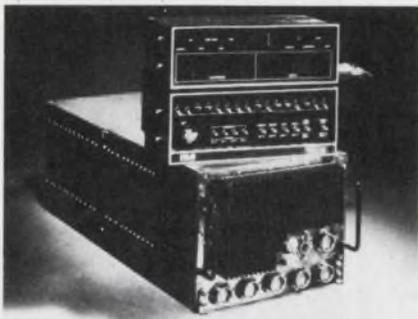
1500 East Ninth St., Pomona, Calif. 91766  
Telephone (714) 623-3463, TWX: 910-581-3822



CIRCLE NUMBER 59

## MICRO/MINI COMPUTING

### Militarized computer has 19.56-in. ATR case



Rolm Corp., 4900 Old Ironsides Dr., Santa Clara, CA 95050. Rich Conley (408) 988-2900. From \$12,750; 30 days.

The 1602A militarized computer packs a CPU, up to 64 k 16-bit words of core memory, seven I/O interfaces, power supply and control-panel interface into a 19.56-in. ATR chassis. Requiring just one-third of the space of the previous model, the 1602A uses a redesigned, microprogrammed CPU. The same 1602 instruction set is retained and the CPU operates at a 20 MHz rate, executing a 52-bit micro-instruction in 150 to 250 ns. There is also room for an optional floating-point instruction set and the built-in test (BITE) self-diagnostic capability. Owners of 1602 systems can use the control panel with the 1602A.

CIRCLE NO. 338

### Floppy discs fit in IBM or non-IBM drives

Electronic Memories & Magnetics, Media Prod. Div., 1020 Timothy Dr., San Jose, CA 95133. (408) 298-7090. From \$5 (unit qty.); stock.

A line of flexible disc media has been added to the company's Caelus line of disc products. Designated the CM-F11, CM-F21, and CM-F31, the discs use a special intermix lubrication to make the surfaces smooth. All envelopes are provided with special tabs for color coding and extra filing labels. The Model CM-F11 is totally compatible and interchangeable with the standard IBM 3740 or 3540 data entry systems. For Shugart-type systems requiring 32 sector holes and one index hole around the inside diameter, EMM's CM-F21 can be used. CM-F31 flexible discs are designed for Memorex 651 or equivalent disc drive systems requiring 32 sector holes and one index hole around the outside diameter.

CIRCLE NO. 339

### Debug software handles 8080 assembly language

Computer Mart of New Jersey, 501 Route 27, Iselin, NJ 08830. (201) 283-0600. \$30 (paper tape), \$35 (diskette); stock.

The Dynamic Debugging System (DDS) is a debugging facility for 8080 assembly language programs. DDS can run a program one instruction at a time, automatically maintaining on a CRT a display of all registers, the following instructions, and portions of memory. The system can also operate in a breakpoint mode in which the program runs at full speed until it reaches one of several selected instructions. The automatic program monitoring provides an alternative to breakpoints. Rather than running the program with breakpoints, DDS can run the program until a prespecified condition occurs or DDS detects an error by itself.

CIRCLE NO. 340

### Desktop microcomputer comes ready to run



Digital Electronics, 415 Paterson St., Oakland, CA 94601. Robert Christensen (415) 532-2920. From \$2200; 30 days.

The DE68DT microcomputer contains a full alphanumeric keyboard, 20-column alphanumeric display, 40-column impact printer, single or dual minicassette tape drives, a miniature floppy disc, RS232-C ports and a nine slot card cage. Based on the 6800 CPU, the computer even has the power supplies built into the desktop case. RAM can be expanded to 65 kbytes, and 16 kbyte EPROM cards are available. Software includes assembler, Basic and Fortran IV, as well as a 6 kbyte ROM/PROM operating system called DEbug. Two versions of the DE68DT are available. The standard DE68DT is a desktop unit, 22.25 x 17.5 x 7.5 in., which weighs less than 30 lb. The DE68C is a compact unit without integral miniature floppy disc, but otherwise similar to the DT.

CIRCLE NO. 341

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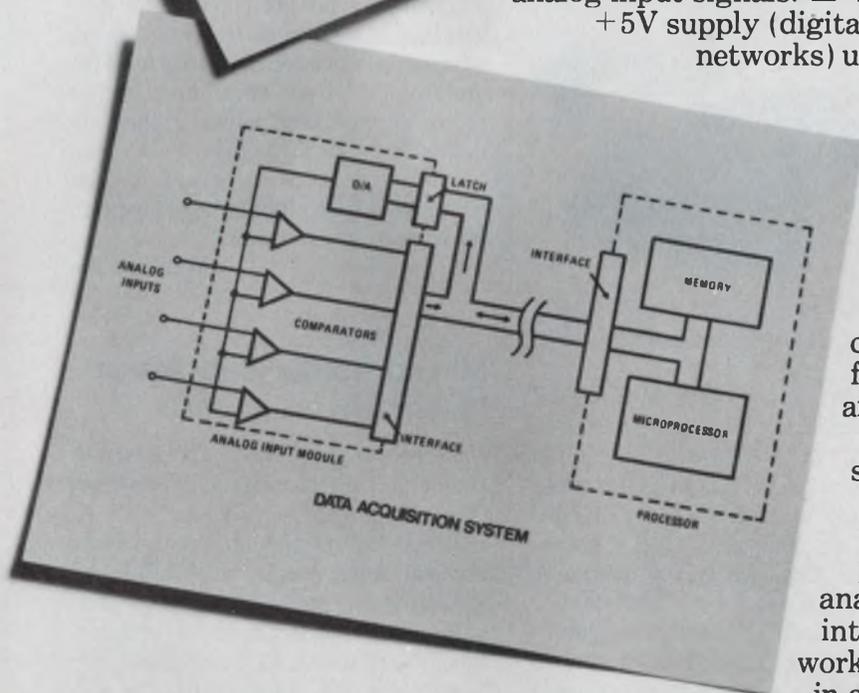
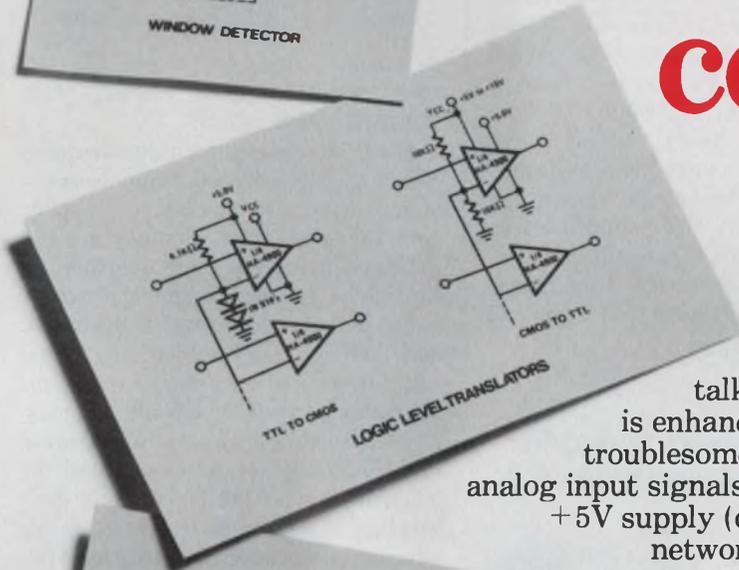
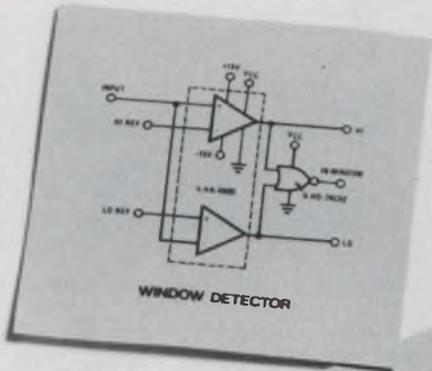
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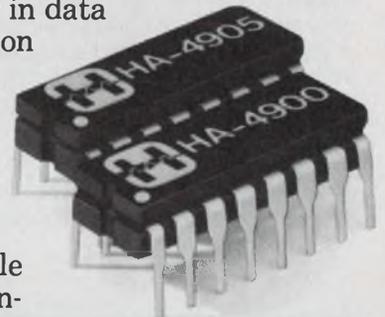
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CIRCLE NUMBER 61

## MICRO/MINI COMPUTING

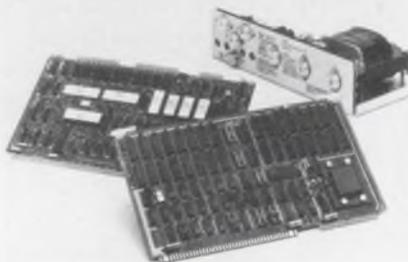
### Simulator program traces $\mu$ P operations

*Peters Associates, P. O. Box 61622, Sunnyvale, CA 94088. (408) 245-1519. \$500; stock.*

Trace-80, a relocatable tracing simulator for use on all 8080-based systems, can operate with only 4 kwords of memory. Major features of the interactive debugging aid include selection of registers for printing, display of or writing to user requested areas of memory, and the capability of running the user program at full speed until a breakpoint returns control to Trace-80. In an alternate mode, a circular queue stores machine status for the last 100 instructions or branch commands. A breakpoint causes display of this list. Trace-80 also warns of probable errors in the user program. The program has a relocating loader, relocatable object tape, test cases and full documentation.

CIRCLE NO. 342

### CMOS memory board for SBC 80 systems holds 4 k



*Intel, 3065 Bowers Ave., Santa Clara, CA 95051. Rob Walker (408) 246-7501. \$795 (unit qty); 4 wks.*

The SBC 094, a 4096 byte CMOS RAM and battery backup board, can be shared by up to 16 master SBC 80/20 boards. Or, the board can be dedicated to a single master, such as the SBC 80/10. The SBC 094 CMOS memory gives any SBC 80 central processor ample time to transfer critical data to the CMOS RAM and execute an orderly shutdown procedure. Data can be retained for at least four days, using power from an on-board battery. The battery recharges automatically when system power is restored. The SBC 094 CMOS memory board uses jumpers to allow addressing to begin on any 4 k memory boundary. Maximum cycle times are 730 ns for read and 800 ns for write.

CIRCLE NO. 343

### Programmable calculator displays and/or prints



*Burroughs Corp., Burroughs Pl., Detroit, MI 48232. Bob Farkas (313) 972-7267. \$2195; stock.*

The C 7400 programmable calculator offers a choice of operating modes—either print and display, or display only. Included in the calculator are 104 independent storage memories and the capability to handle 1000 program steps, including two-level subroutines and indirect addressing. Programs, subroutines and data can be stored on magnetic cards for automatic entry into the calculator. Up to 16 programs and 16 subroutines can be accessed via labeled keys on the calculator's conversational keyboard. Decisions on sequence and selection of control keys for program input are eliminated by use of an "execute key" which is the only method by which a keyboard entry can be transferred into a program. Results are printed with alphabetic description for easier interpretation.

CIRCLE NO. 344

### Minicomputer handles up to 128 kbytes of core

*General Automation, 1055 S. East St., Anaheim, CA 92803. David Armstrong (714) 778-4800.*

The 16/340 minicomputer combines integral input-output capability and 128 kbyte core memory capacity. Built with a microprogrammable architecture, the computer is an extended version of the 330 system with the 450ns 330 CPU. The GA-16/340 offers byte and bit addressing, in 11 direct, indirect, program and base relative, and literal modes; word, byte, and bit manipulation; 16 general-purpose registers; foreground-background processing; hardware multiply-divide and much more.

CIRCLE NO. 345

## Programmable calculators come with software

Texas Instruments, P.O. Box 5012, Dallas, TX 75222. (214) 238-2011. From \$79.95; stock.

The Programmable 58 and Programmable 59 calculators use plug-in, interchangeable software modules containing up to 5000 program steps each. Also available is the Programmable 57 calculator which has eight addressable multi-use memories and can store up to a 150 keystroke program. Both the 58 and 59 permit users to vary the allocation of storage capability between program steps and memory registers. The 58 offers up to 480 steps or up to 60 registers. The TI 59 offers up to 960 steps or up to 100 memories. All three programmables come with instruction books and with the 58 and 59 a Master-Library solid-state software module that contains 25 prewritten programs in mathematics, statistics, finance and other application areas is included. Optional libraries are also available, including applied statistics, real estate/investment, surveying, aviation and marine navigation.

CIRCLE NO. 346

## Impact printer mates with M6800 systems



Motorola Semiconductor, P. O. Box 20924, Phoenix, AZ 85002. (602) 244-6900. \$1725 (60 Hz); stock.

Compatible with M6800 development systems, the EXORprint impact printer delivers up to 65 lines per minute. EXORprint produces lines of up to 80, 5 x 7 dot-matrix characters at 110/s, max. The impact head prints on 8.5-in.-wide roll paper using a conventional teletypewriter ribbon. Optoelectric sensing is used to accurately position each dot and to permit characters to be printed on the fly. A peripheral interface module connects the printer to the system bus. Functionally, EXORprint appears as a parallel interface Centronics 306 type printer. Versions of the printer operate from 110 V ac, 60 Hz or 230 V ac, 50 Hz.

CIRCLE NO. 347

# Introducing Cobaloy P-212. A completely new development in EMI/RFI shielding.

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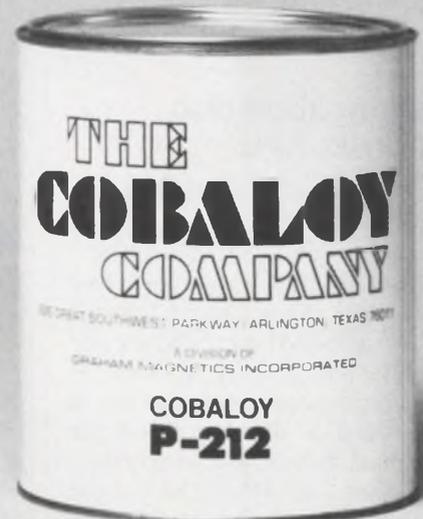
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## DATA PROCESSING

### Interface board drives 3 serial devices

*Incosan, Inc., 160 Woodport Rd., Sparta, NJ 07871. (201) 729-3197. \$695 (unit qty); stock.*

A single serial interface board drives three serial devices from a single omnibus slot in any DEC PDP8/A or PDP8/E computer. The board is particularly suited to a VT50 or VT52 TTY-replacement CRT, but accommodates any standard 20 mA unit. Selectable for each device are speed (75 to 9600 baud), IOT code, word length, parity and stop bit. The board may be operated without software modification.

CIRCLE NO. 348

### Flexible-disc system is unusually flexible

*Tri-Data Corp., 800 Maude Ave., Mountain View, CA 94043. Melinda Magnett (415) 969-3700. \$1995.*

The FlexiFile 11  $\mu$ P-controlled flexible disc system provides low-cost storage for data processing and data communications. It enables the user to write, edit, store and retrieve information on flexible discs without tying up communications lines and CPU time. Front panel switches permit selection of the operating mode, and manual access to 32 tracks. Software-controlled lights indicate current mode status. Storage capacity is 98,304 bytes per disc with a transfer rate of up to 5120 bytes/s. The unit weighs 20 lb and measures 17 x 8.6 x 8 in.

CIRCLE NO. 349

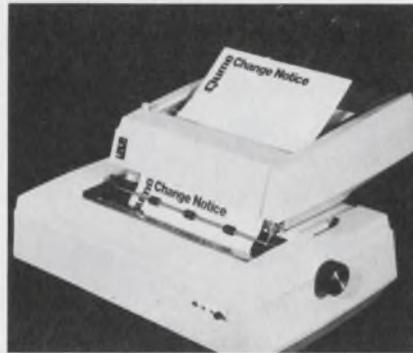
### IBM-compatible disc talks Basic, APL

*Sykes Datatronics, Inc., 375 Orchard St., Rochester, NY 14606. Albert J. Montevicchio (716) 458-8000. \$3000.*

Comm-Storr/5100 is a floppy-disc system, which plugs directly into the IBM 5100 serial I/O port without any changes in hardware or software. It features high-speed random access to any file on disc, directory-based file management system, and compatibility with Basic and APL. Files created under Basic can be read under APL and vice versa. The system comes with a tape cartridge containing 10 Basic key files and 14 APL functions. A dual drive is also available (\$4000).

CIRCLE NO. 350

### Piggyback feeder serves 'daisy' printer

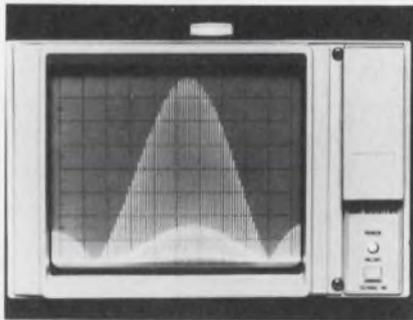


*Qume Corp., 2323 Industrial Parkway West, Hayward, CA 94545. (415) 783-6100. From \$1390 (unit qty); 12 wks.*

SpeedFeed is an add-on device that automatically inserts fresh paper into a printer and removes typed output under control of the customer's system. Designed to operate with any model of Qume's Q Series, Sprint 1 or Sprint Micro 3 Series of daisywheel printers, SpeedFeed accommodates a variety of paper types, weights, and sizes. Mounted atop a printer, SpeedFeed inserts paper directly into the printer's platen, then stores completed work in a hopper that holds up to 180 sheets in sizes up to 12 x 14 in.

CIRCLE NO. 356

### There's no 'phantom' on this monitor



*Tektronix, Inc., P. O. Box 500, Beaverton, OR 97077. Bob Down (503) 644-0161. \$1250 (unit qty); 12 wks.*

In the Model 608 display monitor, a special CRT design suppresses the "phantom" spot which causes washout of contrast in gray-scale images. Other features of the 608 that contribute to crisper displays are 35-ns z-axis rise time, 22.5-kV accelerating potential, and a spot size of 0.012 in. Display area is 12 x 15 cm. Bandwidth is 5 MHz in x-y and 10 MHz for the z-axis.

CIRCLE NO. 357

### Is it a terminal? Or is it a mini?



*Lear Siegler Inc., 714 N. Brookhurst St., Anaheim, CA 92803. (714) 754-1193. From \$7000.*

The VDP 1000 Video Display Processor defies classification. With a 16-bit computer, 16 kwords of high-speed memory (expandable to 32 k), and a virtual-memory operating system and dual floppy-disc backup storage built in, the VDP 1000 is more than a smart terminal. The 16 kword memory capacity is divided into 8 kwords of read-only memory for the terminal-handling program and 3 kwords for refresh and scrolling, leaving 5 kwords to user discretion.

CIRCLE NO. 358

### Plotter routine generates halftones



*Versatech, 2805 Bowers Ave., Santa Clara, CA 95051. Carl Larson (408) 988-2800. \$1000; 16 wks.*

Full gray-scale halftones are produced on any Versatec electrostatic plotter with the Fortran package "Versaplot gray scale," which maintains high contrast and sharp detail with more than 32 levels of gray. Blacks are 100% black, whites are 100% white. Versaplot can also modify digital images—a tiny picture can be enlarged to fill the entire width of the plotter, multiple images are possible, or single images can be stepped and repeated.

CIRCLE NO. 359

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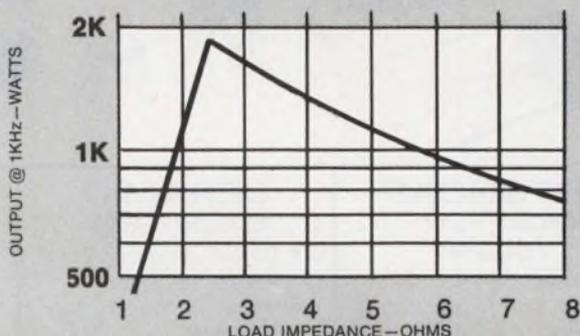
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CIRCLE NUMBER 66

## MODULES & SUBASSEMBLIES

### Isolate high voltages in instrument systems



Intronics, 57 Chapel St., Newton, MA 02158. Richard Beede (617) 332-7350. \$48 (100 qty); stock to 2 wks.

Common-mode voltages as high as 5 kV, ac peak or dc continuous, can be isolated from the output by the IA276 amplifier module. In cardiac monitoring applications, low-level signals can be separated from body noise by 80 dB and from 60-Hz noise by 126 dB. The unit will reject input source imbalances of up to 5 kΩ and has a small-signal bandwidth of 1 kHz. A double-shielded floating output can minimize ac and dc ground loops, maximizing signal-to-noise ratio.

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CIRCLE NUMBER 67

### Registers mate data bus to 12-bit d/a

Datel Systems, 1020 Turnpike St., Canton, MA 02021. E. Zuch (617) 828-8000. From \$99 (1-24 qty); stock to 4 wks.

A 12-bit storage register, internal to the DAC-HK12B series of d/a converters, eases interfacing to either minis or microcomputers. A Load input tells the 24-pin hybrid converter to either store or transfer the input data. In addition to the input registers the units contain a precision zener-reference, a reference control, three quad current switches and a fast output amplifier. The converter's 2 ppm/°C differential-linearity tempco gives you monotonicity over the operating temperature range. Additional features include: output-settling time of 3 μs to 1/2 LSB for a 10-V change; max linearity and differential-nonlinearity errors of ±1/2 LSB; and max gain tempco of ±20 ppm/°C. Four models are differentiated by case type and operating-temperature range. Straight-binary and offset-binary coding are standard; BCD and two's complement coding are options.

CIRCLE NO. 361

## Board adds controlled-gain channels to $\mu$ C

Signal Laboratories, 202 N. State College Blvd., Orange, CA 92668. D. Flagg (714) 634-1533. \$395; stock.

The programmable gain amplifier card is a Zilog Z80- $\mu$ C compatible accessory that offers two channels of computer-controlled amplification, each with both filtered and unfiltered outputs. Under control of the Z80, the gain of each channel can vary from unity (0 dB) through 54 dB (70 dB optional) in 2-dB increments with gain accuracy of 0.1% (0.01% optional). The Z80 can select any one of eight predetermined bandwidths for each channel's filtered output. Unfiltered outputs are 3-dB down at 50 kHz.

CIRCLE NO. 362

## Tiny rf unit switches and modulates pulses

Summit Engineering, 2311 S. Seventh Ave., P. O. Box 1906, Bozeman, MT 59715. (406) 587-0636. \$60 (unit qty); stock to 30 days.

An spst current-controlled attenuator can switch and modulate pulses in a 50- $\Omega$  system, up to 500 MHz. Typ midrange specifications include insertion loss of 2.5 dB, on/off ratio of 40 dB and switching-signal isolation of 25 dB. TO-5.

CIRCLE NO. 363

## MUXed 12-bit a/d mates via three-state logic

Zeltex, 940 Detroit Ave., Concord, CA 94518. R. Terry (415) 686-6660. \$225 (unit qty); stock to 30 days.

Bus interfacing is simple with the ZMP2000. Its 12-bit output, derived from one of the 16 multiplexed analog inputs, is presented via three-state logic. The module contains an s/h amp, 16 channels of FET-MUX switches, a 12-bit a/d converter plus all timing and control logic. Features of this data-acquisition system include: monotonicity from 0 to 70 C, max conversion time of 20  $\mu$ s, throughput rates up to 33,000 ch/s and differential linearity of  $\pm 1$  LSB with no missing codes. Standard inputs and outputs interface with CMOS, TTL logic is optional. 72-pin case, 3 x 4.6 x 0.375 in.

CIRCLE NO. 364

# Cabinets for Electronic Systems CX-9 Series



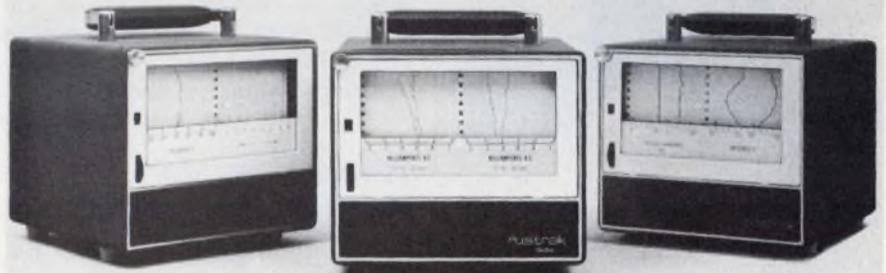
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CIRCLE NUMBER 68

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CIRCLE NUMBER 69

## Compact inductors feature low losses

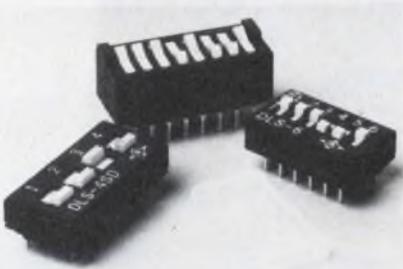


TRW Inc., 401 N. Broad St., Philadelphia, PA 19108. (215) 922-8900.

A small-sized family of power-switching inductors, the SR series, features low temperature rise and low-loss characteristics. The units have an inductance range of 8 to 10,000  $\mu$ H. Losses in the 3-to-100-kHz frequency range are low. Compact and easy to install, the devices have pin terminals for PC-board mounting. Many are available with double windings, which allow series, parallel, center-tapped or transformer connections.

CIRCLE NO. 365

## Dual in-line switches rock or slide



Alco Electronic Products, 1551 Osgood St., North Andover, MA 01845. (617) 685-4371. \$2.70: DSS-8 station (100 qty); 3 to 4 wks.

Two families of DIL switches offer designers a choice of rocker or slide actuation with between four and 10 stations. The DSS series has SPST rocker action and the DLS series SPST, a slide-actuated mechanism. Protective covers with built-in actuator locking features are available. The DLS family also includes SPDT models. All models have gold-plated contacts for dependable low-energy service over long periods of time. All terminals are sealed.

CIRCLE NO. 366

## LEDs viewable over 180° with high brightness

Data Display Products, 303 N. Oak St., Inglewood, CA 90301. (213) 677-6166. \$0.56 (1000-4999); stock to 6 wks.

Ledy Bug LEDs can be viewed with considerable brightness over more than 180 degrees of viewing angle. They are available in red, amber and green. Conventional LEDs maintain full brightness only over narrow angles—typically 30°—with clear encapsulation. The Ledy Bug achieves its wide-angle with a flat-topped cylindrical Lexan fresnel lens. And this cylindrical lens is more attractive than the standard round lens that comes with most LEDs. A flat area on the base of the lens denotes the cathode pin.

CIRCLE NO. 367

## Tilt switch packaged in welded-steel case

Fifth Dimension Inc., 7070 Alexander Rd., Princeton, NJ 08540. (609) 452-1200. Under \$1 (5000 qty); stock to 4 wks.

The TS7 precision tilt switch is normally open and operates when the switch is tilted 15  $\pm$  5 degrees in any direction from vertical. Other nominal angles of operation are available. The switch opens its contacts at 10  $\pm$  5 degrees from vertical. Hysteresis is less than 5 degrees. Not a glass capsule, but a rugged welded-steel package, the danger of broken capsules or mercury leakage is virtually eliminated. The mercury contacts of the unit are rated 1 A at 12 V dc or 0.5 A at 115 V ac. Contact resistance is under 1  $\Omega$ .

CIRCLE NO. 368

## Trimmer resistors MIL-R-39035 qualified

Bourns, Inc., 1200 Columbia Ave., Riverside, CA 92507. (714) 781-5050. Stock.

Trimmers of the RJR28 and RJR32 style are claimed by Bourns to be the first qualified under the reliability requirements of MIL-R-39035. The RJR28 unit features a 1/2-in.-long rectangular package, giving it a volume 1/10 of the smallest trimmer in its style now available. Key specifications include a 10-turn mechanism, resistance range of 10  $\Omega$  to 2 M $\Omega$  and a power rating of 0.6 W at 25 C, derated to 0 at 150 C. The RJR32 trimmer is T0-116 DIP sized for automatic insertion on PC boards, and it has 20-turn adjustability.

CIRCLE NO. 369

## Capacitive keyboard life is 3 $\times$ 10<sup>8</sup> operations



Cherry Electrical Products Corp., 3600 Sunset Ave., Waukegan, IL 60085. (312) 689-7702.

Cherry solid-state capacitive keyboards feature low-profile capacitive keys with no mechanical contacts. Virtually any customer requirement can be custom built. Life is estimated in excess of 300,000,000 operations, and the price will be competitive with mechanical contact units. The integrated keyboard encoder requires only a 5-V-dc supply. Up to 10 bits for 110 keys and four modes per key can be encoded. Codes are designed-in with a low-cost mask option and any code can be selected. Scan time is extremely adjustable from 10 to 80  $\mu$ s per key. A noise-immunity circuit distinguishes "good" keys from noise. Also featured is a key-recognition circuit to eliminate key teasing. Burst-rate speed capability is 1000 characters per second.

CIRCLE NO. 370

## 53-key ASCII keyboard available in kit form



George Risk Industries, GRI Plaza, Kimball, NE 69145. (308) 235-4645. \$59.95: kit, \$71.25: assembled (unit qty); stock.

The KBM series Model 753 key-switches and glass-epoxy PC-board circuit allow user selection of data and strobe polarity, parity sense, upper-case alpha-lock and access to three user-definable keys for custom keycode or function key assignment. The switchboard is available either in kit or assembled form and comes with full documentation. Estimated construction time is 2 h. A custom plastic enclosure, Model 701, precut for the 753 keyboard is also available.

CIRCLE NO. 371

## Bodine has doubled its AC horsepower



AVAILABLE FROM STOCK

And our new 48-frame TEFC parallel shaft and right angle gearmotor designs are shorter, too. Proven gearheads with ratios from 5:1 through 60:1. Speeds from 340 through 28 Rpm. And torques through 330 Lb-in. Available in all popular AC windings and voltages. In a wide range of mounting configurations. You can get continuous duty ratings through 1/3 Hp—with gearhead or without. But get all the facts. Write for Catalog S.

ADE (After Delivery Economies)  
make Bodine a better fhp buy



Bodine Electric Company, 2500 W. Bradley Place, Chicago, IL 60618.

CIRCLE NUMBER 70

## NEW!



**A mighty big  
catalog about  
some mighty  
small switches.**

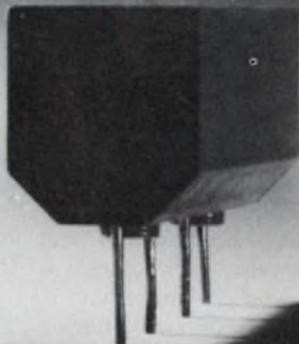
This 44 page catalog consolidates the complete line of C&K small switches into a single, fact-filled, easy-to-read volume. It includes everything you need to know about toggles, rocker and lever handles, printed circuit mountings, snap-acting pushbuttons, 6 AMP alternate action and momentary pushbuttons, subminiature and microminiature pushbuttons, illuminated rockers, miniature power, slide, and thumbwheel switches—plus how-to-order information and a complete list of worldwide C&K distributors. Ask for your free copy and we'll show you a million and one ways to turn on the juice.

**C&K Components, Inc.**, 103 Morse Street, Watertown, MA 02172  
TEL: (617) 926-0800 TWX: 710 327-0460 TELEX: 92 2546

Free Engineering Samples on Request.

CIRCLE NUMBER 72

## Special Relays — QUICKLY



### Customer Designs Own Relay

One of our customers needed a relay to switch an Amp at 50 volts, inductive. Together we filled out an EAC application questionnaire. The result? A satisfied customer, and the specs below.

1 Amp switching current, 4 Amp surge current.  
5, 6, 12, 24, or 48 volt DC coil voltage  
switches inductive loads with little or no arc  
suppression to 50 V DC or AC  
Size is 0.4 x 0.4 x 1.0 inch

You can design your relay too — just call, write, or twx us for your copy of the EAC application questionnaire.



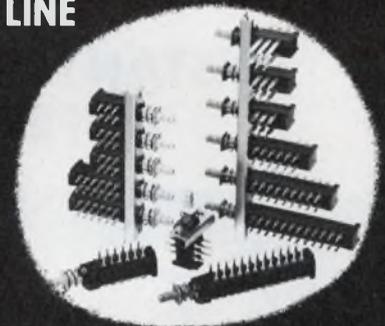
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Applications  
Company

4918 Santa Anita Avenue, El Monte, CA 91734  
213 / 442-3212 Twx 910 / 587-3351

CIRCLE NUMBER 71

ELECTRONIC DESIGN 16, August 2, 1977

## NEW MULTI PUSH-BUTTON SWITCH LINE FROM SMK



The JP-7000 Series Multi Push-Button Switches include interlocking, self-locking, momentary or reset type switches that are available with either 15 or 20MM spacing in DPDT, 4PDT, 6PDT, and 8PDT configurations. The switches are rated at 300mA @ 30V DC and operate from -10°C to +70°C with a mechanical life expectancy of 30,000 cycles. Up to a maximum of 6 switch stations can be interlocked if desired, and up to 12 switches can be mounted on the same frame. Representatives throughout the U.S. Call, write or wire:

SMK

SMK Electronics Corporation  
of America

118 East Savarona Way Carson, California 90746  
Tel: (213) 770-8915

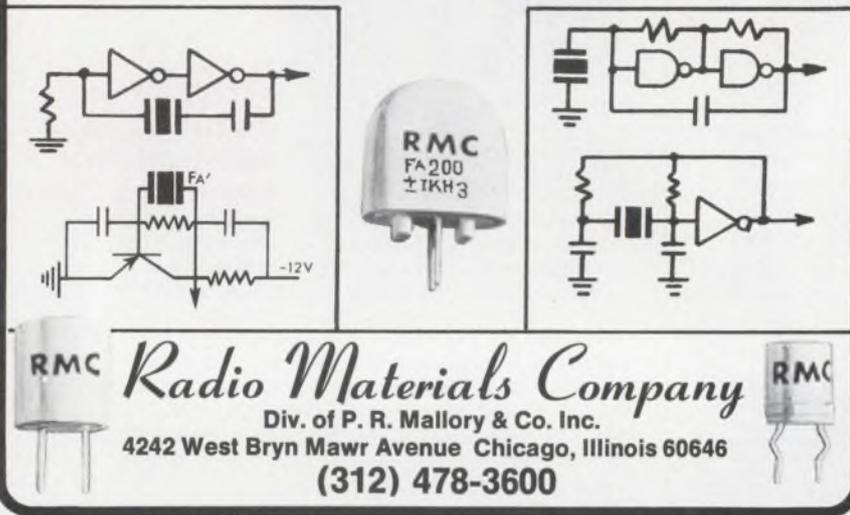
CIRCLE NUMBER 73

# THE UN-QUARTZ RESONATOR

## RMC CERAMIC RESONATOR

**WHY** pay for quartz, if quartz accuracy is not required in your digital clock generator—**USE RMC CERAMIC RESONATORS.**

**ONLY 55¢** in 100 quantities for any oscillator frequency between 195 KHz and 600 KHz,  $\pm 1$  KHz. Less in larger quantities. Temperature stability:  $< \pm 0.2\%$  ( $-20^{\circ}\text{C}$  to  $+65^{\circ}\text{C}$ ).



The advertisement features several circuit diagrams and a photograph of the RMC ceramic resonator. On the left, there are two diagrams: the top one shows a simple oscillator circuit with a feedback loop, and the bottom one shows a more complex circuit with a -12V supply. In the center is a photograph of the RMC FA200  $\pm 1\text{KHz}$  resonator component. On the right, there are two more circuit diagrams, one showing a square wave generator and another showing a different oscillator configuration. At the bottom, the RMC logo is flanked by the company name and address.

**Radio Materials Company**  
Div. of P. R. Mallory & Co. Inc.  
4242 West Bryn Mawr Avenue Chicago, Illinois 60646  
(312) 478-3600

CIRCLE NUMBER 74

## NEW! INSTANT FREQUENCY DIFFERENCE!



**Tracor Model 527A measures frequency difference instantly, precisely. For precisely \$3,150.** Front-panel meter reads directly to parts per  $10^{11}$ . Allows adjustment of two oscillators to the same frequency, adjustment to a specific offset, determination of offset—all instantly. Plus both short-term and long-term stability analysis. Internal oscilloscope extends precision to  $1 \times 10^{-12}$ . Reference and signal frequencies need not be the same. Write or call for full technical and application information.

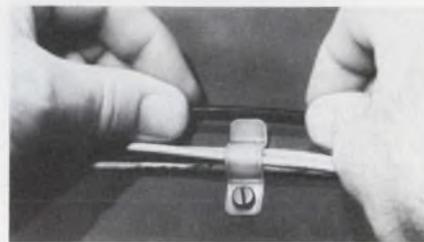
**Tracor** Industrial Instruments

6500 Tracor Lane • Austin, Texas 78721 • AC 512/926-2800

CIRCLE NUMBER 75

## PACKAGING & MATERIALS

### Flexible clip holds wires securely

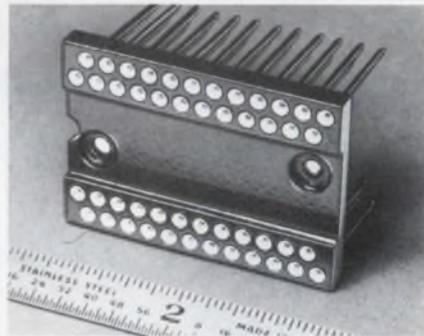


Weckesser Co., Inc., 4444 W. Irving Park Rd., Chicago, IL 60641. David Haines (312) 282-8626. \$20.53/100 (50,000 qty); stock.

The nylon Flex-Clip is specifically designed for convenience in the initial assembly of wires. Wires can be easily slipped in and out of a specially designed lip. Nevertheless, the clip's contour design and the spring-back flexibility of nylon holds bundles of wires securely.

CIRCLE NO. 372

### Quad in-line socket accepts LSI packages



Garry Mfg. Co., 1010 Jersey Ave., New Brunswick, NJ 08902. Harry A. Koppel (201) 545-2424. \$1 to \$2.50; stock.

A 48-position QUILL (Quad-in-line) socket for packaging LSI and MSI headers accepts the Motorola QUILL M10800 and Texas Instruments SN-74581 series of bipolar devices. The headers are low-profile—made of thermoplastic Valox 420 SEO, UL 94VO listed—and use four-leaf beryllium-copper sockets for high retention. Closed-entry design prevents damage from misalignment of the IC chip-lead frame. Terminal sleeves are brass and available with either gold-over-nickel or electrotin-over-copper plate. They are supplied with dip-solder terminals, P/N 860-48-CC-D, and 0.025-in.<sup>2</sup> solderless wire wrap terminals, P/N 860-48-AA-D.

CIRCLE NO. 373

## INSTRUMENTATION

### Clamp-on meter reads digitally

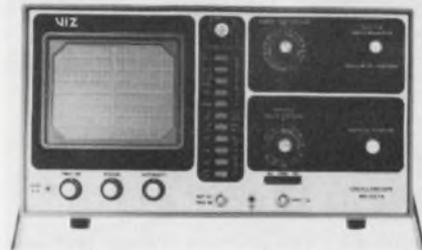


Amprobe Instrument, 630 Merrick Rd., Lynbrook, NY 11563. (516) 593-5600. \$149.85, effective Aug. 1, 1977.

Model ACD-1 clamp-on volt/amp/ohmmeter, with digital readout, eliminates the possibility of reading incorrectly. The 3-digit readout is 0.43-in. high. Values under 100 are shown to the nearest tenth. The jaws of the new instrument take a conductor as large as 2 in. in diameter. Ranging is automatic.

CIRCLE NO. 374

### 15-MHz scope offers triggering features



VIZ Test Instruments Group, 335 E. Price St., Philadelphia, PA 19144. (215) 844-2626. \$479 (dealer optional).

The WO-527A 5-in. triggered scope offers a vertical-amplifier frequency response to 15 MHz. The bandwidth of the horizontal amplifier covers dc to 1 MHz. Front-panel pushbutton switches control the display-mode and sweep-function selection. The trigger-level adjustment system uses LEDs to indicate trigger polarity at a glance. Sensitivity is 10 mV/cm.

CIRCLE NO. 375

### $\mu$ P controls modes in frequency synthesizer



Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, CA 94304. (415) 493-1501. \$7000; 90 days.

Model 3335A  $\mu$ P based, 200-Hz to 80-MHz frequency synthesizer provides a resolution of 0.001 Hz and amplitude flatness of 0.15 dB over its entire range. For automated instrumentation systems, the 3335A includes the HP-IB (IEEE-488) interface bus as a standard feature. Among the benefits provided by the  $\mu$ P is control of the automatic, manual and single-sweep modes. At turn-on, the  $\mu$ P sets the instrument to 1 MHz at minimum output. Up to 10 instrument settings can be stored in 10 memory registers for later recall.

CIRCLE NO. 376

## Here are the latest additions to the Par.Metal line of modern electronic housings!



### new... sectional wall cabinets

WC SERIES

Made of 3 sections —

- Wall mounted rear unit — 4" deep
- Center body section — 12" deep
- Front door — 2" deep

### new... low silhouette console cabinets

MODEL FS-21

Designed for any control requirement

- Provides unobstructed views
- Modular units for grouping
- 21" wide x 44" high x 24" deep

### new... mod-cab welded desk cabinets

DC SERIES

- Panel heights from 3½" to 21"
- Two panel widths 9½" and 19"
- Three depths — 12", 18" and 22"
- Choice of 10 colors with walnut or black vinyl aluminum trim

SEND FOR COMPLETE LITERATURE OF PAR-METAL'S PACKAGING SYSTEMS

## Par.Metal PRODUCTS, INC.

1260 Atlantic Ave., Brooklyn, N.Y. 11216 (212) 772-5800



CIRCLE NUMBER 76

## POWER SOURCES

### Unregulated dc supply powers microprocessors

Standard Power, Inc., 1400 S. Village Way, Santa Ana, CA 92705. Carroll Goldsworth (714) 558-8512. \$27.50; stock.

Microprocessors and peripherals with on-board voltage regulators can use the compact SMP 30B supply. Three output voltages (+9 V dc at 1 A and  $\pm 18$  V at 0.5 A) are provided, with either 115-V or 230-V, 50 or 60-Hz, input. The unit is one of a series of 13 SMP models that provide three or four output voltages with power handling capabilities from 30 to 100 W. The unit measures  $3\frac{1}{2}$  (W)  $\times$   $3\frac{1}{2}$  (H)  $\times$   $4\frac{1}{4}$  (L) in. and weighs 2.1 lb.

CIRCLE NO. 377

### Battery power systems handle critical loads



Stored Energy Systems, 2271 Mora Dr., Mountain View, CA 94040. Herb Kaewert (415) 961-7500. From \$600 (unit qty).

Power sources for loads that cannot be interrupted are provided by the BPS line. The units contain a battery, control system and a battery charger. Available in capacities from 20 to 1700 A-h, the units can contain one of five different battery types: high performance nickel cadmium, high capacity nickel cadmium, lead-planté, lead-antimony or lead calcium. The battery and charger sections are isolated by acid-alkali resistant steel housings.

CIRCLE NO. 378

## MICROWAVES & LASERS

### Continuous mixer covers 0.2 to 22 GHz

Vari L Co., Inc., 3883 Monaco Parkway, Denver, CO 80207. (303) 321-1511. \$650 (1-9 qty); 8 wks.

The DBM-1800 is a doubly balanced mixer with a continuous frequency response from 200 MHz to 22 GHz, and i-f response from 5 MHz to 7 GHz. Typical performance specs include: conversion loss, 8.0 dB; isolation, 25 dB; VSWR,  $\leq 3:1$ . The mixer package measures  $2.3 \times 1.3 \times 0.85$  in. Hermetically sealed version is available.

CIRCLE NO. 379

### Compact coax attenuators give 70 dB in 10-dB steps



Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, CA 94304. (415) 493-1501. \$690 and \$1050; 4-6 wks.

Models 33321D (manual) and 33321K (programmable) coaxial step attenuators offer a range of 70 dB in 10-dB steps and mode-free operation to 26.5 GHz. Both models fit a  $6.6 \times 2.1 \times 1.7$ -in. envelope. Repeatability is typically 0.05 dB after 1 million steps. Typical accuracy is 7% of dB reading at 26.5 GHz, where SWR  $< 2.2$ .

CIRCLE NO. 380

### Superfast attenuator clips 10 dB in 1 $\mu$ s

Avantek Inc., 3175 Bowers Ave., Santa Clara, CA 95051. Bob Goff (408) 249-0700. \$60 (1-5); 30 days.

Hermetically sealed in a TO-8 package, the UTF-025 voltage-controlled attenuator typically zips from 0 to 25 dB in 2.5  $\mu$ s. It is designed to work with 5-to-2500-MHz amplifier modules, and works over -54 to 100 C without degradation. Flat attenuation, high voltage-vs-attenuation linearity, improved intermodulation and a positive control voltage also contribute to the UTF-025's remarkable performance.

CIRCLE NO. 381

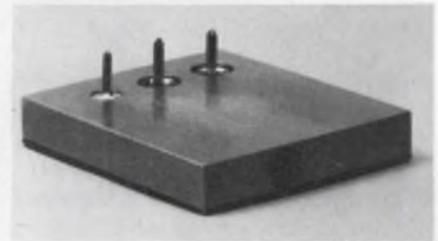
### GaAs power FET handles 1 W at 8 GHz

Microwave Semiconductor Corp., 100 School House Rd., Somerset, NJ 08873. Richard Moffett (201) 469-3311. \$575 (100 qty); 1 wk.

The 88004 GaAs FET has a bandwidth of 2 to 10 GHz and a power capability of 1 W at 8 GHz. Designed for oscillators and linear power amplifiers, these flip-chip bonded devices have half the thermal resistance and common-source inductance of their predecessors. Three other GaAs FET models in the 88000 series offer various combinations of power, gain, and thermal resistance.

CIRCLE NO. 382

### Tiny VCO reaches 3 GHz



Applied Research, Inc., 76 S. Bayles Ave., Port Washington, NY 11050. Aldo Scandurra (516) 883-5700. \$150 (50 qty); 4-6 wks.

The matchbook-size VCOs, series OSC, are designed for PC board insertion. Standard octave ranges start at 100 to 200 MHz, and go to 700 to 1500 MHz, 1.5 to 2 GHz, and experimental units reaching 3 GHz are also available. Power output is greater than 0 dBm, and linearity is  $\pm 1\%$ .

CIRCLE NO. 383

### Canned amplifier boasts 13 dB at 2 GHz

Watkins-Johnson Co., 3333 Hillview Ave., Palo Alto, CA 94303. (415) 493-4141. \$140; stock.

A low-noise, 10 to 2000-MHz amplifier in a TO-8 can, the WJ-A31, offers a typical noise figure of 3.7 dB with a gain of typically 13 dB. The A31 provides -2-dBm output power capability at the 1-dB compression point. Cascaded with other TO-8 amplifiers, an over-all typical performance of 3.9-dB noise figure, 42-dB gain, and +15-dBm power output over the full 10 to 2000-MHz range is possible.

CIRCLE NO. 384

# now there is one... in signal processing

## IF and Microwave Components From One Source.

Where others cut-off at 1 GHz, and still others begin at 1 GHz, Merrimac does it all from DC-18 GHz with lumped elements, stripline or ferrites. For years Merrimac has been a leader in IF while quietly manufacturing components for microwave systems. Now, we have two complete Signal Processing lines with IF, RF, microwave components and subsystems where we can meet your particular needs from over 700 standard off-the-shelf devices.

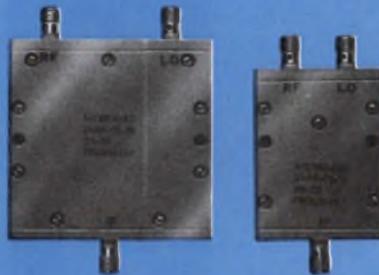
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## SINGLE AND DOUBLE BALANCED MICROWAVE STRIPLINE MIXERS



### 1.7-18 GHz

Check our minimum performance characteristics and see for yourself why Merrimac has the winning combination for you...

#### SINGLE BALANCED MICROWAVE STRIPLINE MIXERS

MODEL SMM-01-	RF & LO FREQ. (GHz)	IF BW (MHz)	ISOLAT'N dB (MIN)	NOISE FIG. dB (MAX)	CONV. LOSS dB (MAX)
2 95 G	1.7-4.2	DC-400	6	8.0	6.5
3 G	2.0-4.0	DC-400	8	7.5	6.5
3 90 G	2.6-5.2	DC-400	7	7.5	6.5
6 G	4.0-8.0	DC-400	6	8.0	7.0
10 G	8.0-12.4	DC-1000	6	8.5	7.5
15 G	12.4-18	DC-1500	6	9.0	8.0

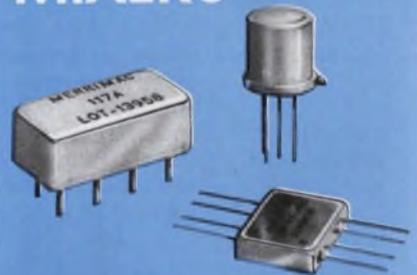
#### DOUBLE BALANCED MICROWAVE STRIPLINE MIXERS

MODEL DBM-01-	RF & LO FREQ. (GHz)	IF BW (MHz)	ISOLAT'N dB (MIN)	NOISE FIG. dB (MAX)	CONV. LOSS dB (MAX)
2 95 G	1.7-4.2	DC-400	20	8.5	7.5
3 G	2.0-4.0	DC-400	20	8.0	7.0
3 90 G	2.6-5.2	DC-400	20	8.5	7.5
6 G	4.0-8.0	DC-400	20	9.0	8.0
8 G	6.0-12.4	DC-400	16	9.5	8.5
10 G	8.0-12.4	DC-700	18	9.0	8.0
15 G	12.4-18	DC-1000	15	10.0	9.0

send for our  
**NEW '77 MICROWAVE  
CATALOG.**

Circle the Reader Service Number 238

## DOUBLE BALANCED MIXERS



### DC to 1 GHz — in TO-5, Flat Pack or Relay Header

Check our minimum performance characteristics and see for yourself why Merrimac has the winning combination for you...

DC-500 MHz MODELS				
PACKAGE	MODEL NO.'S	PRICE	CONVERSION LOSS	ISOLATION (DB-MIN)
RELAY HEADER	117A	\$ 8.45	5.5 dB Typ. 8.0 dB Max	L-R 40-30 L-X 35-20
FLAT PACK	DMF-2A-250	\$28.00	7.0 dB Typ. 8.0 dB Max	L-R 40-35 L-X 30-20
TO-5 (0.3" HIGH)	M-109	\$25.00	6.0 dB Typ. 8.5 dB Max	L-R 40-25 L-X 30-18
DC-1000 MHz MODELS				
RELAY HEADER	M-119	\$15.00	7.0 dB Typ. 8.0 dB Max	L-R 30-20 L-X 25-15
FLAT PACK	DMF-2A-505	\$28.00	7.5 dB Typ. 8.0 dB Max	L-R 35-25 L-X 30-20
TO-5 (0.3" HIGH)	M-122	\$38.00	6.5 dB Typ. 9.5 dB Max	L-R 40-25 L-X 30-20

LO POWER (ALL MODELS) +7 DBM NOMINAL

Send for complete data on the above Mixers and we will also include free MTBF data and information on our complete line of DC-3GHz "Connectorized" Single and Double Balanced Mixers.

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COMPONENTS**

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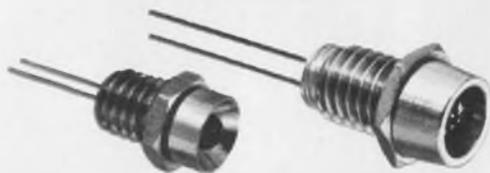
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# Bright 'n Beautiful!

## MIN-Lites

LED INDICATORS



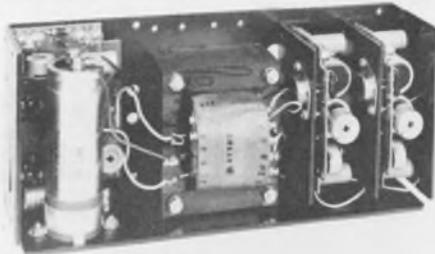
Minelco's bright new 1550 Series LED indicators are made to be seen. High intensity LEDs, set into a beautifully finished and plated threaded mount to enhance your finest up-front panels. Low voltage, fully IC compatible, with fast switching time, and an exceptionally long life expectancy. **Write or call for prototypes and Bulletin C-21.** Minelco — A Talley Industries Company, 135 South Main St., Thomaston, Conn. 06787. Phone (203) 283-8261.

...from **Minelco**



CIRCLE NUMBER 77

## MICROPROCESSOR POWER SUPPLIES



### Featuring . . . High Reliability and Low Cost

Now Power/Mate introduces a series of triple output, open frame power supplies designed specifically for microprocessor users.

Based on a rugged, field proven design, the ETR series of microprocessor power supplies features Dual AC Input, remote sensing, adjustable current limiting and plug-in IC regulation throughout the line.

Built to the same rigid quality standards that have made Power/Mate the industry leader, they offer a very impressive 100,000 hour MTBF.

Best of all, the ETR series is economical and in stock. Call or write for our free brochure.



### POWER/MATE CORP.

World's largest manufacturer of quality power supplies.

514 South River Street/Hackensack, N.J. 07601/Phone (201) 343-6294 TWX 710-990-5023

CIRCLE NUMBER 78

## Application notes

### Detector diodes

Using a zero-bias Schottky detector diode is the subject of a four-page application note. Hewlett-Packard, Palo Alto, CA

CIRCLE NO. 385

### Software programs

"Software Programs" describes the company's repertoire of software programs to support the Z80-microcomputer family. Also available are brochures describing the Z80-MCS-microcomputer system, the Z80 and Z80A CPUs and Z80A-microcomputer-board series. Zilog, Cupertino, CA

CIRCLE NO. 386

### 4-k RAMs

Selecting worst-case test procedures for 4-k RAM devices is described in an application note. Macrodata, Woodland Hills, CA

CIRCLE NO. 387

### Alphanumeric display

"Applying the DL-1416 alphanumeric display" covers: device electrical description and operation; considerations for general-circuit designs; multidigit display systems; and interfacing to the 6800, Z80, and 8080 microprocessors. Litronix, Cupertino, CA

CIRCLE NO. 388

### $\mu$ C system design

Three publications describe major trends in microcomputer-system design—the use of high-density dynamic RAMs, single-chip  $\mu$ Cs and  $\mu$ C-based OEM computers. Intel, Santa Clara, CA

CIRCLE NO. 389

### Microwave components

Check full of performance graphs, specifications and photos, a 68-page "Microwave Component Applications" guide is a helpful aid when designing with modular amplifiers. Also available is an eight-page booklet, "A 1 GHz Prescaler Using GPD Series Thin-film Amplifier Modules." AvanteK, Santa Clara, CA

CIRCLE NO. 390

## New literature



### Plug-in oscilloscopes

A booklet offers help in selecting both plug-in modules and mainframes for the 7000-Series and 5000-series oscilloscopes. The selection procedure is designed to best match an oscilloscope to your present needs while providing expansion capability to meet future needs. Tektronix, Beaverton, OR

CIRCLE NO. 391

### Electrical components

Photographs, engineering drawings, and specifications of switches, relays and solenoids are found in a 52-page catalog. Oak Industries, Crystal Lake, IL

CIRCLE NO. 392

### Digital indicators

Complete specifications, option descriptions, and prices of the Trendicator digital indicators are contained in an eight-page brochure. Doric Scientific, San Diego, CA

CIRCLE NO. 393

### Desktop computing system

A desktop computing system, featuring the data-retrieval power of a mainframe, is the subject of a six-page brochure. Wang Laboratories, Lowell, MA

CIRCLE NO. 394

### Connectors

Specifications on series 1000, 2000 and 3000 miniature connectors are provided in a 16-page catalog. Methode Electronics, Rolling Meadows, IL

CIRCLE NO. 395

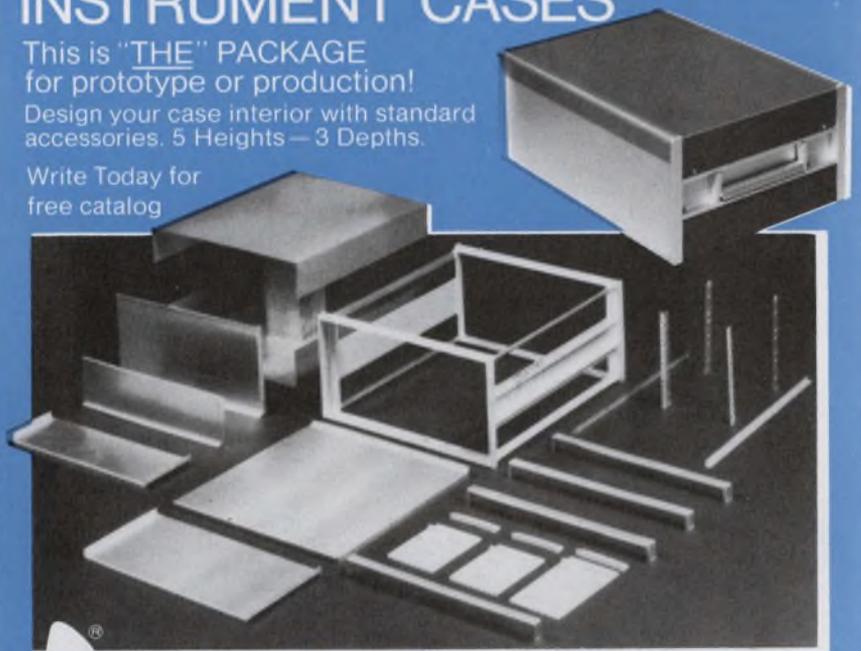
ELECTRONIC DESIGN 16, August 2, 1977

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**NEW LITERATURE**



**Solid-state keyboards**

Included in a six-page brochure are several full-scale photographs showing a solid-state capacitive keyboard in full view and low profile. Features and engineering drawings of an encoder are included. Cherry Electrical Products, Waukegan, IL

CIRCLE NO. 396

**Displays**

Bright low-voltage displays for calculators, DMMs, test equipment, car dashboards, clocks, radios, and POS terminals are shown in a guide. NEC America, Santa Clara, CA

CIRCLE NO. 397

**5-1/2-digit DMM**

Specifications of the DMM 52 5-1/2 digit, laboratory/systems type, digital multimeter are given in a four-page brochure. Aiken Industries, San Diego, CA

CIRCLE NO. 398

**Precision pots, dials**

Single and multiturn, laboratory and rectilinear-precision and non-precision potentiometers are covered in a 68-page catalog. Turns-counting dials are included. To simplify searching, two tables of contents organize products—one by key parameters and one by model numbers. Beckman Instruments, Helipot Div., Fullerton, CA

CIRCLE NO. 399

**Thermal cutoffs**

Specifications for thermal cutoffs, multiprotectors and pressure switches are given in a 16-page brochure. Micro Devices Div., Emerson Electric, Dayton, OH

CIRCLE NO. 403

## Panels and accessories

Packaging panels and accessories, DIP and transistor sockets, test jacks, and feedthrough terminals are covered in this 52-page catalog. Photos, schematics, and complete specs are included. Electronic Molding Corp., Woonsocket, RI

CIRCLE NO. 404

## Batch control systems

Listing over 40 industrial process applications, a 12-page bulletin describes different levels of batch control and the related instrumentation used. Programs for single-loop, multiple-loop, and multi-unit systems are included. The Foxboro Co., Foxboro, MA

CIRCLE NO. 405

## CMOS ICs

A catalog gives characteristics of CMOS integrated circuits for clock and timing applications. Circuits included in the catalog are frequency dividers, decoders, and ripple counters, as well as a combination inverter-ripple counter-control logic device. Sprague Electric, North Adams, MA

CIRCLE NO. 406

## Test instruments

Test instruments including oscilloscopes, frequency counters, digital and analog multimeters, audio and rf signal generators, semiconductor testers, power supplies, and CB and TV test instruments are featured in a 44-page catalog. B&K Precision, Chicago, IL

CIRCLE NO. 407

## Microwave equipment

An 88-page coaxial and waveguide catalog gives product information and specifications on more than 350 microwave components used in measurement. Hewlett-Packard, Palo Alto, CA

CIRCLE NO. 408

## Multicounters

The 1910A and 1911A automatic multicounters are highlighted in a four-page brochure. Specifications, ordering information and prices are included. John Fluke Mfg. Co., Mountlake Terrace, WA

CIRCLE NO. 409

## Linear ICs

A 992-page technical manual describes more than 275 linear ICs and modules. Fully illustrated. GTE Sylvia, Stamford, CT

CIRCLE NO. 410

## Motor-speed controls

Prices, photos and schematics are given in a motor-speed controls catalog. Electrol, York, PA

CIRCLE NO. 411

## Memories

The 928-page 1977 data catalog presents an update of Intel's products and services. Sections of the catalog cover memory components, memory systems, microcomputer components and systems, OEM computer systems, MDS, software, user's software library, training courses and literature. The catalog costs \$2.50 each. Intel, Literature Dept., 3065 Bowers Ave., Santa Clara, CA 95051

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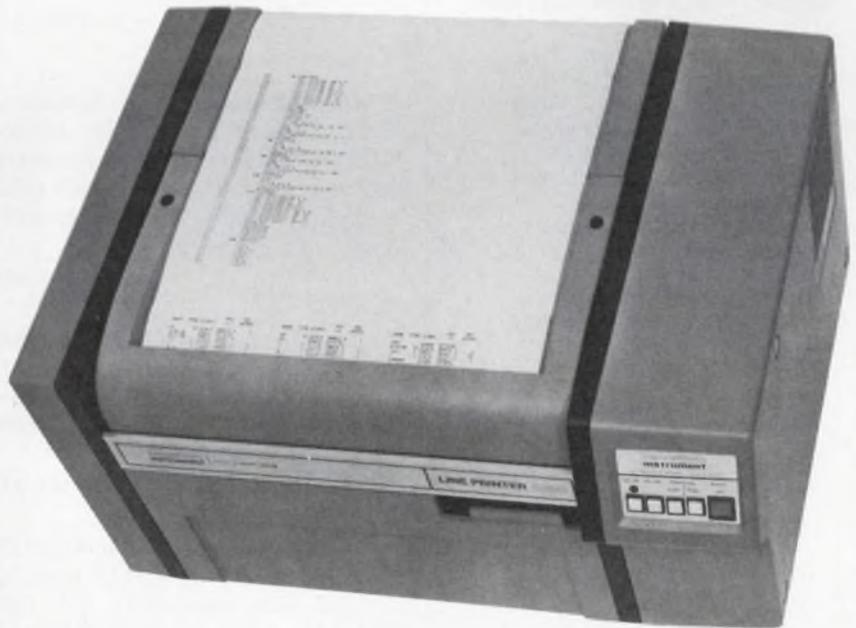
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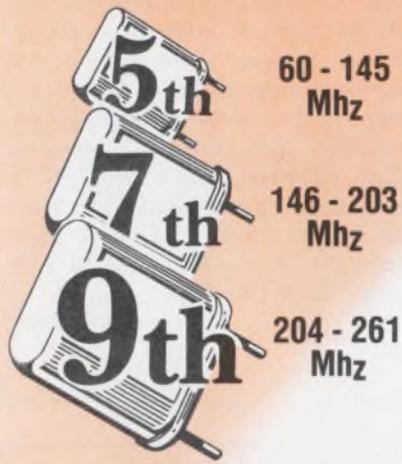
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CIRCLE NUMBER 84

## Bulletin board

**National Semiconductor's muPro-80 development system** now costs \$3950 as part of National's 8080A design package.

CIRCLE NO. 412

**Solitron Devices' Semiconductor Div.** has introduced two **nnp, high-voltage, planar, power transistors**—the 2N 6306 and 6308—that have recently received JAN, JAN-TX and JAN-TXV approval.

CIRCLE NO. 413

**Texas Instruments' new regulating pulse-width modulator, the SG3524,** is functionally equivalent to the Silicon General part with the same designation.

CIRCLE NO. 414

**The Integrated Circuit Div. of Motorola** has introduced its **1.5 and 2-MHz versions of the M6800 microcomputer components.** The new parts, in addition to the 50 to 100% improvement of throughput potential, have a power dissipation that is about 20% less than their M6800 predecessors.

CIRCLE NO. 415

**Ryan-McFarland** has introduced ROM versions of its 8080 MICRO BASIC runtime system. The firmware, delivered as a set of four 2308 (1024 × 8) parts, is priced at \$120 per set in single unit quantities.

CIRCLE NO. 416

**Honeywell** has reduced purchase prices 35% on memories above 512 kwords for its **large-scale Series 60—Level 66 and 68—and Series 6000 computer systems.**

CIRCLE NO. 417

**Intersil** has entered the **bipolar FET op amp** market by second sourcing National Semiconductor's LF 155/156A/155A and LF 355/356A/355A linear circuits.

CIRCLE NO. 418

**Mostek** has licensed Motorola as second source for the **MK 3870 single-chip microcomputer.**

CIRCLE NO. 419

## Vendors report

Annual and interim reports can provide much more than financial position information. They often include the first public disclosure of new products, new techniques and new directions of our vendors and customers. Further, they often contain superb analyses of segments of industry that a company serves.

Selected companies with recent reports are listed here with their main electronic products or services. For a copy, circle the indicated number.

**Belden.** Wire, cable and cord.

CIRCLE NO. 420

**Decision Data Computer Corp.** Computer peripherals.

CIRCLE NO. 421

**Thomas & Betts.** Electrical/electronic connectors, terminals, fittings and accessories and related application tooling.

CIRCLE NO. 422

**Bunker Ramo.** Development, manufacture and leasing of electrical and electronic components.

CIRCLE NO. 423

**General Automation.** Computers and software.

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**Sierracin.** Transparency products; heating and sensing devices; precision servo motors, and components.

CIRCLE NO. 425

**Oak Industries.** Components, controls, materials and communications.

CIRCLE NO. 426

**Ball Corp.** Glass containers and computer products.

CIRCLE NO. 427

**AMP.** Connection, switching and programming devices and application tools and machines.

CIRCLE NO. 428

**Cutler-Hammer.** Electrical/electronic equipment and aerospace systems and subsystems.

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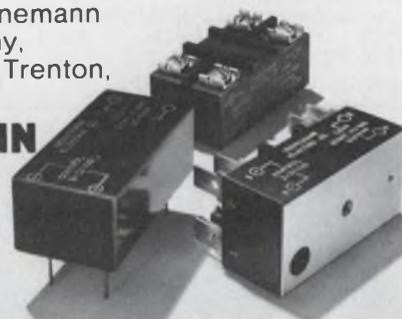
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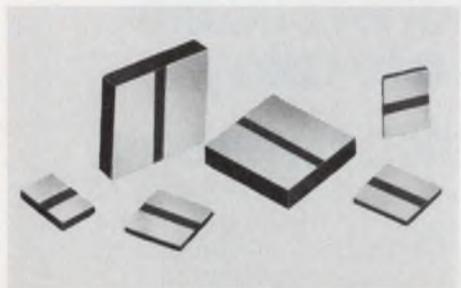
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CERAMIC CHIP CAPACITORS

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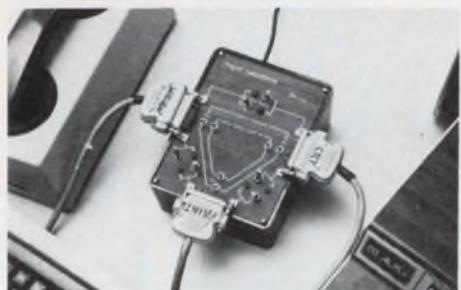
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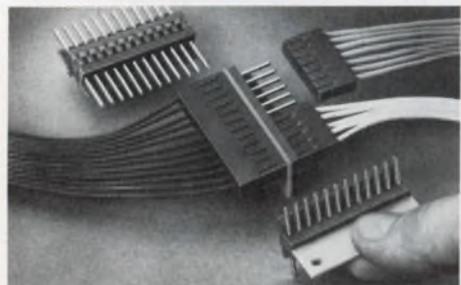
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PLANAR CATALOG

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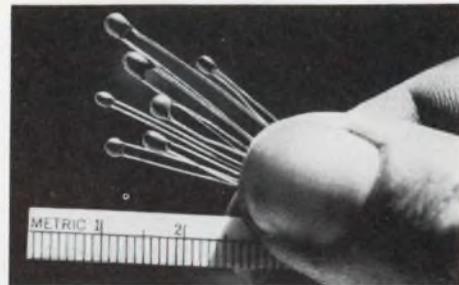
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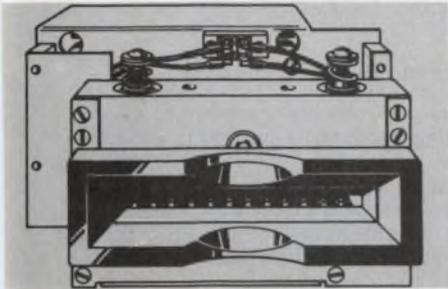
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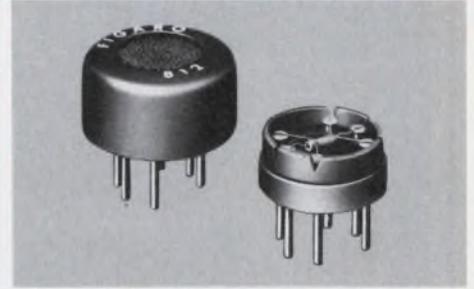
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COMBINATION CARD READER 190



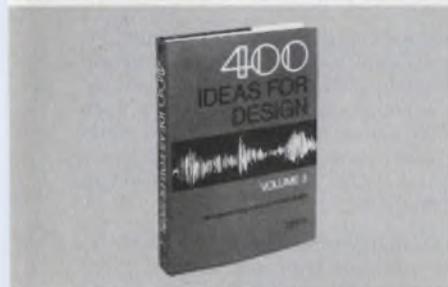
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GAS SENSOR 196



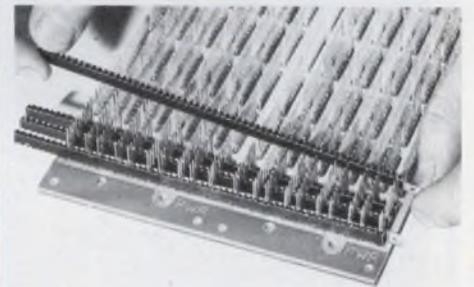
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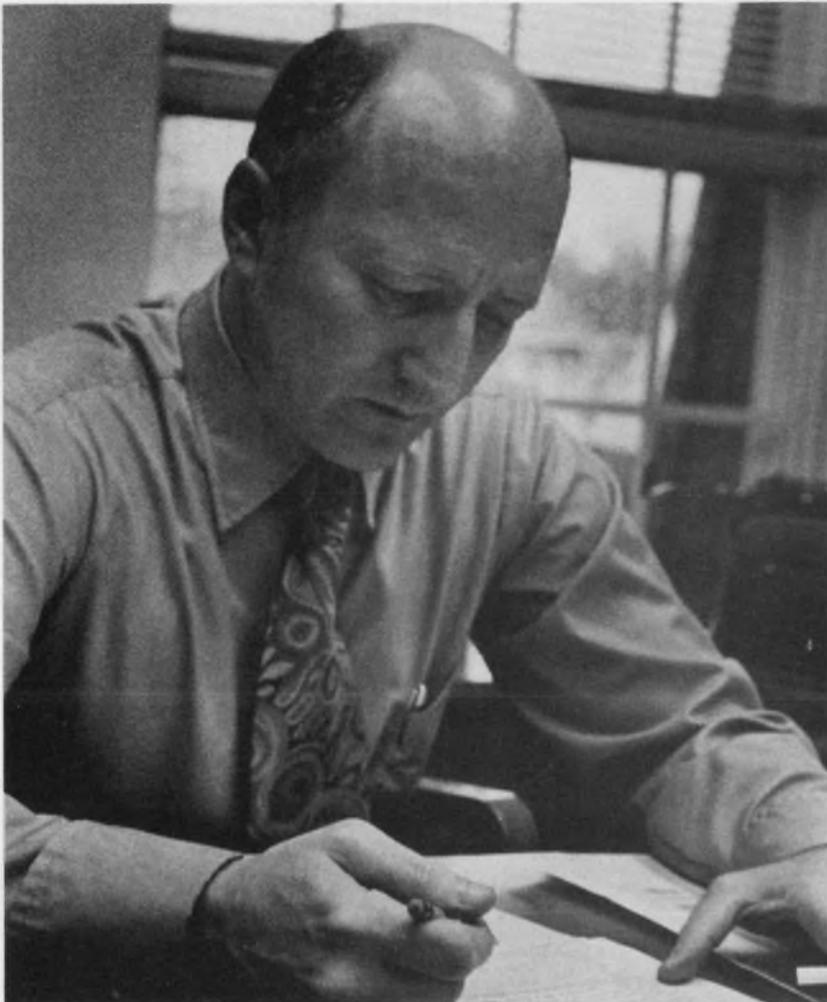
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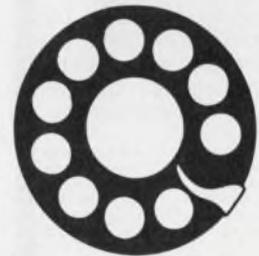
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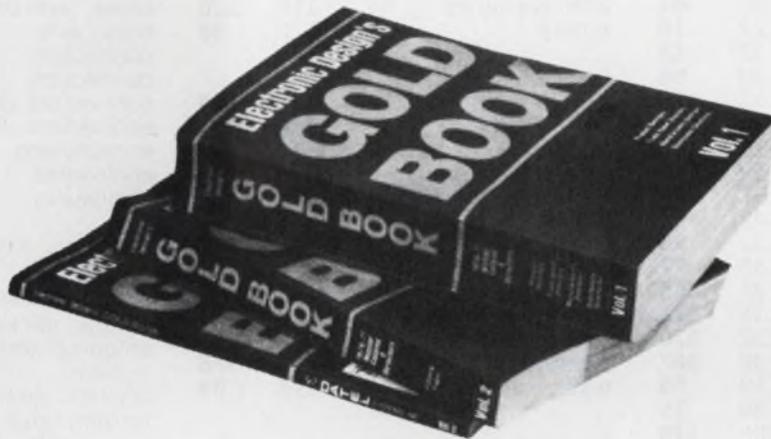
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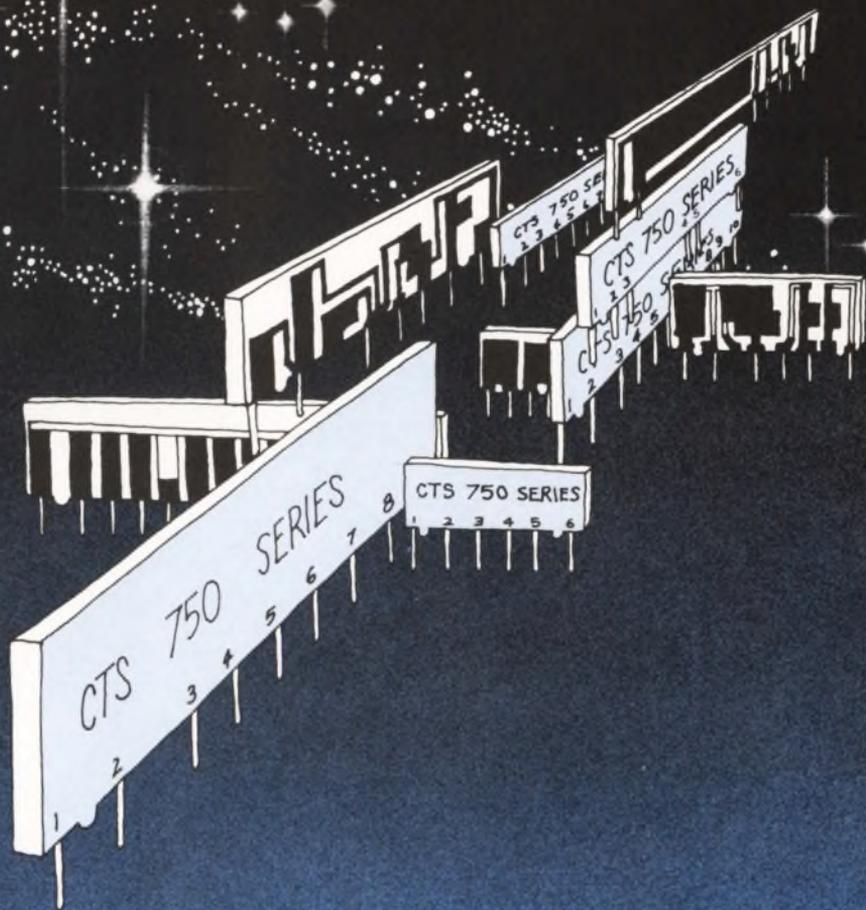
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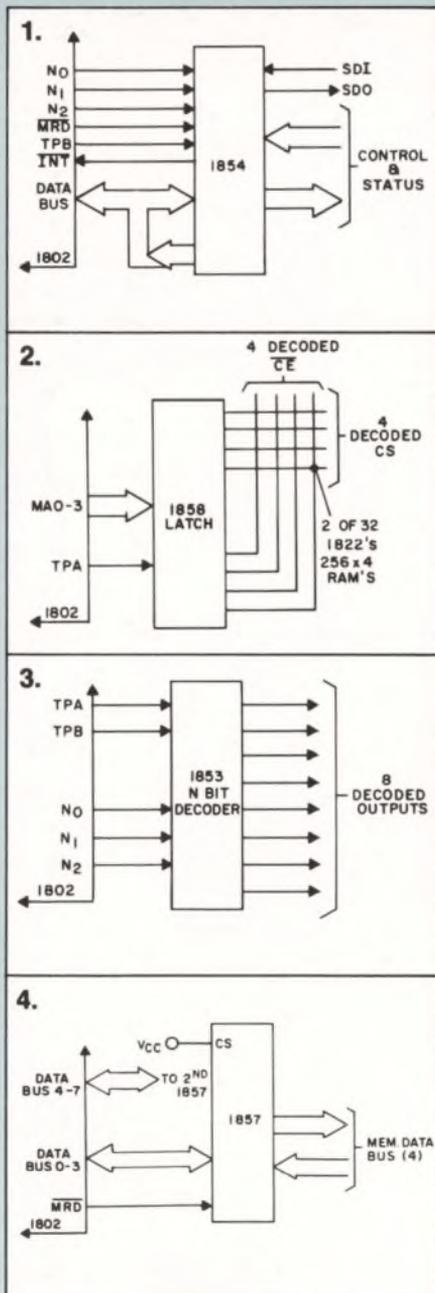
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For more information, contact your RCA Solid State distributor. Or RCA.

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