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JANUARY 21, 1981

A CAHNERS PUBLICATION

EDN

EXCLUSIVELY FOR DESIGNERS AND DESIGN MANAGERS IN ELECTRONICS

Second annual Programmable-Memory Directory

Accurate autocal tester measures low resistances

Error-hunting program evaluates memory reliability

Dot-matrix printers approach letter-quality output

Vrrroom to grow.

It started as a racehorse. It's becoming a workhorse. Because our Sentry® Series 20 LSI test system is adding the capabilities to run more devices in more technologies. And still grow to meet the future head on.

Modularity makes it work. Configure Series 20 to meet a variety of duties. Characterization. Production testing. Incoming inspection. Or a combination. Its designed-in expandability lets you get exactly what you need. When you need it.

Start by testing a full 60 pins of microprocessor, peripheral chip and memory at 20MHz. Or 30 pins at 40MHz. With full I/O operation on each pin. Then enjoy higher resolution and accuracy, with greater flexibility, because our Enhanced Timing Module is built in.

If you're working with CMOS or PMOS devices, try our new high voltage test head. You can run 28V at 5MHz, 16V at 15MHz or 10V at 20MHz.

And if high speeds or high pin counts are in your future, Series 20 should be on your line. Modular bays let you expand your system with surprising ease.

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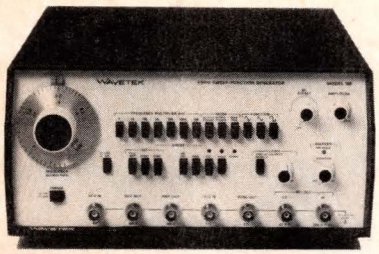

Wavetek Model 189 sells for $695.* Yet it has digital storage of sweep settings just like the expensive instruments.

Turn the dial to the desired low frequency (down to 4 mHz) and push START. Then turn the dial to the high frequency (up to 4 MHz within sweep limits) and push STOP. Both frequencies are stored in memory, so the dial is now available for setting the marker frequency.

Other controls set sweep rates from 100 microseconds to 120 seconds, hold or reset sweeps, and set output level (up to 20V). As a function generator, Model 189 gives precision sine, square and triangle waveforms from 4 mHz to 4 MHz in continuous, triggered or gated modes.

So if you're looking for an inexpensive sweep/function generator that handles precision sweeping assignments, remember the Wavetek Model 189. Better yet, call or write us today. Wavetek San Diego, P.O. Box 651, 9045 Balboa Avenue, San Diego, CA 92112. Tel (714) 279-2200; TWX 910-335-2007.

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All our modules have been tested, evaluated and approved by the device manufacturers, so you program exactly to their specifications.

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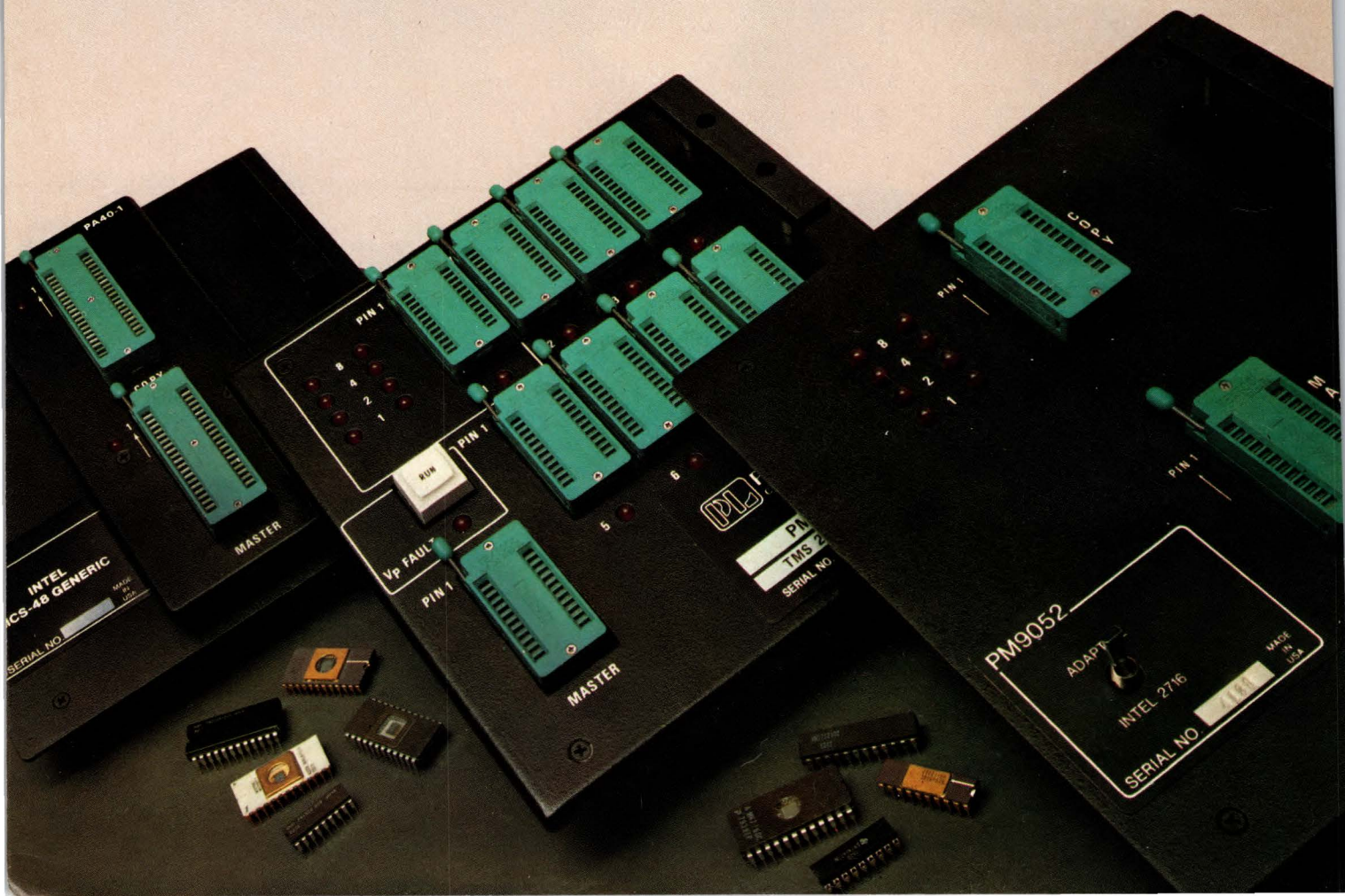
PRO-LOG PROM PROGRAMMER



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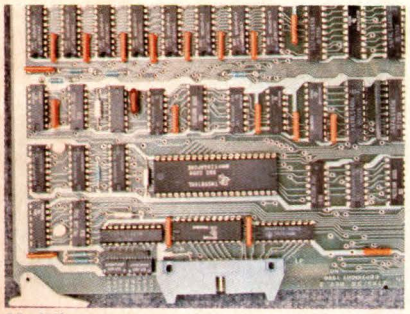
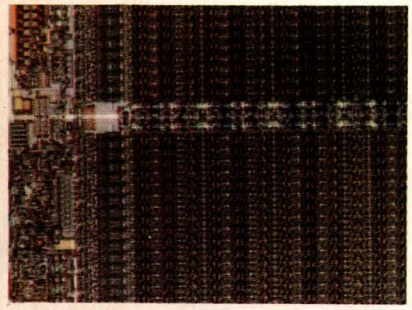
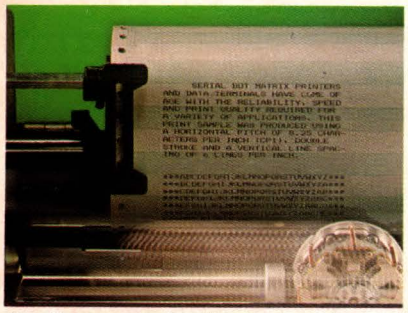


Multibus-compatible interface card *implements 488-bus controller (pg 71).*



EDN's Programmable-Memory Directory *reflects expanded options and new device types (pg 106).*



On the cover: *In the realm of serial impact printers, dot-matrix and fully-formed-character units vie for designers' favor. Turn to pg 90 for more details. (Photo courtesy Texas Instruments Inc)*

CP VBPA ABP

DESIGN FEATURES

TECHNOLOGY NEWS

NEW PRODUCTS

DEPARTMENTS

EDN (ISSN 0012-7515) is published semimonthly (except monthly in July and December) by Cahners Publishing Company, Division of Reed Holdings, Inc, 221 Columbus Avenue, Boston, MA 02116. Norman L Cahners, Chairman; Saul Goldweitz, President; William M Platt, President, Boston Division. Controlled Circulation paid at Pontiac, IL 61764 and Oakland, CA 94623. Postmaster: Send Form 3579 to EDN, 270 St Paul St, Denver, CO 80206. Advertising and editorial offices: 221 Columbus Ave, Boston, MA 02116. Phone (617) 536-7780. $2/copy (special issues may vary), $30/year; international subscriptions: $5/copy ($3/copy in Canada) (special issues may vary), $70/year ($40/year in Canada), with air mail delivery available for $150. Send requests for qualification forms and/or change of address to subscription office.

Cost-effective LSI simplifies central office and

First monolithic SLIC performs BORSHT functions and more . . . MC3419 now available in quantity.

Motorola's bipolar MC3419, the heart of the monolithic SLIC function, is available in quantity. Now production of the world's first transformerless, all-monolithic LSI digital switching line circuits can begin.

The 18-pin MC3419, with support from the Motorola MDA220 transient protection bridge and the specially-designed MJE270 and MJE271 Motorola power Darlington transistors, is all the silicon necessary to perform the BORSHT functions. In fact, the resulting SLIC can do more than the transformer-based circuit.

Availability of the unique new MC3419 SLIC completes the requirements for production of the world's first all-monolithic digital switching line circuits.

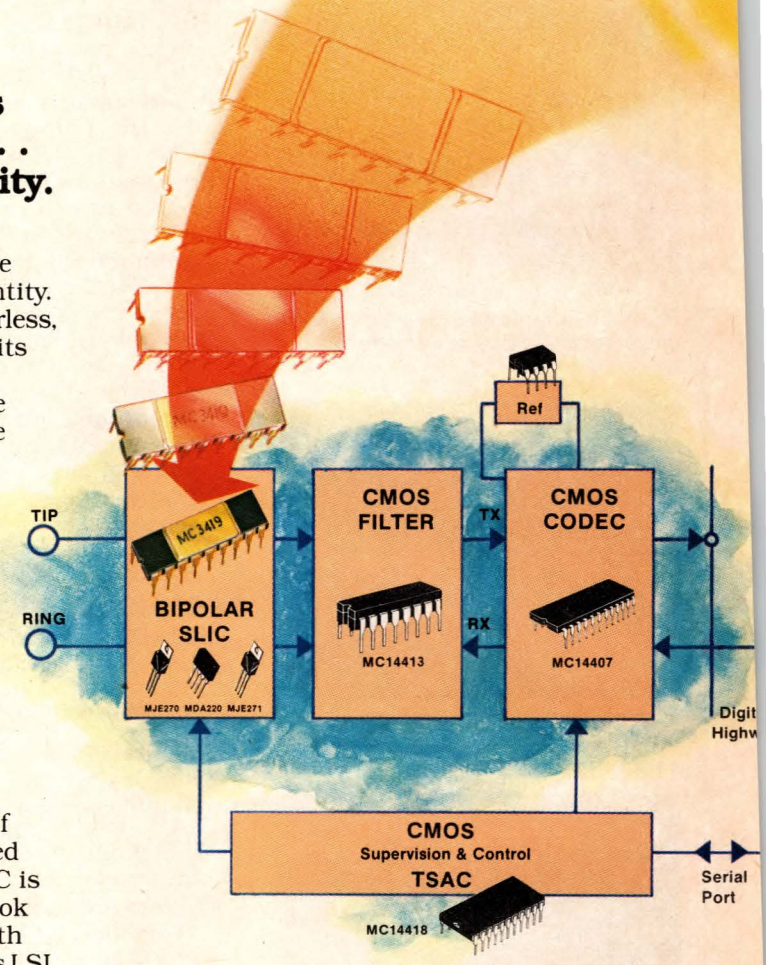
Battery-feed features include the options of feeding the loop resistively, in a current-limited mode or in a constant-current mode. The SLIC is automatically powered down during an on-hook condition. On a line card designed entirely with fully-compatible Motorola telecommunications LSI, one signal will power down the entire card. The power-down features not only save power, they also enhance reliability by minimizing average junction temperature.

Even when powered down, the line is continuously supervised for changes in hook status. That's also useful in line testing. Hook status and Ring trip outputs are provided.

Implementation of the 2-to-4-wire conversion hybrid function is fundamental to the SLIC. In fact, the IC technique used to provide this function is patented. Ground-fault, power line cross and 1500 V lightning protection are all features of the overvoltage and fault protection of the circuit.

The MC3419 is fabricated with Motorola's standard, well-characterized, high-volume linear bipolar process. Additional reliability is achieved by nitride junction sealing.

We recognize the importance to users of a strong second-source. A second-source announcement is anticipated during the first quarter of 1981.

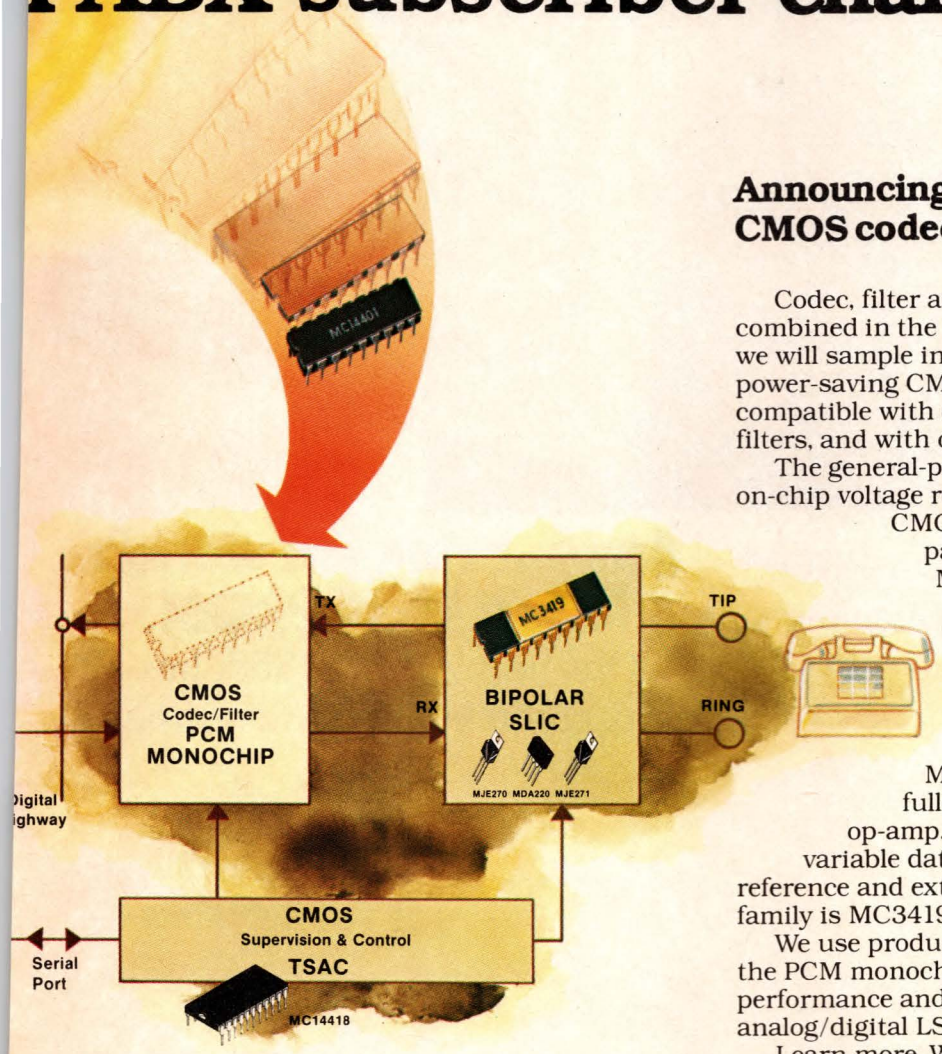


System savings.

When the bipolar MC3419, with its three discrete power devices, is teamed up with Motorola's CMOS families of codecs, filters and TSACs, a cost-effective, low-power and space-efficient, quad line card can be realized. In fact, a bank of eight 7″ × 7″ quad line cards can be mounted within the area of a 7″ cube. Even in such a compact configuration, heat dissipation is absolutely no concern thanks to the lower-power design approach.

In order to minimize component count and save board space, Motorola has taken the system approach to the design of components for the digital line card from the outset. Generic functions were identified, technologies carefully selected, and components designed to interface efficiently with each other as well as with the components o

design, saves space in PABX subscriber channel units.



Announcing the upward-compatible CMOS codec/filter PCM Monochip.

Codec, filter and voltage references are all combined in the MC14400 family PCM Monochips we will sample in Q1, 1981. These space- and power-saving CMOS components are completely compatible with existing Motorola codecs and filters, and with other industry-standard devices.

The general-purpose, 16-pin MC14400 provides on-chip voltage reference, pin-selectable TTL and CMOS levels, A-law and Mu-law companding and D3/D4/CCITT/Sign Magnitude formats, synchronous and asynchronous operation, on-chip transmit bandpass and receive low-pass filters. The others, in 18-pin and 22-pin packages, offer all features of the MC14400 and more. The MC14401 adds selectable full-scale voltages and an input op-amp. The MC14402 also accepts variable data clocks, external voltage reference and external gain adjust. The entire family is MC3419-compatible.

We use producible, tried-and-true CMOS for the PCM monochips for its reliable low-power performance and proven success for complex analog/digital LSI.

Learn more. Write to Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, AZ 85036, or use the handy coupon to get information for your other suppliers. Features like the single power-down control were designed in from the beginning.

We also recognized that not all functions were generic. The technique for assigning time slots, for example, was seen as heavily dependent on system architecture. Consequently, time slot assigner functions are not integrated into the generic parts, but are offered in a family of stand-alone Time Slot Assigner Circuits (TSACs).

Motorola's commitment to supporting the telecommunications switching market continues into the future. We project, among other things, that the ultimate codec/filter standard will be a 16-pin CMOS PCM Monochip.

Your next opportunity for refining digital switching line circuits will come soon with our MC14400 family of low-power CMOS codec/filter PCM Monochips.

Innovative systems through silicon.

MOTOROLA INC.

TO: Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, AZ 85036.
74 EDN 1/21/81

Please send me information on:

☐ MC3419 SLIC ☐ PCM MONOCHIPS

Name _____

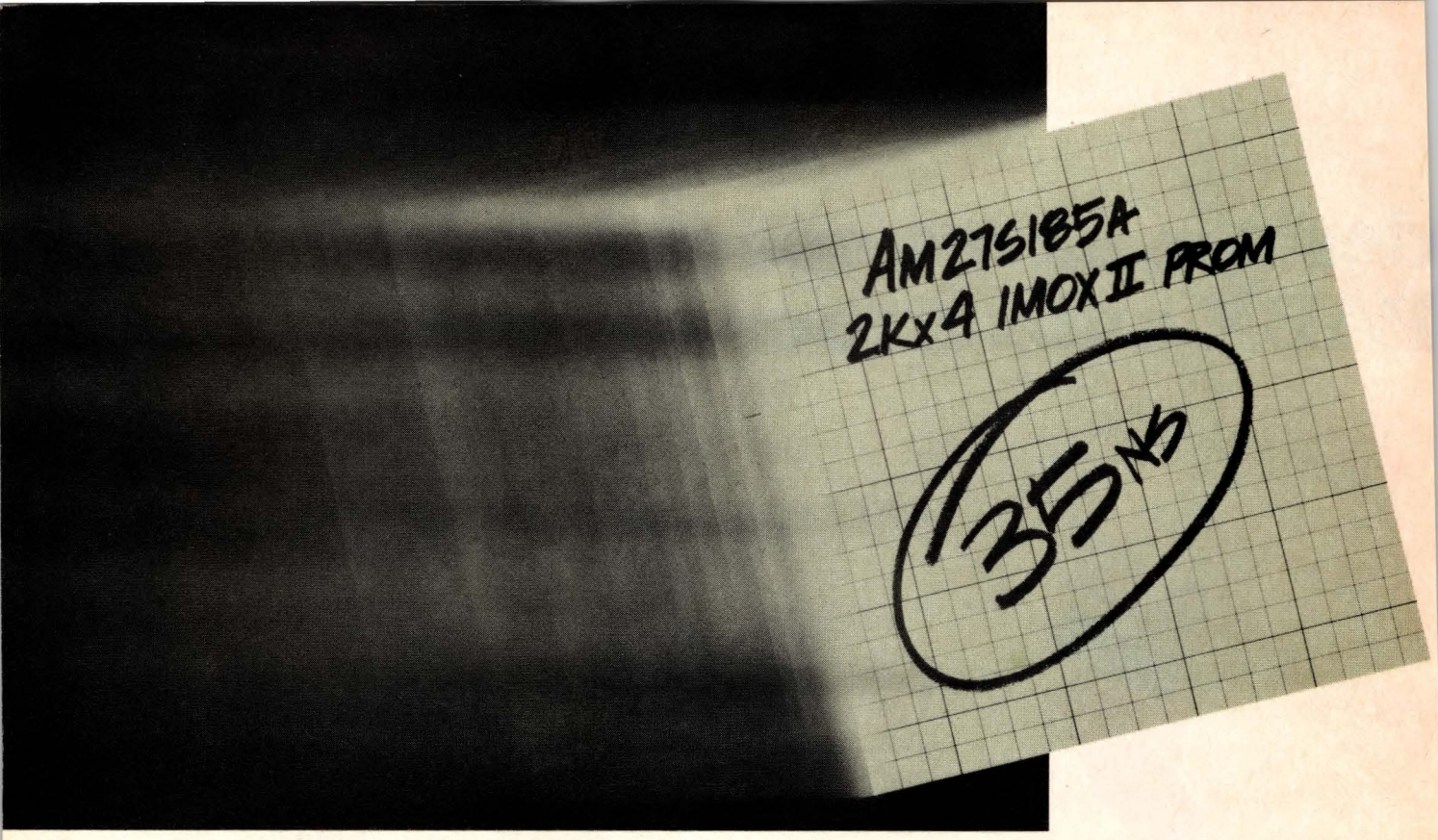
Title _____

Company _____

Address _____

City _____

State _____ ZIP _____



The Signetics 2Kx4 PROM was fast in its day. But now there's a 27S185 that leaves it in the dust.

Announcing the world's fastest 2Kx4 PROM.

Our new Am27S185A has a max commercial* access time of

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35 nsec. Guaranteed. That's about 3 times faster than the original. Even our standard 27S185 is twice as fast as the original.

What's our secret? IMOX II.™

IMOX II is Advanced Micro Devices' very advanced selective oxidation process. It lets us make faster PROMs by increasing density and decreasing capacitance. With IMOX II on your side, you'll be as far ahead of your competitors as we are.

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Advanced Micro Devices is out to make the fastest, the most reliable, the most stable family of PROMs in the world.

IMOX II is going to help. So is platinum silicide. (That's what we use in our fuses instead of nichrome.) Not one of our fuses has failed in over six billion hours of testing. Not one. There isn't anybody anywhere who can offer you that kind of reliability.

What about military performance? Our PROMs are designed with fully voltage compensated and temperature compensated bias networks. The result: Incredible stability over the entire military supply and temperature ranges.

Of course, we give you MIL-STD-883 for free. Always have, and always will.

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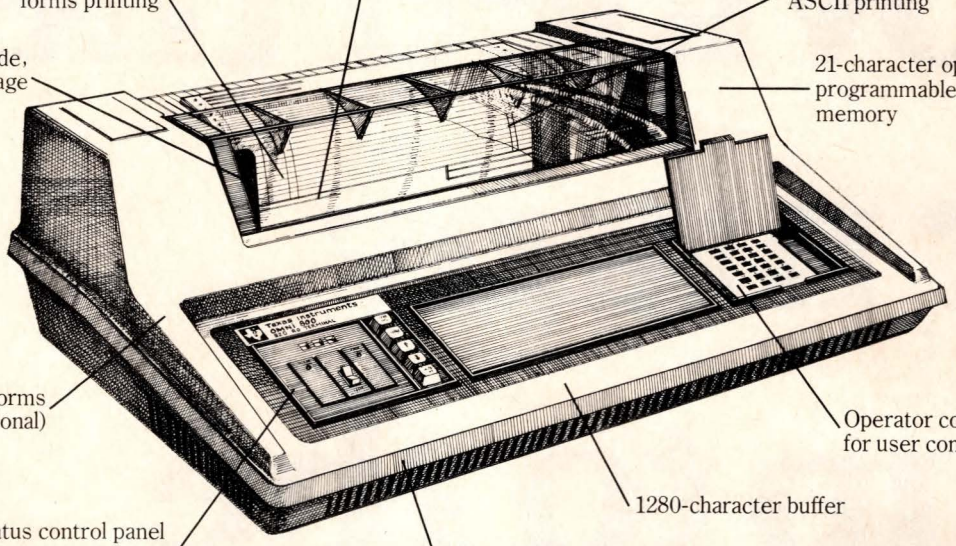

The OMNI 800* Model 820 RO Printer has the same designed reliability as its associate, the 810 RO. With more standard features and options like expanded and compressed printing, the 820 RO offers greater flexibility for additional applications. And, should application needs change, the 820 RO is easily upgraded to a KSR model for a modest cost. The productive 820 RO Printer has all the quality and performance you associate with the OMNI 800 Family.

TI is dedicated to producing quality, innovative products like the Model 820 RO Printer. TI's hundreds of thousands of data terminals shipped worldwide are backed by the technology and reliability that come from 50 years of experience, and are supported by our worldwide organization of factory-trained sales and service representatives.

For more information on the 820 RO, contact the TI sales office nearest you, or write Texas Instruments Incorporated, P.O. Box 1444, M/S 7884, Houston, Texas 77001, or phone (713) 373-1050. In Canada, write Texas Instruments Incorporated, 41 Shelley Rd., Richmond Hill, Ontario L4C 5G4, or phone (416) 884-9181.

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News Breaks

Edited by Joan Morrow

32-BIT μP EMPLOYS OBJECT-ORIENTED ARCHITECTURE

Further details on the Intel iAPX 432 μP were announced at the ACM SIGPLAN Conference on ADA held December 8 to 11. According to Intel representative Steve Zeigler, the 432 is an object-oriented unit that has been under development for 6 yrs. An object-oriented architecture means that high-level entities, such as records, queues, tasks and collections of procedures, are treated as elementary software components; they are thus as easily manipulated as, say, a single-character variable in a Z80.

The 32-bit 432 is implemented on two chips. You can add more processor chips to achieve a multiprocessor system without altering any software.

According to Nicole Allegre, an Intel software engineer working on Project Aloha (Intel's code name for the 432), the firm is currently developing a software environment for the 432, using the DOD's ADA. Allegre indicates that the 432 hardware might be available this quarter, with a basic software environment available in the fall.

Further data on the iAPX 432 is scheduled for presentation at ISSCC '81. See EDN's show preview in the February 4 issue for more details. — WP

UPDATED 488-BUS CONTROLLER ADDS MEMORY, IMPROVED SOFTWARE

Model 3522 from Systron-Donner Corp (Concord, CA) is the huskier brother of the previously introduced $995 Model 3520 488-bus controller. Housed in the same desktop case as its predecessor, the new instrument features as much as 12k bytes of RAM, compared with the earlier model's 2k memory limit. The 3522's 16k-byte ROM space includes an extended version of the company's control-oriented BASIC language.

This BASIC adds floating-point arithmetic with up to 16-digit precision, Boolean operators, math and trigonometric functions, automatic line numbering and a string package. It includes the earlier version's bus-driver commands, 2-dimensional arrays, subroutines and nested subroutines, single-step operation, error messages and PROM-program/read option.

Model 3522 with 8k bytes of RAM costs $1995. — AS

LOW-COST MATRIX PRINTER PACKS HIGH-PRICED PERFORMANCE

Model 445 dot-matrix printer sports the lowest price of any Integral Data Systems (Milford, NH) Paper Tiger model. The $795 unit comes with a ballistic-type printhead, a 36-yd Mobius-loop ribbon cartridge, and motor-driven head, paper and ribbon mechanisms. Key performance features include eight software-selectable character sizes, 80- and 132-column formats, 42 to 300 lpm (depending on line size) at unidirectional speeds to 198 cps, and parallel (Centronics) and serial (RS-232) interfaces. — GK

NEXT-GENERATION SMALL TERMINAL ADDS VERSATILE I/O FEATURES

The TM71-I/O Microterminal from Burr-Brown (Tucson, AZ) follows in the footsteps of its TM25 and TM71 predecessors. But it provides eight more LED status and monitor indicators, noncontinuous or continuous modes for accepting external instruments' input data, decimal or ASCII character output modes and two 8-line ports (one output and one input/output). These extra functions transform the TM71-I/O into a more general-purpose data-gathering and data-distributing station, controlling and monitoring exterior system operations in response to CPU commands. Available this quarter, the TM71-I/O costs $385 (100); less expensive but dedicated-performance models will make their debut during the year. — GK

News Breaks

GRAPHICS APPLICATION SOFTWARE PACKAGES SERVE NONPROGRAMMERS

Recognizing that most new engineering and scientific graphics-terminals users are nonprogrammers, Tektronix Inc (Beaverton, OR) has introduced seven Plot 50 products, most of them menu driven and including built-in tutorials and "help" files. The graphing, drawing, document-preparation, statistics-generating, planning, project-management and digitizing programs cost $800 to $4000. All are upwardly compatible on the firm's 4050, 4052 and 4054 desktop computers an use the new Graphic Model Exchange (GMX) — Tektronix's standard format that allows pictures to pass from one computer to another.

This spring, a trio of products will further expand the Plot 50 applications library; they will cover presentation aids, statistics and 2-dimensional drafting. — WP

TWO-BOARD CONTROLLER SUPPORTS WINCHESTER DRIVES

For S-100-bus systems, the Xcomp (San Diego, CA) 2-board Winchester-drive controller utilizes a microprogrammed data board common to all the firm's controllers. This board operates with a second drive-interface board that supports a variety of drives, including the SA1000 and the ST-506 5¼-in. Winchester units. The $980 SG/S board pair for the SA1000 sports a 256-byte buffer and full-sector buffering. The $980 Model ST/S for the ST-506 uses the same basic data board as the SG/S but a different interface card. — CW

LOW-COST 16-BIT μC BOARD RUNS AT 8 MHz

Based on an 8086 μP that runs at an 8-MHz clock rate, the Multibus-compatible iSBC 86/05 from Intel's OEM μC Systems Div will debut early next month. The $1800 board will carry 8k bytes of high-speed static RAM, sockets for four 28-pin EPROMs and three Multimodule sockets for special computing capabilities.

Additionally, the Aloha, OR-based division will emphasize system solutions to OEM design problems in 1981 and will introduce many new software packages to complement its hardware products. The first software offering — to be introduced concurrently with the iSBC 86/05 — is RMX-80, a high-performance real-time operating system with a 16-bit nucleus. — WP

WINCHESTER-DRIVE STORAGE ROCKETS TO 136M BYTES

Available in three models, Ontrax Corp's Series 8 Winchester disk drives feature a patent-pending digital read/write-head-positioning actuator that helps to achieve a 960-tpi storage density on standard 210-mm (8-in.) hard disks. Using dual positioners, five platters and 116 read/write heads, Model 136 from the Sunnyvale, CA-based firm provides a record-breaking 136M-byte unformatted capacity in 9600 data tracks. Models 68 and 34 furnish 68M and 34M bytes, respectively. Evaluation drives will be available in March, with production units expected by the summer. For 200 to 500 quantities, Models 136's cost should start at approximately $4000. — GK

MAGNETIC SENSING DEVICES MEASURE EXTREMELY-LOW-INTENSITY FIELDS

Experimental superconducting magnetic sensing devices, when incorporated in complete measurement systems, could permit measurement of magnetic field changes as small as 10^{-12} of the earth's field when those changes occur at frequencies greater than 10 kHz. Constructed by researchers at IBM's Thomas J Watson Research Center (Yorktown Heights, NY), these Squids (superconducting quantum interference devices) provide a 100-fold increase in measurement capability over commercial measurement systems that use similar sensing devices. Applications for Squids include searches for geothermal energy sources and minerals, earthquake prediction and heart and brain-wave detection. — AR

PDP-11® and LSI-11®
TAPE and DISK CONTROLLERS

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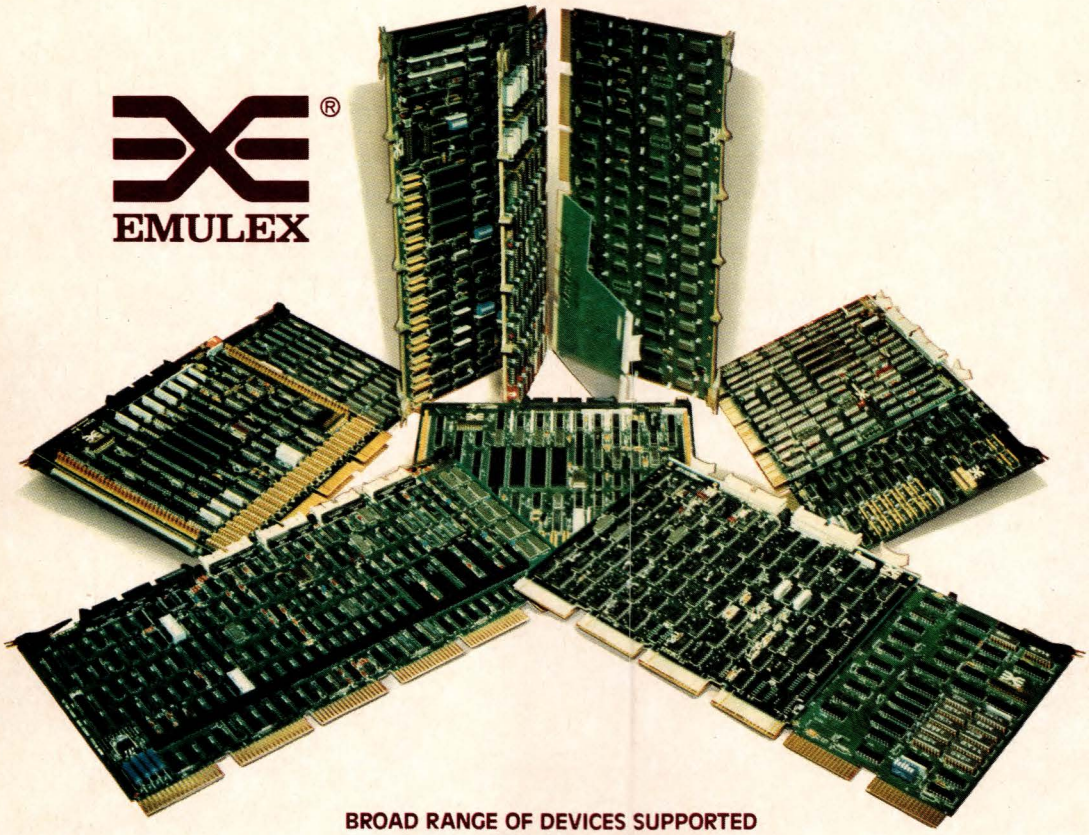

AUTHORIZED EMULEX DISTRIBUTOR
First Computer Corporation, the world's leading DEC computer system integrator now distributes the complete spectrum of EMULEX Tape and Disk controllers for the PDP-11 and LSI-11 family of computers.

HARDWARE/SOFTWARE TRANSPARENCY
These microprogrammed, emulating Tape and Disk Controllers are fully software transparent to both the PDP-11 hardware and software. The use of these controllers protects you from the impact of future versions of the operating system software. They are so compatible you can plug them into your system and be up and running the standard DEC diagnostics and operating systems in minutes.

ADDED FEATURES
These controllers provide you with added features such as automatic self-testing, onboard pack formatting, and programmable bandwidth control at no additional cost.

BROAD RANGE OF DEVICES SUPPORTED
It makes no difference which of the DEC PDP-11 or LSI-11 family you are using or which type of storage device is required for your application. We can support 59 different drives from 13 different manufacturers.

HIGHEST QUALITY AND SUPER RELIABILITY
You can be assured of the quality and reliability of these Tape and Disk Controllers because First Computer Corporation specializes in PDP-11 and LSI-11 computer systems, components, and peripherials. Over the years our reputation was built on the quality and reliability of the products we sell. We continue to protect this reputation by selling only the very best.

SUPER FAST SERVICE
Because we are the largest system integrator specializing in PDP-11 and LSI-11 systems, components, and peripherials, First Computer Corporation can satisfy most of your Tape and Disk Controller requirements directly from our stock.

GUARANTEED SATISFACTION
Your satisfaction is fully guaranteed by First Computer Corporation. We believe in every product we sell. If for any reason these Tape and Disk Controllers do not meet your expectations, simply return them freight prepaid and insured, within 10 days of receipt and we will refund your money in full. First Computer Corporation backs each of these products with a full one year warranty.

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Set your sites on Intel's nev

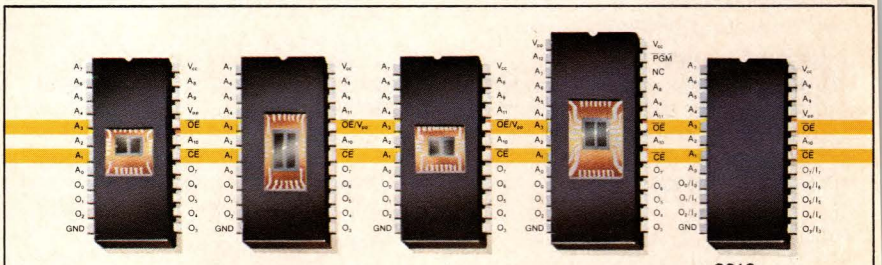
Introducing Intel's 2764 EPROM. The only 28-pin JEDEC-approved EPROM in volume production today.

If you survey the field, you'll discover it's been hard to find high density and high speed in an EPROM. Until Intel introduced its new 2764—the one that has both. Plus Intel's complete family of EPROMs—including the 2764—allows you to get control of tomorrow's memory costs today.

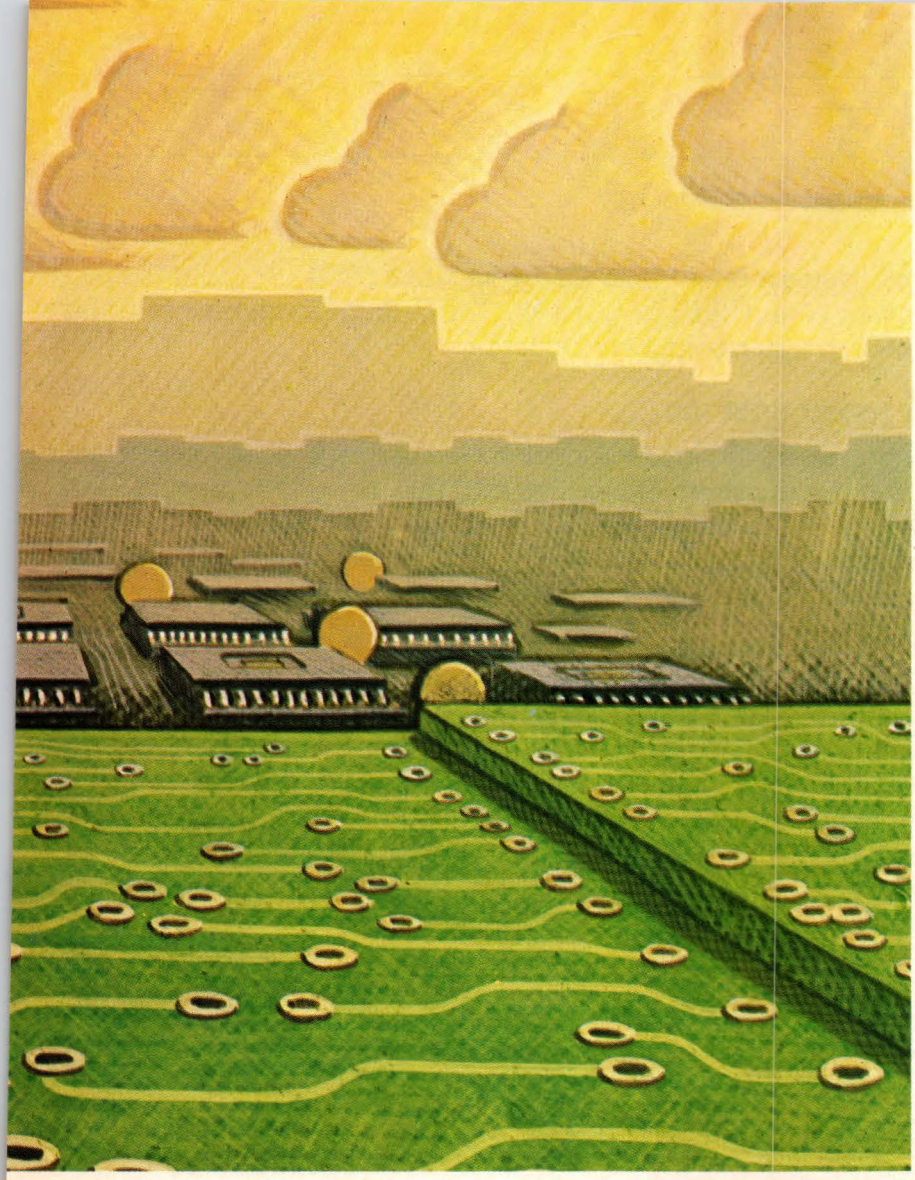
The EPROM standard of tomorrow

Like its predecessor, the 2732A, our new 2764 is fabricated by Intel's proven fourth-generation EPROM technology, HMOS*-E. This technology allows us to shrink 2764 die sizes down dramatically, making this the smallest 64K EPROM chip in production. And HMOS-E makes possible the 2764's standard access time of 250ns. Which means you now have an alternative when you need high speeds and high densities—in applications such as controller systems for automated milling machines, vector color graphics displays, and over-the-horizon terrain radar.

In addition to high performance, the 2764 brings flexibility and cost control to your system designs. Like all of Intel's EPROMs, the



2716 16K 450ns | 2732 32K 450ns | 2732A 32K 250ns | 2764 64K 250ns | 2816 16K 250ns E²PROM



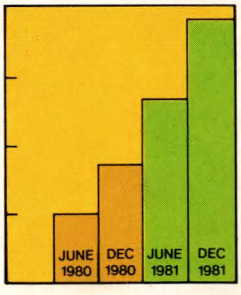
64K EPROM. Now.

2764's pinout conforms to the 28-pin JEDEC standard for Byte-Wide memories from 16K to 256K bytes. So when you design with 28-pin sites now, you can choose the EPROM that meets your needs today. Then upgrade your memory performance or density later — without any jumpers or expensive engineering changes.

Intel's universal EPROM solution

The 2764 represents the latest addition to our complete EPROM family — the only one that offers you a *universal* EPROM solution that begins with our industry standard 2716 and 2732 EPROMs.

With this solution, your EPROM cost-per-bit will continue to drop. That means that by mid-1982, high-speed, high-density EPROMs will cost no more per bit than the EPROMs you presently buy. That also means that when it's right for you to upgrade, you'll save valuable board space *and* get increased performance — at no cost penalty.



Intel's EPROM Production Ramp-up

Getting all of the EPROMs you need will be easier, too. We'll more than triple our production capability by the end of 1981. Plus, more than ten ROM and EPROM manufacturers have already committed to the JEDEC Byte-Wide memory pinout standard, further increasing your design choices.

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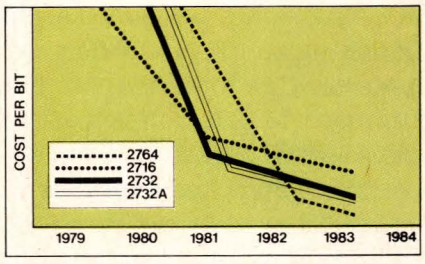

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For further information about Intel's EPROM family, including the new 2764 and 2816 E²PROM, contact your local Intel distributor or sales office. Ask for the "Intel EPROM Applications Manual." Or write directly to Intel Corporation, Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051. Telephone (408) 987-8080.

*HMOS is a patented Intel process.

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News Breaks

SPEAKING OF VOICE I/O . . .

If you're curious about Telesensory Systems Inc's Series III speech units (EDN, Editor's Choice, January 7), you can now hear what they sound like by calling (415) 856-0225. You'll hear samples of systems' LPC speech and some direct conversion from text to speech. — ET

PRODUCT HIGHLIGHTS FROM INTELCOM '80 . . .

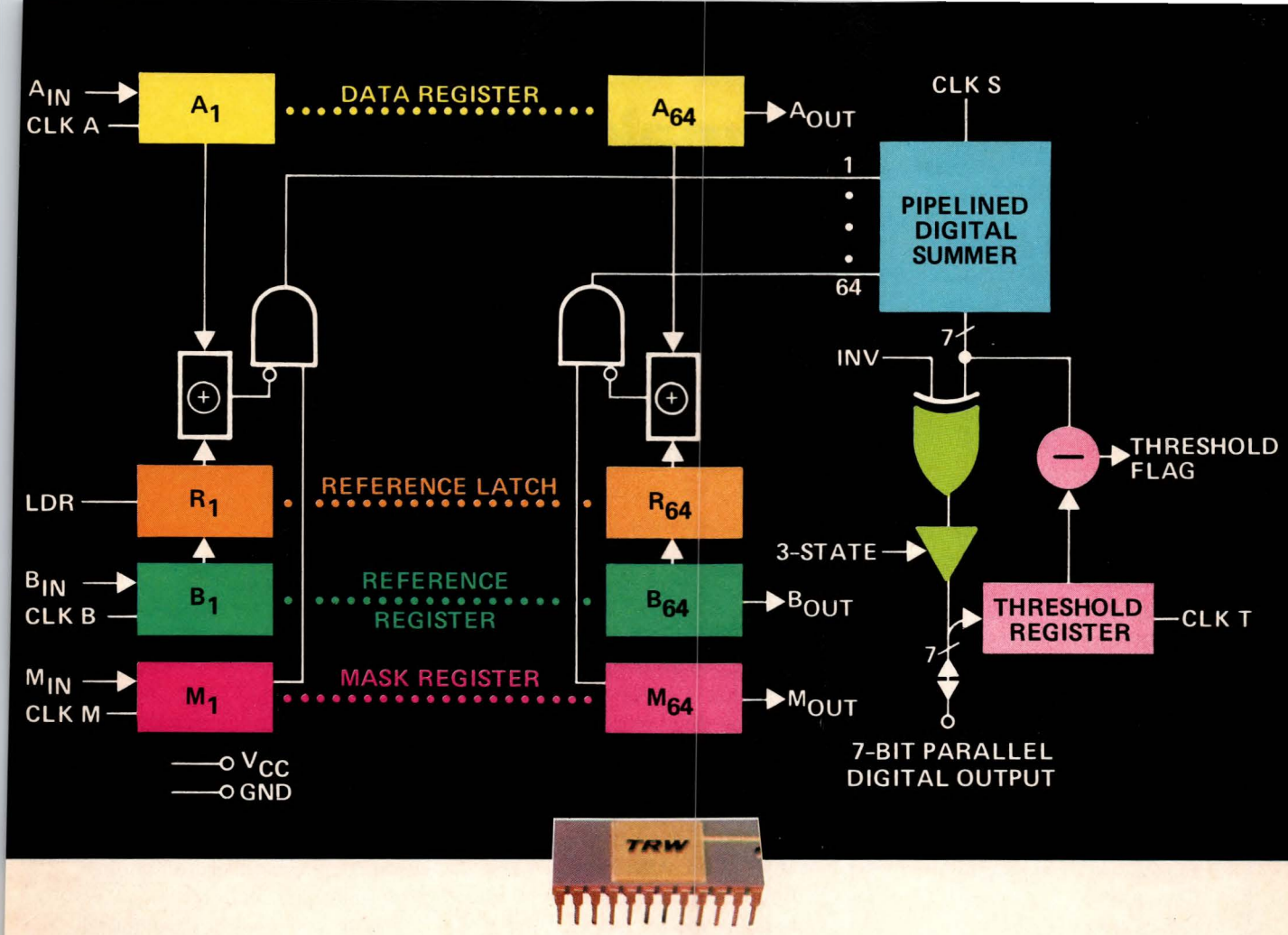
The International Telecommunication and Computer Exposition held in Los Angeles in November provided the site for some significant product introductions. For example, Novation (Tarzana, CA) introduced the FCC-approved Auto-Cat auto-answer direct-connect modem. Compatible with Bell's 100 Series modems, the $249 device exchanges data at 0 to 300 baud for full- or half-duplex modes. Weighing only 12 oz, the line-powered 10×4.7×1.2-in. device easily fits under a telephone.

Also at the show, American Microsystems (Santa Clara, CA) displayed its Model S3505 as the first CMOS single-chip-per-channel codec with built-in encoder, decoder and input and output filters. Furnishing an internally derived reference voltage for A/D and D/A conversions, it reduces subscriber-line-interface complexities and costs for digital PABXs and control-office signaling equipment. Meeting or exceeding AT&T D3 and CCITT G.711 and G.733 specifications, the codec handles serial data rates from 64k to 2.1M bps at an 8-kHz nominal sampling rate. To suppress crosstalk, a switched-capacitor circuit furnishes 80-dB separation between transmitter/filter and receiver/filter sections. Housed in 24- or 28-pin ceramic or CerDip packages, the S3505 costs $40, with prototype and production quantities available in the first and third quarters, respectively.

Finally, the FT3 and FT3C telecomm fiber-optic cables were introduced by Seicor (Hickory, NC). They come in 6-, 8-, 10- and 12-fiber versions. At 850 nm, the FT3 cable specs a 5-dB/km attenuation and 250-MHz-km bandwidth; the FT3C cable rates at 4.5 dB/km and 500 MHz-km. Both types are available for aerial, duct and buried installations. From stock, FT3 cable costs from $4.50 to $9.65 per metre; the FT3C type, from $5.40 to $11.45 per metre. — GK

FOR YOUR CALENDAR . . .

The NASA/Marshall Space Flight Center, in cooperation with the Components, Hybrids and Manufacturing Technology Society of IEEE, will hold a seminar to highlight capacitor technologies, applications and reliability. Nineteen papers will cover ceramic, metallized polycarbonate, PVF_2 and electrolytic capacitors. You can contact Leon Hamiter at NASA/EC43, Marshall Space Flight Center, AL 35812, or phone (205) 453-4562 for more details on the February 24 to 25 seminar... "The 1981 Communications Techniques Seminar: Digital Communications" will be held at Princeton University on March 24. Presentation topics will include two digital data networks (one military and one commercial), packetized subscription TV, the proposed Northeast lightwave corridor and a comparison of digital and packet communications. Get in touch with Cynthia A Donovan, Secretary, Room 2F512A, B T L, Holmdel, NJ 07733 for more information. — JM



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Our TDC1023J correlator chip gives you the ability to detect a desired signal in the presence of other signals or noise. It can recognize and compare signal patterns. It may be used to measure time delays through various mediums such as materials, the body, RF paths, electronic circuits. It's ideal for the digital design engineer working in these areas:

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And just take a look at these key features:

- Separate buffer register--speeds processing, reduces external components
- Threshold register--enables flag at preset correlation level
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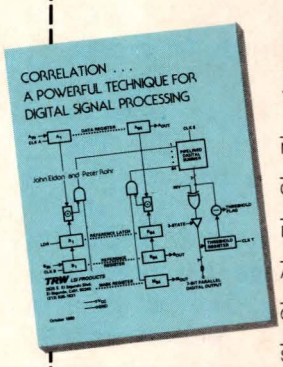
The TDC1023J is in stock at Arrow Electronics and Hamilton/Avnet.

For complete information on our all new digital correlator request our new 32 page brochure, *"Correlation — a powerful technique for digital signal processing."* Call us at (714) 578-5990 or send us the coupon or just attach your business card to this page and mail it back to us.



EDN-1

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Please send your 32 page Correlation brochure covering the **TDC1023J** All Digital Correlator.

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Signals & Noise

Complaints about convention conditions

(Ed Note: A reader sent EDN a copy of the following letter—the original was addressed to the Wescon/80 organizers.)

Gentlemen:

Like many other engineers, I attended your recent convention at the Anaheim Convention Center. The conference was fine, the displays were excellent and the presentations were acceptable. The big loser, however, was the Anaheim Convention Center itself. The streets of Anaheim are clearly incapable of handling convention traffic, even during the working day. The effects of a convention plus normal street traffic almost totally halted movement. That's bad, but then that's typical of Anaheim, which hasn't totally adjusted to the presence of Disneyland—after all, it's only been 25 yrs.

The Convention Center owns the signs surrounding it, which say "parking" and indicate how to get to it. But there is no parking lot at the end of these signs (which stop abruptly), only a loading area. One parking lot that we drove by had empty slots in it, yet a person who hardly spoke English said she couldn't let us in because her boss said not to. The car ahead of us got in, though, for unclear reasons.

We were told to park at Disneyland, which we did. The only reason we were finally able to park anywhere near the Convention Center was because we ignored a sign that directed us another way. The exit from the Disneyland parking area was somewhat near the Center (near doors marked "other door, please") and a long way from the traffic signals. Apparently, Disneyland was trying to discourage convention attendees from using its lot.

"STATISTICALLY SPEAKING, 24.37 PER CENT OF THE PEOPLE IN R&D WANT YOU TO GET WELL."

Inside the Center, we found the aisles often blocked by many people. Use of the food services was out of the question because of the length of the lines—not just at noon, but throughout the entire day. As near as I could tell, the popularity of those places was not based on low prices, but simply on hunger and thirst.

If you got a much bigger crowd than you expected, these types of conditions are understandable. But don't let it happen again. If you decided, however, just to let it become crowded and have everyone fend for himself, you should be ashamed. I wrote the Anaheim Convention Center's manager about these conditions and have received no reply after 2 weeks, so I imagine that the Center's management is partly to blame.

Your early registration is a boon; it saves waiting in lines for a badge as required at past Wescons. To further help attendees, you might also

"We've always been a jump ahead of device technology. And that's where we intend to stay."

Jim Fischer
GENERAL MANAGER
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"Ten years ago, we started the Tektronix S-3200 Series of Semiconductor Test Systems. Time has shown that we've built an excellent foundation. This same basic concept accommodates any chip made today and many that are still on the drawing board. We're continually refining the concept and making it a logical solution to contemporary measurement problems. The new Tektronix S-3275 Semiconductor Test System is the latest example of our permanent commitment to anticipate upcoming measurement problems and meet them head on.

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The S-3200 Series of Semiconductor Test Systems is just one more example of Tektronix' commitment to excellence. For 34 years, we've been continually making the engineer's job easier through an unbeatable combination of technical innovation and superior quality. As technology advances toward more refined horizons, Tek will continue to be there with a solution to match.

For more information on Tektronix S-3200 Semiconductor Test Systems, call 1-800-547-1512 toll free.

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Signals & Noise

include parking and shuttle-bus information with registration materials. You should be able to hold a large convention and provide adequate parking, shuttle buses, room in the aisles and refreshments after a wait of a couple of minutes or less. I've seen it done at the NAB in Las Vegas. If you can't get the service you need from the place you use, use another. The Los Angeles site wasn't bad; you could also consider Las Vegas.

I doubt that I'm the only person with these feelings. Maybe you might consider using a statement like "we've got our act together" in your promotions for the next Wescon.

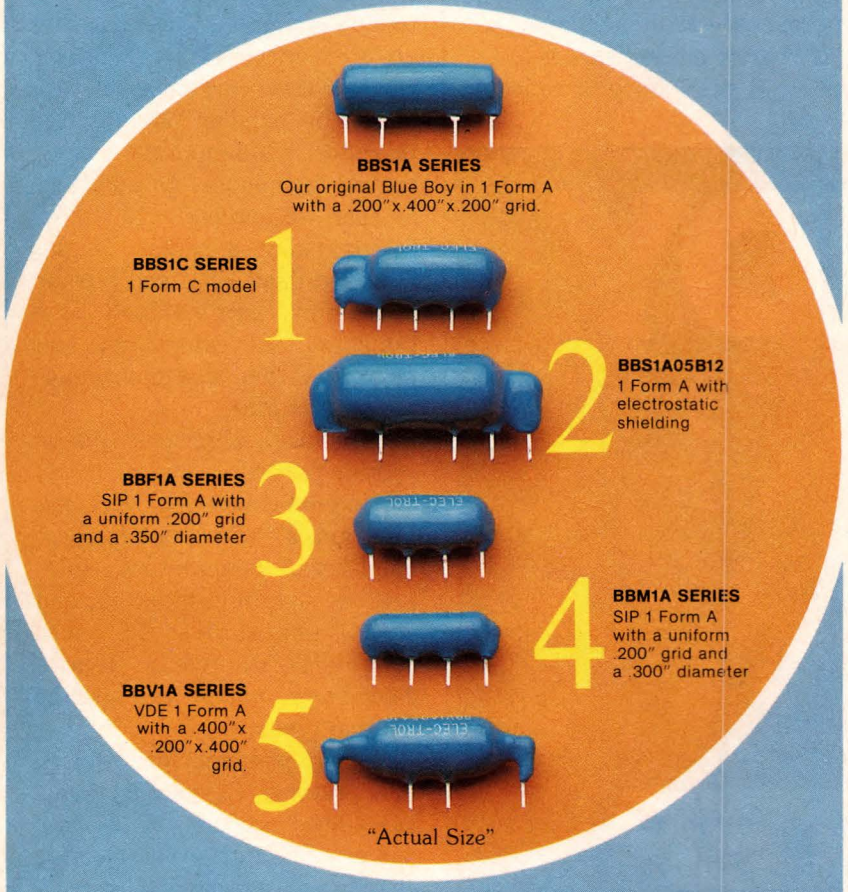
Sincerely,
James Rieger
Engineer/PTBW
Ridgecrest, CA

You'll need the proper address

The address given for Waterloo Distance Education Inc on pg 22 of EDN's September 5, 1980, News Breaks was incorrect. The correct one is Box 62, Waterloo, Ontario, Canada N2J 3Z6.

Your turn...
EDN welcomes your comments, pro or con, on any issues raised in the magazine's articles. Address letters to **Signals and Noise Editor, EDN, 221 Columbus Ave, Boston, MA 02116.** Names will be withheld upon request. We reserve the right to edit letters for space and clarity.

ELEC-TROL BLUE BOY REED RELAYS



NOW A WHOLE FAMILY OF BLUE BOYS TO SERVE YOU

If you like our low-cost fully-encapsulated Blue Boys but wish there was a broader line to select from—here's some good news. We've just added five new products.

We still offer our original Blue Boy in 1 Form A with a .200"x.400"x.200" grid. But now we are introducing the following additional models: (1) a 1 Form C model; (2) a 1 Form A with electrostatic shielding; (3) a SIP 1 Form A with a uniform .200" grid and a .350" diameter; (4) a SIP 1 Form A with a uniform .200" grid and a .300" diameter; and (5) a VDE 1 Form A unit designed with 5000 V peak isolation and the wide input-to-output spacing of a .400"x.200"x.400" grid.

All units in the Blue Boy line incorporate hermetically sealed reed switch contacts encapsulated in rock-hard blue epoxy for low-cost protection against hazardous environments, production cleaning solvents, and rough handling.

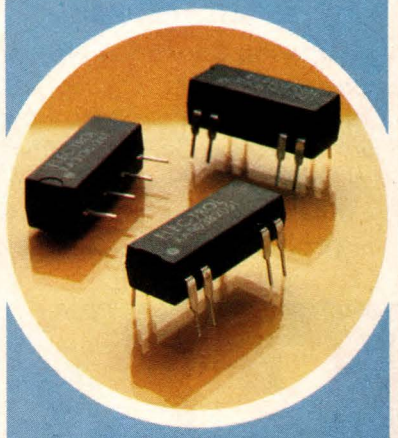
Send for more information, or for prices and samples, contact your local Elec-Trol distributor or representative.

Elec-Trol, Inc., 26477 N. Golden Valley Road, Saugus, CA 91350, (213) 788-7292 (805) 252-8330. TWX 910-336-1556.

ELECTROL

For more information, Circle no 113

ELEC-TROL DIP RELAYS



140 STANDARD MODELS

Elec-Trol now offers one of the broadest lines of DIP Reed Relays available, 140 different standard models. You can select 1A, 2A, 1B, and 1C dry reed contacts with either 3-watt or 10-watt ratings or 1A mercury-wetted with 50-watt rating. All of them are available with or without clamping diodes and with a choice of 5, 6, 12, or 24 VDC coils. For off-the-shelf delivery or to ask about samples, contact your Elec-Trol distributor.

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For more information, Circle no 115

Books

Analog basics, revised and updated

***IC Op-amp Cookbook** (second edition), by Walter G Jung. 480 pgs; $14.95 (paperback); Howard W Sams & Co, Indianapolis, IN, 1980.*

Analog-circuit engineers have never had it so good—literally. Technology has recently yielded a generation of IC op amps that sport outstanding dc and dynamic specifications; indeed, for many applications, the newest devices very closely approximate ideal components.

If there's a bad-news side to this good-news story, it reflects the growing obsolescence of your analog-design reference library. Although basic theories haven't changed, many classic texts contain circuit examples that have become obsolete by today's standards. Realizing this obsolescence, Walter Jung rewrote and reorganized almost half of his popular 1974 tutorial to reflect contemporary analog design techniques. In addition, he has researched the latest commercially available single, dual and quad FET and bipolar op amps; summarized and tabulated their capabilities; and illustrated their use in challenging applications.

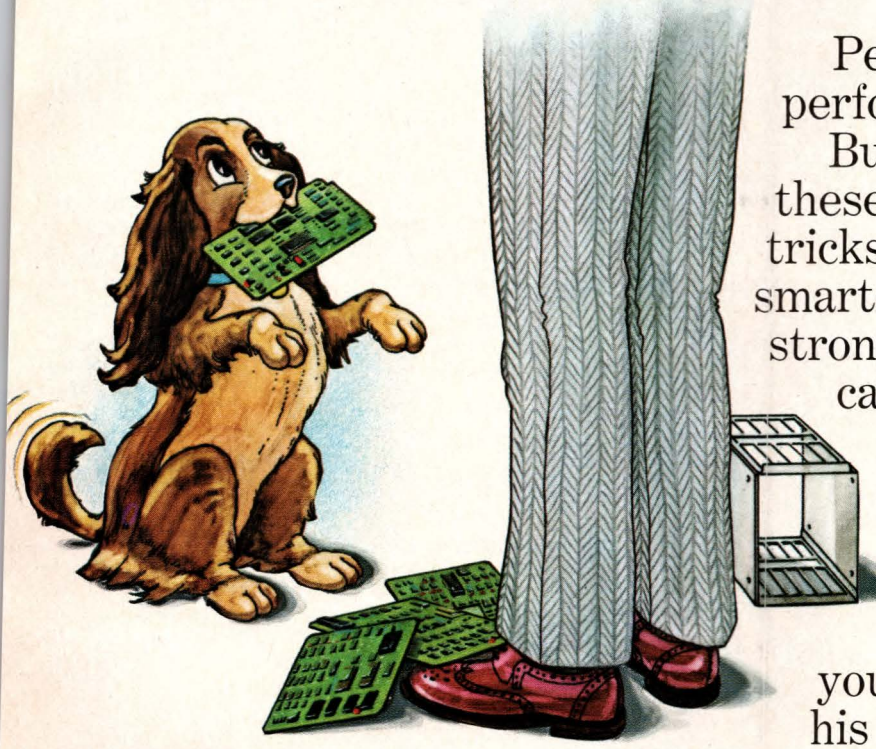
Separate chapters cover voltage regulators and references, signal-processing circuits, log amps and multipliers, amplifiers, comparators, integrators and differentiators, and signal generators. In each, schematic diagrams denote component values and specific op-amp types.

To help you transform theory into practice, Chapter 2 details specialized groups of devices and provides numerous selection charts; an appendix supplements this text with part-number breakdowns and data sheets.

Given all of Mr Jung's expansions to the first edition, it's small wonder that this second edition required some deletions to remain less than 500 pgs long. Thus, the original book's sections on "Audio" and "Unique Devices" are now available (in expanded form, of course) as separate, stand-alone texts. Nevertheless, a broad range of subjects remains.

As a guide to the shades-of-grey analog world, we find this book's countless design examples interesting, useful and documented in commendable detail. ***—Walt Patstone***

Oh, Look! SCOUT can do new tricks.



Perform, SCOUT™ perform.

But wait! What are these? These are new tricks.* Now SCOUT is smarter. Now SCOUT is stronger. Now SCOUT can do more.

New tricks from SCOUT—all with ISOLITE.™ So if SCOUT performs badly, you simply replace his badly performing board. And in about 3 minutes, he is off and running again. Quick like a bunny.

Run, run, run. Save, save, save.

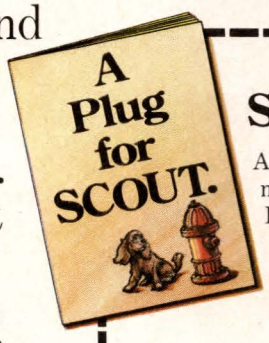
If you were an OEM, would you like SCOUT? Of course you would.

SCOUT starts at less than $1,000 for a CPU, I/O, 32K Byte RAM and card cage.

And now he knows new tricks.

He is one smart SCOUT, isn't he? Wouldn't you like to design him a nice little home?

*Digital-to-Analog Converter; 32-bit Parallel Digital I/O Module; Universal Floppy Controller; Dual Single-Sided, Single-Density Floppy Subsystems; Dual Quad Floppy Subsystem; 2/4 Channel Async I/O Module and Battery Back-up/Watchdog Timer Module. Existing, previously announced modules include CRT Async I/O – RS232C; Modem Async I/O – RS232C; Paper-Tape Reader; Paper-Tape Punch, General Purpose Parallel I/O; Analog-to-Digital input and Solid-State Relay output.



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All devices in TI's TMS2500 EPROM Family are plug-compatible with each other. And will be with all the ones that are on the way. Pinouts are derived from popular industry standard ROMs for maximum compatibility.

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Plug-in compatibility means easy upgradability. From 8K to 64K. For upgrading from 16Ks to 32Ks, for example, just include the signal to PD in the address decoder. No jumpering. Minimal modification for upgrade to 64K. And beyond.

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For more information about the industry's first EPROM Family, and other Texas Instruments EPROM products, write to Texas Instruments Incorporated, P.O. Box 1443, M/S 6965, Houston, Texas 77001.

TI's Growing TMS2500 EPROM Family

Device	Description	Power Dissipation*	Access Time*
TMS2564-45	64K	840 mW	450 ns
TMS2532-45	32K	840 mW	450 ns
TMS2532-35	32K	840 mW	350 ns
TMS25L32-45	32K	500 mW	450 ns
TMS2516-45	16K	525 mW	450 ns
TMS2516-35	16K	525 mW	350 ns
TMS2508-30	8K	446 mW	300 ns
TMS2508-25	8K	446 mW	250 ns

*Worst case over operating temperature range

TEXAS INSTRUMENTS
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For more information, Circle No 15

85142A

The Remarkable Intelligent Display

It's the ideal readout for interactive systems

Want a sure way to label your "smart" system as a product of the 80's?

Give it the ability to communicate, not in lights, but in operator language.

You don't need an expensive CRT. For short alpha-numeric messages, an Intelligent Display from Litronix will do the job with a minimum of circuit design.

The Intelligent Display is a 4-character, 17-segment alpha-numeric module that interfaces just like a RAM and can be stacked to any length. It has a CMOS chip that includes an ASCII decoder, multiplexer, memory and LED driver. Litronix also offers a pre-engineered Intelligent Display Assembly™ with either 16 or 32 characters.

A new generation of systems that communicate interactively

Intelligent Displays are now being designed into a broad range of "smart" industrial and consumer products.

They include portable data entry equipment. Point of sale systems. Business phones. Banking terminals. Security systems. And automatic test instruments.

A parking lot system in Europe actually tells drivers which number stall to take and whether the lot is full.

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If you are designing or updating products to take advantage of today's microprocessor technology, doesn't it make sense to take it one step further...and give your products the ability to communicate?

With a Litronix Intelligent Display it couldn't be easier.

For information contact Litronix, 19000 Homestead Road Cupertino, CA 95014. (408) 257-7910.

Part Number	Character Height	Horizontal Row Spacing	Vertical Row Spacing	Viewing Angle	Character Positions	Character Segments
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DL-1416	.160"	.250"	1.200"	±25°	4	16
DL-2416	.160"	.250"	.800"	±50°	4	17

IDA-2416-16, Intelligent Display Assembly, 16 characters
IDA-2416-32, Intelligent Display Assembly, 32 characters

U.S. Distributors: Advent, Almac-Stroum, Arrow, Component Specialties, Gerber, Hamilton Avnet, Harvey, Kirkman, Lionex, Marshall, Moltronics, Pioneer-Standard, Summit and Zeus. Canadian Distributors: C.M. Peterson, Electro Sonic, Future, Hamilton Avnet and L.A. Varah.

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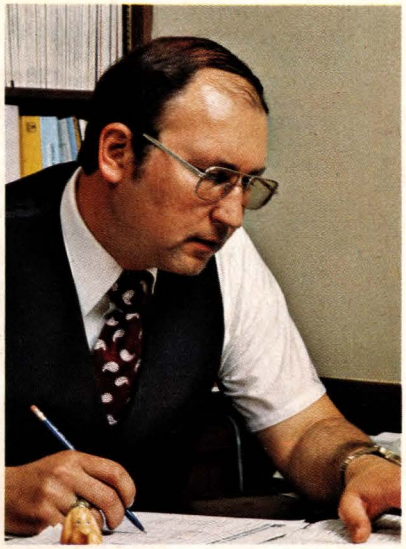
Editorial



A step backwards for quality?

Quality has become the most popular buzzword in the electronics industry today, particularly in the semiconductor segment. Spurred by the achievements of some Japanese manufacturers, many US firms have given top priority to improving their own products' quality.

Such an emphasis is a positive result of the Japanese competition. However, EDN fears that a giant step backwards might occur in 1981 because of the current mad scramble to capture 64k-RAM market share.

In that scramble, semiconductor manufacturers (US and Japanese alike) appear to be abandoning traditional learning-curve pricing methods, as indicated by the latest rounds of "price bombing." Some firms that have barely run first silicon are participating in this price war, yet they can't really be sure they can manufacture production quantities that meet announced specs. And all the competitors, even those few currently delivering production parts, are being denied the chance to recover huge front-end R&D costs.

So what's likely to happen in 1981? Some companies, faced with large quantities of marginal-performance, early-production parts, will dump them on the market at very low prices merely to cut their losses. And that action will not only erode the prices of parts that meet specs, but also establish a quality level well below what companies are now striving for.

The leading computer manufacturers will certainly maintain their procurement standards; they won't specify these low-cost, marginal-performance memory chips. But some other companies could lower their sights just to get scarce parts, or to take advantage of the lower prices. And if that happens, the computer market will be flooded with a substantial quantity of low-quality, unreliable equipment.

EDN urges you to avoid 64k RAMs exhibiting marginal performance levels. Many of you will also have to beef up your incoming-inspection operations to insure that marginal parts aren't slipped in with the good ones. (It's happened before.)

The alternative? Double or even triple your field-service force. And if you choose that alternative, be prepared to live down a poor reputation for quality for a long, long time—should you survive the competition at all.

Roy W. Forsberg

Roy Forsberg
Editorial Director

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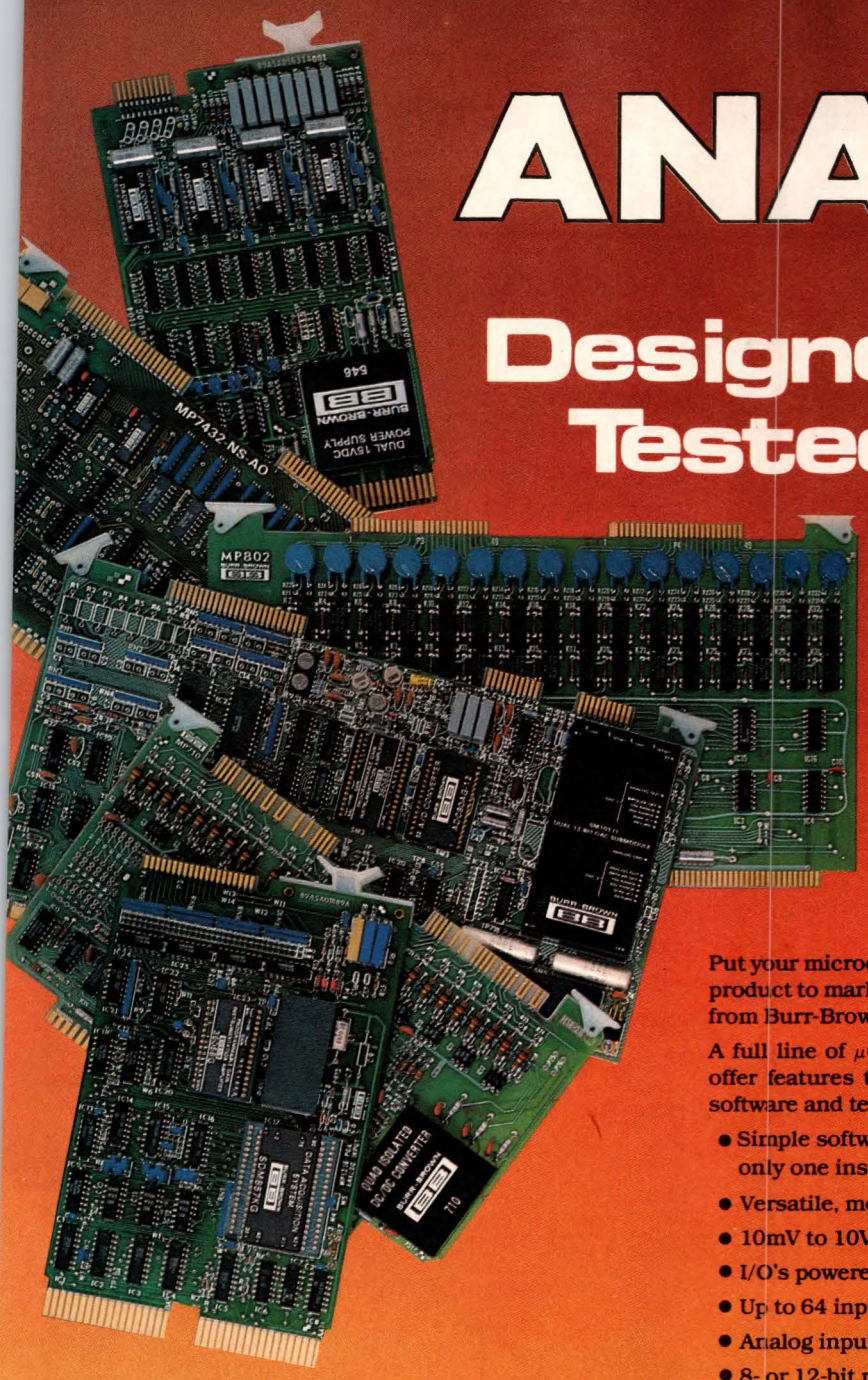

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Leadtime Index

ACTIVE COMPONENTS

PRODUCT	LEADTIME IN WEEKS Min.	Max.	Trend
DISCRETE SEMICONDUCTORS			
Diode, switching	6	10	=
Diode, zener	5	10	=
Rectifier, low-power	5	12	=
Rectifier, power	5	12	=
Thyristor, low-power	7	12	=
Thyristor, power	7	13	=
Transistor, bipolar power	6	12	=
Transistor, bipolar signal	8	14	=
FET, power	5	14	=
FET, signal	7	14	=
Transistor, RF power	7	12	=
DISPLAYS			
Fluorescent	6	11	=
Gas-discharge	5	12	=
Incandescent	6	10	=
LED	5	11	=
Liquid crystal	4	18	=
Plasma panel	6	16	=
ELECTRON TUBES			
CRT, black and white TV	4	13	=
CRT, color TV	8	12	=
CRT, industrial	6	14	=
Industrial power	8	16	=
Light and image sensing	6	12	=
Microwave power	14	18	=
INTEGRATED CIRCUITS, DIGITAL			
CMOS	10	25	=
Diode transistor logic (DTL)	10	16	=
Emitter-coupled logic (ECL)	10	20	=
Low power Schottky TTL	14	26	=
Standard Schottky TTL	15	24	=
Standard TTL	12	17	=
INTEGRATED CIRCUITS, LINEAR			
Communications circuit	8	13	=
Data converter	8	14	=
Interface circuit	7	12	=
Operational amplifier	8	15	=
Voltage regulator	5	11	=

PRODUCT	LEADTIME IN WEEKS Min.	Max.	Trend
MEMORY CIRCUITS			
EPROM	4	12	=
PROM, bipolar	14	30	=
RAM, bipolar	15	27	=
RAM, CMOS	7	12	=
RAM, 4k MOS dynamic	8	15	**up**
RAM, 16k MOS dynamic	9	14	=
RAM, 1k MOS static	7	10	=
RAM, 4k MOS static	10	14	=
ROM, masked MOS	16	18	**up**
MICROCOMPUTER/MEMORY SYSTEMS			
Core memory board	9	13	=
IC memory board	7	12	=
Interface board	8	11	=
Microcomputer board	6	12	=
MICROPROCESSOR IC'S			
CPU, bipolar bit slice	7	15	=
CPU, 4-bit MOS	12	18	=
CPU, 8-bit MOS	6	14	=
CPU, 16-bit MOS	7	16	=
Peripheral chip	7	10	=
OPTOELECTRONIC DEVICES			
Coupler and isolator	8	13	=
Discrete light-emitting diode	6	12	=
PACKAGED FUNCTIONS			
Amplifier, instrumentation	6	15	=
Amplifier, operational	6	18	=
Amplifier, sample/hold	7	14	=
Converter, analog/digital	7	15	=
Converter, digital/analog	7	15	=
PANEL METERS			
Analog	7	14	=
Digital	6	14	=
POWER SUPPLIES			
Custom	13	19	=
Enclosed modular	12	15	=
Open-frame module	10	16	=
Printed circuit	10	14	=

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SINGLE OUTPUT MODELS

AC INPUT(1)	PM2496A	PM2497A	PM2498B	PM2499	PM2500
DC INPUT(2)	PM2721	PM2722			
TOTAL OUTPUT	250-300W	500-750W	1000-1500W	1000-1100W	1000W
OUTPUT VOLTAGE	OUTPUT CURRENT				
2	100	200	400	300	
3	60	100	200	200	
5	50	120	200	200	200
5	60	150	300		
12	25	60	120	85	
15	25	50	100	70	
24	16	33	66	45	
28	13	27	54	40	
48	8	16	32	24	
CASE SIZE:	5"x8"x11"		5"x16"x11"	5"x8"x15"	5"x8"x11"

MULTIPLE OUTPUT MODELS

AC INPUT(3)		PM2675A	PM2676A	PM2677A	PM2678A	PM2679
DC INPUT(4)		PM2775(4)	PM2776(5)	PM2777(6)	PM2778(7)	
MAX. TOTAL OUTPUT		375W	600W	750W	850W	1000W
MAIN CHANNEL	OUTPUT VOLTS	2, 3, 5, 12, 15, 18, 21, 24, 28, 48VDC				
	MAX. POWER	250W	500W	600W	750W	875W
2nd & 3rd CHANNEL	OUTPUT VOLTS	5, 12, 15, 18, 21, 24, 28VDC				
	OUTPUT CURRENT	10	10	10	Check Factory	
4th CHANNEL	OUTPUT VOLTS	5, 12, 15, 18, 21, 24, 28VDC				
	OUTPUT CURRENT	4	4	4	4	4
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5) 48, 120, 240 VDC
6) 120, 240 VDC
7) 120, 240 VDC.

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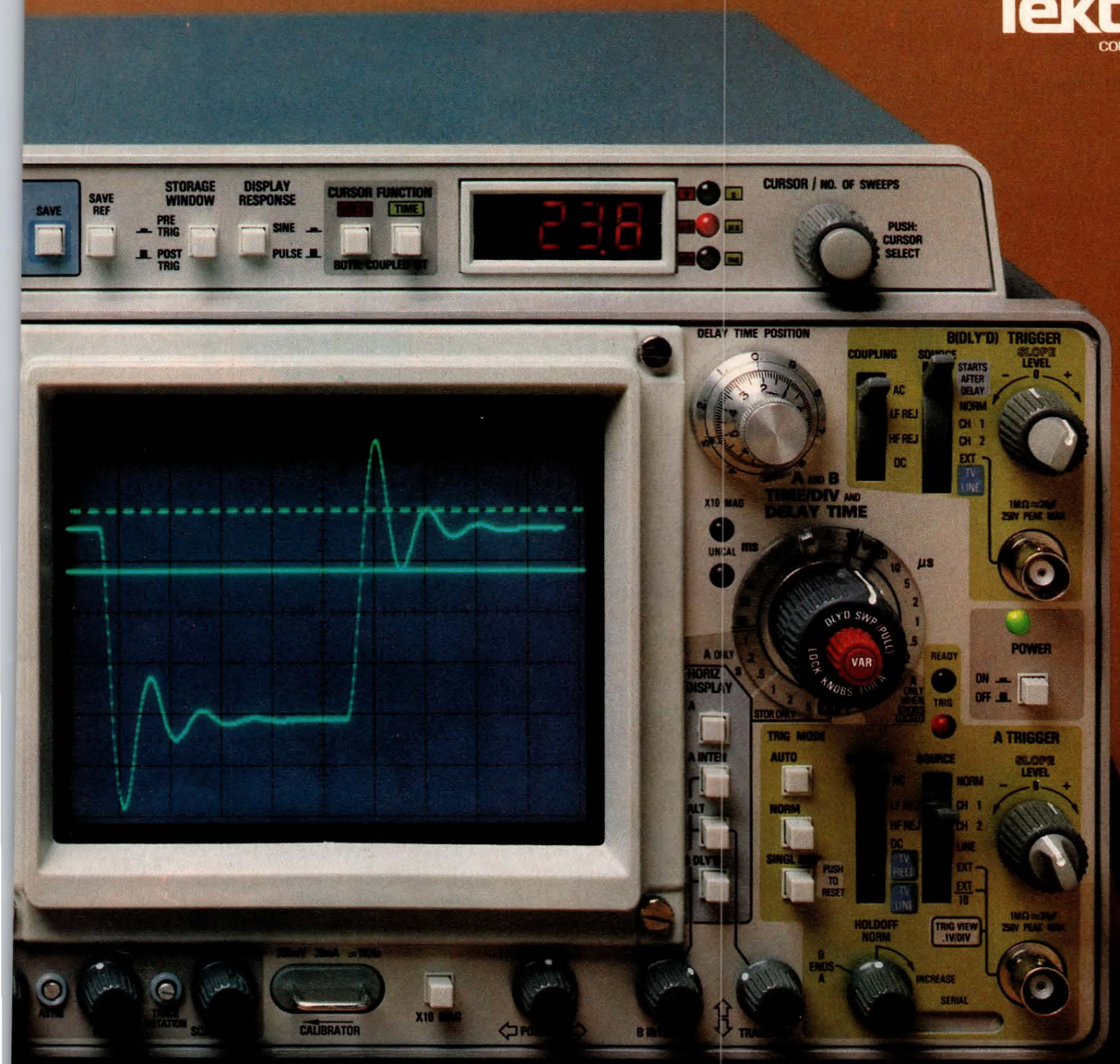

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			Instruction ROM	Data RAM
N-MOS	MN1400	40 Pin DIP/Plastic	1024 x 8 bits	64 x 4 bits
	MN1402	28 Pin DIP/Plastic	768 x 8 bits	32 x 4 bits
	MN1403	18 Pin DIP/Plastic	512 x 8 bits	16 x 4 bits
	MN1404	16 Pin DIP/Plastic	512 x 8 bits	16 x 4 bits
	MN1405	40 Pin DIP/Plastic	2048 x 8 bits	128 x 4 bits
	MN1498	40 Pin DIP/Plastic	External	64 x 4 bits
P-MOS	MN1430	40 Pin DIP/Plastic	1024 x 8 bits	64 x 4 bits
	MN1432	28 Pin DIP/Plastic	768 x 8 bits	32 x 4 bits
	MN1435	40 Pin DIP/Plastic	2048 x 8 bits	128 x 4 bits
C-MOS	MN1450	40 Pin DIP/Plastic	1024 x 8 bits	64 x 4 bits
	MN1453	18 Pin DIP/Plastic	512 x 8 bits	16 x 4 bits
	MN1454	16 Pin DIP/Plastic	512 x 8 bits	16 x 4 bits
	MN1455	40 Pin DIP/Plastic	2048 x 8 bits	128 x 4 bits

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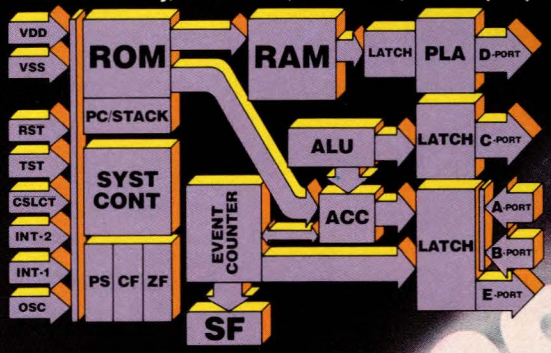

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EEPROMs gain in density and speed, threaten to displace UV EPROMs

William Twaddell, Western Editor

As improvements in memory devices continue unabated on every front, the latest and possibly most far-reaching advances concern nonvolatile memories such as electrically erasable PROMs (EEPROMs; also termed E²PROMs). Manufacturers developed these EEPROMs in their search for nonvolatile memories as easy to use as RAMs; many believe that these devices will replace ultraviolet-erasable units (UV EPROMs) by the middle to late 1980s.

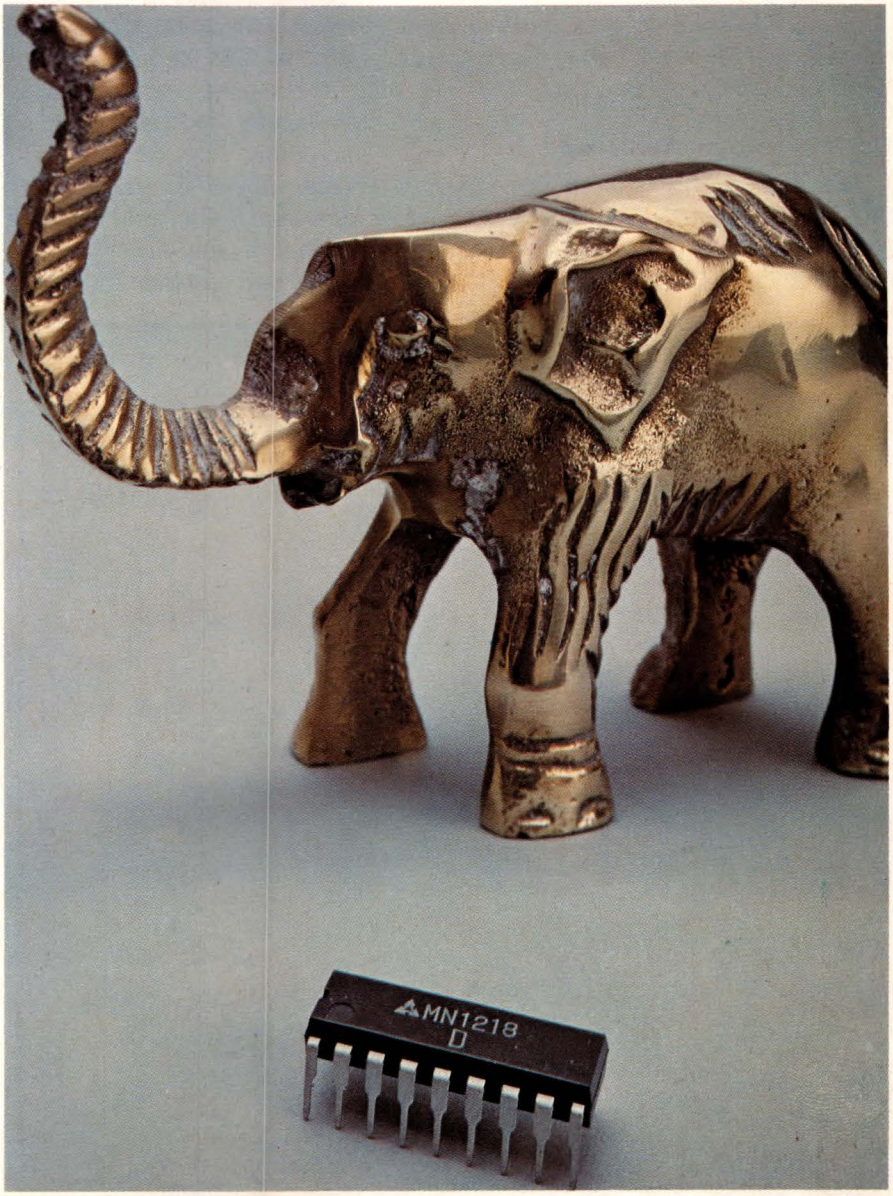
Fabricated with floating gates in both NMOS and CMOS or employing improved MNOS (metal-nitride-oxide semiconductor) techniques, and in one case offering an innovative combination of RAM and EEPROM, these new devices feature fast access times, a virtually unlimited number of read cycles, much improved endurance (erase/write cycling) and longer data-retention times than their predecessors. Further improvements along these lines could ultimately yield a RAM-like nonvolatile memory.

μPs drive EEPROMs

The prime driving force behind memory development in the past has been μP requirements. And although much of the push has concerned random-access memory, μPs also require some nonvolatile memory. This latter memory's form has continuously changed over the years, always tending to add more versatility for users.

Moving from mask-programmed ROM to fuse-link PROM to UV EPROM, programmable and reprogrammable memories have steadily progressed toward the ideal form—nonvolatile RAM. In the present generation of products, the popular UV EPROM is certainly field reprogrammable, but not while in circuit (except with difficulty).

MNOS-based memories, termed EAROMs (electrically alterable ROMs), also belong in the EEPROM category. Available for a half-dozen years or so, these parts do permit in-circuit reprogramming. But several factors have



Pushing data-retention time to 10 yrs, *Panasonic's MN1218 (an updated version of the 1-yr-retention 1208) allows both word and bulk erasures and exhibits a typical endurance of 10^5 cycles. Not a slip-in replacement for the 1208, it needs ±5 and −28V supplies, and the separate 1-word memory now contains 16 bits instead of 12. However, the device still features separate 4-bit input and output buses, a 16×16 main memory and on-board address and control latches. Because it typically requires refreshing after 10^7 read cycles, it doesn't suit use as a RAM.*

restricted their acceptance to specialty applications. These factors include disadvantages such as high erase and write voltages with dual-polarity power supplies, complex voltage sequencing, a limited number of read cycles before refresh is required, and access times in the microsecond range.

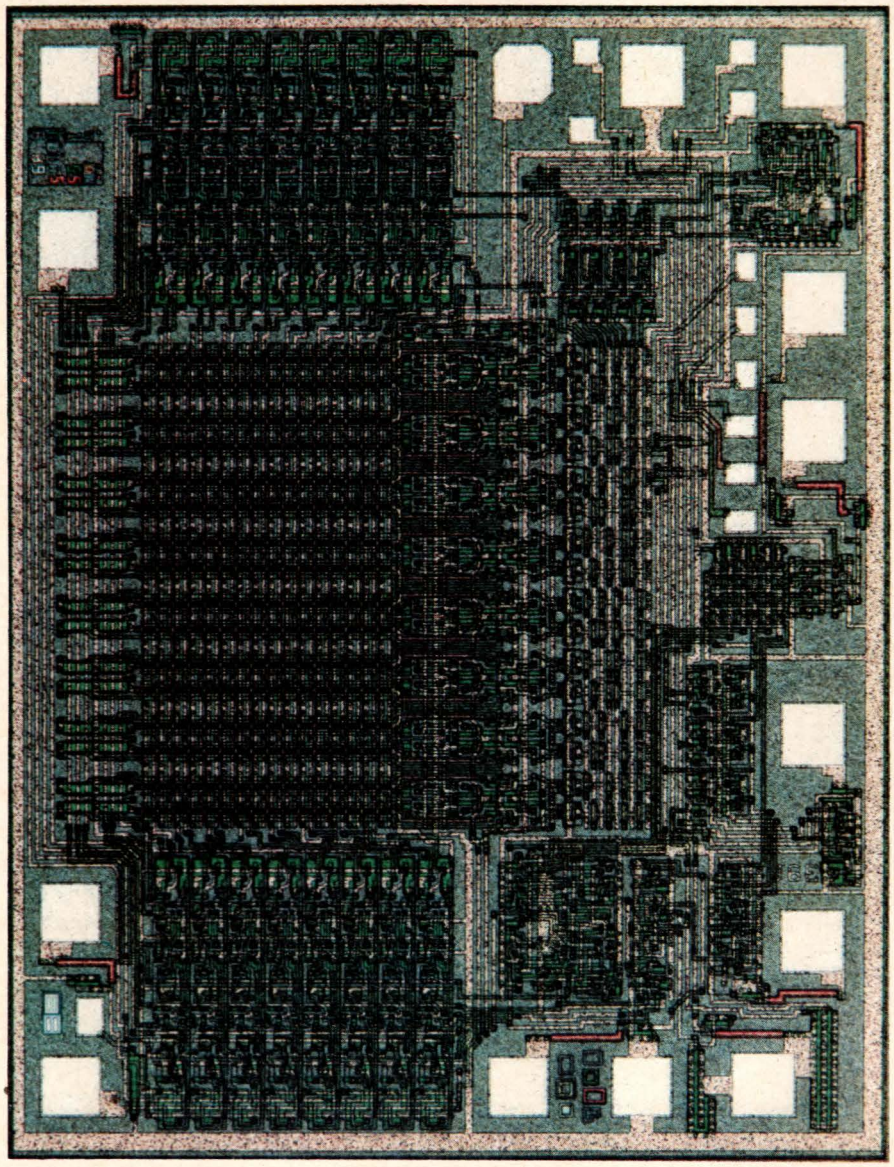
Floating-gate performance

The latest EEPROMs change all that. The first of the floating-gate types to appear, the M 120, comes from Italy's SGS-ATES. A 256×4 CMOS device, it uses two control gates to erase and write to a polysilicon floating gate isolated by an easy-to-fabricate 1000Å oxide layer.

The double control gates allow you to alter individual bits while using only a 20V supply. When reading, the device needs only 5V and takes just 450 nsec for a read—incredibly fast for an EEPROM introduced in mid-1979. Write and erase times are much longer, but the chip incorporates the control and timing functions necessary for these operations. In addition to input/output buffers, it includes address and control latches, an internal oscillator and read and modify timing circuits.

The M 120 takes 300 nsec to latch the input word for a modify operation, but it then floats its 4-bit bus and sends out a Busy signal, while a 2- to 100-msec modify sequence runs internally. To save time and power, the chip internally compares each input bit with its stored counterpart to determine whether modification is necessary. In this way, no cell is ever modified unnecessarily. At the end of the sequence, the memory reconnects to the bus and drops the Busy signal.

The device draws 300 mW in Read mode and 400 mW during a modification. Supplied in an 18-pin DIP, it exhibits an endurance of 10^4 cycles. SGS-ATES is also developing a 4k version of this memory.



Starting out small, *the MCM2801 256-bit EEPROM is Motorola's first entry in the field. But the firm plans to offer a 16k device soon and additional densities later. Organized as 16×16 with serial input and output, the device requires a 5V supply for a read and a 25V supply for programming. A 3-bit parallel instruction bus controls the part, which normally draws 30 mA but needs only 300 μA in Standby mode.*

MNOS speeds up its act

Designating the HN48016 an EEPROM rather than an EAROM, Hitachi has introduced this first available 16k part. The device illustrates the capabilities that enable MNOS EEPROMs to stay competitive with their NMOS and CMOS counterparts.

The 48016 is built with an n-channel silicon-gate process instead of the slower p-channel aluminum-gate fabrication method used for earlier EAROMs. This new process brings its access time down to 350 nsec max, 250 nsec typ.

Pin compatible with the 2716 UV EPROM, the 2k×8 unit requires the same voltages—5V for read and 5V and 25V for programming or erasure. Programming takes 10 msec/byte, but erasure requires a 1-sec pulse and clears the entire memory. Endurance conservatively rates at 10^3 cycles, while data retention is greater than 10 yrs. The part is available now at a very competitive price of $57 (100).

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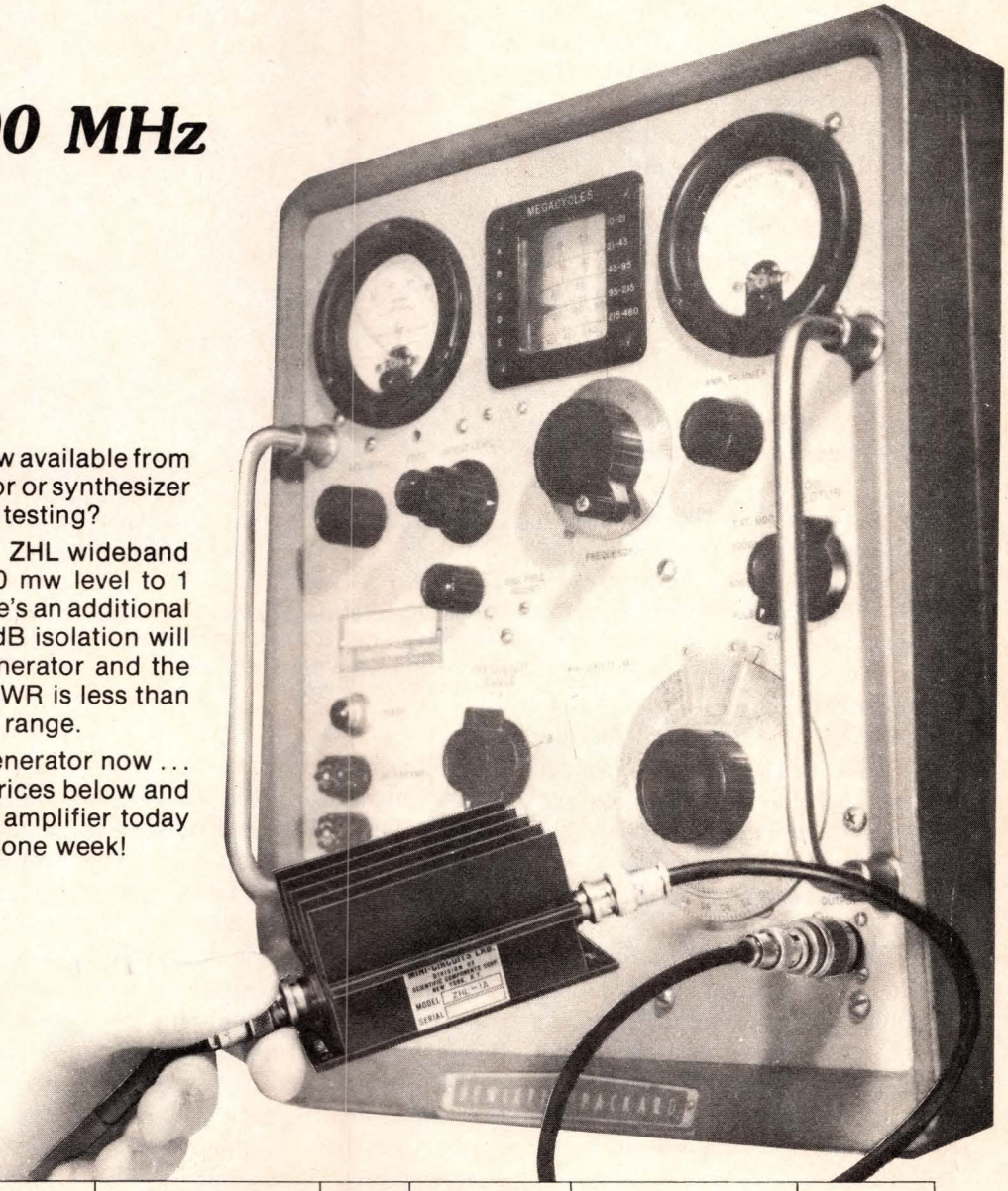

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ZHL-3A	0.4-150	24 Min.	±1.0 Max.	+29.5 Min.	11 Typ.	+38 Typ.	+24V	0.6A	199.00 (1-9)
ZHL-1A	2-500	16 Min.	±1.0 Max.	+28 Min.	11 Typ.	+38 Typ.	+24V	0.6A	199.00 (1-9)
ZHL-2	10-1000	16 Min.	±1.0 Max.	+29 Min.	18 Typ.	+38 Typ.	+24V	0.6A	349.00 (1-9)
ZHL-2-8	10-1000	27 Min.	±1.0 Max.	+29 Min.	10 Typ.	+38 Typ.	+24V	0.65A	449.00 (1-9)
ZHL-2-12	10-1200	24 Min.	±1.0 Max.	+29 Min.*	10 Typ.	+38 Typ.	+24V	0.75A	524.00 (1-9)

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the EEPROM field and a high-volume user of p-channel metal-gate MNOS—is also getting into the n-channel business to obtain devices with shorter read times. The firm is sticking with the metal-gate approach, however.

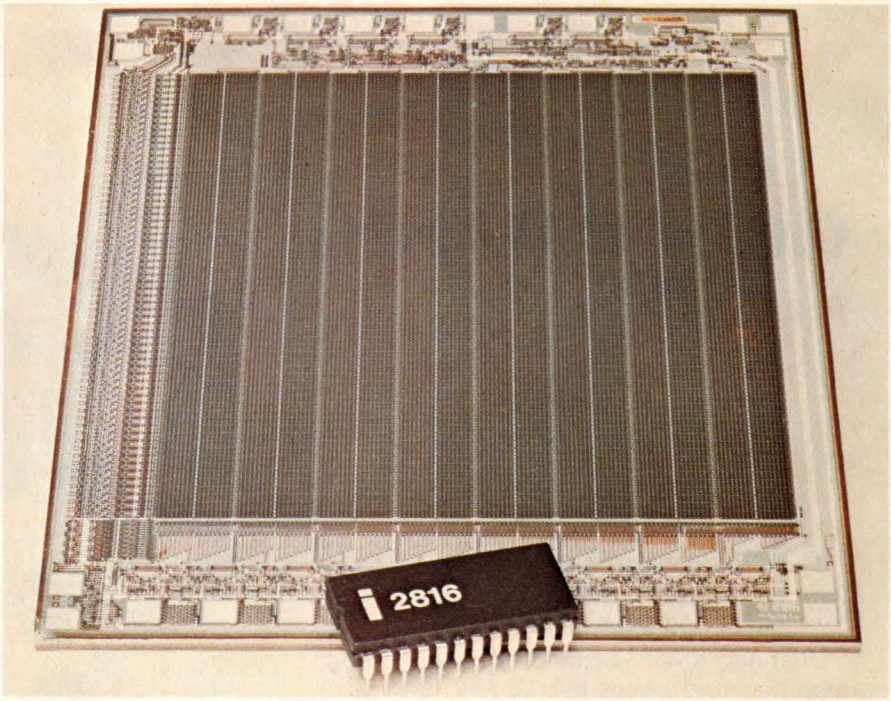
GI's ER4201 features a 128×8-bit configuration, 5V read, 24V write/erase without voltage sequencing, less than 350-nsec read time, 10- to 20-msec programming time and data-retention time greater than 10 yrs.

Moreover, the 4201 has some added functionality that makes it very easy to use—features that will doubtless appear in all manufacturers' future generations of EEPROMs. To relieve the peripheral hardware load, for example, the chip contains data, address and mode latches and timing circuitry and provides a Busy signal during write cycles. You can either word- or bulk-erase it, and an automatic erase/write-cycle command further eases μPs' control burden. Finally, an external RC network sets the internal frequency for erase/write times, furnishing a tradeoff between erase/write speed and data-retention time.

Although GI now makes 8k devices and is reportedly working on a 16k part, the company intends to serve what it sees as a significant market for small nonvolatile memories—a commitment reflected by the number of small memories in its catalog.

More firms enter the fray

Bypassing lower density parts altogether and advocating the floating-gate approach it terms Flotox, Intel is just getting into production with its Model 2816 16k EEPROM. A 2k×8 design that conforms to the JEDEC byte-wide package standard, the part features a 250-nsec max access time that suits it for use with high-performance μPs without the necessity for Wait states. 200- and 350-nsec versions are also available.



Furnishing a 16k density, *Intel's 2816 EEPROM is one of the largest such devices offered. Featuring a short (250-nsec) access time, it can interface with fast μPs without requiring Wait states. Two-line chip control eliminates contention between addresses and data on multiplexed bus lines.*

Programmable on a byte-erase/write basis, the 2816 also permits bulk erasure. Erase/write time per byte and chip-erase time each equal 10 msec. Active power dissipation specs at 495 mW, but power in Standby mode drops to 132 mW. The device operates from a 5V supply in Read mode and requires a 21V pulse for writing and erasing.

The Intel part is typical of thin-oxide floating-gate cell structures that use Fowler-Nordheim tunneling (also termed cold electron injection) to achieve cell writing and erasure. Because this type of tunneling stresses the cell less than does avalanche injection (as with UV EPROMs), endurance increases by several orders of magnitude.

Impact on μC-system design

As this and other approaches are refined, they will profoundly affect μC-system design. Applications such as self-compensating or self-modifying process or numerical controllers, for example, will revolutionize the industrial market and virtually every other one. EEPROM-based systems will permit you to phone in diagnostics and subsequent repair instructions or updated diagnostics as they are improved. Eventually, such systems could eliminate field calls by service people except in extreme cases.

As envisioned by Larry Jordan, strategic marketing and applications manager for Intel's Special Products Div, the combination of today's increasingly powerful μPs with EEPROMs starts a whole new chapter in the μP story. The capability to dynamically reprogram a μP on the fly will in itself open up an enormous application area, particularly in the field of robotics.

In error-correcting mainframe memory, EEPROMs allow dynamic mapping of good RAM over bad, thus eliminating many maintenance calls and reducing down time. And any application in which variables—such as tax rates in point-of-sale terminals and taxi-meter rates—

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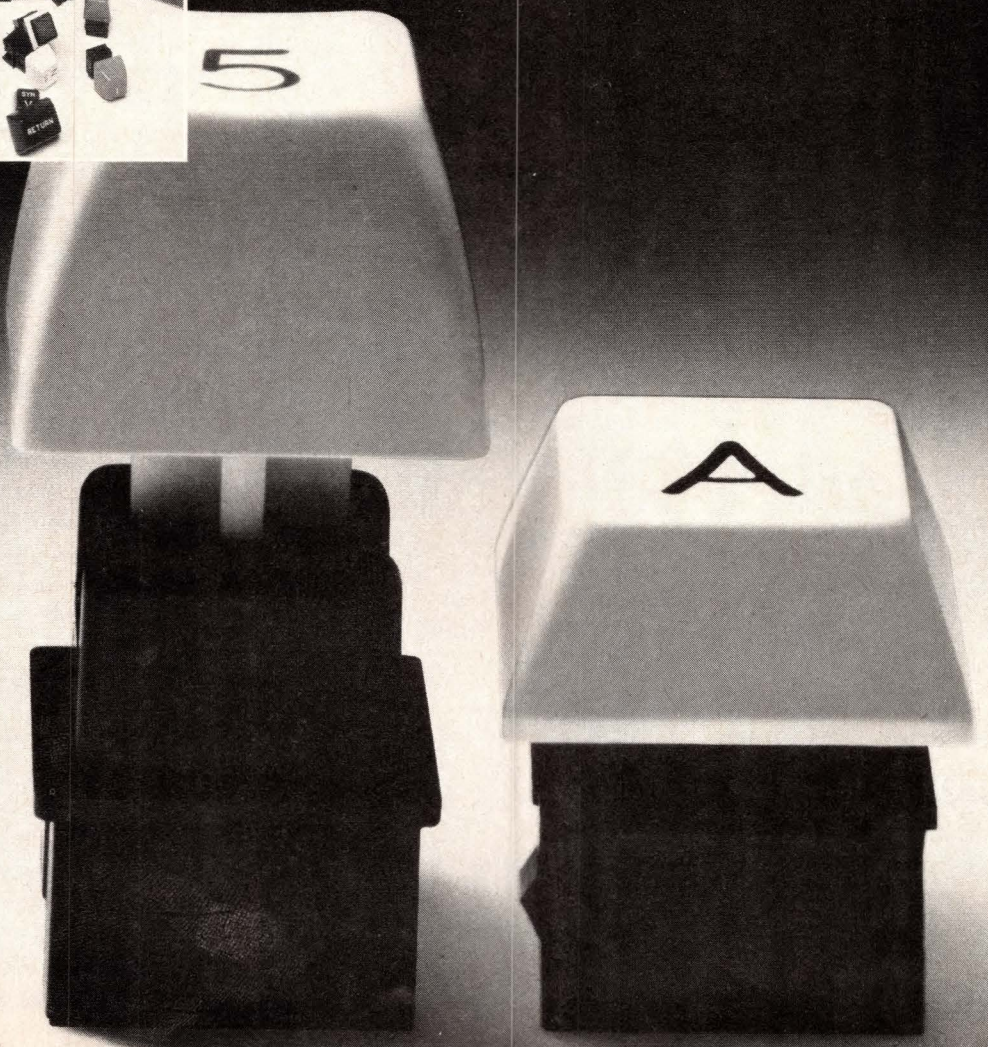

change slowly (over weeks or years) will gain cost and time savings using EEPROM instead of UV EPROMs or fuse-link PROMs.

In military applications, the devices will permit in-flight target reprogramming of missiles, more secure encryption methods and navigational and radio-frequency changes via an umbilical cord rather than by removing sensitive memory cards.

Although Intel's 2816 cells employ both a storage and a select transistor, future designs will merge the two, producing a cell size no larger than that of a UV EPROM. And despite the several extra masking steps required to make EEPROMs, other factors, such as a cheaper package (no quartz window) and ease of testing (no 30-min-plus erase), will drive the devices' price down to the UV-EPROM level by the mid-'80s. In Jordan's opinion, the EEPROM will eventually (by 1990?) completely displace the UV EPROM. He also expects EEPROM speed and density specs to match those of current EPROM devices.

Additionally, in agreement with other EEPROM marketers such as Motorola's Dave Ford, Jordan expects to see the parts' functionality increase, thanks to added features such as power-supply switching, address and control latches and possibly programming-voltage bias generators. Many of these features already exist in MNOS devices produced by the more experienced companies in the business, but as newer manufacturers gain experience, they will doubtless add similar capabilities.

CMOS achieves 8k

One company already garnering the density advantages of merging an EEPROM's select and storage transistors is Hughes Aircraft with its 8k CMOS device. Among its outstanding features, the HNVM 3008 includes a 5V read voltage, a programming and erase voltage of

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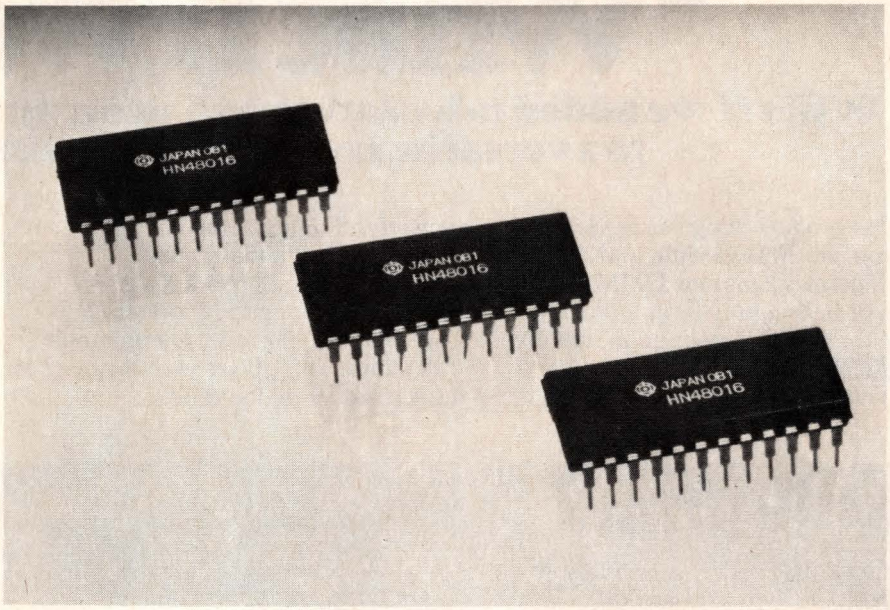
Technology News



The first EEPROM to achieve 16k density, *Hitachi's HN48016 is also one of the fastest devices available with a maximum access time of 350 nsec. The n-channel MNOS part requires 5V in Read mode and only one 25V supply for programming and erasure. Pin compatible with the 2716 EPROM, it block erases in 1 sec and programs at 10 msec/byte.*

only 17V and a 5-mW typ operating power dissipation at 200 kHz; typical standby power drops to just 50 μW.

Configured as 1k×8 and using a floating silicon gate and thin tunneling oxide, the device bulk erases in 100 μsec, accesses in 500 nsec typ, programs at 100 μsec/byte, operates over −55 to +125°C and exhibits data retention of 10 yrs at 100°C and an estimated durability of 10^5 cycles. The company also plans to produce a 512×8 version (HNVM 3004). The 3008 and 3004 cost $300 and $175, respectively, but Hughes expects prices to drop to less than $50 before year's end.

Another company just entering the EEPROM market, Motorola now offers the 16×16 MCM2901. Reading a 16-bit word serially with this device takes 168 μsec, and an erase/write cycle requires 110 msec; reading calls for a 5V supply, while write/erase uses a 25V supply.

Utilizing a floating-gate structure, the 2801 is the forerunner of a 2816-type memory that the company will sample this quarter. Performance should be equivalent to that of the Intel part.

Mostek (Carrollton, TX) is in the early stages of definition for its proposed EEPROM, an NMOS device that might employ triple-level poly to produce a very small merged-transistor cell. Mostek presented a paper on the technology at last December's IEDM.

Small-scale MNOS

Although most of the manufacturers just entering the EEPROM field use the thin-oxide/floating-gate approach, the older MNOS technology is far from dead. Companies such as Nitron, Panasonic and Plessey are still adding p-channel MNOS products to their lines.

Nitron, for instance, recently introduced the NC7810, an alternative to NCR's 2k×8 NCR2810. Although the 7810 requires a −28V pulse for erasure, durability runs to 10^5 cycles with a minimum of 2×10^{11} read cycles before refresh. Price is approximately $20 (100).

Sticking with smaller densities for now, Panasonic offers the MN1208, a 256-bit part with a 4-bit data bus and on-chip latches. Requiring −10 and −33V supplies, the $5.75 (1000) device has a typical durability of 10^5 cycles. Panasonic

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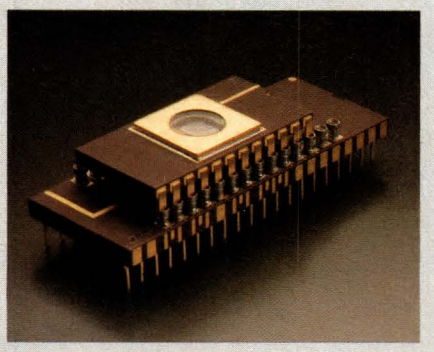

Now there is a practical alternative to a masked-ROM 8-bit microcomputer for low and medium volume applications: The MK38P70 from Mostek. It features a piggyback EPROM socket capable of accommodating industry standard 1K, 2K, or 4K X 8 EPROMs. Though the MK38P70 is an excellent prototyping tool, a recent, dramatic price reduction makes it highly efficient for production use as well. In fact, for low volume levels, the MK38P70 is now more economical than its masked-ROM counterparts.

For medium, or even high-volume levels, an EPROM-backed 3870 may still be your more efficient choice for production. Especially if time and flexibility are important. First, consider time. Delivery for the MK38P70 is off-the-shelf from your local Mostek distributor. And because it is an EPROM microcomputer, you can put it into production immediately.

Now consider flexibility. With the MK38P70, flexibility before, during or after system design is only limited by your ability to program it with a standard EPROM programmer. You can customize, refine or change your program as the need arises. Plus, flexible off-chip memory address capability from 1K to 4K bytes lets you customize your product line with a smaller inventory. And/or upgrade existing products quickly and efficiently.

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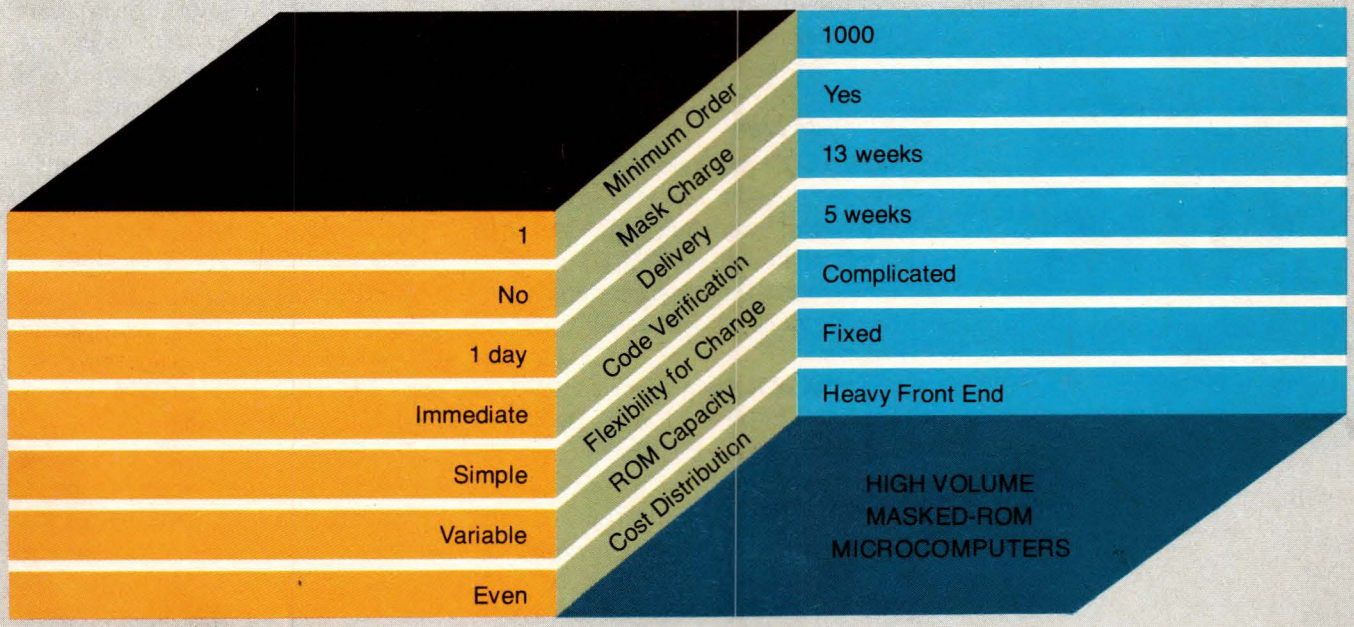

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Technology News

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expects to introduce 1k and larger devices this year and sees no density restrictions in MNOS technology.

Plessey Semiconductor's latest EEPROM is also a 256-bit device, and it also features a 4-bit bus and data and address latches. The MN9210 furnishes a 1-yr data-retention time (as does the Panasonic part), operates over −40 to +70°C and costs $28.69 (100).

NV-RAM ideal

All of the products described here are moving the memory art toward the ideal nonvolatile-RAM goal. And although EEPROMs don't quite merit that designation as yet, one product comes closer than the others.

The X2201 from Xicor combines a fast standard RAM with a floating-gate EEPROM in an exceptionally easy-to-use 1k×1 memory. The RAM portion accesses in less than 250 nsec typ, and the entire memory transfers to EEPROM in one snapshot operation requiring less than 5 msec. Recall from storage to RAM requires less than 1 μsec, and both operations employ a simple TTL signal for initiation.

This part's key advantage, however, is its use of a single 5V supply for all operations. The chip generates its own tunneling voltages, eliminating the need for multiple supplies. Additionally, once a store operation begins, you can access the contents of the foreground RAM normally, causing no μP waits. The X2201 permits an unlimited number of reads, and endurance specs at 10^3 to 10^5 cycles.

At present, the device's main problems center on density and price: It comes only in a 1k version priced at $25 (1000), but Xicor expects to reduce the price to $10 by late this year and introduce a 4k model at about the same time.

Meanwhile, the X2201 remains probably the best choice for a power-fail memory because of its speed of transferral. And—if your application warrants the price—it's the easiest to use nonvolatile memory on the market. **EDN**

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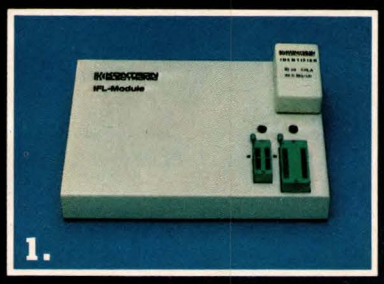

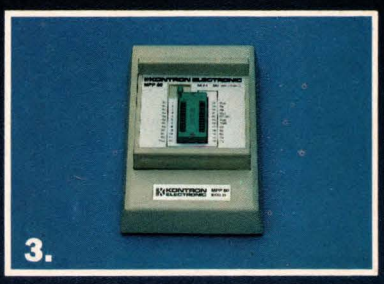

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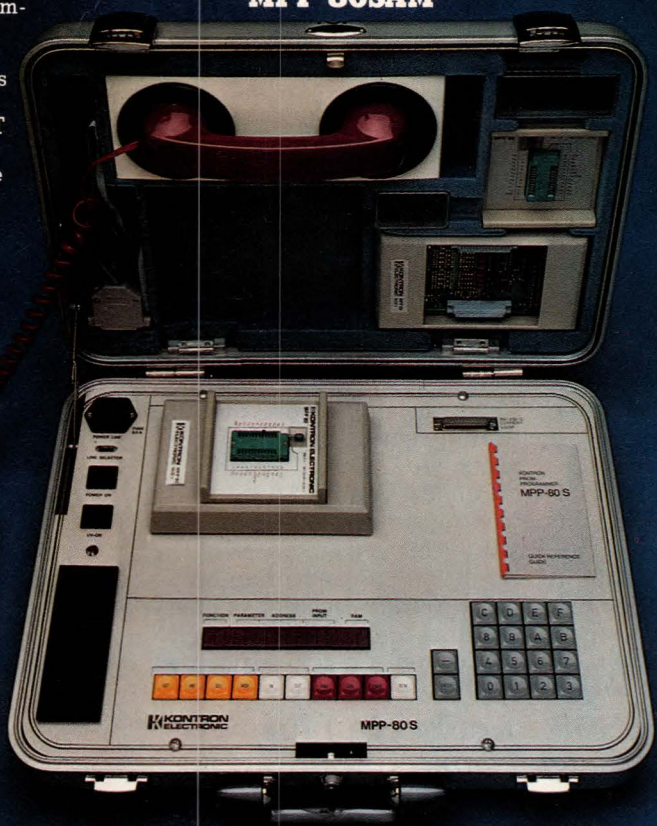

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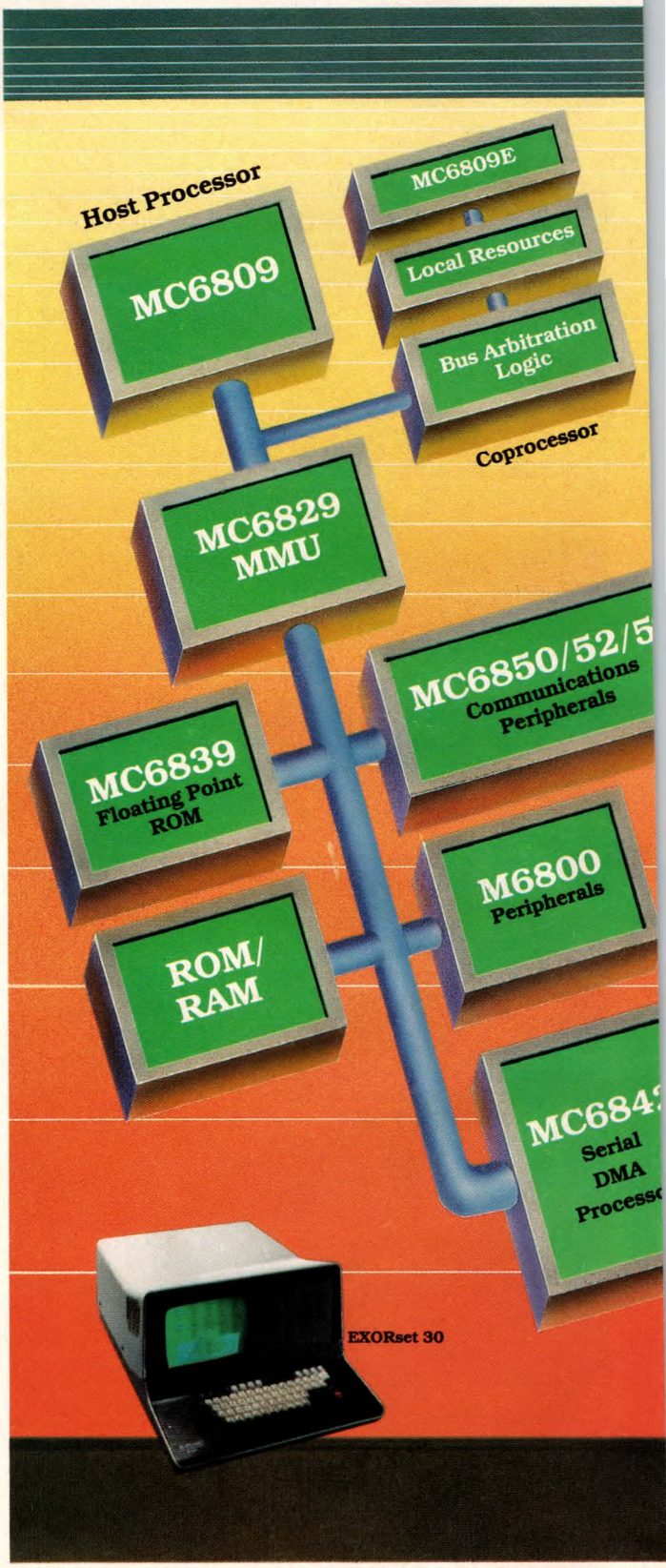
Architectural advantages, beyond 16-bit registers and modern programming techniques, add to the versatility and cost-effectiveness of the MC6809. Auto-increment and auto-decrement addressing modes improve the efficiency of block moves and string handling, and extensive stack manipulation capabilities make block-structured high-level languages a natural.

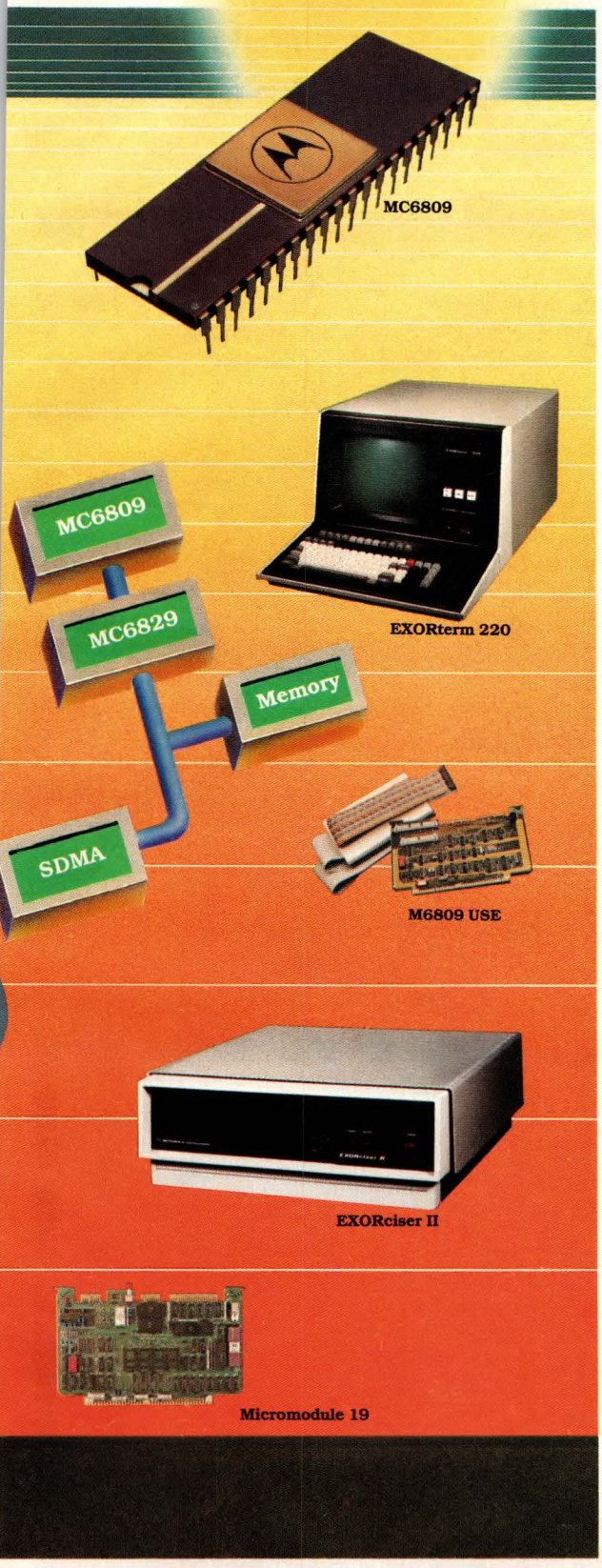
The M6809 Family plan for advanced systems.

A whole new family of VLSI peripherals has been designed to take advantage of the many powerful features of the MC6809, and in turn, to help users obtain its full potential in flexible, high-performance 8-bit and pseudo 16-bit systems.

System support for the MC6809 is still supplied by the entire complement of M6800 Family peripherals, and several of the high-performance VLSI peripherals of the 16-bit M68000 Family also are directly compatible.



high-performance MC6809 advanced 8-bit systems.



Coprocessing is easily accomplished with the M6809 Family. The new externally clocked MC6809E provides the flexibility required for multiprocessing: multiple processors operating in parallel on the same bus. Unlike some coprocessing schemes, with the MC6809E users are not limited only to floating point or string manipulations.

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The MC6842 Serial Direct Memory Access Processor is a family addition planned for next year to handle high-speed transfer of data and control between and among microprocessors and intelligent controllers in distributed processing systems.

The last word in support.

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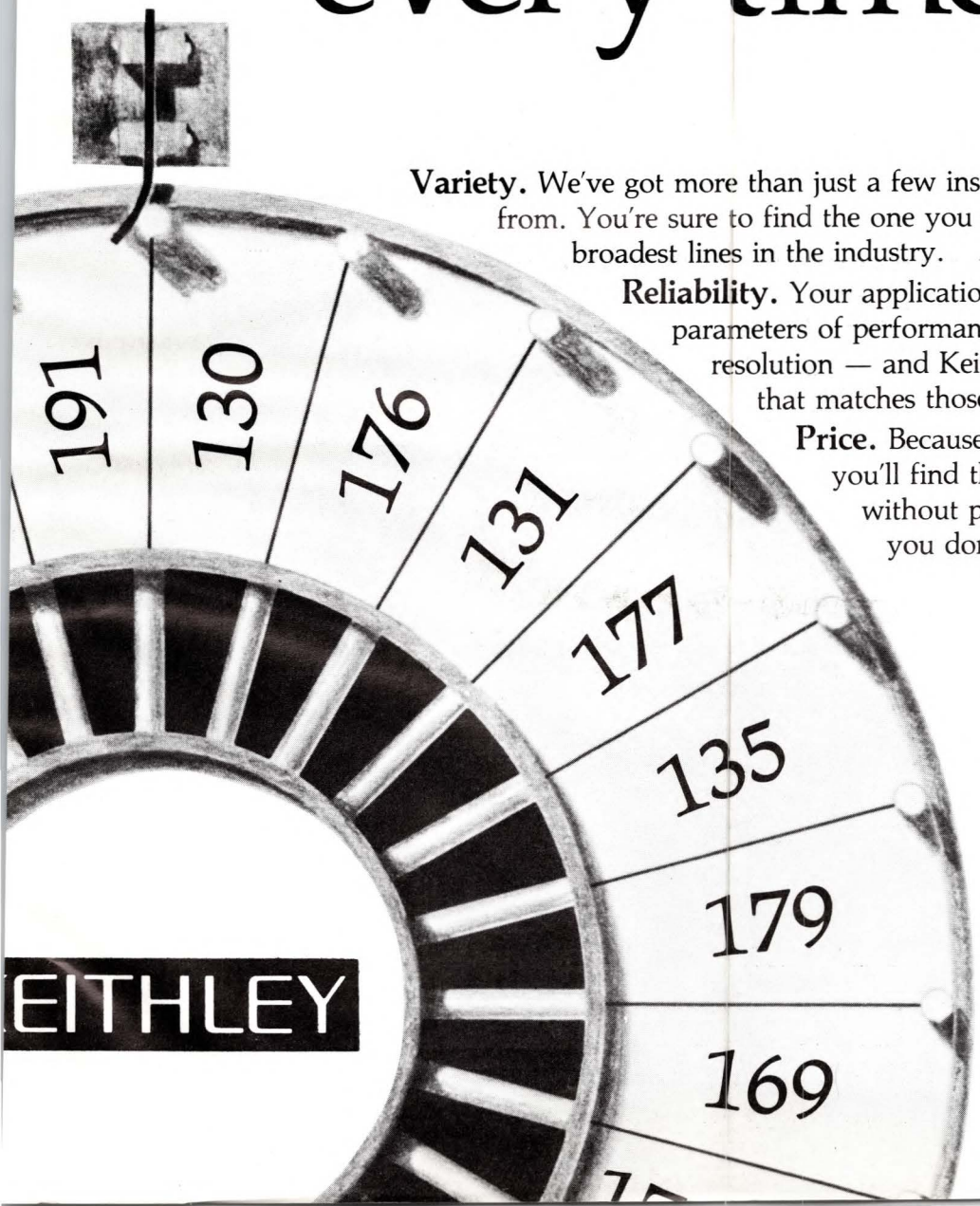

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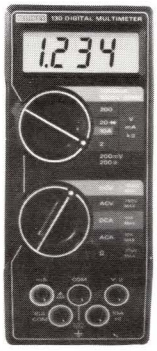

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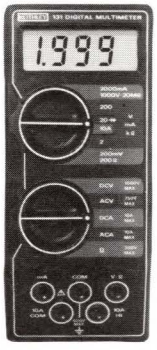
This solidly-built 5-function DMM weighs just 10 oz., yet is packed with performance features like a large (0.6"), easy-to-read LCD, 0.5% basic DCV accuracy, 10A current range, easy-to-use rotary switches, low battery annunciator on the display, auto zero and auto polarity. **$115**



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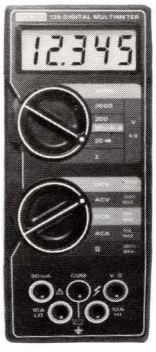

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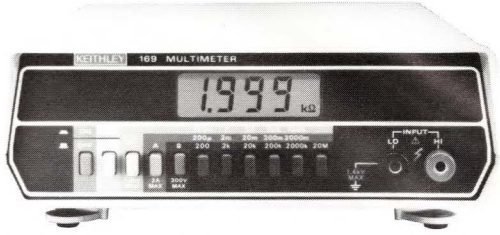

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With battery eliminator $199

Model 176: Free digit.

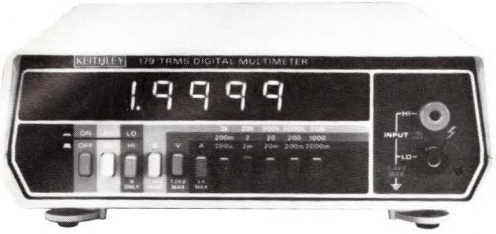
The fully portable Model 176 allows you to move up to a 4½ for the same price you'd pay for many 3½'s. Or, if you're already using a 4½, you can replace it with the 176 for less than the repair cost of your old instrument. Basic accuracy of 0.05%, solid construction, externally accessible fuse, and polarity, range, function and low battery annunciators give the 176 top-of-the-line capability. **$249**

With battery eliminator $279

MODEL		130	131	135	169	176
	Digits	3½	3½	4½	3½	4½
DCV	Sensitivity	100μV	100μV	100μV	100μV	100μV
	Accuracy	0.5%	0.25%	0.05%	0.25%	0.05%
ACV	Sensitivity	100μV	100μV	100μV	100μV	100μV
	Accuracy	1%	1%	1%	0.75%	1%
DCA	Sensitivity	1μA	1μA	10μA	100nA	1μA
	Accuracy	1%	0.75%	0.5%	0.75%	0.5%
ACA	Sensitivity	1μA	1μA	10μA	100nA	1μA
	Accuracy	2%	2%	1.5%	1.5%	1.5%
OHMS	Sensitivity	100mΩ	100mΩ	100mΩ	100mΩ	100mΩ
	Accuracy	0.5%	0.2%	0.2%	0.2%	0.2%
	PRICE	$115	$134	$219	$169	$249

High performance bench DMMs.

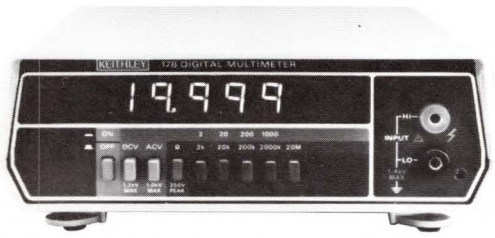
KEITHLEY



Models 179 & 179-20A: Versatile.

Five full functions and optional IEEE-488 interfaceability make the Model 179 ideal for most general purpose bench measurements. Both instruments feature 10μV sensitivity and 0.04% accuracy, TRMS AC and HI-LO ohms. The Model 179-20A is identical to the 179, with the exception of an added 20A range — ideal for uses beyond most DMMs' 2A range.

179 $329
179-20A $395

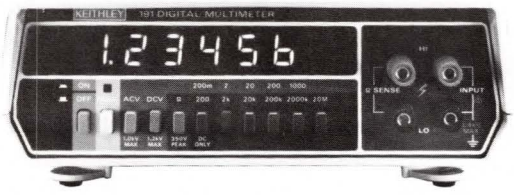


Model 178: No frills.

The Model 178 provides all the capability needed for most general production uses. It offers the three most used functions — DCV from 100μV to 1000V, average responding ACV from 100μV to 1000V, and ohms from 0.1Ω to 20MΩ. A large, bright LED display and color-coded front panel provide easy use. Basic DCV accuracy is 0.04%. The 178 also accepts the full line of Keithley accessories. $249

Model 177: Sensitive.

Extended capabilities make the Model 177 ideal for the most demanding bench measurements. Sensitivity ranges down to 1nA, 1μV and 1mΩ. Basic DC accuracy is 0.03% on most DC ranges and 0.04% on most ohms ranges. The 177's TRMS AC volts and amps lets you accurately measure sinusoid, distorted sinusoid and non-sinusoid waveforms. Analog output drives chart recorders or acts as an amplifier. $449



Model 191: μP, 5½ digits.

Our top-of-the-line Model 191 offers high resolution, 0.007% basic DCV accuracy and 1μV/1mΩ sensitivity on the standard DCV and ohms ranges. The microprocessor replaces signal conditioning hardware to reduce component count and enhance reliability. Relative measurements are easily made with the pushbutton null. Other features include 1000MΩ input impedance and 2/4-wire ohms. $595

MODEL		178	179*	179-20A*	177*	191
	Digits	4½	4½	4½	4½	5½
DCV	Sensitivity	100μV	10μV	10μV	1μV	1μV
	Accuracy	0.04%	0.04%	0.04%	0.03%	0.007%
ACV	Sensitivity	100μV	10μV	10μV	10μV	† 10μV
	Accuracy	0.3%	0.5%	0.5%	0.5%	† 0.1%
DCA	Sensitivity	—	10nA	10nA	1nA	—
	Accuracy	—	0.2%	0.2%	0.2%	—
ACA	Sensitivity	—	10nA	10nA	10nA	—
	Accuracy	—	1%	1%	0.8%	—
OHMS	Sensitivity	100mΩ	100mΩ	100mΩ	1mΩ	1mΩ
	Accuracy	0.04%	0.04%	0.04%	0.04%	0.012%
	PRICE	$249	$329	$395	$449	$595

*IEEE-488 Interfaceable †Optional

Interfaceable—now or later.

The Keithley 488 line of interfaceable DMMs can solve your budget and measurement problems, because you can build an automated IEEE-488 bus system at a lower price than ever before. The optional interface is easily field-installed with a screwdriver, and is powered from the instrument's normal power cord. Whether you decide to interface now or later, you still receive maximum value. A high-quality basic Keithley DMM is a fraction of the cost of competitive IEEE-488 compatible DMMs. And the IEEE-488 bus interface can be added at any time for less than the cost of the original unit. With Keithley, you buy only what you need, when you need it. The Isolated IEEE-488 Output is for Models 177, 179 and 179-20A. **$295**

A full line of accessories is available to extend the capabilities of all Keithley DMMs.

Model 1010: Single Rack Mounting Kit $55
Model 1017: Dual Rack Mounting Kit $90
Model 1600: High Voltage Probe (40kV) $125
Model 1651: 50-Ampere Current Shunt $50
Model 1681: Clip-On Test Lead Set (48 in.) $6
Model 1682: RF Probe $170
Model 1683: Universal Test Lead Kit with 14 tips $10
Model 1684: Hard Shell Carrying Case with foam insert $40
Model 1685: Clamp-On AC Current Probe $75
Model 1691: General Purpose Test Lead Set $6

Other DMM Accessories

MODEL	130 & 131	135	169	176	178	179 & 179-20A	177	191
Battery Pack	Std.	Std.	Std.	1768*	1788	1788	1788	
BCD Output						1792	1792	
IEEE Interface						1793	1793	
Spare Parts Kit	1309	1359	1699	1769	1789	1789	1779	1919
Battery Eliminator			1766	1766				
Carrying Case	1304	1304	1684	1684	1684	1684	1684	1684
Calibration Cover								1913
Kelvin Leads								1641

*Battery operation is standard on Model 176; 1768 option converts Model 176/1766 (ordered with 1766 Battery Eliminator installed) to battery operation.

Model 1304: Soft Carrying Case & Stand $10
Model 1309: Spare Parts Kit $30
Model 1359: Spare Parts Kit $30
Model 1641: Kelvin Test Leads $99
Model 1699: Spare Parts Kit $35
Model 1766: Battery Eliminator $40
Model 1768: Battery Pack $40
Model 1769: Spare Parts Kit $30
Model 1779: Spare Parts Kit $75
Model 1788: Rechargeable Battery Pack $79
Model 1789: Spare Parts Kit $85
Model 1792: Isolated BCD Output $165
Model 1793: Isolated IEEE-488 Output $295
Model 1910: AC Volts Option $175
Model 1913: Calibration Cover $35
Model 1919: Spare Parts Kit $85

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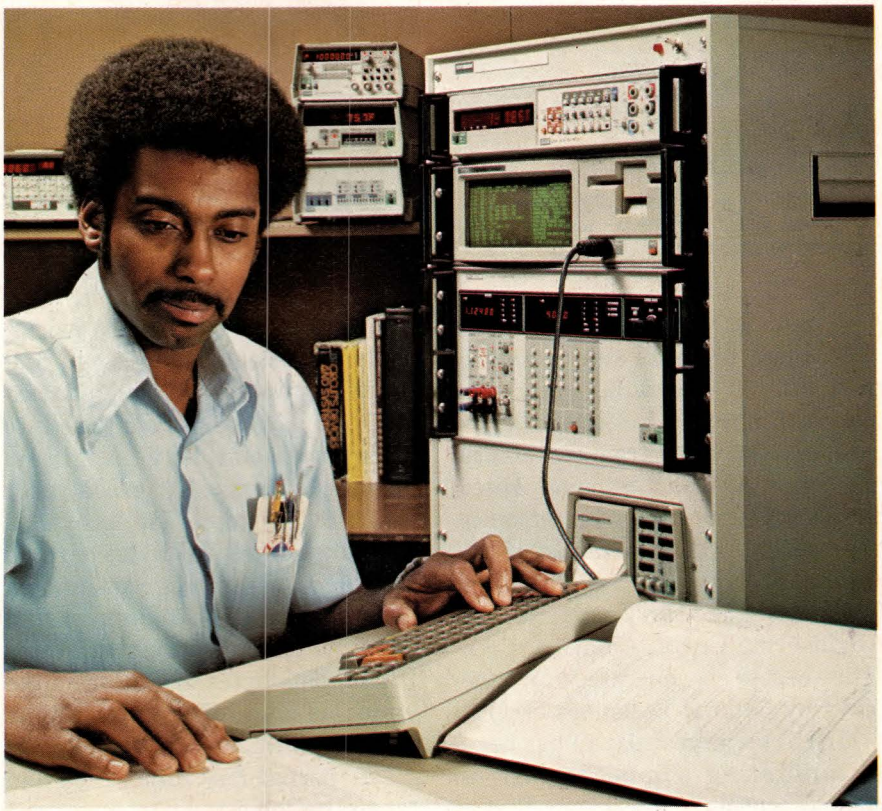
Use Navy calibration-system spadework to configure your own calibrators

Andy Santoni, Western Editor

A US Navy-developed system for calibrating shipboard test equipment is bringing to the commercial instrument market a series of "modules" that, although built by different suppliers, can work together easily to calibrate a wide variety of instruments. Housed in portable cases for use in the Navy program, the Series's IEEE-488-bus controller and most of the modules for calibrating oscilloscopes, multimeters, counters and signal generators are also available (or will be) in rack-mounting versions for stationary systems.



The master controller for the Navy's MECCA calibration system *is Fluke's Model 1720A, although you can use other IEEE-488 controllers as well in the commercial version of the system.*

New modules join old

In the 6 yrs the Navy's Modularly Equipped and Configured Calibrators (MECCA) program has been in development, four pieces of the system have been designed and made commercially available:

- The bus controller, currently a version of Fluke's Model 1720A
- The frequency-counter calibrator, ArgoSystems' Model AS 210
- The multimeter calibrator, a version of Fluke's Model 5100B
- The oscilloscope calibrator, at present a version of Tektronix's Model CG 551AP.

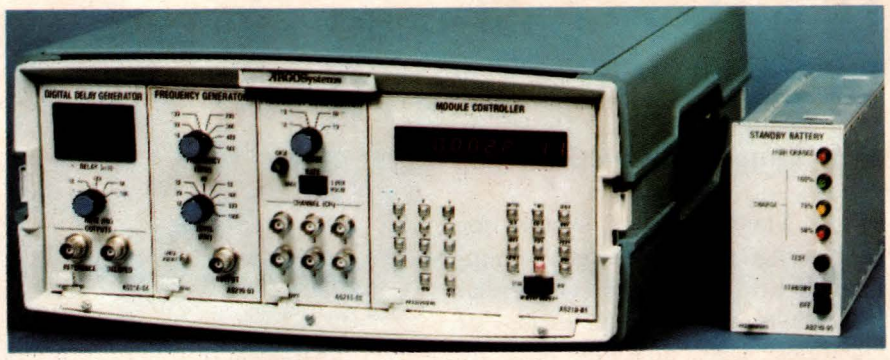
An earlier MECCA IEEE-488-bus controller was produced by Instrumentation Technology Corp, which has since gone out of business.

This year, three new modules will join the family:

- A higher accuracy multimeter calibrator, derived from Fluke's Model 8502A
- A signal-generator calibrator, based on Weinschel Engineering's Model VM-4A
- A second scope calibrator, derived from Ballantine Labo-

Prompting software *helps you write calibration-procedure programs for Tektronix's Model CG 551AP scope calibrator.*

More than 80% of the Navy's needs *for DVM and DMM calibration are met by a modified version of this Fluke Model 5100B.*



A rubidium standard *is at the heart of ArgoSystems' frequency-counter calibration set. Its 10-MHz output goes to all the plug-ins in the portable mainframe.*

ratories' Model 6125C.

All these products aim to reduce the cost of calibrating precision instrumentation. In the Navy's case, savings result from portability and ease of use, explains Peter Strucker, supervisor of electronics engineering and branch head of the Advanced System Development Group at the Navy's Metrology Engineering Center (Pomona, CA). (The center is operated for the Navy by General Dynamics Corp.)

MECCA's largest payoff has been in calibrating shipboard instruments, continues Strucker. Portability allows technicians to bring calibrators aboard ship while in port, rather than bringing the instruments ashore for calibration. In addition to reducing turnaround time, this shipboard calibration eliminates the potential of damage or misalignment resulting from such a move. Better yet, the calibration technique eliminates the chance of the ship's sailing before all calibrations are completed and all instruments returned.

Because the equipment is easier to use than manual calibration gear, technicians can operate it with less training, says Strucker. This feature is especially important aboard ship, where rotation of personnel often calls for continuous retraining.

Controller uses touch CRT

Disk-based software and a touch-sensitive CRT screen provide the Fluke Model 1720A controller with its ease of use. (In the earlier Instrumentation Technology controller, a tape drive and plasma-panel display were configured to provide the same features.) In its commercial version, the controller costs $8900 or more and includes a floppy-disk drive, 24k bytes of RAM available for user programs and an "electronic disk"—a file-structured semiconductor memory that stores 128k or 256k bytes of data from the floppy. This unit functions as working memory to speed file access, permit disk duplication and increase reliability.

The controller's touch-screen CRT display allows an operator to run an instrument system without using a keyboard and thus prevents operators from making unauthorized software changes. Prompting software provides graphics-generated boxes on the screen so the operator need only touch the screen to make a choice—like checking off the correct box on a multiple-choice test.

Naturally, because the other modules in the MECCA system are controlled over the standard IEEE-488 bus, you can also use other units, from interface boards to complete computer systems, as bus controllers for MECCA configurations. However, such systems sacrifice Model 1720A's touch-screen control and perhaps other features as well. (For a description of available IEEE-488-bus control hardware, see EDN, November 5, 1980, pg 69.)

The key to a MECCA system, though, is the calibration-procedure software: MECCA's operating system provides a learning mode and a running mode. Procedure disks contain instructions for calibrating specific instruments with step-by-step, hand-holding directions for less skilled technicians and less explicit directions for experienced operators.

Strucker explains that beginners need detailed directions to avoid making errors, whereas well-trained technicians need less prompting; otherwise they grow bored. "Some users don't like complete automation," he says, adding that they want to have something to do so they can feel that they're part of the operation.

Good tryout results

MECCA hardware and software have been in the field for about 1 yr now, and with more than 50 systems in operation, notes Strucker, the equipment has proven itself effective, even though some learning is still required.

The alternative to a MECCA system (see **box**, "Calibration-system alternatives") is a manual one operated by a qualified technician—a person becoming increasingly difficult to find and pay, says Thomas O'Brien, program manager in the Systems Analysis Group at ArgoSystems. And especially in frequency-counter calibration, the alternatives are usually not portable, require

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With two new lines of high performance dc servo motors, PMI can now offer you the specific motor best suited for your incremental motion control applications.

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lengthy warmup and manual calculation of such important factors as drift rate, and ignore important parts of the calibration procedure, (such as sensitivity testing) while concentrating on accuracy.

ArgoSystems' MECCA Model AS 210, though, comes in a portable carrying case and weighs only 26 lbs, warms up to a frequency offset less than one part in 10^{10} in less than 10 min, can calculate drift rate per year, day or hour, and provides accurate frequency and level outputs for testing amplitude sensitivity.

The $26,845 AS 210 system (mainframe plus five plug-ins) is housed in a Tektronix Model TM 515 mainframe that ArgoSystems has extensively modified. In it, the TM 515's power supply and backplane are replaced with a module that combines a new power supply and backplane with a rubidium frequency standard. The new backplane assembly distributes the 10-MHz standard frequency, power and control signals and is designed with connectors offset from the TM 515's connector positions so that a user can't plug in the wrong modules.

Rb standard fixes frequency

The rubidium standard in the $10,335 AS 210 mainframe uses a higher propagation mode than most similar devices from Hewlett-Packard Co and other sources. Thus, it achieves smaller size. The tradeoff lies in accuracy: This parameter lies within 3×10^{-11} frequency retrace after turn-on for the AS 210, compared with better than 2×10^{-12} for HP's $9250 Model 5065A rubidium frequency standard, for example.

Another part of the AS 210 configuration is the $3990 Model AS 210-01, a dual-width μP-based plug-in controller for the AS 210 system, programmable through its front panel or over the IEEE-488 bus. Built-in drift-rate-calculation programs produce per-hour, -day or -year calculations and display those values on the front panel.

A Self Test mode checks not only the controller's major operating parameters, but also those of other installed plug-ins. Battery backup for the unit's real-time clock and RAM is included.

Model AS 210-02 ($2190), another piece of the ArgoSystems frequency-calibrator module, is a single-

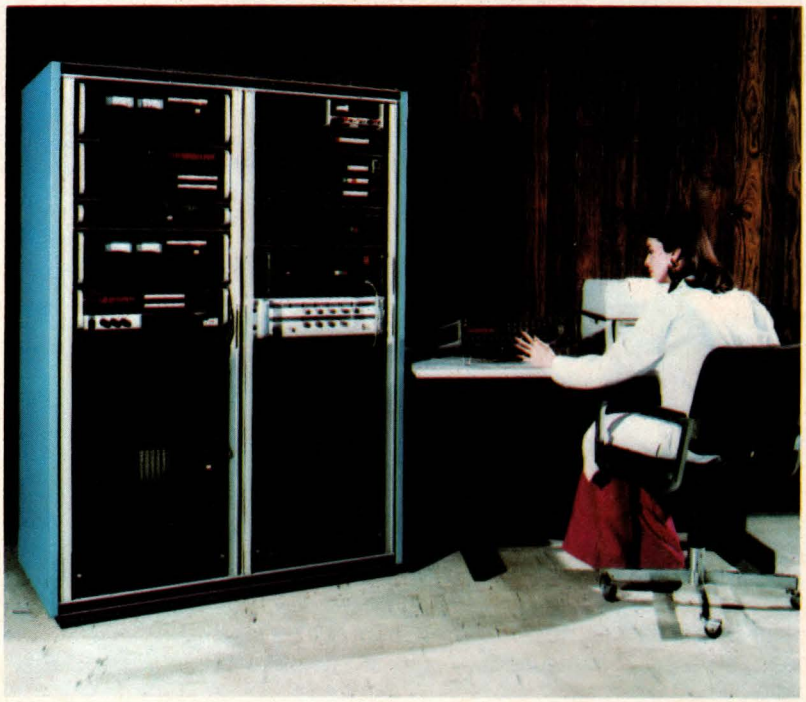
Calibration-system alternatives

Although taking advantage of the Navy's development work and buying similar equipment for your calibration requirements might offer the advantages of portability, programmability, compatibility and relatively low cost, other approaches to calibration might be more appropriate for your needs.

You must decide, for example, whether your instruments need the precision and versatility available with MECCA calibration equipment. Otherwise, you could be better off with lower cost equipment, such as Data Precision's $1595 Model 8200 voltage calibrator or Global Specialties' $225 Model 4401 frequency standard.

On the other hand, you might need even higher precision than MECCA components can achieve. In that case, you could look into equipment such as Hewlett-Packard's Model 5061A Option 004 cesium-beam atomic frequency standard, a $23,700 instrument with accuracy of $\pm7\times10^{-12}$, or Ballantine Laboratories' Model 1600A automatic balancing ac/dc transfer standard, a $5295 instrument with 5-Hz to 30-MHz frequency range and 0.01% basic accuracy.

As part of this latter approach, you can buy precision voltage dividers, standard voltage cells and potentiometers from Julie Research Laboratories. And if you don't want to design your own calibration system, you can also obtain turnkey automated calibration systems from Julie Research or from Fluke.



Turnkey automatic calibration systems *like this Julie Research Locost 106 provide an alternative to designing your own calibration equipment.*

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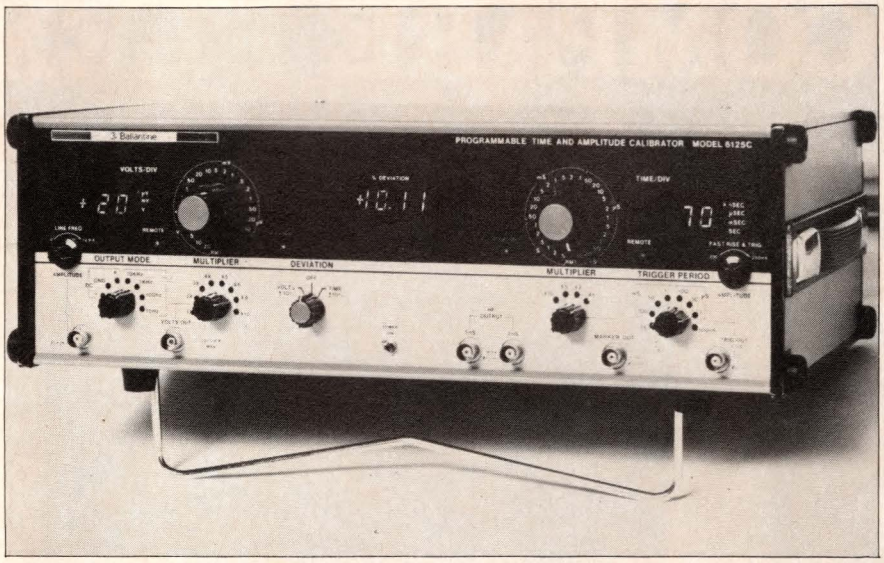
width plug-in that lets you compare the frequency of the internal standard with those of as many as six external sources. You can store up to 500 samples for computing warmup, drift-rate and aging characteristics. And Model AS 210-03 ($4445), a single-width plug-in frequency generator, operates over 1 to 500 MHz and a 60-dB dynamic range. Its output-level accuracy lies within 10% to 300 MHz and within 15% at 400 or 500 MHz.

A digital-delay generator, the $3990 Model AS 210-04 provides a selectable time interval between a reference pulse and a delayed pulse. Its outputs can produce −2.5V to +2.5V into 50Ω with rise and fall times less than 3 nsec. Finally, Model AS 210-05 ($1895) is a battery pack and recharger that provides at least 3 hrs of standby power (which can be required in precision frequency measurements where low ac-line voltages or dropouts are a severe problem).



In the second round *of MECCA procurements, the Navy selected a modified version of Ballantine Laboratories' Model 6125C as a scope calibrator.*

DMM calibrator meets most needs

Other elements of the MECCA system are equally versatile. For example, for calibrating DMMs, the modified Fluke 5100B meets 80% of the Navy's needs, says Strucker. And Fluke should have a higher accuracy DMM calibrator with true-rms capability this year to meet the other 20%.

The $7495 Model 5100B provides sources for dc and ac voltage and current as well as resistance. It can calibrate devices ranging in complexity from 1-function panel meters to autoranging multimeters with resolution as high as 4½ digits.

The instrument's μP can calculate whether an instrument under test is within tolerance, no matter what form you use to express tolerance: volts, amps, ohms, decibels or percent. IEEE-488 and RS-232C interfaces cost $400 each.

Model 5100B features basic dc accuracy of ±(0.005% of setting+0.001% of range+5 μV) and ac-voltage accuracy of ±(0.05% of setting+0.005% of range+50 μV) from 50 Hz to 10 kHz and ±(0.08% of setting+0.008% of range+50 μV) from 10 kHz to 50 kHz. Accuracy on dc-current ranges is ±(0.025% of setting+0.0025% of range+0.01 μA), and it's ±(0.07% of setting+0.01% of range+2 μA) on ac-current ranges. Finally, accuracy equals ±0.005% on most resistance ranges. A $1500 wide-band option broadens the ac frequency range to 10 Hz at the low end and 10 MHz at the high end.

Scope cal also grows easier

The standard MECCA scope calibrator is a version of Tektronix's Model CG 551AP, although a follow-on order has gone to Ballantine Labs for a version of its $5950 Model 6125C time and amplitude test set with IEEE-488-interface option. The $12,000 Tektronix instrument, a 3-wide plug-in for the firm's TM 500 Series mainframes, won't plug into ArgoSystems' modified case but will work in any of Tektronix's standard cases, including the $380 portable model.

This calibrator checks an oscilloscope's vertical gain, horizontal timing and gain, vertical bandwidth and pulse characteristics, probe accuracy and compensation, current-probe accuracy and calibrator-output accuracy. And along with governing operator actions and generating calibration signals, Model CG 551AP's software can take over many measurements of oscilloscope error and comparisons with the user's permissible standards. A Scope Cal Procedure Development Aid Program simplifies generating calibration programs by prompting a technician to set up the instrument's front panel for each test condition; it also learns these settings to generate the test program.

The MECCA scope calibrator from Ballantine offers amplitudes from 30 μV to 220V ac and 300 μV to 220V dc as well as four crystal-controlled standard square-wave frequencies from 10 Hz to 10 kHz to check oscilloscope amplitude, attenuator compensation, scope and frequency-counter trigger sensitivity and voltmeter accuracy. In the Amplitude Deviation mode, you can vary the output amplitude until the square wave aligns with the graticule marks on the scope under test, then read the scope deflection error on the calibrator's LED display with a resolution of 0.01% over a 10%

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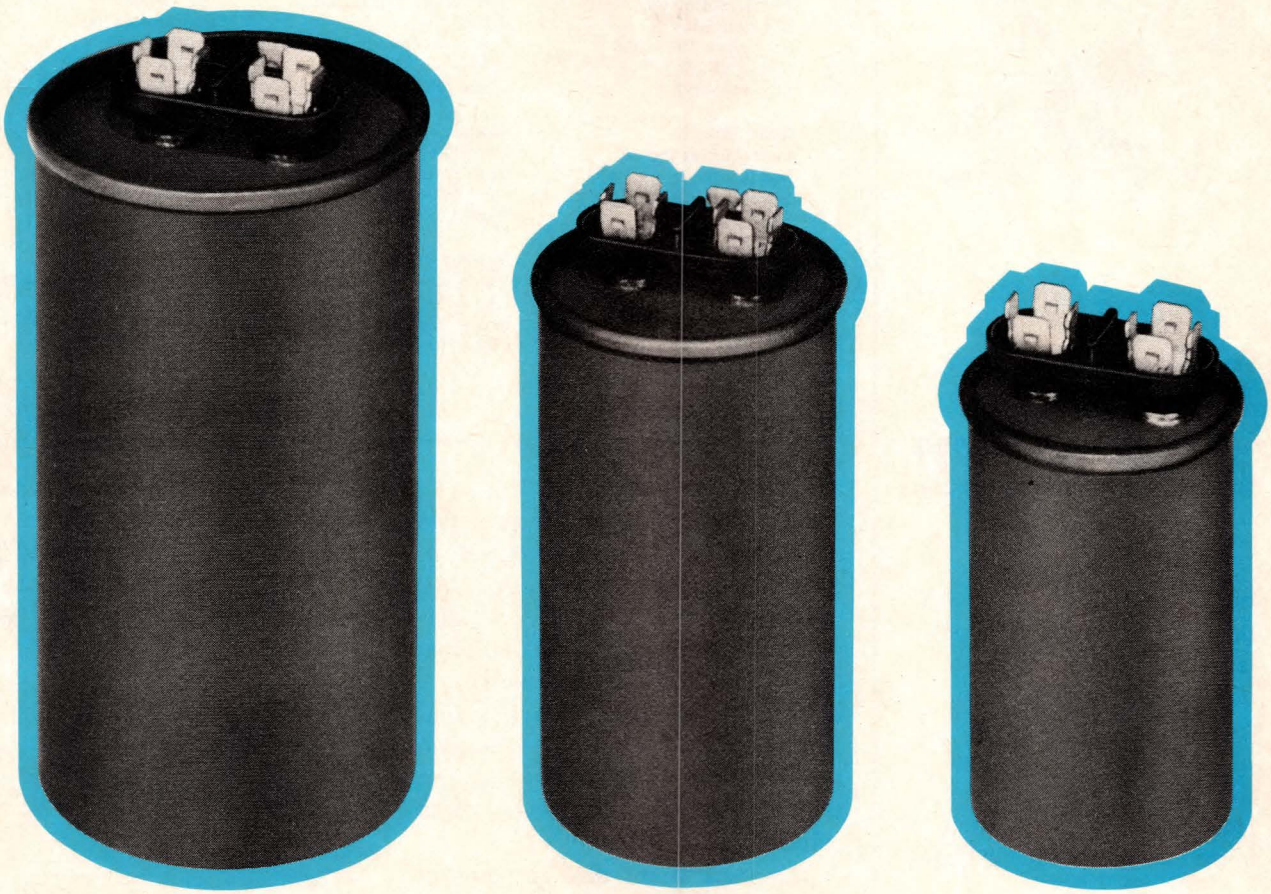

Sprague Type 325P Metallized-Film A-C Capacitors are much smaller, much lighter, and more reliable than oil/paper types.

These capacitors are an excellent choice for new equipment designs or as replacements of larger, heavier oil/paper types in split-phase motor, appliance power factor correction, and allied general-purpose applications.

Utilizing metallized-polypropylene rather than bulkier aluminum foil and paper, they provide substantial size and weight advantages.

The polypropylene dielectric employed has a very low dissipation factor and minimizes heat rise.

Type 325P Capacitors are identified by Underwriters' Laboratories, Inc. as recognized components under its Component Recognition Service. Capacitance values range from 4 to 70 μF at 330 and 370 V, and 4 to 50 μF at 440 V.

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For complete technical data, write for Engineering Bulletin 4710B to Technical Literature Service, Sprague Electric Co., 491 Marshall St., North Adams, Mass. 01247.

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deviation range.

A time-mark generator provides crystal-controlled timing pulses in 1, 2, 5 sequence from 50 sec to 2 nsec, extended to 1-nsec (1-GHz) markers with the $125 optional 61251A multiplier accessory. A trigger-output square-wave signal from 1 sec to 100 nsec is also provided; the time markers and triggers are gated to be time coincident.

The instrument also provides a Variable Time mode, which lets you align the time-mark spacings to your scope's graticule lines and read the scope time-base error directly over a ±10% range with 0.01% resolution.

Sig-gen calibrator coming

The final piece of the MECCA system currently in the works is a signal-generator calibration package from Weinschel Engineering. The instrument, scheduled for delivery to the Navy this year and to be available as a commercial product in 1982, is based on Weinschel's $65,000 Model VM-4A μP-controlled dual-channel receiver, with frequency counter, power meter and modulation analyzer added.

The single-channel Model VM-24, housed in two portable cases, measures output attenuation, power, frequency and AM and FM characteristics over 10 MHz to 18 GHz. **EDN**

NEXT TIME

EDN's February 4 issue will feature a Special Report on switching power supplies, plus useful articles on

- A versatile over/undervoltage-protector IC
- The design of a low-cost but highly accurate electronic watt/watt-hour meter
- A program for performing network analysis on a desktop computer
- The modeling of memory-system reliability
- Techniques for holding productive meetings

. . . and much more. Also look for preview coverage of ISSCC 81 and a news roundup of the latest product developments in small rigid- and floppy-disk drives, plus our regular Design Ideas, μC Design Techniques and Looking Ahead departments. You can't afford to miss this issue!

EDN: Everything Designers Need

Say goodbye to your old Analog RMS Voltmeter.

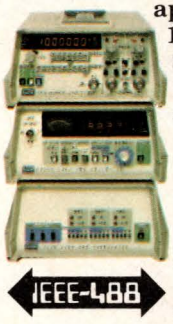
And say hello to Fluke's family of True RMS Digital Voltmeters at analog prices. The advantages of a digital voltmeter's speed and accuracy have finally come to wideband true rms measurements. Thanks to an exclusive Fluke-designed microelectronic chip, you can now make true rms measurements with an ease never before possible—and starting at just $1195.*

Try this on your old analog meter. Each model boasts an autoranging LED display of volts (3½ digits) or dB (4½ digits) with 0.5% midband accuracy. An exclusive "dial-a-reference" feature lets you match the instrument's dBm reference to the impedance of the system you're working with. The resultant direct reading of dBm eliminates time consuming calculations. With the relative dB feature, you can set the existing dB reading to zero establishing the input voltage level as the dB reference. Subsequent readings will be indicated as ± dB. All with ac or ac + dc input coupling.

For simplified peaking/dipping measurements, an analog meter complements the digital display. Counter and log output options are available for your system applications.

Match the model to your measurement needs. There's no compromise when buying a Fluke True RMS Voltmeter. The 8920A and 8921A boast 10 Hz to 20 MHz specifications with a 2 mV range to 2 MHz. Choose the 8920A with a BNC input or, for floating measurements to 500 V, the 8921A with isolated banana jacks.

The 8922A, newest in the series, includes design enhancements for both audio measurements (with specifications to 2 Hz) and rf applications (with an 11 MHz, 2 mV range). Selectable 200 kHz filtering enhances audio performance by eliminating unwanted high frequency noise.



Latch them together, then put them on the bus. Each 8920-Series Voltmeter is housed in the exclusive Fluke portable test instrument package. This system allows convenient stacking and latching of multiple instruments for unrivaled transportability. And by adding the new 1120A Translator, with appropriate instrument options. you can make your new voltmeter IEEE-488 compatible.

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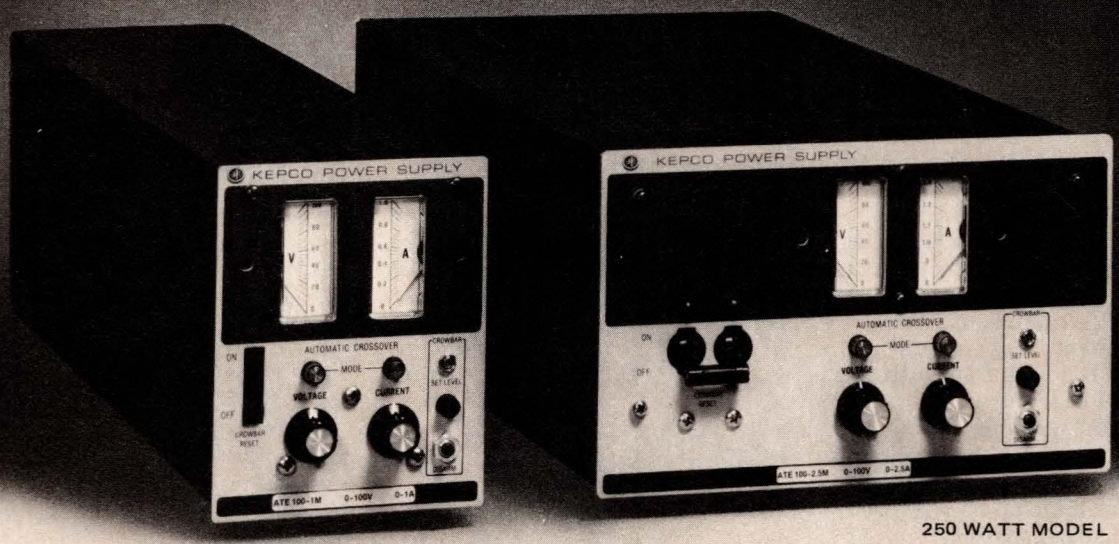

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Fiber-optic flashes: Receiver, fibers, interconnect system, computer link

Tom Ormond, Senior Editor

A single-chip optical receiver could lead to more economical fiber-optic computer-system data-communication links. Developed by researchers at IBM's Thomas J Watson Research Center (Yorktown Heights, NY), it employs current-mode amplification to achieve wide bandwidth (180 MHz) and relatively low fabrication cost.

The current design accommodates 200M-bps data rates, a factor-of-13 improvement over commercially available integrated optical receivers producing logic outputs. And anticipated advances in silicon-chip technology could readily extend this performance to 1000M bps.

Current-mode amplification is well suited to integration because it uses few resistors and places few stringent requirements on the device's integrated components—gain and bandwidth depend little on the components' absolute values. It lends itself to implementation with today's standard logic arrays.

Reduced fiber prices could result from a new manufacturing process developed by researchers at Bell Labs, Murray Hill, NJ. A variation on the modified chemical vapor deposition (MCVD) process, the technique uses a plasma—an energetic mixture containing ionized atomic fragments—to speed up preform production (an early step in fiber fabrication).

Experimental results show glass-deposition rates of 2.5g/min—a factor-of-five speed increase over the standard MCVD process. And the technique exacts no performance tradeoffs: Transmission losses of 3.4 and 1.5 dB/km at 0.85 and 1.2 μm, respectively, compare favorably with figures for today's MCVD-fabricated fibers.

The process is also efficient. It uses more than 70% of the fabrication method's germanium input (compared with less than 5% in current techniques) and nearly 100% of the silicon. (Germanium is the most expensive ingredient in the fiber-forming process.)

A military-aircraft fiber-optic interconnect system developed at Boeing Aerospace Co (Seattle, WA) is helping to demonstrate fiber optics' suitability for critical-information transmission.

Under Navy contract, a Boeing engineering team has redesigned an E-3A aircraft electrical harness to employ fiber-optics technology. The 32-ft-long hybrid harness consists of four twisted-wire power-carrying pairs and 20 fiber-optic communications-signal cables (including both single and bundled fiber designs).

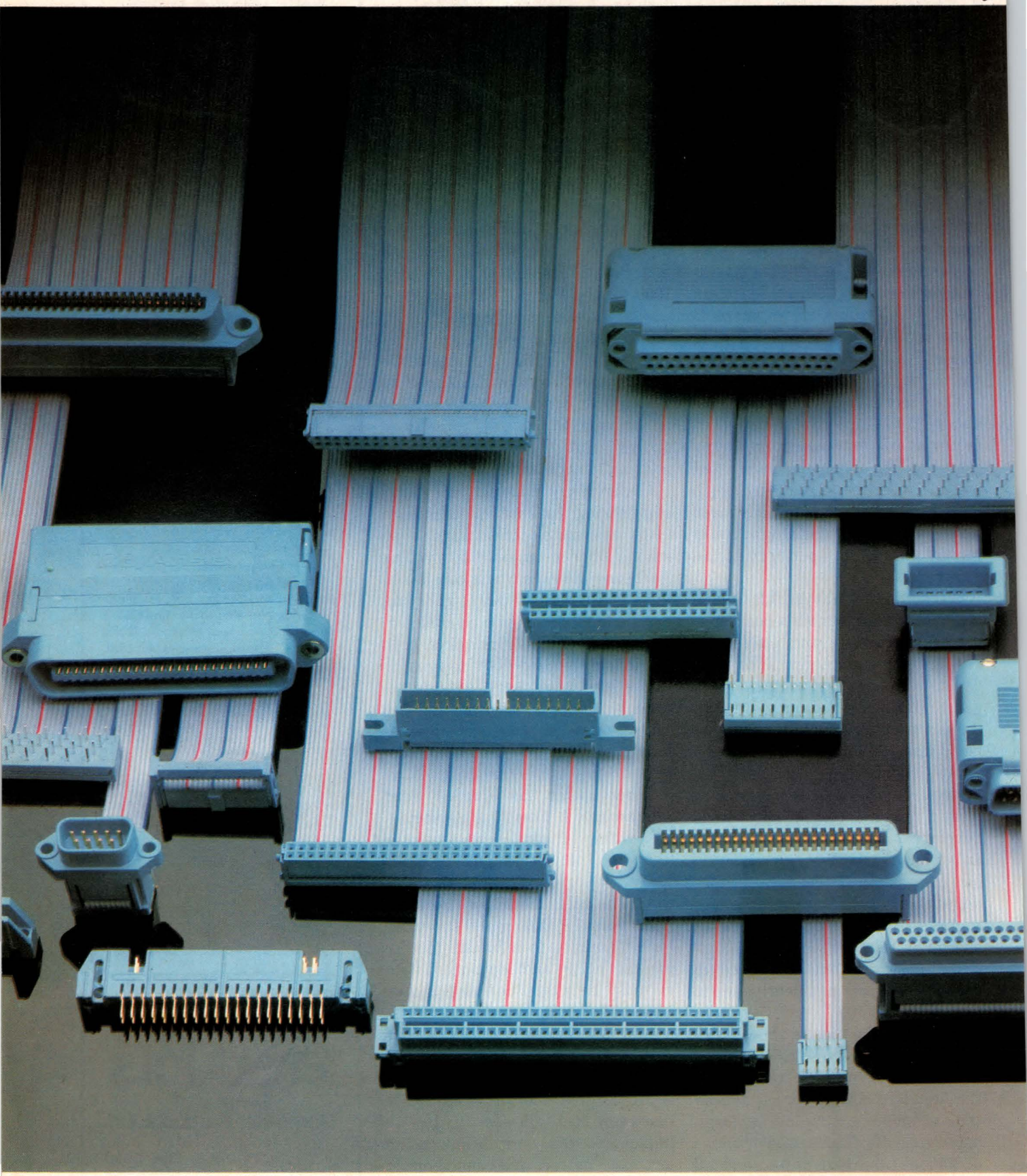
The engineers have also developed techniques for inspecting the cables, plus fabrication, maintenance and quality-control procedures.

Fiber optics has invaded word processing: A fiber link connects a μC editing terminal with a printer in Vydec Inc's (Florham Park, NJ) Model 4000 word-processing system. The link, fabricated from Du Pont Pifax P-240 cable, provides high immunity to induced environmental noise and enhanced data security because fibers are almost impossible to tap remotely.

Although the plastic-fiber cable is relatively lossy, it readily accommodates 30m terminal-to-printer runs. And the fiber's large 368-μm core diameter has allowed Vydec to implement the optical link using low-cost emitters and connectors.

EDN

You either have it,



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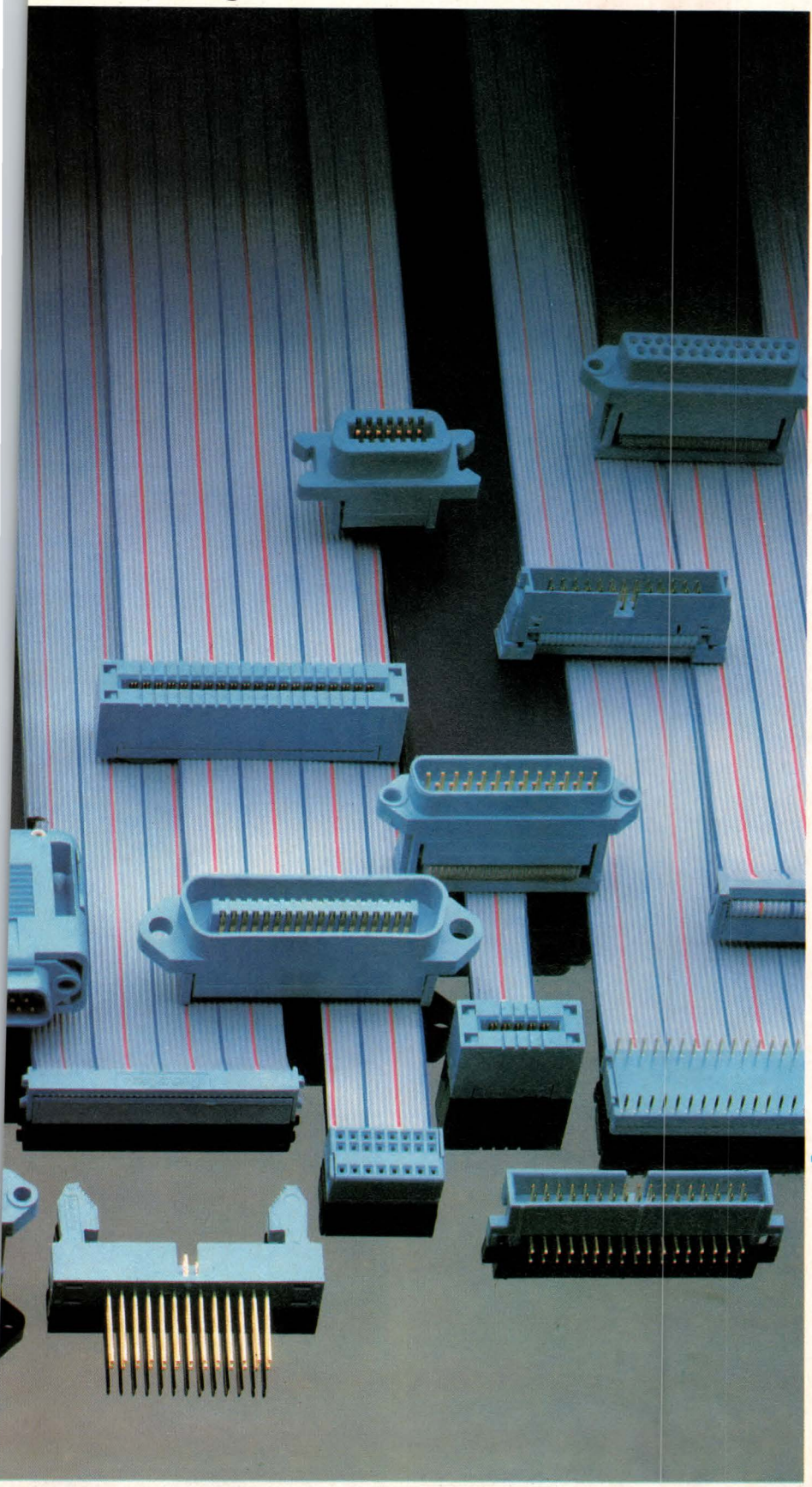

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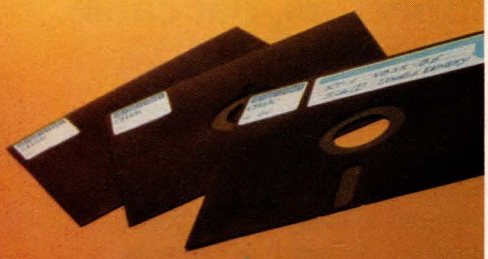

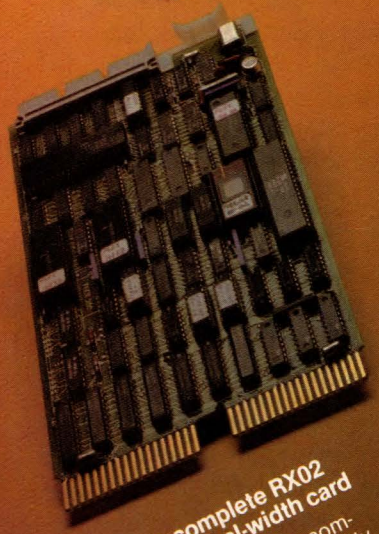

FLEX 02 offers complete RX02 emulation on one dual-width card

Media compatible and software compatible, the FLEX 02 card plugs directly into your LSI-11, 11/2 or 11/23. This low-priced controller has built-in bootstrap; handles single or dual-head floppy disk drives. Order now for 30-day delivery!

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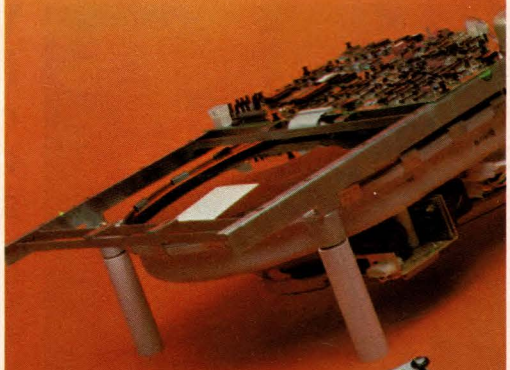
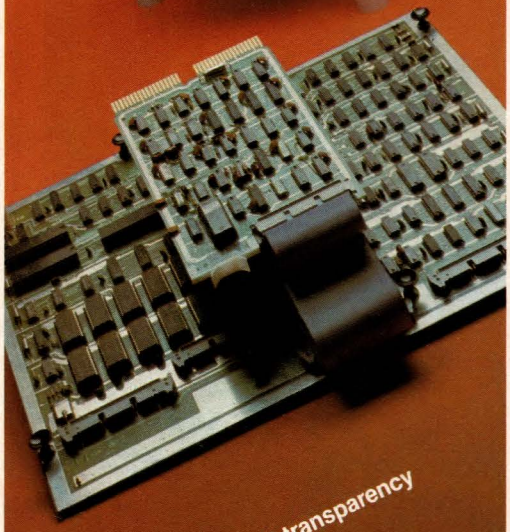
DEC COMPATIBILITY





WINC 01 offers RL01 transparency for Winchester-type drives

Software transparent to RL01 driver, WINC 01 maps the data of three RL01 cartridges (15.6 MBs) on one Winchester. Dual-width interface card plugs into LSI-11, 11/2 or 11/23; low-cost controller mounts onto Marksman drive. Call today, they're going fast!

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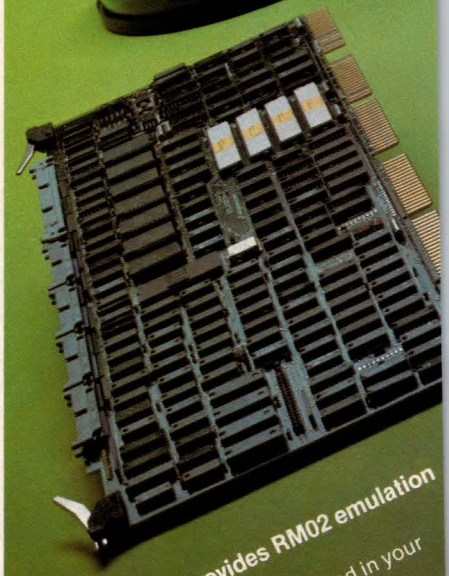


STORM 02 provides RM02 emulation for PDP-11 users

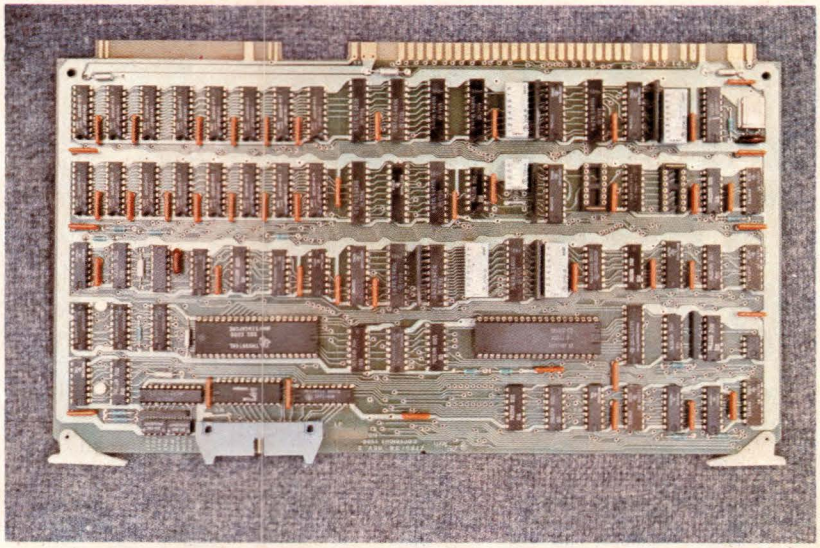
This single hex card, embedded in your PDP-11, runs under standard RM02 drivers. STORM 02 accommodates up to four 80 MB storage module drives and provides disk pack interchangeability with DEC. 30-day delivery and quantity discounts!

For more information, Circle No 36

Multibus-compatible interface card turns μC into 488-bus controller

Model ZT85/38 GPIB controller card adds IEEE-488 controller, talker and listener capability to Multibus computers. It allows you to transfer data from the host CPU at up to 250k bytes/sec.

Compatible with SBC 80/XX, SBC 86/XX and MDS 800 microcomputers, the card complies with the IEEE-796 standard for Multibus-compatible systems. It contains 8k bytes of static RAM for buffering or other use; this memory can reside on any 8k-byte boundary within the system's 20-bit-memory-address space and can overlap other system memories using the Multibus INH1 protocol. You can access the RAM as 8-bit bytes or as 16-bit words on even byte boundaries.



Control 488-bus instruments and peripherals *with a Multibus computer and the ZT85/38 interface board, which lets you transfer data at up to 250k bytes/sec.*

Restrict I/O decoders

Input/output facilities include 32 I/O addresses locatable on any 32-port boundary within the card's 16-bit-I/O-address space. You can restrict the unit's I/O decoders to an 8-bit address to provide compatibility with older Multibus-based boards; I/O ports are accessed only as bytes.

Software driver routines ($125) for DMA and non-DMA operation modes are available on 8-in. single-sided floppy disks. Operating-system formats include CP/M in single-density versions and ISIS in single- or double-density forms.

The card's 16 GPIB interface lines are terminated with Texas Instruments transceiver ICs to provide 400-mV input hysteresis and 0.5V output at 48 mA. Bus voltage equals 2.6 to 3.75V with open-collector or 3-state drivers.

Cable option available

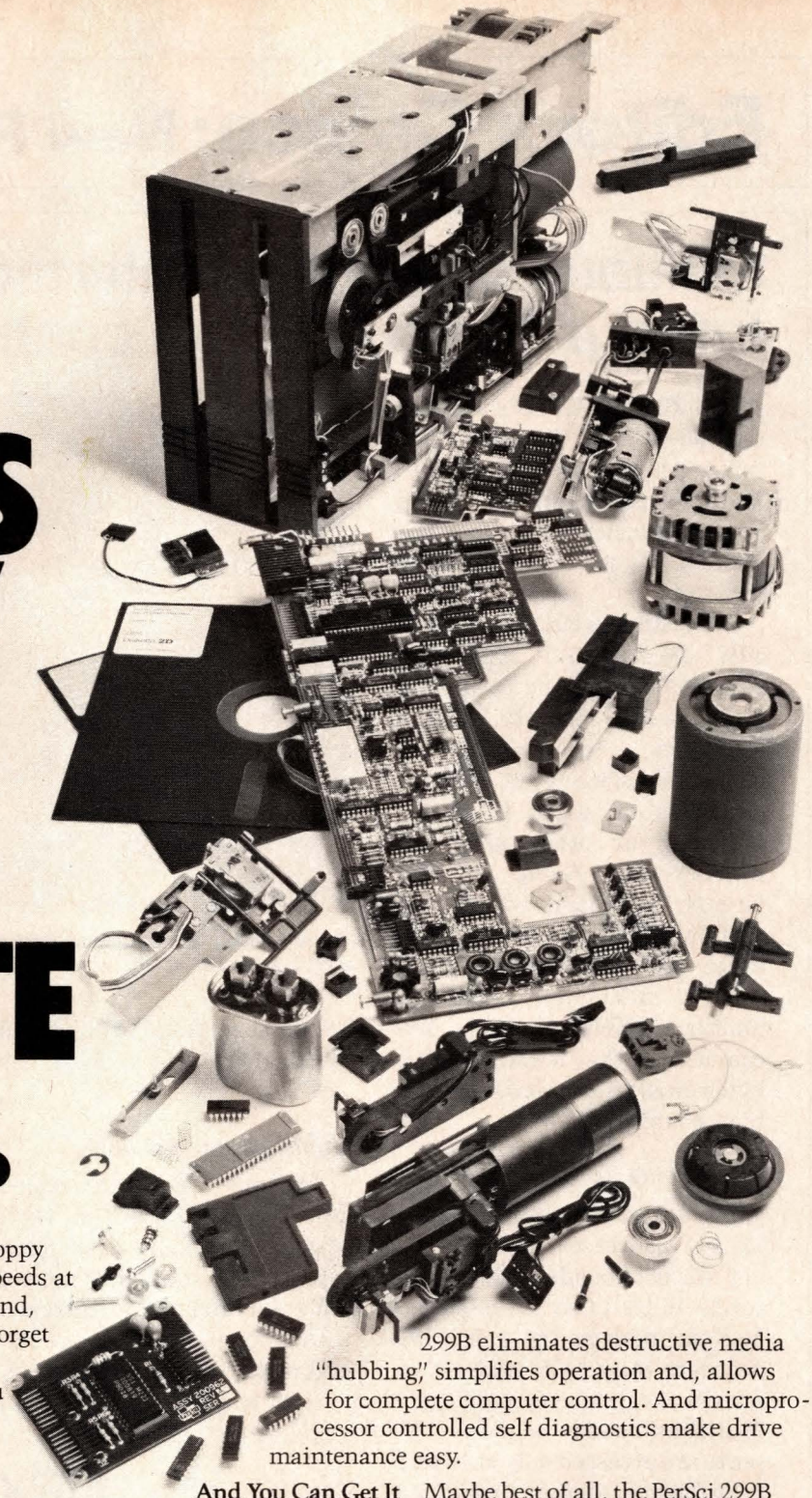
The card's standard cable is 2m long and has the GPIB-standard stackable male/female connector at one end. Option 557 ($50) substitutes a 1m cable with a panel-mount female connector and metric-threaded standoffs.

Data-transfer rates spec at 250k bytes/sec under DMA control, 40k bytes/sec with programmed I/O and 20k bytes/sec (command rate) with the GPIB ATN control line asserted. The card operates from a 5V power supply and draws 2.8A typ, 4.1A max. $1200.

Ziatech Corp, 2410 Broad St, San Luis Obispo, CA 93401. Phone (805) 541-0488.

Circle No 450

IT TAKES A LOT OF GUTS TO PAY $1450* FOR A DISKETTE DRIVE.



But if your system is ready for the 2½ Mbyte floppy *today* not next year—and, if you need access speeds at least three times faster than you have today—and, if you want data integrity that will make you forget every bad thought you ever had about double sided heads—then there is only one choice. You need the PerSci 299B, the IBM compatible, microprocessor-controlled flexible disk drive with hard disk performance.

Four Heads and Fast Positioning Look at PerSci's gutsy design. Four heads reading both sides of two diskettes in a chassis the size of a standard drive. That gives you two drives in one (at only $725 a spindle) for a total of 2½ Mbytes of formatted and removable data storage. And using high accuracy, "big disk" voice coil positioning, the 299B seeks data at a rate of 76 tracks in only 100 ms (including settle) with virtually no media wear. It's the worlds fastest floppy.

Microprocessor Controlled and Autoloading PerSci's superior patented read/write electronics allow the 299B to read all double density codes without (as well as with) write precompensation. Only PerSci and IBM can do it—so 2D interchange is assured. Diskette autoload on the 299B eliminates destructive media "hubbing," simplifies operation and, allows for complete computer control. And microprocessor controlled self diagnostics make drive maintenance easy.

And You Can Get It Maybe best of all, the PerSci 299B is not pie-in-the-sky. It's a quality-manufactured, dynamically tested reality with more than 12,000 operating spindles in the field. There's also a single sided version and a line of controllers to back it up.

Somebody once said you get what you pay for. He probably owned a PerSci. Now, we'd like to talk to you. PerSci, Inc., 12210 Nebraska Avenue, W. Los Angeles, California 90025. (213) 820-7613.

*In OEM Quantities

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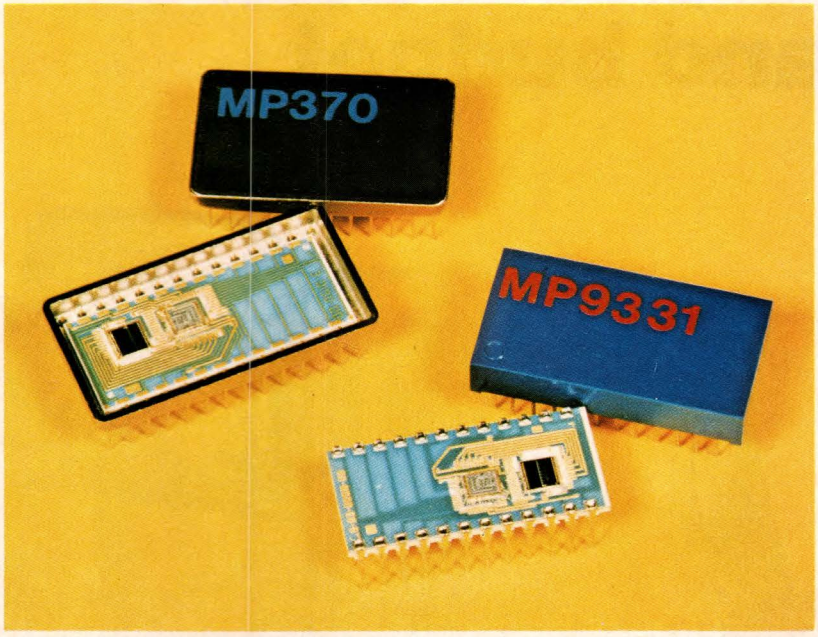
For more information, Circle No 37

18-bit resolution with 16-bit linearity results from MDAC's switching scheme

Achieving high linearities at high resolutions is difficult in any multiplying-DAC design, especially for a 16-bit-linear, 18-bit-resolution device. And the problem doesn't lie in the resistor network, which can be laser trimmed. The CMOS MP370 solves this problem, though, thanks to a novel switching design.

An n-bit DAC generally requires n switches that turn n voltage (or current) sources on or off, depending on which bits are HIGH or LOW. Hence, such a DAC can generate 2^n discrete output levels.

But therein lies the problem: In a 10-bit DAC, for example, a 1% MSB error causes a 0.5% output error; the same 1% shift in the LSB causes only a 0.001% output error. Thus, whatever the intended DAC performance, the MSB causes the accuracy problems.



Additional switches *combine with extra current sources and resistors to provide the MP370 18-bit CMOS MDAC with true 16-bit linearity. Decoding the unit's four MSBs with 15 switches reduces switch-induced errors by a factor of eight. A companion MDAC, the 16-bit MP9331, also achieves a 16-bit linearity.*

More switches, less errors

To deal with this difficulty, the MP370 adds switches. For if three lines decode an MDAC's top two MSBs, the maximum single-switch-induced output error drops from 0.5 to 0.25%. Similarly, decoding three MSBs with seven lines reduces switch sensitivity by a factor of four. And serving four MSBs with 15 lines produces a factor-of-eight improvement.

At this point, the law of diminishing returns takes over. And that's where the MP370's manufacturer stopped: The device's top four MSBs are decoded by 15 switches that must be matched to within only 5%; 14 switches handle the remaining 14 bits conventionally. The result? 18 bits you can use.

Two chips reside in the MP370's 28-pin hermetically sealed metal DIP. One contains the 29 resistors employed in the 4-MSB decoding scheme and a conventional R/2R ladder for the remaining 14 bits. The other chip, the workhorse, houses all of the switches along with two 8-bit input storage registers and latch-control logic.

Speed remains high

The MDAC requires one 15V nominal supply at 60 mW max. Speed isn't sacrificed to low power consumption or high resolution; the device's small-signal 3-dB bandwidth specs at 1 MHz, and settling time—for a major code transition—is 2 μsec to 0.01% FSR.

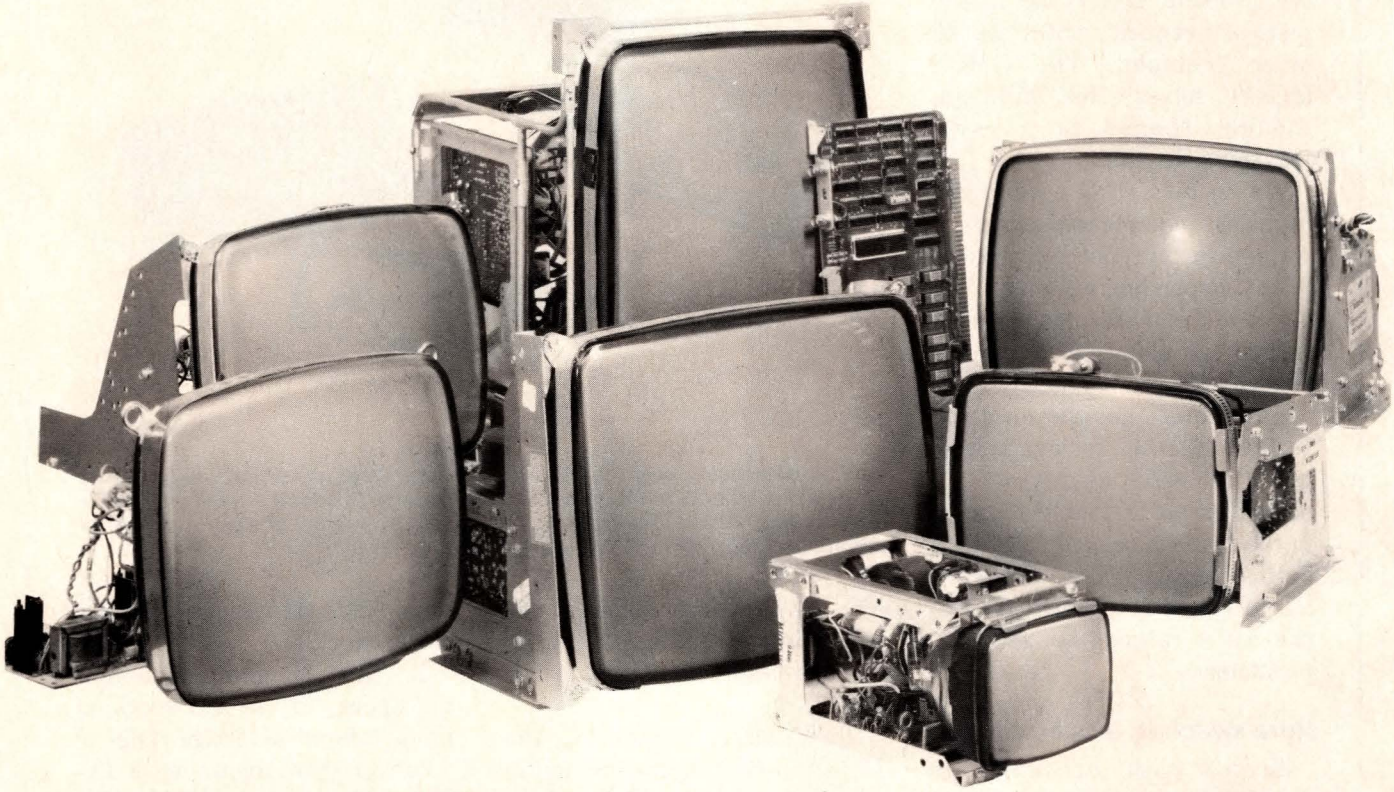
A full 2- and 4-quadrant multiplier, the hybrid specs an input reference-voltage range of ±25V. Digital inputs are DTL, TTL and CMOS compatible. The device achieves a noteworthy integral linearity of ±0.0008% (16 bits) and differential linearity of ±0.0004%.

Two temperature ranges are available: The -B version operates over −55 to +125°C; the -C unit spans 0 to 85°C. Both types are second sources to Hybrid Systems Corp's DAC370 family. MP370C, $159; MP370B, $470 (100).

Micro Power Systems Inc, 3100 Alfred St, Santa Clara, CA 95050. Phone (408) 247-5350.

Circle No 451

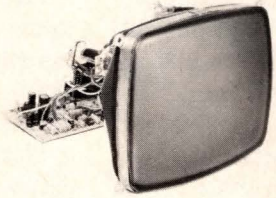
Motorola matches the display module to your application and budget



Every Motorola module, from 5″ to 23″, is available in a variety of configurations and electrical specifications to meet the most diversified customer needs. It is this flexibility—adapting basic design to individual user specs—that has kept Motorola in the forefront of CRT display technology.

The result is the best possible value for your information display dollar—real value measured in performance, reliability, experience and service support—value designed to complement the time and money you've put into your terminal and its application.

The reliability of Motorola displays is measured in *demonstrated* and *calculated* MTBF. Samples of every model are continuously monitored to duplicate customer life tests, assuring you top performance year after year. Write or call Motorola Display Systems.



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For more information, Circle No 38

25W encapsulated switchers compete with 5W linears

Series 325 encapsulated off-line 20-kHz switchers sport three outputs and an $89 price tag, making them price competitive with 5W 3-output encapsulated linear supplies.

The 14-oz, 2.75×4×1.375-in. supplies come in two versions: Model 325 furnishes 5V at 4A and ±12V at 200 mA, and Model 326 furnishes 5V at 4A and ±15V at 200 mA. Both units operate from 85 to 135 or 170 to 260V (47 to 470 Hz) inputs.

Schottky rectifiers and a half-bridge rectifier provide 80% efficiency independent of load, although the primary output requires a 10%-rated load (min) to ensure regulation. At rated output, surface temperature rises 10°C.

Basic specs include ±0.1% line regulation, ±0.2% load regulation and ±0.02%/°C temperature coefficient. Transient response to within 1% of final output level is less than 300 μsec. Additionally, the switchers provide 1500V ac I/O isolation and 16-msec hold-up time after loss of ac power, and they deliver rated output in −25 to +70°C temperatures.

Overvoltage protection and current limiting come standard. Noise and ripple equals 50 mV p-p or 10 mV rms on the primary output; the secondary outputs' series-pass regulators reduce their noise and ripple spec to 5 mV rms.

Offering a 25W rating in a 2.75×4×1.375-in. package, *Model 325 delivers 5V and ±12V outputs. The off-line switcher operates on 85 to 135 or 170 to 260V ac inputs and features epoxy encapsulation.*

Encapsulated for performance

Each supply is assembled on one pc board and epoxy encapsulated for resistance to vibration and adverse atmospheric conditions. These mechanical features, plus the use of polynylon wire, metal-film resistors and derated electrolytic capacitors, result in an MTBF spec of 45,000 hrs, per MIL-HDBK-217B.

Solder pins and two 4-40 threaded inserts molded into the case facilitate pc-board mounting. The switchers are pin compatible with competing linear supplies but have larger footprints (although they weigh less).

One feature you won't find on these switchers is extensive shielding and input line filtering. The manufacturer claims that because built-in switcher filters usually don't ensure compliance with FCC and VDE specs, power-supply users generally furnish their own filtering when necessary.

Power General, 152 Will Dr, Canton, MA 02021. Phone (617) 828-6216. **Circle No 452**

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For more information, Circle No 39

● Flexible circuits ● Flex-hardboard combinations ● Flex-multilayer combinations ● Flat cable ● Thick film hybrids

μC Design Techniques

EDN Software Note #61

Print decimals without leading zeros

Robert D Grappel
Hemenway Associates Inc, Boston, MA

Printing decimal values with leading zeros can make a printout confusing to read. The code shown in **Fig 1** provides a neat and efficient way of eliminating these leading zeros. Although it was written for use in a PASCAL compiler for the Z8002, it works just as well in other environments.

The flowchart shown in **Fig 2** illustrates how the program works. The two key points are the division by 10 at OUTD2, which returns both a quotient and a remainder, and the use of the stack to store digits as they are computed.

Beginning at OUTD, the algorithm initializes a digit counter to zero. It then tests the sign of the value under consideration. If the sign is positive, the program jumps to OUTD2; a negative sign causes the routine to output a minus sign and then negate the value.

At OUTD2 the routine divides the value by 10 and converts the remainder, a value between zero and nine, to an ASCII digit. Then it increments the digit counter and pushes the ASCII digit onto the stack.

```
* subroutine to print signed 32-bit values in decimal
* with leading-zero suppression
* coded for the Z8002 processor
* assumes: 32-bit signed value in RR10
*          subroutine TYWR outputs ASCII char  in RL0
*
*
OUTD        CLRB RH1          init  digit counter
            TEST R10          value positive?
            JR PL,OUTD2       if so, skip
*
            LDB RL0,#'-'      if not, output minus sign
            CALL TYWR
            COM R10
            COM R11           negate RR10
            ADDL RR10,#1
*
OUTD2       EXTSL RR8         sign of RR10 into RR8
            DIVL RQ8,#10      divide value by 10
            LD R2,R9          get remainder into R2
            ADDB RL2,#'0'     make RL2 into ASCII digit
            INCB RH1          bump digit counter
            PUSH @R15,R2      stack digit
            TESTL RR10        quotient=0?
            JR NZ,OUTD2       if not, loop
*
OUTD3       POP R0,@R15       unstack a digit
            CALL TYWR         output the digit
            DBJNZ RH1,OUTD3   loop through digits
*
            RET               done
```

Fig 1—Suppress leading zeros *with this simple Z8002 assembly-language routine.*

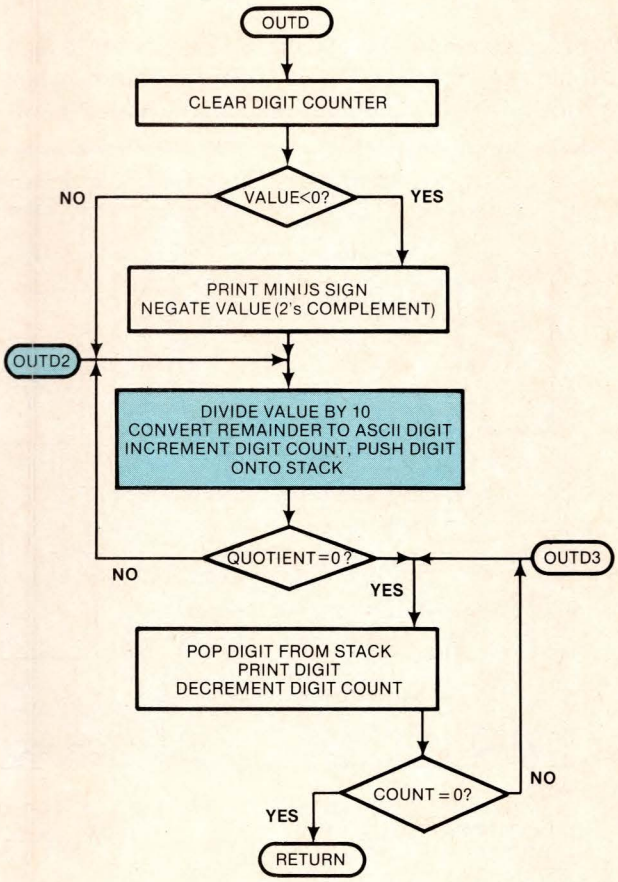


Fig 2—Dividing by 10 at OUTD2 *returns both a quotient and a remainder.*

If the quotient is zero at this point, the routine goes to OUTD3 to output the stacked digits. If the quotient isn't zero, though, the routine loops to OUTD2 for the next digit.

The output routine at OUTD3 uses the digit counter to keep track of the number of digits that it must print. After producing a digit, it decrements the counter; when the counter equals zero, no digits remain to be printed.

Fig 1's routine accepts a 32-bit value passed in the R_{10} register pair. It assumes the existence of a routine (TYWR) that outputs an ASCII character stored in register RL_0. Note that the division step uses a quad register (R_8, R_9, R_{10}, R_{11}) as one operand. **EDN**

μP evaluation kit forms half-duplex interface

Brett Roberts
Fairchild Camera & Instrument Corp, Syosset, NY

The Motorola 6800 μP evaluation kit can serve as a half-duplex interface to a teletypewriter when provided with a minimum amount of added hardware. You need only furnish three power supplies, three ICs, two switches, a fuse, a power-on indicator, a metal box, four tip jacks, one connector, seven resistors and two capacitors.

The interface (**Fig 1**) provides no extra features. However, you could easily add a 7-segment display for operator messages or even upgrade the circuit

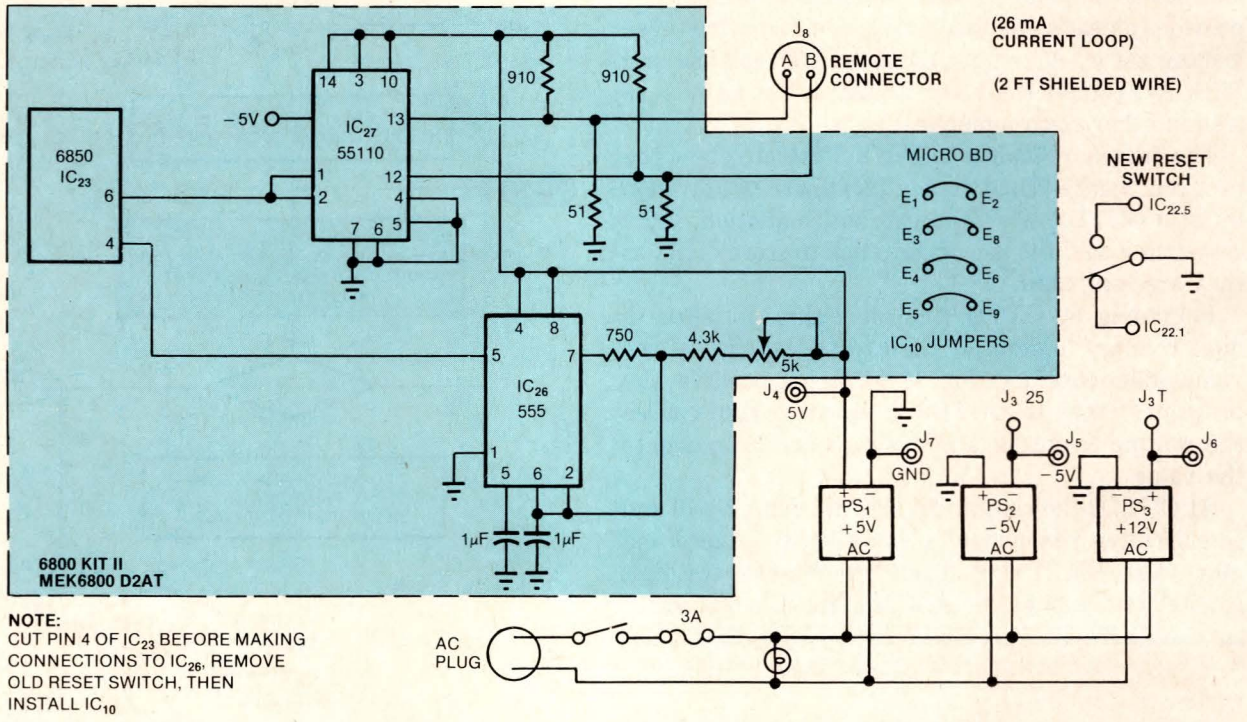
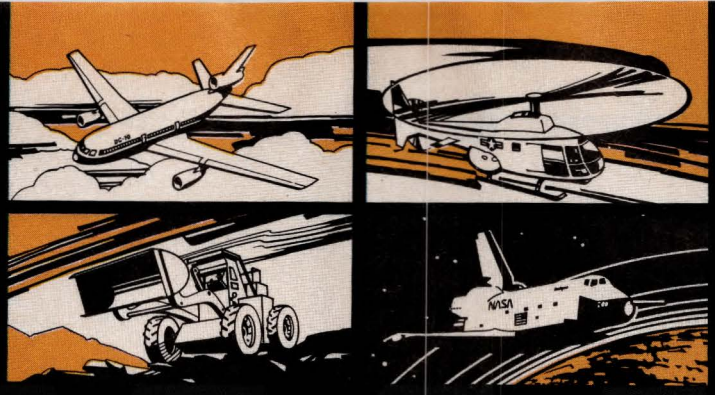


Fig 1—An evaluation board *forms the basis for a complete μP-to-TTY half-duplex interface.*

```
                    °
                °°°°SUBROUTINE TO DISABLE NMI INTERRUPTS°°°°
*See NOTE 1         °
00    86 3C     DISNMI LDA A *$30
02    B7 8021          STA A DISCTR    INTR MASKED CA1 ACTIVE LOW
05    B7 8023          STA A SCNCTR    INTR MASKED CB1 ACTIVE LOW
08    39               RTS
                    °
                °°°°RESTART ROUTINE°°°°  TO RUN PROGRAM TYPE 0009G
                    °
09    8E A078   RESTAR LDS   *$A078
0C    BF A008          STS   SP         INITIALIZE STACK POINTER
0F    CE C080          LDX   *$KEYDC    GO DECODE KEYBOARD
12    FF A006          STX   NIO        INITIALIZE NMI INTERRUPT
                  °INITIALIZE KEYBOARD/DISPLAY PIA
15    86 FF            LDA A *$FF
17    B7 8022          STA A SCNREG     PB0-PB7 OUTPUTS
1A    44               LSR A
1B    B7 8020          STA A DISREG     PA0-PA6 OUTPUTS, PA7 INPUT
1E    8D E0            BSR   DISNMI     DISABLE KEYBOARD/TRACE
                  °°INITIALIZE ACIA°°
20    86 03            LDA A *3
22    B7 8008          STA A ACIAS      RESET THE ACIA
25    7F A01D          CLR   VFLAG      INITIALIZE VFLAG
```

Fig 2—A 273-byte program *performs all the necessary interfacing tasks and leaves plenty of ROM space for your own routines.* *(Listing continues on pg 80.)*

```
28    8D 04     INIT   BSR   CLFLG      CLEAR DISPLAY AND FLAGS
2A    01 01            NOP               NO OPS
2C    20 52            BRA   KEY DC
                °°°°SUBROUTINE TO CLEAR DISPLAY BUFFER AND FLAGS°°°°
2E    CE A014   CLFG   LDX   *DIGIN4
31    4F               CLR A             CLEARS DIGIN4 AND DIGIN3
32    A7 00     CLFLG1 STA A 0,X         CLEARS MFLAG AND RFLAG
34    08               INX               CLEARS NFLAG AND TEMP2
35    8C A01A          CPX   *DIGIN4+6   END?
38    26 F8            BNE   CLFG1       NO LOOP BACK
3A    CE A00C          LDX   *DISBUF
3D    FF A01A          STX   XKEYBF      INITIALIZE XKEYBF
40    86 7F     CLRDS  LDA A *$7F
42    B7 8020          STA A DISREG      BLANK DISPLAY
45    86 11            LDA A *17
47    CE A00C          LDX   *DISBUF
4A    A7 00     CLRDS1 STA A 0,X         CLEAR OUT DISPLAY BUFFER
4C    08               INX
4D    8C A014          CPX   *DISBUF+8   END?
      *NOTE 1: ALL ADDRESSES PRECEDED BY CO.
50    26 F8      BNE     CLRDS1
52    39         RTS
53-58 01         NOP
                °SUBROUTINE TO DELAY 20 MS OR X MS
                °   WHEN ENTERING AT DLY1 THE XREG MUST CONTAIN
                °   THE DESIRED DELAY CT (APX 13USEC/COUNT)
59    CE 0600    DLY20  LDX   *$0600
```



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```
    5C    09          DLY1    DEX
    5D    26 FD               BNE    DLY1
    5F    39                  RTS
                °°°°SUBROUTINE TO SCAN KEYBOARD°°°°
    60    86 FF       KEYCL   LDA A *$FF
    62    CE 8020             LDX    *DISREG
    65    A7 00               STA A 0,X        BLANK DISPLAY
    67    86 3F               LDA A *$3F
    69    A7 02               STA A 2,X        ALL ROWS LOW
    6B    A6 02       KEYCL1  LDA A 2,X
    6D    6D 00               TST    0,X
    6F    2A 08               BPL    KEYCL2    KEY DOWN?
    71    8B 40               ADD A *64
    73    A7 02               STA A 2,X        SELECT NEXT COLUMN
    75    84 C0               AND A *$C0
    77    26 F2               BNE    KEYCL1    LAST COLUMN SCANNED?
    79    39          KEYCL2  RTS               NO KEY BOUND
7A-7F     01          NOP
                °°°°ROUTINE TO SCAN AND DECODE KEYBOARD°°°°
    80    8D DE       KEYDC   BSR    KEYCL
    82    27 FC               BEQ    KEYDC     NO KEY CLOSED
    84    8D D3               BSR    DYL20
    86    CE 8020             LDX    *DISREG   RESTORE X
    89    86 01               LDA A *$01       SETUP SCAN FOR FIRST ROW
    8B    A7 02               STA A 2,X
    8D    8D DC       KEYDC1  BSR    KEYCL1    SCAN KEYBOARD, GET KEY
    8F    26 0A               BNE    KEYDC2    KEY FOUND
    91    A6 02               LDA A 2,X        CLEARS NMI INTERRUPT
    93    81 20               CMP A *$20
    95    27 E9               BEQ    KEYDC     LAST ROW
    97    68 02               ASL    2,X       SHIFT LEFT
    99    20 F2               BRA    KEYDC1
    9B    5F          KEYDC2  CLR B             INITIALIZE COUNTER
    9C    CE E3DC             LDX    *KEYTBL
    9F    A1 00       KEYDC3  CMP A 0,X        SEARCH TABLE
    A1    27 09               BEQ    KEYDC4
    A3    8C E3F4             CPX    *KEYTBL+24  END OF TABLE?
    A6    27 61               BEQ    KEYDOF    NO KEY FOUND IN TABLE
    A8    98                  INX
    A9    5C                  INC B                ADVANCE
    AA    20 FE               BRA        KEYDC3
    AC    8D          KEYDC4  BRS        KEYCL
    AD    B2                                       WAIT FOR KEY RELEASE
    AE    26          BNE                KEYDC4
    AF    FC
    BO    BD          JSR        DLY20
    B1    C0
    B2    59
    B3    01          NOP
    B4    01          NOP
    B5    01          NOP
    B6    01          NOP
    B7    01          NOP
    B8    CE          LDX
    B9    C0          WITH
    BA    C2          1 ADDRESS LESS THAN STARTING DATA ADDRESS
    BB    5C          INC B
    DC    08          INX
    BD    5A          DEC B
    BE    26          BNE
    BF    FC          TO BB
    C0    7E          JMP
    C1    C0          TO
    C2    E0          ASCII
                      ASCII KEY
    C3    2E              .
    C4    21              1
    C5    22              2
    C6    23              3
    C7    24              4
    C8    25              5
    C9    26              6
    CA    27              7
    CB    28              8
    CC    29              9
    CD    41              A
    CE    42              B
    CF    43              C
    DO    4B              K
    D1    48              H
    D2    53              S
    D3    50              P
    D4    54              T
    D5    58              X
    D6    59              Y
    D7    51              Q
    D8    0D              CR
    D9    52              R
    DA    47              G
    DB          01
    DC          01
    DD          01
    DE          01
    DF          01
    EO          A6 LDA
    E1          00
    E1          B7 STA
    E3          00
    E4          DF
    E5          01 NOP
    E6          86 LDAA
    E7          09
    EA 08
    EB CE LDX
    EC 00
    ED 08
    EE B6 LDA
    EF 00
    FO DF
    F1 BD BSR
    F2 E3
    F3 7A
    F4 09 DEX
    F5    26        BNE
    F6    27        LOOP TO EE
    F7    7E        JUMP TO RESTAR
    F8    C1
    F9    03
                °°°°SUBROUTINE TO DISABLE NMI INTERRUPT°°°°
    FA    86 3C     DISNMI  LDA A  *$3C
    FC    B7 8021           STA A  DISCTR    INTR MASKED CA1 ACTIVE LOW
    FF    B7 8023           STA A  SCNCTR    INTR MASKED CB1 ACTIVE LOW
   102    39                RTS
                °°°°RESTART ROUTINE°°°°
   103    8E A078   RESTAR  LDS    *#A078
   106    BF A008           STS    SP         INITIALIZE STACK POINTER
   109    CE 0080           LDX    *KEYDC     GO DECODE KEYBOARD
   106    FF A006           STX    NIO        INITIALIZE NMI INTERRUPT
                °INITIALIZE KEYBOARD/DISPLAY PIA
   10F    86 FF             LDA A  *$FF
   111    B7 8022           STA A  SCNREG     PB0-PB7 OUTPUTS
   114    44                LSR A
   115    B7 8020           STA A  DISREG     PA0-PA6 OUTPUTS, PA7 INPUT
   118    8D E0             BSR    DISNMI     DISABLE KEYBOARD/TRACE
                °°INITIALIZE ACIA°°
   11A    86 03             LDA A  *3
   116    B7 8008           STA A  ACIAS      RESET THE ACIA
   11F    7E C080           JMP    KEYDC
```

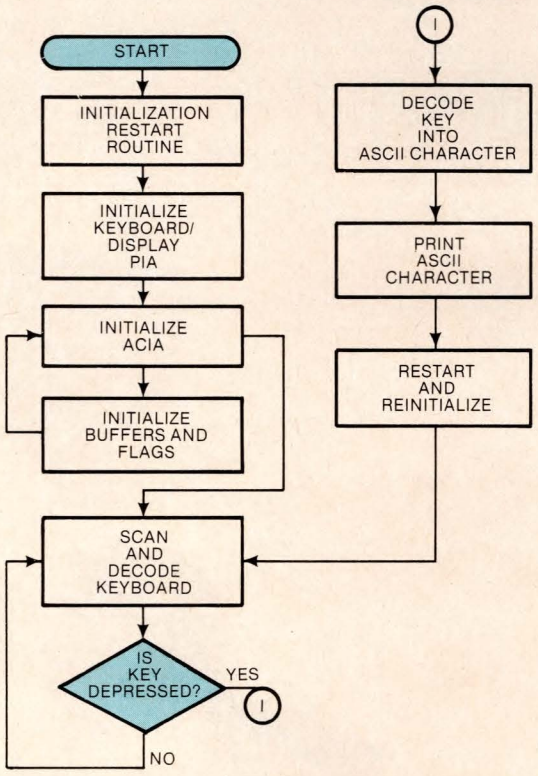

Fig 3—Follow this flowchart *to write similar programs for other μP evaluation boards.*

for full-duplex operation.

The design's software program (**Fig 2**) requires only 273 bytes of the 2k ROM space available on the μP board; you can enter this code directly. The software's flowchart (**Fig 3**) illustrates the few operations the code must perform to provide half-duplex operation. **EDN**

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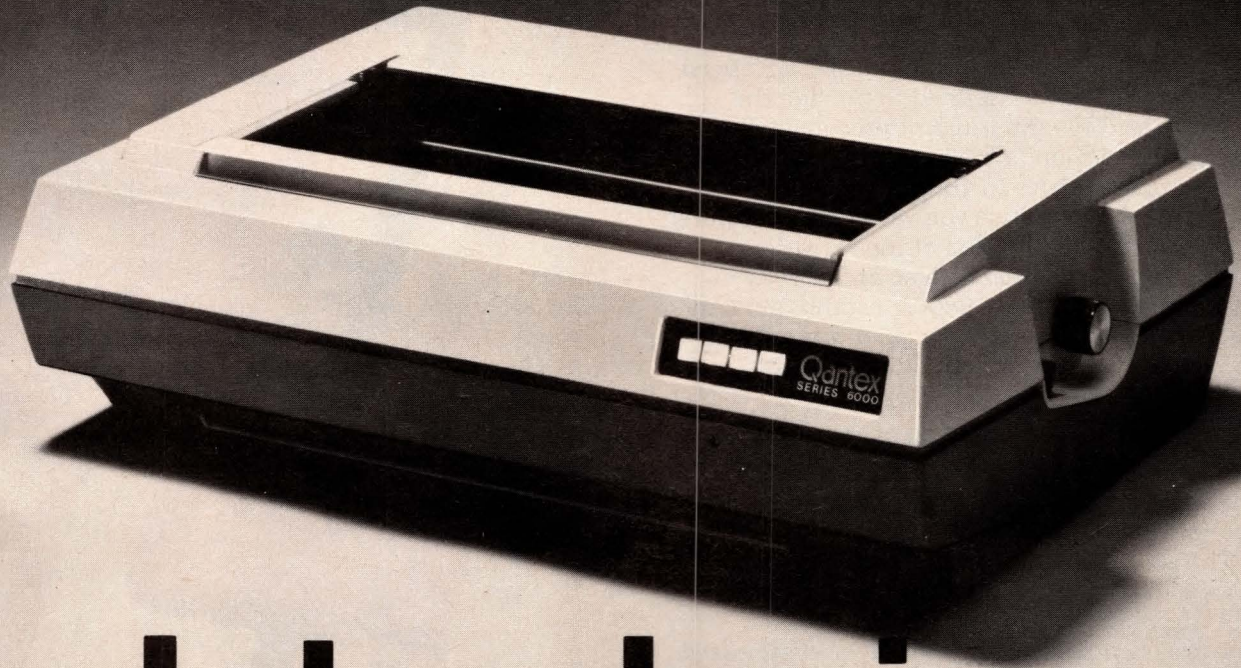

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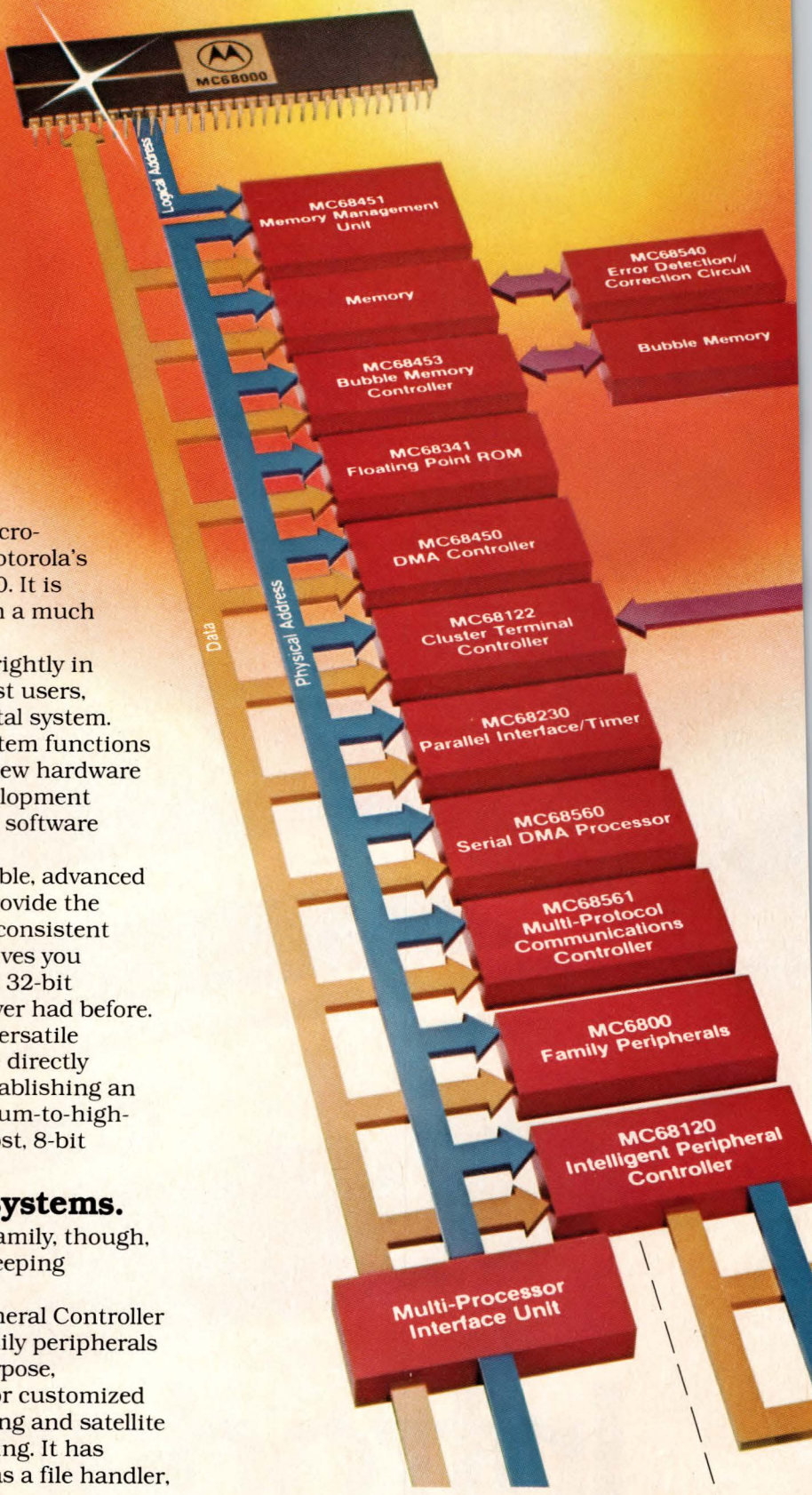

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ıtelligent floppy or hard disk controller, data ɔmmunications protocol controller, CRT driver nd GPIA bus-management controller.

Also scheduled for imminent introduction re a Cluster Terminal Controller, the MC68122, nd a compatible bipolar interface Error etection and Correction circuit, the MC68540 lso numbered MC34040). The Cluster erminal Controller will relieve the host rocessor of the coordinating task for ommunications between and among terminals, nd the EDAC circuit performs the error check/ correct function in 8-bit or 16-bit systems. It's directly expandable to 32-bit operation.

More HMOS VLSI.

Following these, availability is scheduled for the MC68451 Memory Management Unit, MC68450 DMA Controller, MC68230 Parallel Interface/Timer and the MC68341 Floating-Point ROM.

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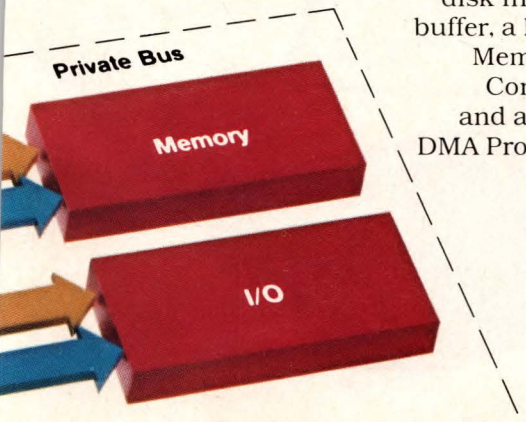

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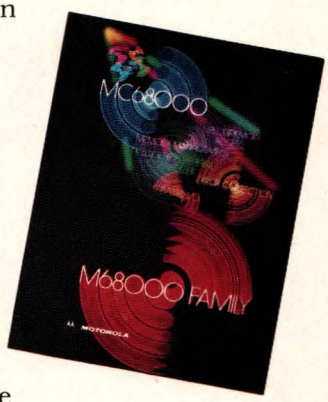

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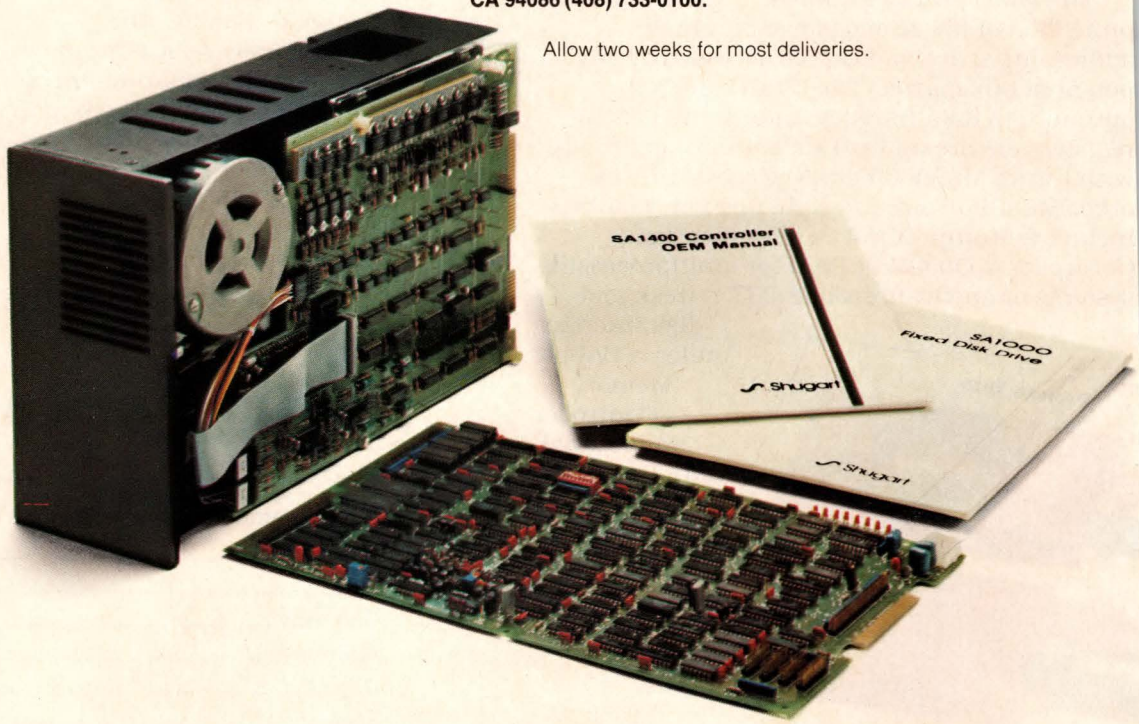


A Question of Law

When a judgment of patent invalidity short circuits a patent-infringement suit

Professor H Newcomb Morse
Pepperdine University, Malibu, CA

Can a holder of a patent recover damages for infringement if his patent is subsequently ruled invalid?

The Sensytrol Corp brought suit in the US District Court for the Southern District of New York against the Radio Corp of America (RCA), charging it with patent infringement by its manufacture, use and sale of Type CR-101-A radar equipment. The patent in question, designated 2,238,040 (the '040 patent), was originally issued to Harry Dickens but subsequently assigned by him to Sensytrol.

Neither a tinkerer nor an inventor be

Dickens was a US citizen who had been brought up in Germany before World War I and had received the equivalent of a trade-school education at a technical institute. Although never engaged professionally in the electronics industry, he retained an interest in electronics from his school days and was aptly described by his attorney during the trial of the suit as a tinkerer. When his patent was issued, he was employed by a radio station in Washington, DC, as a program director.

Dickens's invention evolved from a discussion with friends about the high incidence of automobile accidents. In the course of the discussion, he had proposed a device, mounted on an automobile, that would generate an electromagnetic wave. Reflected from another object, the wave could activate a car's brakes under certain conditions and thereby prevent collisions. A model of such a machine was constructed, and on February 25, 1936, Dickens applied for a patent.

A long and tortuous course

The patent application followed a long and tortuous course through the Patent Office, encountering four rejections and accumulating seven amendments. Its difficulties were probably the result of Dickens's deficient technical education, which left him unaware of developments in the rapidly changing field of radar and its associated electronics.

Dickens admitted at the trial of Sensytrol's suit that neither his device nor the circuit he had patented had found commercial use. Additionally, none of these devices had been manufactured or sold, and no licenses had been granted. Furthermore, his expert witness testified at the trial that he had never seen the machine operate.

During the trial, an instrument built according to the '040 patent's specifications was brought into court but failed to work. Thus, while a lack of commercial utility is not necessarily a conclusive factor in a patent case, it is, nevertheless, a factor that can be taken into account in determining a patent's validity.

Patent Office examiner rejects 33 claims

On October 23, 1939, a Patent Office examiner had rejected all 33 claims in Dickens's original patent application on the grounds of prior disclosures of the art involved. On May 30, 1940, Dickens had withdrawn these claims and proposed Claim 34, which was subsequently allowed by the Patent Office. In a letter preceding this amendment, Dickens's attorney had stated: "Applicant has restricted [patent] protection to the specific disclosure of the[se] circuits..."

Claim 34 described Dickens's device in the following terms:

"A control for power circuits, comprising two substantially identical thermionic oscillators connected in parallel to each other, each oscillator including a grid circuit having a coil and a tuning condenser, [and] to a source of plate-current supply. A relay [is] interposed in the plate circuit between...[the] source of supply and...[the] oscillators, the grid circuit of one of...[the] oscillators directing its radiant energy in a beam...[The] oscillators normally maintain...[the] relay in one position during unobstructed flow of radiant energy from the grid circuit. [The] obstruction of...[the] radiant-energy flow reacting on the system...shift[s] the energy distribution between the oscillators and thereby cause[s] a plate-current change in each oscillator...[This] change in plate current to the two oscillators causes operation of the relay to a different position."

In summarizing the '040 patent in its brief, Sensytrol explained it as follows:

"The '040 patent here involved relates to an

electrical circuit utilizing radio waves for object-detection purposes. The circuit disclosed by the patent...employs two oscillators A and B comprising appropriate tank circuits...coupled to a single antenna and to a relay. Oscillator A generates a radio-frequency signal that is sent out through the antenna for a short interval depending on the values selected for the grid-leak circuit.

"As was pointed out at trial and is well known in the prior art...the grid-leak components...served to provide for periodic interruptions (or pulsing) of the oscillations of these oscillators.

"During the period of quiesence, the radio wave transmitted via the antenna and produced by oscillator A will, upon striking an object, be reflected therefrom to the antenna...whence the reflected signal induces a radio frequency in the antenna that is passed to a common conductor...joining oscillators A and B.

"Oscillators A and B are set up to beat against each other, so that while one oscillator is quiescent, the other is active and vice versa. During the period of quiescence of oscillator A, any signal reflected back to the antenna...will be mixed with the signal generated by oscillator B.

"Since there is a relative movement between the transmitting apparatus and any object detected, there will be a variation of this reflected frequency from the initially transmitted frequency due to the Doppler effect. The slight difference in frequency produced by the Doppler effect on the reflected signals will reflect in a beat frequency in [the common conductor]...as a result of the slight difference between the frequency of oscillator B and the Doppler-effected reflected signal. This beat frequency serves as an IF or intermediate frequency for actuation of the relay..."

Anticipation the mother of invention?

The problem thus facing the District Court was whether the prior art anticipated the particular circuits described in Claim 34 (the only claim allowed in Dickens's patent).

In this respect, the use of electromagnetic or radio waves transmitted through the air for the detection of objects was known before Dickens's invention, and the principle was employed in patents awarded to Edwards (1934), Ballantine (1935) and Patterson (1935), among others.

The Edwards patents, for example, use a self-pulsing triode oscillator and an oscillating circuit operating 180° out of phase as well as a relay that is activated by imbalance in the system. The Ballantine patent also utilizes these elements, as well as a directional antenna. Furthermore, Dickens's method of activating the relay had earlier been employed in patents issued to Walter Schaffer (1929) and Edward B Mallory (1932).

The Patent Office examiners had considered the Mallory patent in detail—an evaluation that had led them to reject and cancel 20 of Dickens's original patent claims. The Mallory patent describes a burglar alarm containing two triode thermionic oscillators. The first of these has a fixed frequency. The other connects to an antenna so that an object coming within its range varies the oscillator's frequency. Utilizing the superheterodyne principle, the circuit creates an intermediate frequency that, when rectified, operates a loudspeaker or other indicating device.

The Mallory device employed two triode thermionic tubes and two oscillatory circuits, both of the Dickens type, and a single antenna. Oscillator B, as in Dickens's specification, operated at a constant frequency.

The following extract from the Mallory patent specifications constitutes a reasonably fair statement of Dickens's activation principle:

"The frequencies of these two thermionic tube oscillators are so chosen that the frequency of the beat note produced by their interaction in the sound producer...is either zero or at a frequency above or below audibility. If, however, the capacitance between the element 10 and the ground 23 is changed by change in the dielectric between these elements, the frequency of oscillation of tube 1 will be altered, and the constants of the circuit are so chosen that any change in this frequency will give rise to an audible beat note...When...the dielectric constant of the protected space is changed by the ingress or presence of a foreign agency or object, the frequency of oscillation of tube 1 is changed sufficiently to give an audible signal."

Dickens had finally differentiated his device from Mallory's by confining himself to two oscillators with identical frequencies and by pointing out that the Mallory machine had to be grounded to work, whereas his invention did not necessarily have to be grounded.

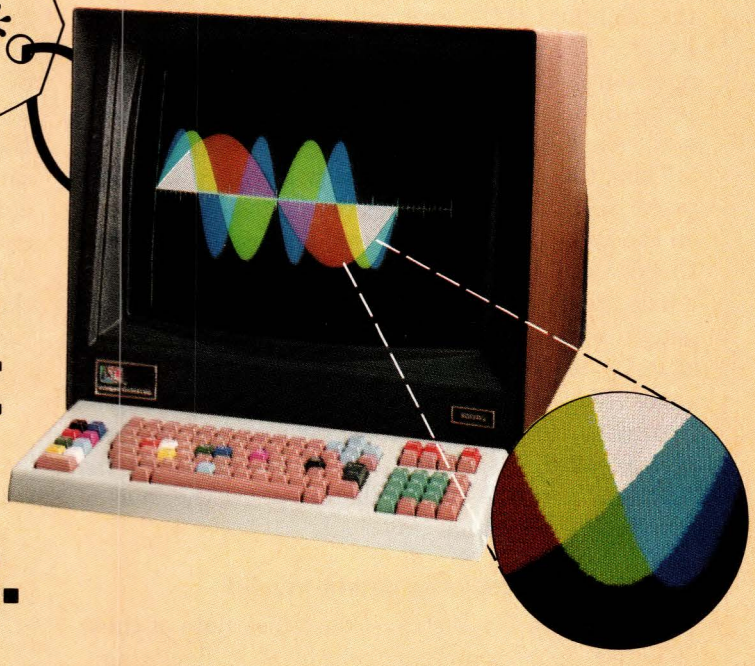
Patterson patent anticipates Dickens's device

The type of circuit described by Dickens was also anticipated in the Patterson patent. Issued on November 26, 1935, it details an airborne radio-echo altimeter that determines an aircraft's altitude. Because the circuits involved were substantially the same as those described by Dickens, the Patent Office had cited the Patterson patent against him. Dickens's attorney, however, had distinguished between the two patents:

Introductory Special

$3,355*

8001-I 19" CRT Terminal



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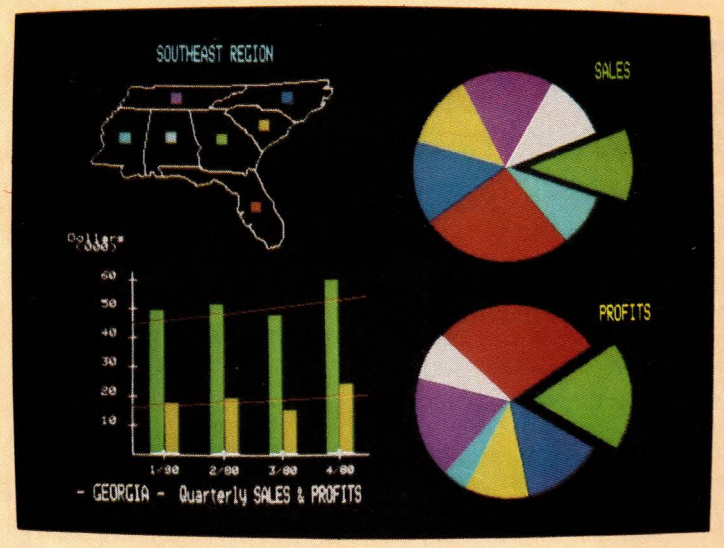

Introducing the world's lowest priced high resolution color graphics.

Now high prices don't have to keep you from high performance graphics. ISC's new 8000 Series "I" terminals and desktop computers display color vectors and arcs with full-screen, 480 x 384 individual dot precision —note the close-up photo above. Impressive? With terminals starting at a quantity 100 price of $3,355, try incredible.

For any application requiring critical picture definition.

ISC's new "I" series is suited for process control, energy management, MIS —virtually any application needing sophisticated color graphics. Available in contemporary or industrial cabinets, each model features an 80 cpl by 48-line character format and RS-232C interface. Individual dots displayed in any of 8 colors can shade to a wide spectrum of color combinations.

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A Question of Law

"Wholly aside from the fact that Patterson may, in a manner, accomplish a similar result, the patent does not meet the specific claims now pending, for as the [Patent Office] examiner admits, in an official letter, Patterson has but one oscillator. The applicant [Dickens] has restricted the desired protection to the specific disclosure of the circuits and their details..."

Thus, the Patterson device accomplished the same result as Dickens's but was distinguishable from it on the ground that it employed one oscillator, while Dickens's unit employed two.

The Schaffer patent, which preceded Dickens's patent application by almost 10 yrs, had not been cited by the Patent Office. But it showed a circuit almost identical to Dickens's, employing two coupled thermionic oscillators of constant identical frequency. Schaffer's specifications even describe the relationship of the two oscillators along the lines of Dickens's description.

District Court declares patent invalid

In 1961, the US District Court took note of these facts and dismissed Sensytrol's lawsuit, declaring:

"...we have a situation here where the type of circuit involved was anticipated by the Patterson patent, but the [Patent Office] examiner apparently found a distinction in Dickens's use of two oscillators. However, this feature was clearly anticipated by Schaffer, a fact of which the examiner apparently was not aware. Thus, there was in the application of Dickens no novelty, and no presumption of validity can arise from the patent grant if the Patent Office did not consider the Schaffer patent, which apparently it did not...Since the [Dickens] patent is invalid, it becomes unnecessary to consider whether the radar apparatus manufactured by the defendant [RCA] infringes the patent." **EDN**

H Newcomb Morse, JD, LL M, FAAFS, received the Juris Doctor degree from Tulane University and the Master of Laws degree from the University of Wisconsin. He is currently Professor of Law at Pepperdine University.

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Circle no 45 for general information
Circle no 46 for detailed specifications

Burroughs

Serial Impact Printers

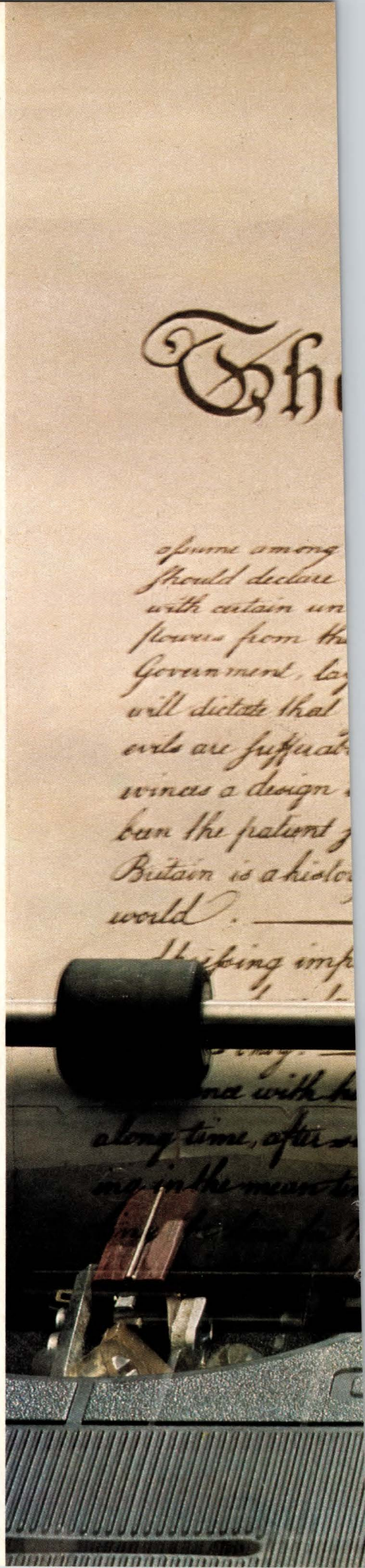
Dot-matrix units are rapidly invading the realm of fully-formed-character devices, forcing OEM designers to take a second look at their applications' requirements.

Carl Warren, Western Editor

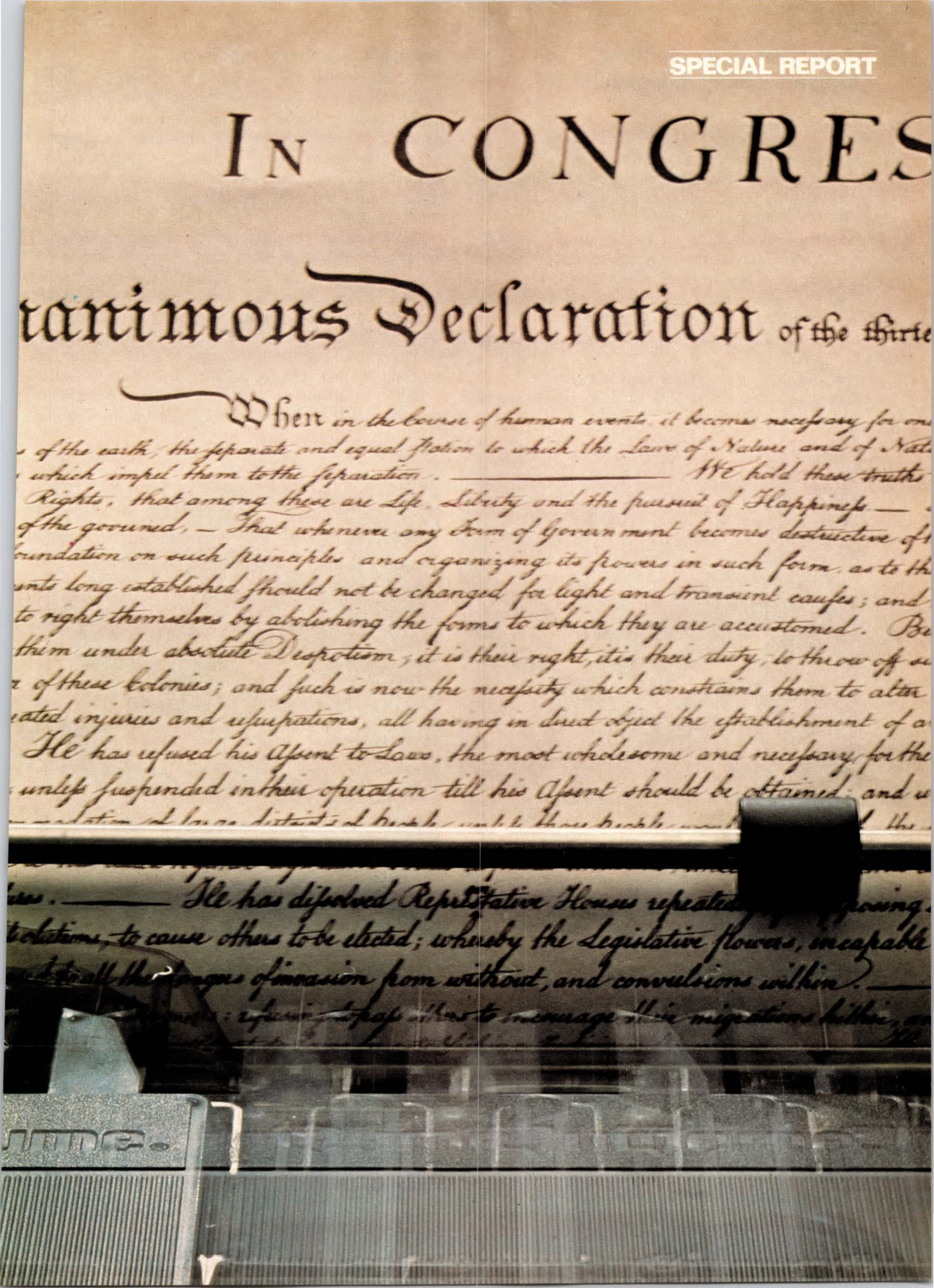
The growing demand for hard-copy printouts in data- and word-processing applications is making serial impact printers increasingly important components of OEM systems. And to satisfy this increased demand, printer manufacturers are offering a growing range of products with extensive new capabilities.

Faced with the expanding list of choices, you might have difficulty making a wise and cost-effective selection. And recent advances in dot-matrix print quality could further complicate the selection process; these advances are spurring OEMs' interest in dot-matrix printers as viable, cost-effective alternatives to fully-formed-character units for a broad range of applications. Meanwhile, manufacturers of fully-formed-character printers aren't sticking their heads in the sand; they, too, are responding to OEM needs with lower cost designs that compete with the less-than-$1000 dot-matrix units. And they're offering more functions on current models without appreciably raising those printers' prices.

How can you find your way through this morass of sometimes conflicting considerations? Start by asking several questions whose



Declare your independence *from poor-quality printouts with the latest serial impact printers. (Photo courtesy Qume Inc)*


IN CONGRES
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When in the course of human events it becomes necessary for on
of the earth, the separate and equal station to which the Laws of Nature and of Natu
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Rights, that among these are Life, Liberty and the pursuit of Happiness —
of the governed, — That whenever any Form of Government becomes destructive of t
foundation on such principles and organizing its powers in such form, as to th
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ctions, to cause others to be elected; whereby the Legislative Powers, incapable
to all the dangers of invasion from without, and convulsions within. ———

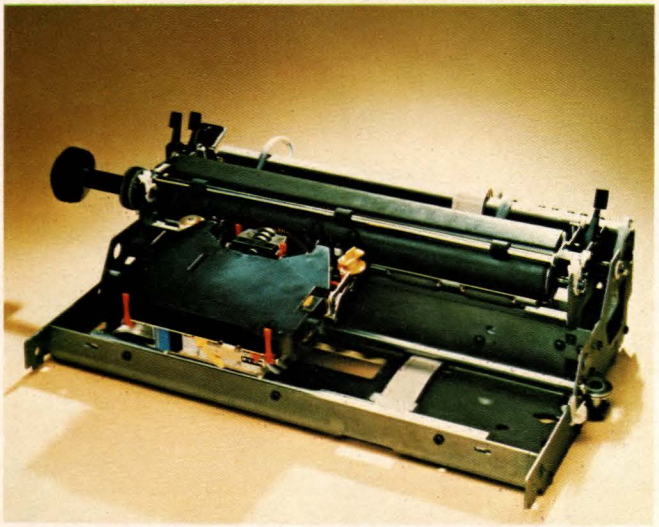
Ask a few key questions to avoid costly mistakes

answers help guide the selection process:

- What type of application(s) are you designing for?
- What is your application's required duty cycle?
- Will your system use multipart forms?
- How important is speed to your application?
- What interface meets your system requirements?
- How intelligent must your printer be?
- Do you require special functions (graphics, plotting), or will you in the future?
- What considerations govern your need for spare parts?
- What price are you willing to pay?

This article provides some help in developing and evaluating your answers.

Equipped with dual 8085 μPs *and a 512-character receive-data buffer and achieving print rates from 30 to 120 cps, General Electric's Terminet 2000 Series printers suit desktop data-communication requirements.*



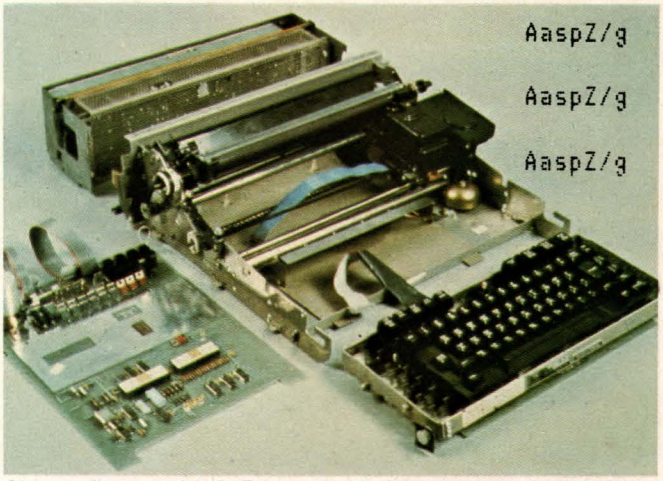
Producing as many as 100 characters *in several type sizes, fonts and languages, Pertec's daisy-wheel Stylist 360 operates at a relatively slow 17 cps but costs only $730 (1000).*

The application's most important

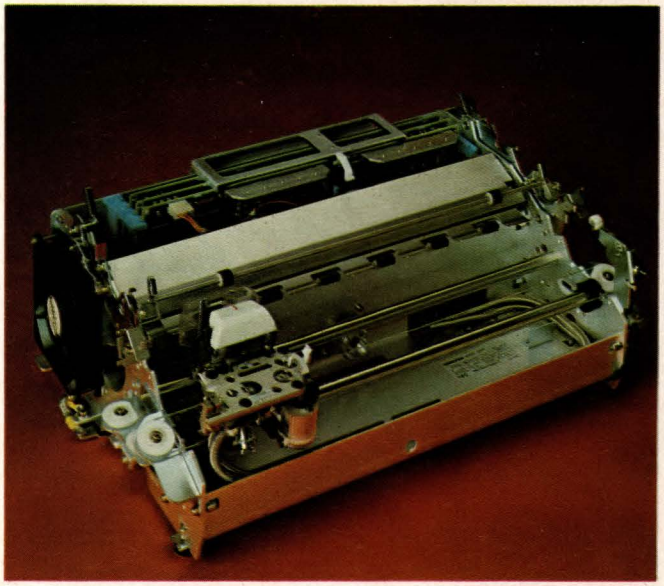
Which printer technology—dot matrix or fully formed character—should you choose? Your application is the primary factor governing the answer to this question. For example, because word-processing applications require "quality" printing, a fully-formed-character printer, such as those manufactured by Qume, Diablo and NEC, would appear to be the natural choice for them.

Unfortunately, "quality" can be subjective. However, system designers agree that the best method of measuring it uses the IBM Selectric typewriter as a standard. This comparison points up the the major attributes of quality printing, especially with regard to the output of a 7-wire dot-matrix printer **(Fig 1).** Note, for example, that the Selectric's print clarity is constant, whereas the dot-matrix output is less smooth.

But even though a fully-formed-character printer provides quality printing, it exhibits some drawbacks,



Shown disassembled, *Teletype's Model 43 uses a 9-wire single-column printhead to produce a 7×9 matrix. It concedes speed (achieving 47 cps max) to ensure reliability and print quality (note sample)—both important attributes for unattended data-communication applications.*



Employing a thimble-type print mechanism, *NEC's Model 5500 Spinwriter comes in the basic form shown here, consisting of the mechanism and internal electronics. It's available with Diablo-, Ontel- or Qume-type interfaces.*

particularly with regard to print rate. Most fully-formed-character printers achieve their print clarity—including precise line and character registration—by operating at a relatively low rate: 55 cps is a typical speed. This low rate virtually precludes their use in electronic-data-processing (EDP) applications, where a high print rate is paramount. If you do use a fully-formed-character unit in an EDP application, increased duty cycle (the percentage of time the printer is actually printing) severely inhibits the unit's life.

The bottom line? If your application requires printing speeds in the 120- to 340-cps range, a dot-matrix design will probably prove necessary. And you'll just have to accept the resulting lower print quality: A typical 7-pin dot-matrix head prints in a 7×7 font, producing characters with varying clarity and no descenders.

All isn't lost, though. To improve dot-matrix units' *perceived* print quality, manufacturers such as Okidata, Centronics and Epson offer printheads with 9×9 character fonts that permit generation of descenders on lower-case letters. And in some cases, n×9 fonts—like those in Centronics's Models 753 and 737—permit character definition that compares favorably with that of fully-formed-character printers.

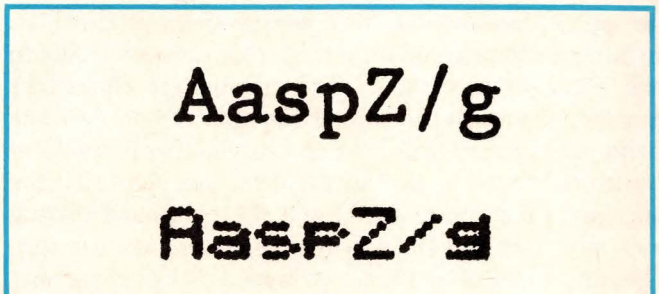


Fig 1—Although this example *grossly overstates the differences between fully-formed-character and dot-matrix printers, it does point up the nature of perceived print quality. The top row is from an IBM Selectric II electric typewriter; the bottom row, from a 7-wire single-column-head dot-matrix printer. Character height for both fonts is 0.1 in., and both outputs are enlarged 300%. You can see that the fully formed characters are extremely clean and sharp, whereas the dot-matrix characters are jagged. Notice also that the dots separate and tend to bleed—a function of ink density and paper consistency.*

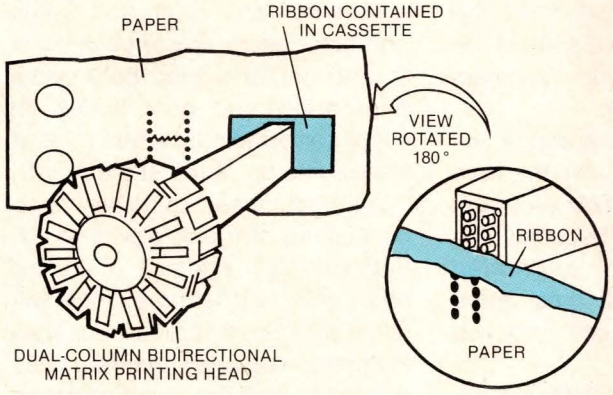


Fig 2—One method that increases permissible head duty cycle *involves the use of multiple wire columns. Dual 7-wire columns create a character in alternating steps; the right column—viewed facing the paper—fires first, and as it settles, the left column fires. This technique can improve duty-cycle ratings by as much as 40% compared with single-column designs. (Courtesy Dataproducts)*

Illustrating another attempt to improve dot-matrix printers' perceived print quality, Malibu Electronics's Model 200 (slated for March deliveries) operates in two modes. In high-speed EDP applications, its standard matrix head outputs 165 to 250 cps. And in word-processing applications, a 2-pass printing technique produces a 42- to 60-cps output that the firm claims exhibits letter quality. Resolution of the $2000 (100) unit's graphics equals 120×144 dots/in.

Several other application-related considerations bear on the choice of a printer technology. For example, John Leighton, Rexon Business Machines manager of product planning, notes that an application geared more toward report generation than word processing lends itself to use of a dot-matrix printer. However, the printer in such an application could be used for a certain amount of word processing, especially on internal documents that don't require letter quality.

Dataproducts vice president Ron Morley agrees. But he also contends that just because quality is quite subjective, dot-matrix-printer manufacturers are aiming to change OEMs' perception of it; those OEMs will then ultimately determine the standards accepted by end users. Morley suggests that the situation in print quality is much like that of photocopies: A few years ago, a photocopy was unacceptable in some applications; now, perceived photocopy quality is good enough to be widely accepted. If Morley is correct—and trends tend to support his view—dot-matrix printers will eventually supplant fully-formed-character units in numerous applications.

Duty cycle proves critical

Another factor to consider when choosing a printer, and one that bears directly on the application, is the printer's required duty cycle. Indeed, John Barny, Microdata's director of terminal engineering, ventures that duty cycle is one of the more critical items affecting selection precisely because it's so misunderstood.

Barny suspects that designers frequently place high-speed dot-matrix printers in the same league as line printers, employing them in applications requiring 8-hour-a-day, 5-day-a-week operation. The result, just as in the case of fully-formed-character units used in EDP applications, is a high failure rate. Typically, serial dot-matrix printers have rated duty cycles of only 25%.

How do printers subjected to abnormally high duty cycles fail? Primarily in the printhead. Daisy wheels or thimble mechanisms, for example, exhibit unusually high print-face wear and a tendency to break. Dot-matrix heads, on the other hand, tend to heat up. As a result, their wires misfire and produce incomplete characters.

To increase their printers' permissible duty cycle,

Print quality can be a subjective matter

manufacturers such as Dataproducts employ such techniques as dual-column (14-wire) printheads (**Fig 2**). In such a head, a wire in the first column fires, then settles; a second-column wire then fires and settles, and the process repeats. This method greatly enhances both printing speed and printhead life (as high as 300 million characters) and permits duty cycles 25 to 40% longer than possible with single-column designs.

No standards for forms

Because not all printing occurs on single-sheet paper, a printer's accommodation of multipart forms can also bear on its choice. Unfortunately, no standards govern the materials used in forms or the forms' thicknesses. Thus, there's really only one method of determining how well a printer handles a form: Try it.

However, you can look for certain basic attributes:

- An adjustable carriage that accommodates forms with varying thicknesses and widths. Typically, expect a maximum specified form thickness of 0.028 in., which includes an original and seven copies. Most printers can handle form widths ranging from 3 to 16 in.
- An adjustable line-spacing mechanism (6 or 8 lpi) to aid in matching lines on the form
- A printhead that moves across the paper freely without touching the form and producing unwanted lines, yet provides sufficient force to print all forms.

Murphy's Law always being operative, though, after ensuring that a printer meets all these criteria, you'll probably encounter a form that somehow defeats it. Unfortunately, there's nothing you can do to avoid such disappointments, other than take as many precautions as possible. Microdata's Barny even suggests that you attempt to print on cardboard.

Three factors govern printing speed

Related intimately to printer choice is the question of speed touched on earlier. Basically, three factors underlie this consideration: print rate, throughput (number of lines per minute) and input data rate.

The print rate, measured in characters per second, tells how many characters can be placed on the paper per unit time. The quantity depends primarily on the print technology and the type of carriage mechanism. To put these factors into perspective, picture the printhead mounted on a carriage that moves parallel to the plane of the paper. The number of characters printed per second is then a function of how fast the print mechanism fires and the mechanism's speed of horizontal travel along a given print line. Note that the carriage's horizontal speed and the printhead's firing rate must remain totally in sync; when one leads or lags the other, characters are overlapped or disproportionately spaced. Several tests help determine whether a printer is properly timed in this regard (see **box,**

Checking printer timing

To ensure that a printer you're evaluating is correctly timed, you can perform a simple test that checks the relationship of printhead timing to horizontal carriage movement.

Print a line of capital Es—40 to 132 columns. Then overprint the same line four times. Skip down to the next line and repeat the process until you've printed a full page (66 lines). If the printer allows you to change pitch (the number of characters per inch), repeat the test for the higher setting.

Now look down at the lines of Es. All of the characters should line up; there should be no overlapping or "rivers" of white space arising from poor spacing.

Wavy lines in a printer's output result from faulty vertical stepping motion of the paper. To test a printer for correct vertical motion, perform the same test as described above, except this time print each line just once, altering the data-input rate and the print rate for each new line. Each line should be free of wavering, and the leading (distance from the bottom of one line to the top of the next) should remain constant (0.10 to 0.16 in. typ).

If the printer can produce expanded characters, repeat both tests in that mode. This provision proves necessary because the timing changes for expanded printing: The head fires more frequently, and it can produce misregistration.

Indexing critically affects a printer's form-feed capability: On issuance of a form-feed command, the paper should advance from the top of the form to the same point at the top of the next sheet. And when the printer advances from the last line to the top of the next form, the index point should also remain the same.

The test for form-feed indexing is simple. Print a letter at the top of the form, then issue a form-feed command and print the same character again. Continue this test for the printer's rated duty cycle, then match the print zones. In every case, the characters printed should line up at the same point.

Although these tests are time consuming, they will assist you in determining a printer's operating efficiency. Furthermore, they will either prove or disprove the manufacturer's reliability claims. Less expensive printers, such as those designed for the low-end hobby market, usually won't stand up to the tests. Consequently, choosing a low-end printer strictly on the basis of price can ultimately be a costly proposition.

"Checking printer timing").

For dot-matrix printers, print rate further depends on the number of wires in the printhead, the arrangement of those wires and the number of dots (7×7, 9×9, etc) in the character font. Most specified rates don't include head turnaround and line feed.

Illustrating these considerations, the Centronics Model 704 dot-matrix printer, with a single-column 9-wire head, has print rates of 180 cps for a 7×7 font and 165 cps for a 9×7 or 9×9 font. Dataproducts' Model M-200, with its dual-column 14-wire head, achieves 340 cps with a 7×7 font. Among fully-formed-character printers, Pertec's Model P360 daisy-wheel unit has an extremely slow print rate of 17 cps, while NEC Information Systems' Model 5500D thimble-mechanism printer scoots along at 55 cps.

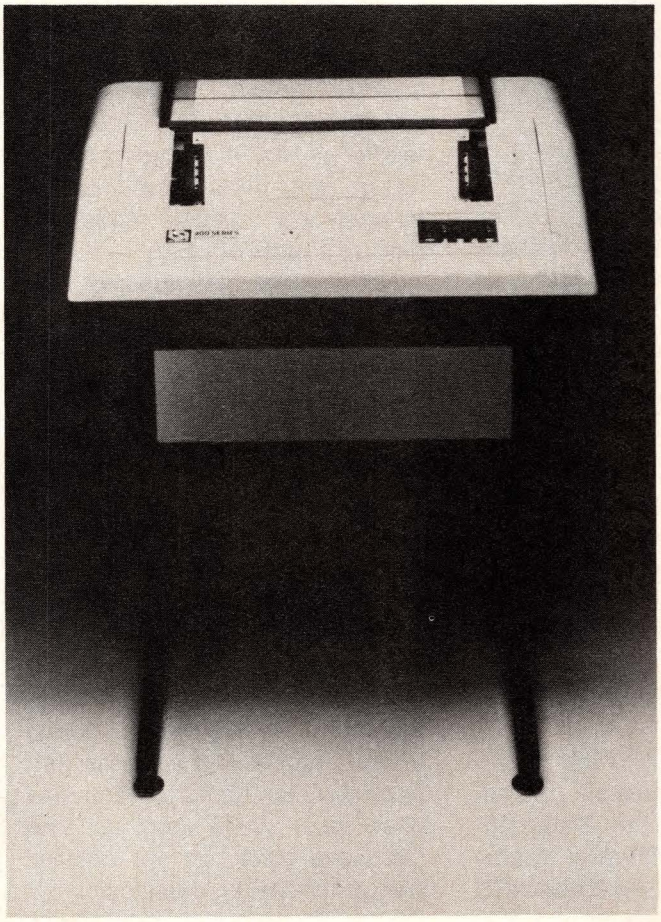
The slower print rates of fully-formed-character printers arise from the printer design's basic physics and the need for the mechanism to come to a complete stop before printing a character. Factors of particular importance in these printers include head acceleration and deceleration, type-finger settling time and character indexing on the wheel or thimble (the latter mechanism requires the least time). Typically, for a 55-cps fully-formed-character printer, printing one character takes approximately 18 μsec. Contrast this figure with the 5.5 μsec required by a 180-cps 7×7 dot-matrix printer, which needs no character indexing and printhead deceleration—it prints characters on the fly. (Interestingly, a single-column 9-wire head, printing 165 cps in a 9×9 font, requires approximately the same time, and a dual-column 14-wire head operating at 340 cps requires only 2.9 μsec).

Turning now to printer throughput, note that this quantity varies with the printed format. But other factors also affect it. For example, printers with logic-seeking capability direct the head to the optimum starting point for each print line, either in the forward or reverse direction, and thus improve throughput.

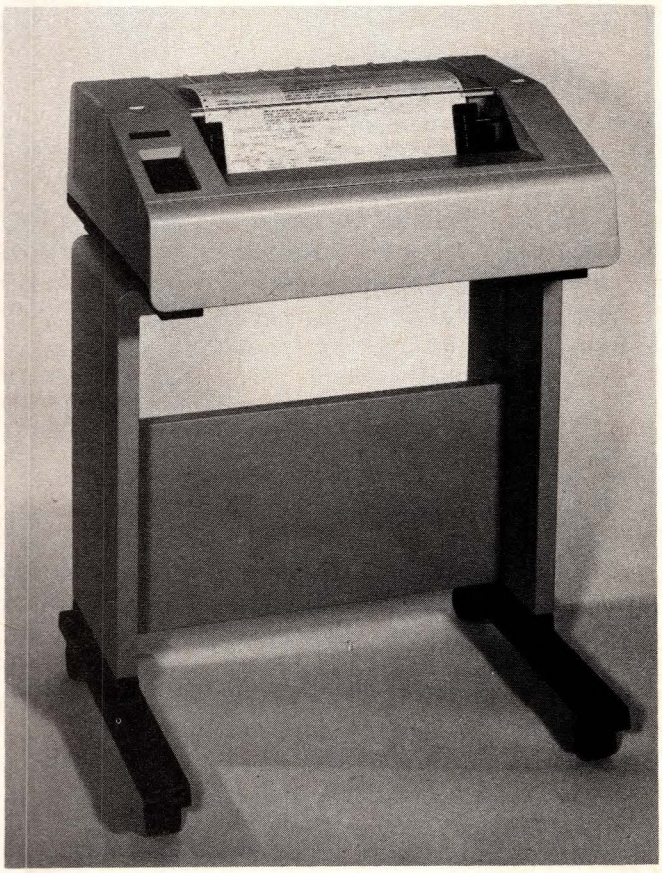
Three interface choices

Input data rate, the third factor governing print speed, is intimately related to printer-interfacing considerations. Three interfacing methods exist: 8-bit parallel, RS-232C serial and Centronics compatible. The latter interface, a de-facto standard, is an 8-bit-parallel method with special pinouts. Centronics bases its compatibility on a 36-pin D-type connector, although the firm does offer some printers (such as Model 737) with a 40-pin pc edge connector.

An important aspect of a printer's interface is that the unit, as delivered, might not provide pinouts compatible with your host. In such cases, you must either redesign the interface on the host or implement one in the printer. But the amount of space available inside the printer can in some cases block the second



To reduce noise, *Lear Siegler provides an optional acoustic quieting cover for its Model 310 Ballistic printer. The option reduces the printer's noise level from 71 to approximately 55 dB.*



Utilizing a single-column 9-wire printhead and a 7×9 matrix, *Hewlett-Packard's Model 2361G offers raster graphics, an IEEE-488 interface and print speeds as high as 180 cps. HP also offers alternative character sets for eight languages, Roman extension, math symbols and a special high-density font.*

Check out forms handling by trying as many forms as possible

approach, especially in units shipped with parallel interfaces and requiring a serial add-on.

Although RS-232C defines an electrical standard for serial connection, it leaves room for designer choices. Thus, not all RS-232 interfaces are the same, especially with regard to handshaking. Generally, look for a version that accepts X-on/X-off signals to select or deselect the printer and to avoid character losses arising from a full buffer.

Regardless of the interface type, the input data rate relates to how fast the printer can process characters and therefore determines how frequently the printer and host must handshake. Printers with small buffers must obviously handshake more often; those with large FIFO buffers require less frequent handshaking and thus have better overall throughput.

Also consider the protocols a particular printer accommodates. Such a protocol specifies the method of selecting or deselecting the printer and the method of data transmission. In general, look for one start bit, seven data bits, one parity bit (frequently not used) and one or two stop bits in a 10- or 11-bit data word.

μP control supports printer functions

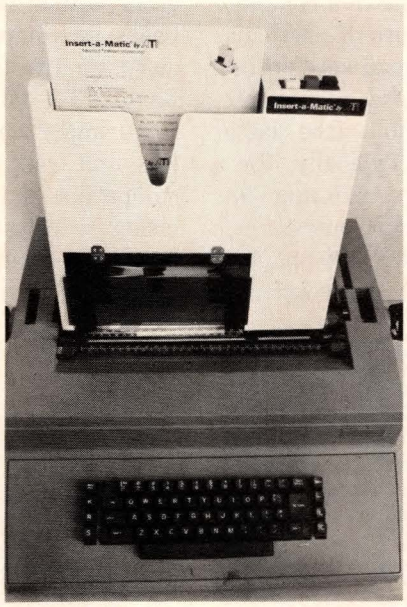
You might suspect that intelligence also plays a major

Sheet feeders improve printer productivity

As greater numbers of small systems incorporate word-processing capability, the need to handle a variety of forms becomes increasingly important. One of the most difficult to handle of these forms is the cut sheet (letterhead paper); consequently, printer systems houses are now incorporating single or dual sheet-feeder mechanisms into their offerings.

Currently, the number of sheet-feeder-mechanism manufacturers is small; three companies dominate the market. All three firms—BDT (West Germany), Rutishauser Data AG (Stafa, Switzerland and Dallas, TX) and Advanced Terminals Inc (Mohawk NY)—offer products designed for incorporation into fully-formed-character printers.

Advanced Terminals (ATI), for instance, manufactures the Insert-a-Matic. This single-sheet unit, priced at $1600, uses firmware for system control and comes with either a parallel or serial interface. ATI will also introduce Model 5000 in April; this unit will incorporate dual bins for handling letterheads and second sheets, use coded cartridges that permit operation with a printer serving more than one workstation and accept paper up to 14 in. wide and 14 in. long. A built-in collator, tractor feeds and a sound-damping enclosure, plus 8048-μC control, complete its list of features.



Permitting the use of cut or continuous forms, *the Insert-a-Matic sheet feeder from Advanced Terminals Inc ensures precise registration by means of photo-sensed top-of-form detection and left-margin column-zero registration with adjustable format.*

Dave Miller, ATI regional manager, says Model 5000 will carry a list price of approximately $3300. It will allow a designer to incorporate a print mechanism right in the feeder and will sense the coded paper cartridges and inform the operator whether the proper paper is loaded.

Rutishauser USA offers a low-cost single- or dual-bin feeder. Versions include the Dataproducts-compatible RS-907, Diablo RS-901, Qume RS-903 and NEC RS-908; their differences are in platen widths and gear locations. These units range in price from $1500 to $1550.

The Rutishauser feeders use a Mostek MK3870 1-chip μC that synchronizes paper movement with printing speed. A photocell recognizes the paper's leading edge. The printer need supply only power and ground; the platen provides the movement.

The BDT feeders, marketed by MQI Computer Products (Fountain Valley, CA), are available in several versions, including the $1495 ASF 160. This single-bin feeder is an electromechanical design and utilizes the platen's forward and reverse motion to pick up sheets of paper.

For applications requiring dual bins, BDT offers the $2195 ASF 171 and 176; the latter is totally mechanical, while the former uses an 8-bit μP designed by BDT specifically for paper handling. Both models accommodate as many as 250 sheets per tray.

Even though sheet feeders are extremely expensive when measured against the overall price of a printer system, they could soon grow less expensive. A $500 mechanism might be just around the corner, sparked by the needs of word-processing systems and by printer manufacturers' desire to offer more OEM options. The Japanese have not yet entered the sheet-feeder business, but they are investigating the market's requirements.

role in printer choice. After all, to provide optimum operating efficiency, especially in small μP-based systems, a printer should be able to handle most of the work with minimum host support. Therefore, OEMs call for units with processor control of such print functions as horizontal and vertical tabbing, number of lines per inch, form feed, skip of perforation, character sets and interface protocol. Manufacturers are employing the 8080A μP and 8048 and 8049 1-chip μCs, as well as proprietary 8-bit devices designed specifically for printer control, to meet these needs.

Interestingly, though, many system designers consider the matter of implanted intelligence a minor issue: It's easy to find the intelligence you need. However, as you shop for a printer, it's appropriate to inquire about the unit's method of control and determine whether it does indeed fit your requirements.

Graphics/plotting capability proves useful

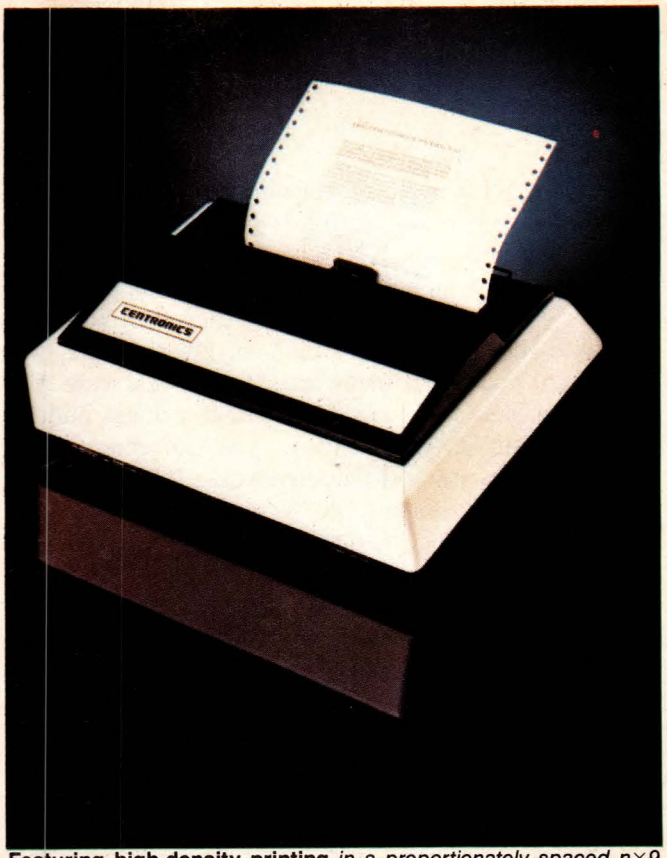
Directly related to a printer's intelligence is its ability to print graphics and perform plotting functions. A PROM-programmed μP controls these functional character sets, interpreting the host's commands and determining which graphics or plotting function to implement.

OEMs are realizing that these functions are important in some applications. However, they don't consider the functions' presence or absence to be the major printer selection factor. Designers of word-processing systems do point out, though, that plotting is beginning to play a more important role, especially in applications requiring the creation of specialized reports. They observe that the incorporation of plotting implies heavy software support, even though printers exhibiting this feature implement it in firmware.

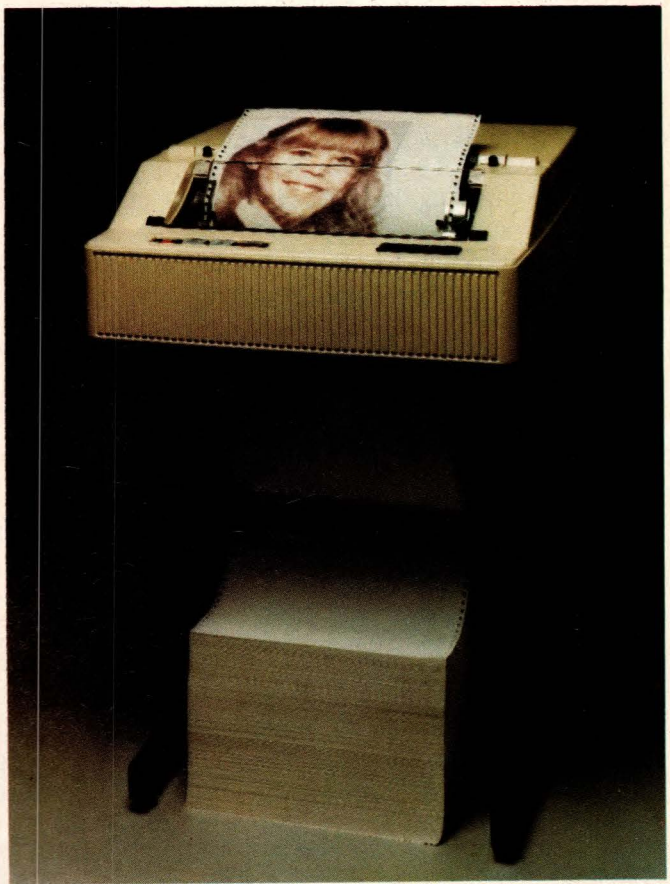
Graphics features appear to be more important to manufacturers and users of personal-computer systems; they consider the ability to print the contents of screens filled with either TRS-80- or Apple-style graphics of prime importance. As a result, manufacturers such as Centronics, Epson and Okidata are incorporating these graphics sets as standard features in their low-end dot-matrix printers.

Graphics isn't necessarily the sole province of hobby printers or dot-matrix designs, though. For example, Qume (in its Sprint Series), Diablo, Dataproducts and NEC all offer graphics options on their fully-formed-character models. But dot-matrix printers seem to be leading the way in graphics. Amperex, for one, offers the Philips Models GP74 and DX486, which support raster-style graphics. And Florida Data's Model BNY produces color graphics with horizontal and vertical resolutions as high as 128 dots/in.

Possibly the manufacturer with the best track record in graphics printers, though, is Hewlett-Packard. Its HP2631G combines the capabilities of a high-performance serial printer with the ability to print raster-data-format graphics with 72×72-dots/in. resolution. The 2631G employs logic-seeking bidirectional printing; one of its dual 256-byte buffers can be filling



Featuring high-density printing *in a proportionately spaced n×9 dot matrix, Centronics's Model 737 measures 14.5×11×5 in. and weighs 12 lbs, making it a possible choice for small desktop systems.*



Featuring a stored-energy print mechanism, *Florida Data's Model BNY dot-matrix printer utilizes a 2-pass 16×16 format and achieves dot-placement accuracy on the order of 0.002 in. It thus depicts graphics with vertical and horizontal resolutions of 128 dots/in.*

Graphics/plotting options can prove useful

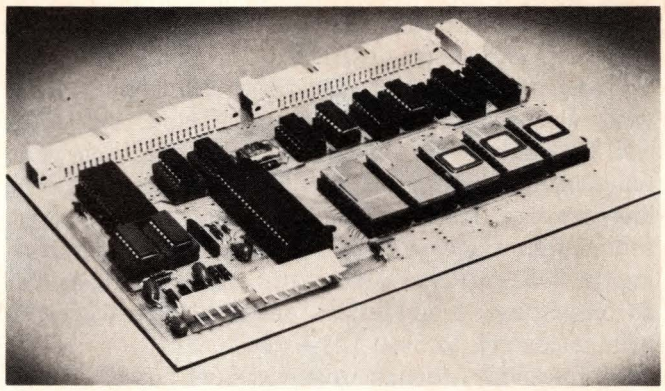
while the other is printing, thus improving throughput. The unit prints a 10×5-in. graphics picture in approximately 50 sec.

If you want graphics and/or plotting functions in a printer, you have several options other than buying a unit with those capabilities built in. For example, you can create your own firmware. But in that case you must take care that you don't defeat critical built-in timing patterns. Alternatively, you can request the vendor to create special firmware to meet your application requirements.

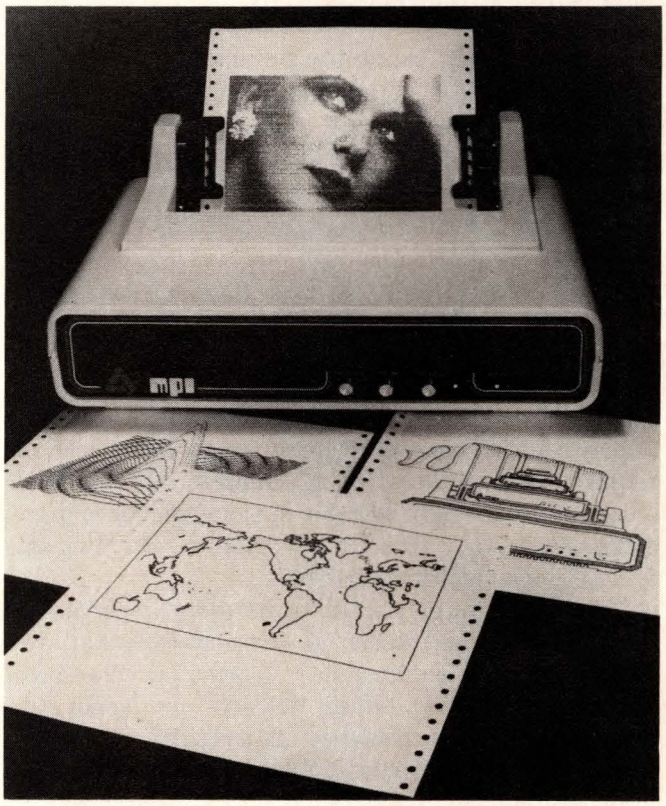
Another possibility is to buy personality cards from a third-party vendor. For example, Wilker Inc (Hayward, CA) offers an RS-232C-interface card designed for daisy-wheel printers. This Z80-based, $700 (1000) Daisy Brain, Model DB200, has a 3k-byte memory and provides line and wrap justification, proportional spacing, centering, graphics/plotting capability, superscript/subscript capability, bold-face and shadow printing, and underlining and overstriking. It also supports data rates as high as 9600 baud, accommodates an X-on/X-off protocol and includes a 2k-byte buffer (expandable to 4k bytes).

Spare parts can prove troublesome

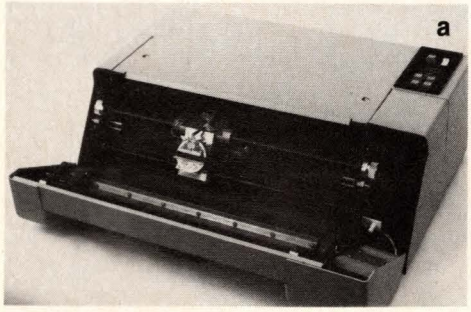
When shopping for a printer, you must also consider how easy it is to obtain spare parts for the unit you choose. Some printer manufacturers admit that salesmen will often advise you to buy an extra printer, from which you can cannibalize parts. They justify this advice by comparing the cost of a complete printer with the cost of spare parts, pointing out that parts are normally marked up by 100 to 150%. You can opt for this method of obtaining spare parts if you want to. But be aware that it's a double-edged proposition. If you purchase one spare printer for every one in the field, you'll not only waste money but will also have to send a bunch of stripped printers back to the manufacturer for refurbishing—a costly procedure.



Providing added value, *Wilker Inc's Daisy Brain DB2000 communicates at up to 9600 baud and is compatible with any host computer or data terminal equipped with an asynchronous RS-232C serial port. The Z80-based interface adds high-resolution graphics and plotting capability to daisy-wheel printers such as the Qume or Diablo units.*



Featuring a high-quality 11×7 serif font *and 80-column output, Micro Peripherals' Model 88G supports a dot-addressable graphics option and sports a low $525 (500) price.*



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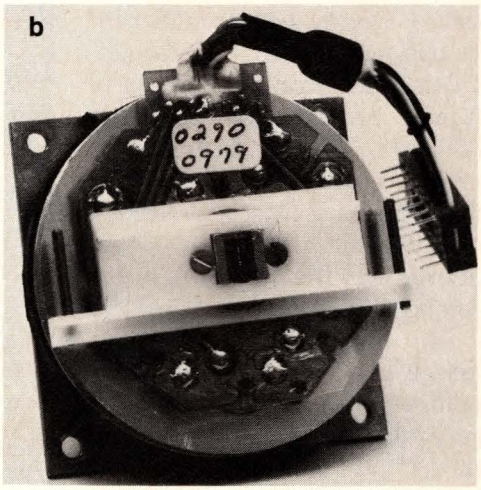

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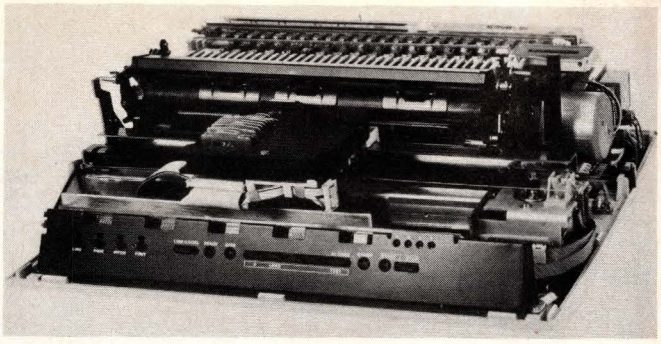
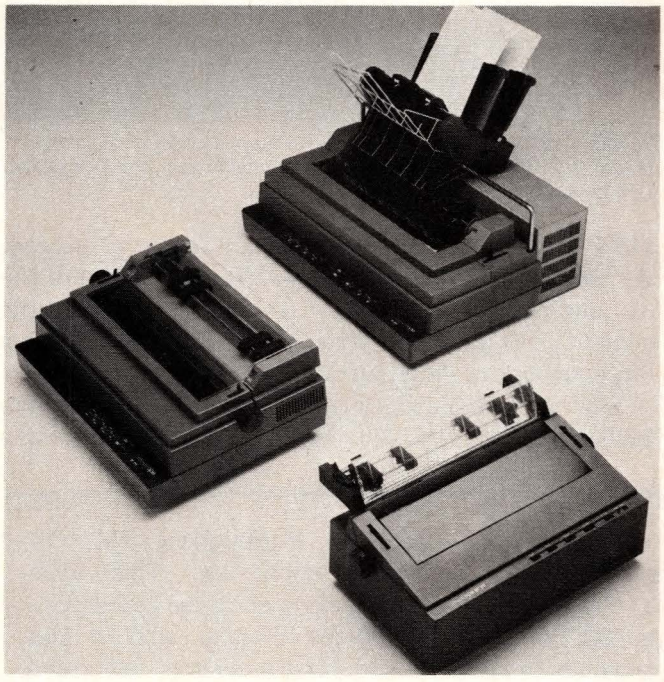
Producing 120 to 216 cps *in 1-pass fonts and 30 to 50 cps in 4-pass fonts, the Sanders Technology Media 12/7* ***(a)*** *utilizes an infinite-matrix principle to achieve the desired print quality. The unit's μP-controlled printhead* ***(b)*** *can produce a variety of print fonts, such as Helvesan (left) and Presentation (right).*



With an 18-wire replaceable printhead, *Amperex Electronics's GP74 generates 9×7, 9×9, 18×25 (1-pass) and 36×50 (2-pass) matrices. It also provides 10-, 12- and 15-cpi pitches.*



Daisy-wheel printers *from Olivetti include Model DY 211 (lower right), which operates at 20 cps. Model DY 311 (left) achieves a peak speed of 38 cps, and Model DY 811 (upper right) outputs 80 cps. Prices range from $1200 to $2600; you can also buy the units in mechanism form.*

Designed as a low-cost ($28) throwaway replacement, *this 9-wire single-column dot-matrix printhead is the heart of Epson's MX-80 tabletop printer.*

Offering such standard features *as 150-cps print speed, 1280-character buffer, 132-column adjustable carriage and the ability to print as many as six copies, Texas Instruments' Omni 820 RO supports applications requiring flexibility as data-processing requirements grow.*

Fortunately, there's a more cost-effective method of obtaining spares. This method involves obtaining the manufacturer's suggested spares list and determining which items on it have the highest failure rate. Then purchase spares of those items, factoring in the number of printers you intend to buy and the leadtime required to obtain parts.

Additionally, even though buying a spare printer for spare parts isn't the most cost-effective method, don't discount the idea entirely. A good approach is to achieve a balanced mix of, say, one spare printer for every 50 in the field, plus a spares inventory that supports approximately 15 to 25% of the printers you buy. You can then use the spare printers either for a swapout or as a source of spare parts for those parts not currently in stock.

A diverse menu of product choices

With all the foregoing considerations in mind, you can go shopping for a printer. And you'll face a wide range of product choices. For example, consider the $2295 (100) Qume dual-head TwinTrack Sprint printers, which employ dual daisy wheels mounted on one carriage. This technique produces print rates as high as 75 cps. Other features include 192-character lines in either 10- or 12-cpi pitch with proportional spacing in increments of 1/120 in., accommodation of forms as wide as 28 in. and vertical spacing in increments of 1/48 in. (up or down), with a slew rate of 4 ips.

NEC Information Systems offers a line of fully-formed-character printers that range in price from $1430 to $2555 (100). This Spinwriter Series achieves print rates between 35 cps (for Model 3500Q) and 55 cps (for Model 5525 KSR), using a thimble print mechanism. Buffer sizes range from 16 to 256 characters, depending on model. Bidirectional printing and fine-line plotting and graphics result from high-resolution positioning of 1/120 in. horizontal and 1/48 in. vertical—5760 plot points per in.[2]

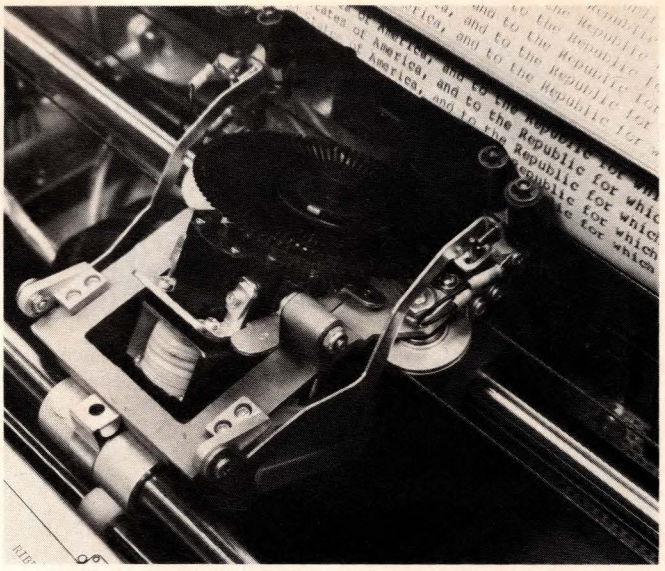
Another fully-formed-character printer is the Data-

Formulate a spares strategy that makes sense for you

products Model D-50. Priced at $1665 (100) for the RO model, it employs a daisy-wheel mechanism. Its parallel interface is compatible with those of both Qume and Diablo printers; a serial RS-232C or 20-mA current loop is also available. The D-50 operates at 50 cps and produces 158 characters/line in 12-cpi-pitch mode or 196 with 15-cpi pitch; modes are software selectable. It achieves 11,520 plot points per in.^{2} with resolutions of 120 positions/in. horizontal and 96 positions/in. vertical. The RO version measures 9×24.25×17.25 in. and weighs 57.5 lbs, allowing it to either fit on a stand or serve in a desktop environment. The unit's maximum noise level is 64 dB measured at 3 ft (see **box,** "Measuring printer noise output").

Dataproducts also serves the dot-matrix-printer market with its M-120 and M-200, priced at $1620 and $1810 (100), respectively. The M-200 employs a dual-column 14-wire dot-matrix head and functions as a bridge between serial impact units and line printers; it achieves a respectable 340-cps bidirectional print rate.

Perhaps the top-of-the-line dot-matrix printer for medium-duty-cycle (approximately 25%) applications, Texas Instruments' Model 810 costs approximately



To minimize downtime *caused by carriage jamming, Dataproducts' Model D-50 KSR daisy-wheel carriage mechanism employs sealed journal bearings that require no lubrication.*

$1500 and employs a single-column 7-wire printhead. Its maximum print rate equals 150 cps. Although the 810 doesn't employ any new technology, it offers the advantage of a proven, widely used design for which a large amount of data exists.

Another notable dot-matrix printer is Infoscribe's $910 (1000) Model 1000. Employing a single-column

The "bare-bones" alternative

Should you consider buying a printer mechanism rather than a complete printer? Unless you have extensive design resources, the answer is no: The required digital control circuitry and analog circuits (drivers for the head and steppers, speed-regulation servo loops, etc) can prove difficult to design.

Still, some designers choose this option. The experiences of Cado Systems (Torrance, CA) and Vector Graphic (Westlake Village, CA) prove enlightening in this regard.

Cado elected to vertically integrate its product line and was concerned that it couldn't find a printer to meet its needs. Consequently, the firm developed its own dot-matrix printer. It buys the basic print mechanism and adds value in the form of software and associated electronics.

Vector Graphic, on the other hand, developed a dot-matrix printer primarily to support its in-house software development. This unit has a 7-wire print mechanism, prints 32 to 132 columns at 10 cpi and outputs 150 cps. Power and intelligence result from a parallel connection to the host bus. Chairman Robert Harp points out that although the design has met with reasonable success, it is not a cost-effective way of doing business. He considers buying a complete unit the more reasonable approach.

Centronics product manager Cyril Colbert takes a somewhat different view. He claims OEMs want a print mechanism, carriage and analog electronics and prefer to add value in the controller and formatter. This approach permits designers to create printers geared specifically to their needs.

Manufacturers such as C Itoh, Burroughs OEM Products, Teletype, Florida Data, Okidata, Olivetti and Victor Data offer a wide range of subsystems to serve those needs. For example, consider Burroughs's PM 114 printer mechanism. This $394 (100) device achieves bidirectional 90-cps printing with a $58 9-wire single-column printhead that creates a 7×9 font. It accommodates continuous forms, roll paper or cut forms and incorporates analog drivers for the head, steppers and speed regulation.

If your design centers on data-logging or instrument applications, consider the mechanisms offered by such manufacturers as Hycom or Eaton LRC. For example, Hycom's $101 (1000) Model DC-2106D uses an 8-wire nonimpact (electrostatic) printhead and prints on aluminized paper.

Eaton LRC's M-4 Series dot-matrix mechanisms, on the other hand, print on low-cost 40-column cash-register type paper. The units incorporate a 7-wire single-column printhead that provides a 5×7 format and generates 120 cps bidirectionally. They accommodate either spool or ribbon cartridges and are priced as low

Measuring printer noise output

How much printer noise can your application tolerate? When does noise become distracting or even harmful?

Regardless of print technology, impact printers typically exhibit noise figures ranging from 50 dBa to as high as 75 dBa (measured at 3 ft). The worst offenders are dot-matrix units, primarily because their heads make a buzzing sound.

Some manufacturers feel that printer noise level is reducible to less than 40 dBa. But until they achieve such noise reduction, you can deal with excessive noise by adding acoustic covers that you purchase separately or construct yourself. Alternatively, you can seek options such as that offered by Lear Siegler for the Model 310 Ballistic printer: A plexiglass cover with polyurethane foam padding reduces noise level from 71 to 55 dB.

9-wire head and a 9×9 font, it prints at 180 cps and incorporates a 1k-byte buffer, expandable to 4k.

And displaying a noteworthy difference in dot-matrix-printhead philosophy, Victor Data Products' $725 (1000) Model 5080 data terminal uses a 7-wire solenoid-controlled print mechanism rather than a ballistic-type design. Director of marketing Ted Singer points out that with this older technology, the firm achieves a life expectancy of 100M characters. And you can rebuild the $70 head. Other features of Model 5080 include 100-cps print rate, graphics capability and compatibility with Hewlett-Packard's HP-IB interface.

The Japanese are entering the dot-matrix realm in a big way, as evidenced by such printers as Epson's $355 (500) MX-80 and $359 (100) MX-70. The latter model produces 40- to 80-character column widths and prints 80 cps. It uses the "throwaway" head employed in the MX-80. C Itoh, another Japanese firm, has targeted both the dot-matrix and fully-formed-character markets. The firm's Starwriter II 45-cps daisy-wheel printer and Comet II 136-column dot-matrix printer each cost less than $1300 in OEM quantities.

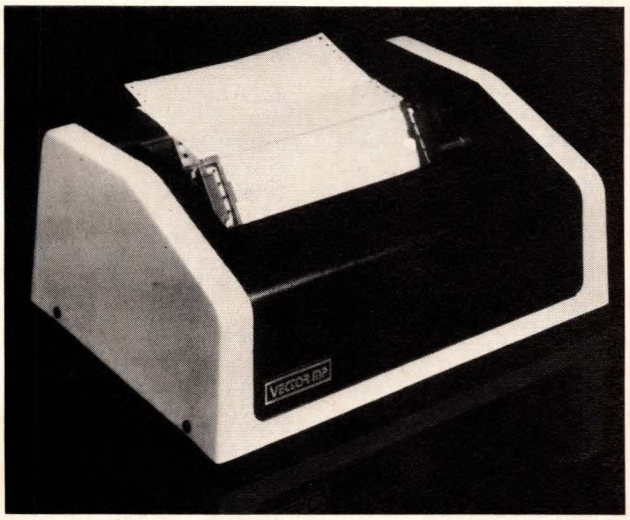
Another recent entry into the OEM-printer market is Olivetti Peripheral Equipment's Model DM 80/180, a dot-matrix design employing a 16-pin printhead arranged in two 8-wire rows. This $2500 (500) unit produces 180 cps with an 8×7 matrix and 80 cps with a high-definition 16×32 matrix. It develops the equivalent of fully formed characters on one pass in the high-density mode.

Furthermore, to provide true fully formed characters, Olivetti also offers three versions of a daisy-wheel unit. The $1200 Model DY 211 outputs 20 cps and allows 10-, 12- and 15-cpi pitches, plus proportional spacing. The $1600 Model DY 311, on the other hand, offers as $100 (500).

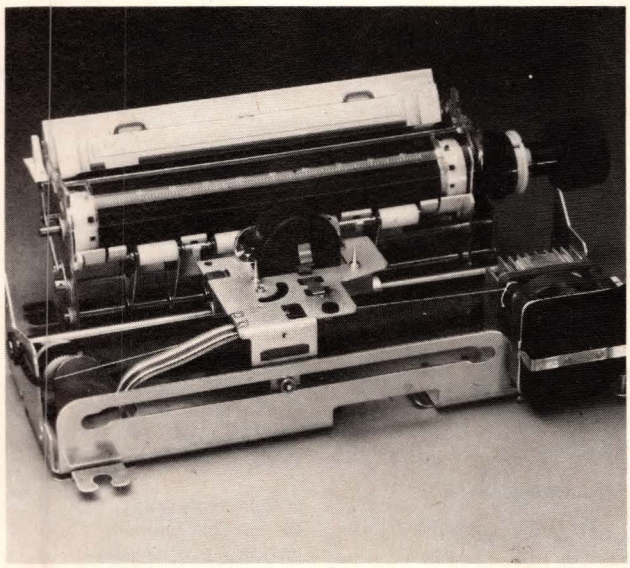
Faced with these product options, how can you decide whether to build, buy or add value when designing a printer system? Consider four key factors:

- Cost
- Your design expertise
- Your ability to service what you design
- The ease with which you can vertically integrate an internally designed printer into your present operation.

Although carefully evaluating all of these factors will probably prevent your making a costly mistake, consultant Andrew Roman (Newark, CA) offers some bottom-line advice: "Determine what the cost will be, now and later. There is really only one bottom-line decision factor—cost."



You can build your own printer, *as Vector Graphic did. Model MP interfaces only to the manufacturer's system via the firm's Bitstreamer II parallel-interface card. Power and logic come from the host processor, providing a high degree of printer control at the expense of high host overhead.*



For $394 (100), *you can buy this Burroughs OEM ballistic-head printer mechanism and build your own printer. The unit produces 132-character columns on 9½-in. paper at 90 cps max.*

Multiple printheads up speed but raise quality questions

print rates ranging from 32 to 38 cps, and the $2600 Model DY 811 produces 65 to 80 cps. All three units have optional forms tractors and automatic sheet feeders. And to cover all the bases, Olivetti also furnishes the DY 211 and DY 311 as print mechanisms only, with and without driving electronics (see **box,** "The "bare-bones" alternative").

New technology spurs new designs

Some interesting technology innovations are available in today's serial impact printers—in both the fully-formed-character and dot-matrix realms. For example, consider the Pertec Stylist. This daisy-wheel

Manufacturers of serial impact printers

For more information on dot-matrix or fully-formed-character serial impact printers, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service card.

Addmaster Corp
416 Junipero Serra Dr
San Gabriel, CA 91776
(213) 285-1121
Circle No 370

Amperex Electronics Corp
230 Duffy Ave
Hicksville, NY 11802
(516) 931-6200
Circle No 371

Anadex Instruments Inc
9825 DeSoto Ave
Chatsworth, CA 91311
(213) 998-8010
Circle No 372

Anderson Jacobson Inc
521 Charcot Ave
San Jose, CA 91202
(408) 263-8520
Circle No 373

Axiom Corp
5932 San Fernando Rd
Glendale, CA 91202
(213) 245-9244
Circle No 374

Bowmar Instruments
4640 126th Ave North
Clearwater, FL 33520
(813) 576-2525
Circle No 375

Burroughs OEM Marketing
Burroughs Pl
Detroit, MI 48232
(313) 972-8031
Circle No 376

Centronics Data Computer Corp
Hudson, NH 03051
(603) 883-0111
Circle No 377

Clary Corp
320 W Clary Ave
San Gabriel, CA 91776
(213) 287-6111
Circle No 378

Computer Devices Inc
25 North Ave
Burlington, MA 01803
(617) 273-1550
Circle No 379

Computer Transceiver Systems Inc
E 66th Midland Ave
Paramus, NJ 07652
(201) 261-6800
Circle No 380

Control Data Corp
1480 N Rochester Rd
Rochester, MI 48063
(313) 651-8810
Circle No 381

Data Equipment Inc
238 E Caribbean Dr
Sunnyvale, CA 94086
(408) 734-5610
Circle No 382

Data General Corp
4400 Computer Dr
Westboro, MA 01581
(617) 366-8911
Circle No 383

Data Machines International
Terrace Hill
Ithaca, NY 14850
(607) 273-1515
Circle No 384

Data Royal Inc
235 Main Dunstable Rd
Nashua, NH 03060
(603) 883-4147
Circle No 389

Data Terminals and Communications
590 Division
Campbell, CA 95008
(408) 378-1112
Circle No 385

Data Test Corp
3200 Coronado Dr
Santa Clara, CA 95051
(408) 496-0400
Circle No 386

Datadyne Corp
960 Rittenhouse Rd
Norristown, PA 19403
(215) 666-5751
Circle No 387

Dataproducts Corp
6219 DeSoto Ave
Woodland Hills, CA 91364
(213) 887-8000
Circle No 388

Datel Systems Inc
11 Cabot Blvd
Mansfield, MA 02048
(617) 339-9341
Circle No 390

Decision Data Corp
100 Witmer Blvd
Horsham, PA 19044
(215) 674-3300
Circle No 391

Diablo Systems
24500 Industrial Blvd
Hayward, CA 94545
(415) 786-5000
Circle No 392

Diamond Engineering
3635 150th St Northeast
Redmond, WA 98052
(206) 883-1071
Circle No 393

Di/An Controls Inc
944 Dorchester Ave
Boston, MA 02125
(617) 288-7700
Circle No 394

Digital Associates
1039 E Main St
Stamford, CT 06902
(203) 327-9210
Circle No 395

Digital Equipment Corp
129 Parker St
Maynard, MA 01754
(617) 493-2268
Circle No 396

Digitec
918 Woodley Rd
Dayton, OH 45403
(513) 254-6251
Circle No 397

Documation Inc
Box 1240
Melbourne, FL 32901
(800) 327-6422
Circle No 398

Epson America Inc
23844 Hawthorne Blvd
Torrance, CA 90505
(213) 378-2220
Circle No 399

Expandor Inc
400 Saint Claire Plaza
Pittsburgh, PA 15241
(412) 746-2910
Circle No 400

Facit Inc
66 Field Point Rd
Greenwich, CT 06830
(203) 622-9150
Circle No 401

Florida Data Corp
3308 New Haven Ave
West Melbourne, FL 32901
(305) 724-6088
Circle No 402

General Electric Corp
General Electric Dr
Waynesboro, VA 22980
(703) 949-1000
Circle No 403

Gould Inc
3631 Perkins Ave
Cleveland, OH 44114
(216) 361-3315
Circle No 404

Gulton Industries
Gulton Industrial Park
East Greenwich, RI 02818
(401) 884-6800
Circle No 405

Hecon Corp
31-45 Park Rd
Tinton Falls, NJ 07724
(201) 542-9200
Circle No 406

Hewlett-Packard Co
1507 Page Mill Rd
Palo Alto, CA 94304
Phone local office
Circle No 407

Hycom Inc
16841 Armstrong Ave
Irvine, CA 92795
(714) 557-5252
Circle No 408

IBM Corp
1000 Westchester Ave
White Plains, NY 10604
(914) 696-6010
Circle No 409

printer, manufactured by Triumph-Adler of West Germany, is compatible with the Adler and Royal typewriters—a feature that allows you to obtain supplies or spare parts from local typewriter dealers. The unit's 17-cps print rate is the penalty you pay along with the $730 (1000) price. A sound-baffling design in the Stylist keeps noise levels below 62 dBa.

In the dot-matrix arena, manufacturers are using multiple printheads to improve throughput and character quality. The method combines a low-resolution head with a high-resolution one: for example, a 7-wire unit with a 14- or 24-wire assembly. Other manufacturers are applying the same techniques to multipass printers: The first head creates the character, while the second overstrikes it with a half-dot offset. (Questions remain regarding this technique's viability, though; it appears that the method requires stopping the head each time to ensure precise dot registration. Thus, what you gain

Inforex Inc
186 Middlesex Tpke
Burlington, MA 01803
(617) 272-6470
Circle No 410

Infoscribe Inc
2730 S Harbor Blvd, Unit G
Santa Ana, CA 92704
(714) 641-9084
Circle No 411

Integral Data Systems
Rte 13 South
Milford, NH 03055
(603) 673-9100
Circle No 412

C Itoh Electronics
5301 Beethoven St
Los Angeles, CA 90066
(213) 390-7778
Circle No 413

Lear Siegler Inc
714 N Brookhurst St
Anaheim, CA 92803
(714) 774-1010
Circle No 414

Litton Datalog
1770 Walt Whitman Rd
Melville, NY 11746
(516) 694-8300
Circle No 415

LogAbax Inc
10889 Wilshire Blvd
Los Angeles, CA 90024
(213) 477-0494
Circle No 416

LRC Inc
Technical Industrial Park
Riverton, WY 82501
(307) 856-4821
Circle No 417

Malibu Electronics
2301 Townsgate Rd
Westlake Village, CA 91361
(805) 496-1990
Circle No 418

Mannesmann Tally Corp
8301 S 180th St
Kent, WA 98031
(206) 251-5500
Circle No 419

Memorex
3015 Daimler St
Santa Ana, CA 92705
(800) 854-3111
Circle No 420

MFE Corp
Keewaydin Dr
Salem, NH 03079
(603) 893-1921
Circle No 421

Micro Peripherals Inc
2099 West 2200 South
Salt Lake City, UT 84119
(801) 973-6053
Circle No 422

Miltope Corp
9 Fairchild Ave
Plainview, NY 11803
(516) 349-9500
Circle No 423

Mitsubishi Electronics Inc
2200 W Artesia Blvd
Compton, CA 90220
(213) 979-6055
Circle No 424

NEC Information Systems Inc
5 Militia Dr
Lexington, MA 02173
(617) 862-3120
Circle No 425

Northern Data Com
30 Plan Way
Warwick, RI 02886
(401) 738-9500
Circle No 426

Okidata Corp
111 Gaither Dr
Mt Laurel, NJ 08054
(609) 235-2600
Circle No 427

Olivetti Peripheral Equipment
525 Executive Blvd
Elmsford, NY 10523
(914) 592-2864
Circle No 428

Panasonic Electronic Components
1 Panasonic Way
Secaucus, NJ 07094
(201) 348-7269
Circle No 429

Perkin Elmer Corp
360 Rte 206 South
Flanders, NJ 07836
(201) 584-1400
Circle No 430

Pertec Computer Corp
12910 Culver Blvd
Los Angeles, CA 90066
(213) 822-9222
Circle No 434

Plessey Peripheral Systems
17466 Daimler St
Irvine, CA 92714
(714) 540-9945
Circle No 431

Potter Instrument Co Inc
10 Main St
Gonic, NH 03867
(603) 332-1991
Circle No 432

Practical Automation
Trap Falls Rd
Shelton, CT 06484
(203) 929-5381
Circle No 433

Printronix
16702 Von Karman Ave
Irvine, CA 92713
(714) 549-7700
Circle No 435

Qantex
60 Plant Ave
Hauppauge, NY 11787
(516) 582-6060
Circle No 436

Qume Corp
Box 50039
San Jose, CA 95150
(408) 942-4000
Circle No 437

Rochester Data
3100 Monroe Ave
Rochester, NY 14618
(716) 385-4336
Circle No 438

SCI Systems Inc
Box 1000
Huntsville, AL 35807
(205) 882-4360
Circle No 439

Sanders Technology Systems
Box 1226
Nashua, NH 03061
(603) 882-1000
Circle No 440

SCM/Kleinschmidt
Lake Cook Rd
Deerfield, IL 60015
(312) 945-1000
Circle No 441

Siemens Corp
186 Wood Ave South
Iselin, NJ 08830
(201) 494-1000
Circle No 442

Star Micronics Inc
200 Park Ave, Suite 208
New York, NY 10017
(212) 986-6770
Circle No 443

System Industries
525 Oakmead Parkway
Sunnyvale, CA 94086
(408) 732-1650
Circle No 444

Teac Corp of America
7733 Telegraph Rd
Montebello, CA 90640
(213) 726-8417
Circle No 445

Teletype Corp
5555 W Touhy Ave
Skokie, IL 60077
(312) 982-2000
Circle No 446

Telex Corp
6422 E 41st St
Tulsa, OK 74135
(918) 627-1111
Circle No 447

Telpar Inc
4132 Billy Mitchell Rd
Addison, TX 75001
(214) 233-6631
Circle No 448

Texas Instruments Inc
Box 1444
Houston, TX 77001
(713) 937-2000
Circle No 449

Trilog Inc
17391 Murphy Ave
Irvine, CA 92714
(714) 549-4079
Circle No 366

True Data Corp
17092 Pullman St
Irvine, CA 92714
(714) 979-4842
Circle No 367

Versatec Inc
2805 Bowers Ave
Santa Clara, CA 95051
(408) 988-2800
Circle No 368

Victor Data Products
3900 N Rockwell Ave
Chicago, IL 60618
(312) 539-8200
Circle No 369

Multipass printing calls for precise timing

in throughput on one end, you might lose on the other.)

The idea of multipass dot-matrix printing isn't new, but it hasn't been fully accepted, primarily because of mechanical problems associated with the design. Even though the technique's reliability currently is low, though, Dataproducts' Ron Morley cautions that you shouldn't write it off. He and others think that multiple-pass printing will eventually come into its own as printer manufacturers experience greater demand for high throughput and better quality. However, Dale Edwards, Lear Siegler's director of printer engineering, expects 1-column-printhead, 1-pass dot-matrix units to remain the high flyers for a long time. (Edwards admits he's biased, though: Lear Siegler's $1545 (1000) Model 310 Ballistic printer employs a 1-column, 9-wire, single-pass mechanism.)

Sanders Technology has led the way in multipass printing. The firm's Media 12/7, priced at $3995, is available with OEM discounts ranging from 38 to 40%, depending on quantity. It achieves print rates as high as 200 cps, depending on which of 100 fonts you choose. The printer's real selling point, though, is its print quality: As many as eight passes create the equivalent of a fully-formed-character printer's output. However, this quality is not without costs in system throughput, duty-cycle penalty and print-mechanism wear. And printer timing and registration are extremely critical; the firm compensates for the latter factor with a pin-fire PROM, keyed to each printhead, whose firmware takes into account the head's characteristics. (Thus, when you replace a head, you change the pin-fire PROM—adding to the printer's cost of operation.)

What's in store?

With at least 79 manufacturers offering serial impact printers, you'll have your hands full in making a selection, even if you're well prepared. And don't expect the decision-making process to get easier.

Complicating the process will be the use of specialized nonimpact printheads, such as R-Ohm's (Irvine, CA) thermal Model KG106. This head provides 203-dots/in. resolution, permitting the creation of very dense printing for graphics and facsimile applications.

Look, too, for decreases in printer size. And also expect to see even more emphasis on noise reduction with the introduction of tighter enclosures and less noisy print mechanisms.

However, don't expect to see any further major price reductions. Microdata peripherals VP Leonard Bleininger, for one, believes that pricing will stay fairly stable, even though more features will be available. **EDN**

Article Interest Quotient (Circle One)
***High* 473 *Medium* 474 *Low* 475**

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Programmable memories make product redesign easy

The latest programmable-memory introductions reflect advances to higher speed devices. But speed isn't the only improvement; new device types and options can aid your designs, too.

George D Huffman, Associate Editor

1980 was a good year for designers who must often change their minds—and thus their systems' memories. Three years before 1984 arrives, they can easily exercise Big Brother-like control—but on men's machines rather than their minds—thanks to the latest reprogrammable memories.

Nearly every semiconductor house regularly announces new erasable programmable memories (EPROMs) and their one-time-only fuse-link-programmable counterparts (PROMs). And as expected, EPROMs have continued their trend toward higher densities. Small-capacity memory users haven't been forgotten, though. In fact, two new low-capacity categories appear in this year's Programmable-Memory Directory: one headed by Motorola's MCM2801 (a 256-bit (16×16) word-alterable, electrically erasable (EEPROM) device), the other by General Instrument's ER4201 (an electrically alterable unit (EAROM) in the 1024-bit (128×8) class).

(Because EEPROMs and EAROMs are evolving so rapidly, EDN explores the newest of the devices and their future in detail on pg 57 of this issue, as well as listing them in this Programmable-Memory Directory. Also note that several devices listed in each category last year don't appear in this year's update.)

Shining some light on PROMs

Ultraviolet-erasable programmable memories (UV EPROMs) still account for the majority of new entrants in the directory. The density growth characterizing these parts is especially obvious in 32k-bit EPROMs. In addition to new second sources for the popular 2732, you'll find some interesting options for this device. For example, whereas many of the 2732-type devices listed in last year's tabulation didn't offer a Power Down mode, all of this year's additions do. Providing a 3:1 or 6:1 reduction in power-supply loading, that's a welcome option.

Perhaps more interesting is National Semiconductor's contribution to UV EPROMs. The firm's standard version, the NMC27H32, employs NMOS technology. But unlike most other manufacturers' NMOS devices, its maximum access time is a very short 200 nsec—apparently achieved without special selection. The next-fastest units are Intel's HMOS 2732A and Texas Instruments' NMOS TMS2532-35, both of which spec 250 nsec max.

If speed isn't your prime concern and power-supply loading is, consider CMOS devices. National's CMOS UV EPROMs work more slowly than the firm's NMOS type by approximately a factor of two, but they aren't any slower than some other manufacturers' slowest NMOS units. And after all, when power consumption is critical, you must trade off a little speed. The CMOS devices require only 50 mW/MHz in Power Up mode (compared with the 750 to 850 mW required by NMOS) and a miniscule 125 μW in standby operation. In addition to providing these same CMOS-derived features in a 16-bit (2716) line, National plans to offer an NMOS-EEPROM version of the 2716 late this year.

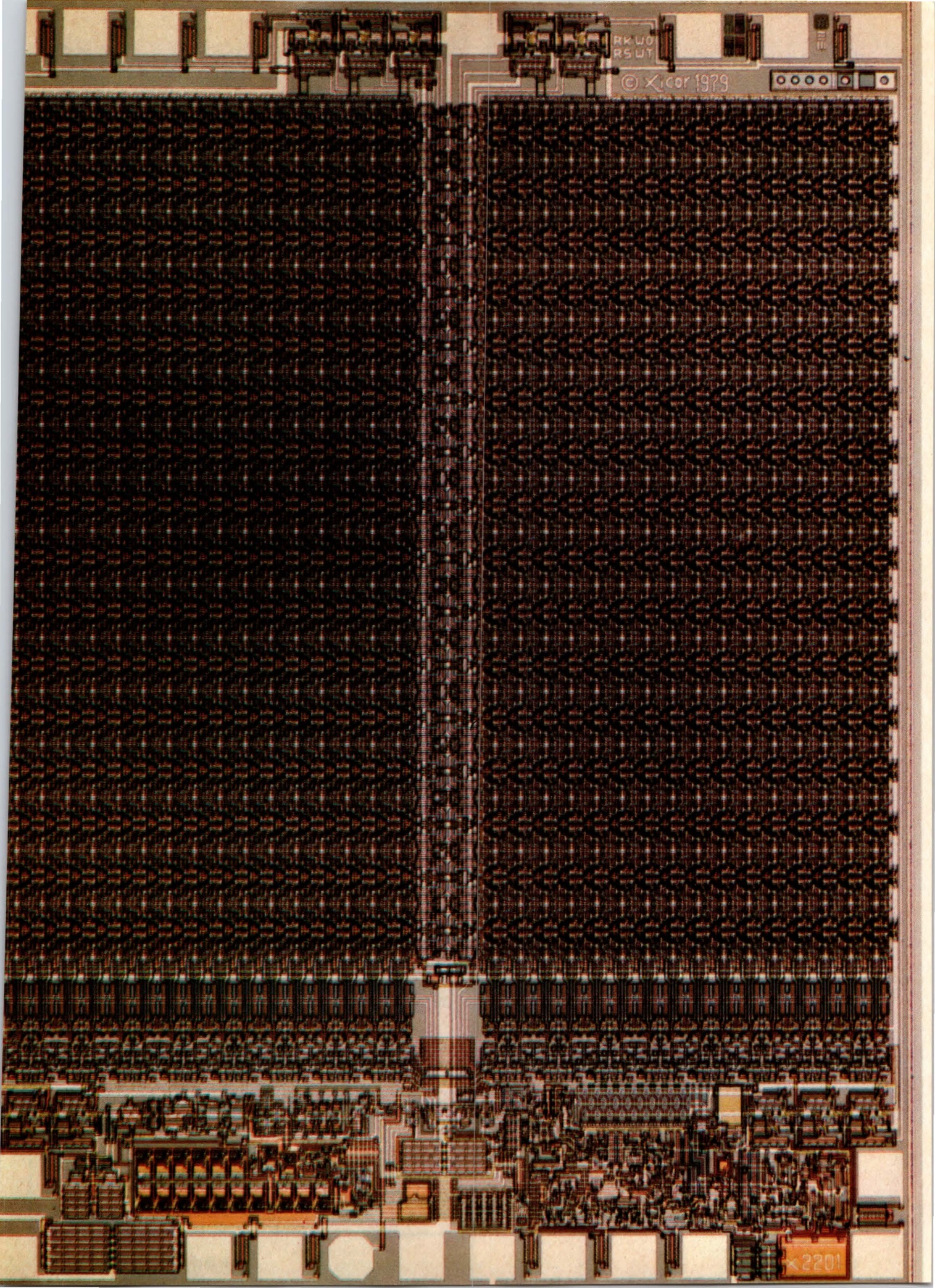
As last year's directory anticipated, Intel has reached the 200-nsec speed barrier with the 64k-bit 2764-2 by employing an enhanced NMOS process, HMOS-II. And Motorola also expects great things from the HMOS process.

A look at the nearby **figure** shows what the firm is striving for in its near-future-planned memory products. If all goes according to plan, you can look for a fast 64k EPROM very soon and a very fast 128k device late this year or early in 1982.

Motorola's plans for packaging the 128k device haven't been revealed—if they've been finalized at all. Caught in the 24-vs-28-pin debate, the company has opted for 24 pins, while TI and Intel have adopted two different 28-pin configurations. (National, leaving nothing to chance, offers its devices in both TI's and Intel's configurations.)

But what about the problem of having only 24 pins to work with? At 32k-bit densities, 24 pins still work well

An effectively nonvolatile RAM *results when an EEPROM backs up a RAM. The device's host computer uses the RAM portion under normal operating conditions, but if a crash is imminent, the EEPROM stores the RAM's contents. A 5V-only part, Xicor's X2201 RAM/EEPROM stores 1k bits.*


RK WO
RS WT
© Xicor 1979
X2201

CMOS UV EPROMs challenge NMOS units in speed

enough; at 64k-bit levels, however, things become a bit crowded and some function MUXing proves necessary. And at 128k densities, 28-pin packages appear mandatory, especially if you want such niceties as output enable—a neat way of solving potential bus-contention problems—and a separate programming-pulse input. Only time and market pressure will resolve the 24-pin controversy, but at least Motorola's approach is coherent; the company's 24-pin 64k EPROM functionally resembles the TI device and plugs into the lower 24 pins of the 28-pin TI socket.

Additionally, Motorola always backs up any EPROM device with a directly compatible masked ROM. But keep in mind that because manufacturers' ROMs usually operate more rapidly than their EPROMs, you can't achieve the fastest possible data-throughput rate until the ROM replaces the EPROM in your system's final version. And don't forget the cost involved in substituting EPROM for ROM; it's not unusual for a UV EPROM to cost four to six times as much as the ROM you'll probably use in the end. Ease of design change has its price.

PROMs: the one-time-only memory

Unlike the various erasable and reprogrammable memories discussed so far, fuse-link-programmable (PROM) devices must be written correctly on the first try. (Actually, the remote possibility exists that some desired reprogramming might only entail blowing additional links.) And unlike masked ROMs or E-PROMs, PROMs are really fast; maximum access times in the 50- to 80-nsec range aren't unusual. The fuse technology used could be the limiting speed factor, however—a point speculated on by several manufacturers interviewed for last year's directory. In general, though, this year's device specs bear out last year's expectations: Titanium-tungsten (Ti-W) links do appear to permit faster memory operation, probably because of their lower inherent capacitance.

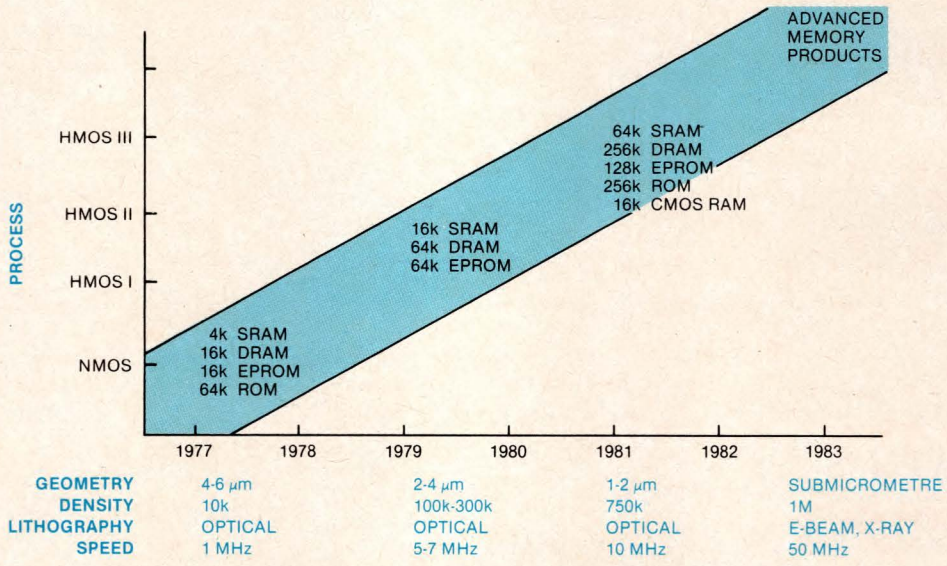
As was anticipated, little PROM-product activity has occurred at capacities above 16k. Last year's tabulation showed no products in the 32k class; this year's lists two. And in the 64k-PROM slot, only Harris has announced an entry, expected to become available in the third quarter.

The 8k and 16k PROM categories have received the most attention. Not only have more "no-frills" devices become available, but you can also obtain many of these basic types with assorted options. Power-down, low-operating-power and on-chip-register versions are appearing in greater numbers. Additionally, some of these enhanced devices come in 300-mil packages.

Tradeoffs among the options exist, too. In general, the low-power versions are the slowest but require only half as much operating power as other parts; power-down types fall into the middle speed range but still stand by at very low power levels. The on-chip-register versions, such as TI's 4k TBP28R45, spec an impressively short typical access time of 20 nsec. This figure could represent only the register's access time and not that of the PROM itself, however. If that is the case, the unit's actual overall access time could easily be longer than that of the apparently slower power-down type. The directory-update information provided by TI didn't clarify this point.

A guess about price and availability

When it comes to anticipating programmable-memory prices and availability, your guess is probably



By combining HMOS processing with fine-line geometries, *Motorola can provide a wide range of memory products for the foreseeable future. A 64k UV EPROM is already available, and within a year, a 128k EPROM could appear.*

Manufacturers of programmable read-only memories

For more information on PROMs, UV EPROMs, EAROMs or EEPROMs, circle the appropriate numbers on the Information Retrieval Service card or contact the following manufacturers directly.

Advanced Micro Devices
901 Thompson Pl
Sunnyvale, CA 94086
(408) 732-2400
Circle No 336

American Microsystems Inc
3800 Homestead Rd
Santa Clara, CA 95051
(408) 246-0330
Circle No 337

Electronic Arrays
550 E Middlefield Rd
Mt View, CA 94043
(415) 964-4321
Circle No 338

Fairchild Semiconductor
464 Ellis St
Mt View, CA 94042
(415) 962-5011
Circle No 339

Fujitsu Microelectronics Inc
2945 Oakmead Village Ct
Santa Clara, CA 95051
(408) 729-1700
Circle No 340

General Instrument Corp
Microelectronics Div
600 W John St
Hicksville, NY 11802
(516) 733-3000
Circle No 341

Harris Semiconductor
Box 883
Melbourne, FL 32901
(305) 724-7407
Circle No 342

Hitachi America Ltd
1800 Bering Dr
San Jose, CA 95112
(408) 292-6404
Circle No 343

Hughes Aircraft Co
Solid State Products Div
500 Superior Ave
Newport Beach, CA 92663
(714) 759-2411
Circle No 344

Intel Corp
3065 Bowers Ave
Santa Clara, CA 95051
(408) 987-8080
Circle No 345

Intersil Inc
10710 N Tantau Ave
Cupertino, CA 95014
(408) 996-5000
Circle No 346

Mitsubishi/Melco
3030 E Victoria St
Compton, CA 90221
(213) 537-7131
Circle No 347

Monolithic Memories Inc
1165 E Arques Ave
Sunnyvale, CA 94086
(408) 739-3535
Circle No 348

Mostek Corp
1215 W Crosby Dr
Carrollton, TX 75006
(214) 242-0444
Circle No 349

Motorola Inc
Integrated Circuit Div
3501 Ed Bluestein Blvd
Austin, TX 78721
(512) 928-6000
Circle No 350

National Semiconductor Corp
2900 Semiconductor Dr
Santa Clara, CA 95051
(408) 737-5000
Circle No 351

NEC Microcomputers Inc
173 Worcester St
Wellesley, MA 02181
(617) 239-1910
Circle No 352

Nitron Inc
10420 Bubb Rd
Cupertino, CA 95014
(408) 255-7550
Circle No 353

Oki Semiconductor
Suite 405
Santa Clara, CA 95051
(408) 984-4842
Circle No 354

Panasonic
1 Panasonic Way
Secaucus, NJ 07094
(201) 348-7276
Circle No 355

Plessey Semiconductors
1641 Kaiser Ave
Irvine, CA 92714
(714) 540-9979
Circle No 356

Raytheon Semiconductor
350 Ellis St
Mt View, CA 94042
(415) 968-9211
Circle No 357

RCA Solid State Div
Rte 202
Somerville, NJ 08876
(201) 685-6000
Circle No 358

SGS-ATES Semiconductor Corp
240 Bear Hill Rd
Waltham, MA 02154
(617) 890-6688
Circle No 359

Signetics Corp
811 E Arques Ave
Sunnyvale, CA 94086
(408) 739-7000
Circle No 360

Synertek
Box 552
Santa Clara, CA 95051
(408) 988-5611
Circle No 361

Texas Instruments Inc
Box 225012, M/S 308
Dallas, TX 75265
Circle No 362

Toshiba America Inc
2151 Michelson Dr
Suite 190
Irvine, CA 92715
(714) 955-1155
Circle No 363

Xicor Inc
1221 Innsbruck Dr
Sunnyvale, CA 94086
(408) 734-3041
Circle No 364

Zilog
10460 Bubb Rd
Sunnyvale, CA 94086
(408) 446-4666
Circle No 365

as good as anybody else's.

When you compare this year's availability data with last year's, you'll notice that some of last year's announced products are still pending. In several cases, manufacturers have retracted devices; they're no longer available—if, indeed, they ever were. But if the directory still lists a device and the Availability column is blank, it's probably safe to assume the device exists—at least in some quantity. On the other hand, a newly listed device not accompanied by specific delivery data could mean one of two things: It exists now in quantity, or it doesn't exist at all and the manufacturer can't or won't say when it will.

Once you ascertain whether a device exists, the next trick is to obtain its firm selling price. But don't ask until you're ready to buy; price slashing in the memory marketplace—especially among EPROMs, it seems—is rampant. A Japanese firm's US-based semiconductor house, for example, recently announced price cuts spanning 45 to 65% for its 1k×8 and 2k×8 EPROMs. And if you negotiate a bit, you can probably reach an even lower price. Unlike last year, manufacturers are reluctant to project "very little change in the pricing structure."

A year from now, when we next update this directory, you'll certainly find faster EPROMs listed. Not only will manufacturers further fine-tune the NMOS and HMOS processes, it's entirely possible they will tune CMOS-based memories so finely that the CMOS parts will become as fast as this year's NMOS units. But regardless of what happens in the access-time race, this year's optional features—power-down, low-power and various chip-select/enable functions—will likely become standard features. Improvements in both EEPROMs and EAROMs also seem inevitable—developments that will probably prompt manufacturers to develop fewer UV EPROMs. **EDN**

Tables begin on pg 110

Article Interest Quotient (Circle One)
***High* 476 *Medium* 477 *Low* 478**

EDN

UV-ERASABLE, ELECTRICALLY ALTERABLE AND ELECTRICALLY ERASABLE MEMORIES

DENSITY (BITS)	ORGANIZATION (BITS)	TECHNOLOGY ①	PART NUMBER		OUTPUT CONFIGURATION		NO OF PINS	MAX ACCESS TIME (NSEC) ②
			COMM	MIL	3-STATE	OTHER		
256	16 × 16	NMOS	MCM2801		●		16	10 μSEC (FIRST BIT)
336	21 × 16	MNOS	NC7033			ACTIVE PUSH-PULL	8	10 μSEC (FIRST BIT)
512	36 × 16	MNOS	NC7051		●		28	4 μSEC
		MNOS	ER2051	ER2051HR	●		28	1 μSEC/2 μSEC (HR)
	64 × 8	MNOS	NC7055		●		22	4 μSEC
		NMOS	ER2055	ER2055HR	●		22	2 μSEC/4 μSEC (HR)
1k (1024)	128 × 8	NMOS	ER4201		●		24	300
	256 × 4	MNOS	ER1711		●		22	900
		MNOS	TMM142P				18	1.5 μSEC
	1024 × 1	NMOS	X2201-30		●		18	300
1400	100 × 14	MNOS	ER1400			DRIVES MOS	14	833 μSEC
		NMOS	M5G1400P				14	20 μSEC
2k (2048)	256 × 8	MNOS	Am1702		●		24	550
		CMOS	CDP18U42CD		●		24	1 μSEC
		PMOS	1702A,-2		●		24	1 μSEC, 650 NSEC
	512 × 4	PMOS	MM5203		●		24	1 μSEC (TYP)
4k (4096)	512 × 8	CMOS	HNVM3004		●		24	550 (TYP)
		CMOS	IM6654	54M	●		24	300/550
		PMOS	MM5204		●		24	1 μSEC
		NMOS	2704		●		24	450
	1024 × 4	MNOS	NC7451		●		22	900
		MNOS	ER2401,2		●		24	2 μSEC
		MNOS	ER3400	ER3400HR	●		22	900 μSEC/ 1000 μSEC (HR)
		CMOS	IM6653	HR 53M	●		24	300/550
8k (8192)	1024 × 8	CMOS	HNVM3008		●		24	550 (TYP)
		CMOS	MW557U58		●		24	750
		CMOS		HM6758	●		24	350
		CMOS	HM6808		●		24	350
		NMOS	MM2708,-1		●		24	450, 350
		NMOS	Am2708		●		24	450
		NMOS	EA2708	DM	●		24	450/550
		NMOS	2708L		●		24	450
		NMOS		M2708	●		24	450
		NMOS	F2708,-1		●		24	450, 350
		NMOS	TMS2508-25		●		24	250
		NMOS	TMS2508-30		●		24	300
		NMOS	TMS2708		●		24	450
		NMOS	TMS2708-35		●		24	350
		NMOS	MK2758/9-8		●		24	450
		NMOS	MCM2708C		●		24	450
		NMOS	MCM27A08		●		24	300
		NMOS	MCM68708C		●		24	450
		NMOS	MCM68A708C		●		24	300
		NMOS	MM2758QA,B		●		24	450
		NMOS	TMS27L08		●		24	450
	2048 × 4	MNOS	NC7810		●		24	1.4 μSEC
		MNOS		ER2810HR	●		24	1.6 μSEC
16k (16, 384)	2048 × 8	CMOS	HM6716		●	DRIVES 2 TTL LOADS	24	350
		CMOS	NMC27C16,-1		●		24	450/350
		CMOS	NMC67C16,-1		●		24	450/350
		NMOS	NMC2724A, B		●		24	450
		NMOS	NMC2816		●		24	350
		NMOS	SY2716,-1,-2		●		24	450, 350, 390
		NMOS	MM2716,-1	M2716QM	●		24	450, 350
		NMOS	Am2716,-1		●		24	450, 350
		NMOS	HN462716		●		24	450
		MNOS	HN48016		●		24	300

SUPPLY VOLTAGES ③	OPERATION (STATIC/ DYNAMIC) 4	POWER-DOWN MODE	POWER DISSIPATION (mW) ⑤		AVAIL IN 1981 ⑥	OTHER COMMENTS, INFORMATION, FEATURES ⑦	MANUFACTURER
			ACTIVE	STANDBY			
5V, 25V	D	●	165	22		WORD-ALTERABLE EEPROM	MOTOROLA
10V	D		28 (TYP)			EAROM; SERIAL I/O; 10-YR DATA RETENTION	NITRON
5V, −28V	D		400			EAROM; 5-BIT PARALLEL-BINARY ADDRESSING	NITRON
5V, −28V	D		500			EAROM; 5-BIT BINARY ADDRESSING; WORD ALTERABLE	GI
5V, −28V	D		400			EAROM; NCR2055 SECOND SOURCE	NITRON
5V, −28V	D		500			EAROM; 6-BIT BINARY ADDRESSING	GI
5V, 25V	D		400			EAROM; TTL COMPATIBLE	GI
5V, −12V	SEE COMMENTS		650			RAM WITH EAROM STORAGE; CE STROBES DURING RAM CYCLES	GI
5V, −15V	S		800			NONVOLATILE RAM WITH EAROM BACKUP	TOSHIBA
	S		275			NONVOLATILE RAM WITH EEPROM BACKUP	XICOR
−35V	D		300			SERIAL EAROM; MOS COMPATIBLE	GI
−35V							
5V, −9V	S		1W			100% MIL-STD-883 TESTING	AMD
	S		20(TYP)	1		1702 SECOND SOURCE IN CMOS	RCA
5V, −9V	S		885				INTEL
5V, −9V	S		900				NATIONAL SEMI
5V, 17V	SEE COMMENTS		7.5			EEPROM; CE USED AS CLOCK	HUGHES
	D	●	30/60	5 μW			INTERSIL
5V, −12V	S		900				NATIONAL SEMI
±5, 12V	S		800				INTEL
5V, −12V	D		450			EAROM	NITRON
±5V, −14V	D		300			EAROM; 2402 HAS OUTPUT DATA STROBE	GI
5V, −12V, −30	SEE COMMENTS		450			EAROM; CE USED AS CLOCK	GI
	D	●	30/60	5 μW		SAME AS IM6654, M	INTERSIL
5V, 17V	SEE COMMENTS		7.5			EEPROM; CE USED AS CLOCK	HUGHES
	S	●	20 (TYP)	1	2Q	CMOS UVPROM; 2708 PINOUT	RCA
	S		50	500 μW	1Q	INTEL 2758 COMPATIBLE	HARRIS
			50	500 μW	3Q	EEPROM; INTEL 2708 PINOUT	HARRIS
±5V, 12V	S		800			INTEL 2708 COMPATIBLE	NATIONAL SEMI
±5V, 12V	S		900			INTEL 2708 COMPATIBLE	AMD
±5V, 12V	S		630				EA
±5V, 12V	S		475				INTEL
±5V, 12V	S		750			−55 TO +100°C	INTEL
±5V, 12V	S		800				FAIRCHILD
	S	●	446	131			TI
	S	●	446	131			TI
±5V, 12V	S		800				TI
±5V, 12V	S		800				TI
	S	●	525	132		PIN 19 = 0V FOR 2758, 5V FOR 2759	MOSTEK
±5V, 12V	S		800				MOTOROLA
±5V, 12V	S		800				MOTOROLA
±5V, 12V	S		800			INTEL 2708 PINOUT	MOTOROLA
±5V, 12V	S		800			INTEL 2708 PINOUT	MOTOROLA
	S	●	525	132			NATIONAL SEMI
±5V, 12V	S		580			LOW-POWER VERSION	TI
±5V, −24V	D		250			SECOND SOURCE NCR 2810 EAROM	NITRON
±5V, −14V	D		300				GI
−23V							
	S	●	50	500 μW		INTEL 2716 PINOUT	HARRIS
	S	●	50	125 μW	1Q	CMOS VERSION OF 2716	NATIONAL SEMI
	S	●	50	125 μW	1Q	ABOVE WITH ADDRESS LATCH	NATIONAL SEMI
	S	●	750	150			NATIONAL SEMI
	S	●	450	125	4Q	EEPROM VERSION OF 2716	NATIONAL SEMI
	S	●	525	132			SYNERTEK
	S	●	750	132			NATIONAL SEMI
	S	●	525	132		INTEL PINOUT	AMD
	S	●	555	213		INTEL PINOUT	HITACHI
	S		300			EEPROM VERSION OF 2716; NO UV REQUIRED	HITACHI

Continued on next page

EDN

UV-ERASABLE, ELECTRICALLY ALTERABLE AND ELECTRICALLY ERASABLE MEMORIES

DENSITY (BITS)	ORGANIZATION (BITS)	TECHNOLOGY ①	PART NUMBER		OUTPUT CONFIGURATION		NO OF PINS	MAX ACCESS TIME (NSEC) ②
			COMM	MIL	3-STATE	OTHER		
16k (16, 384)	2048 × 8	NMOS	EA2716		●		24	450
		NMOS	MBM2716		●		24	450
		NMOS	2716,-1, 2, 5, 6		●		24	450, 350, 390, 490, 650
		NMOS		M2716	●		24	450
		NMOS	F2716		●		24	450
		NMOS	TMS2516-35		●		24	350
		NMOS	TMS2516		●		24	450
		NMOS	MK2716-6,-7		●		24	350, 390
		NMOS	MK2716-8,-12		●		24	450, 650
		NMOS	TMS2716C		●		24	450
		NMOS	TMS27A16C		●		24	300
		NMOS	MCM2716C		●		24	450
		NMOS	MCM27A16C		●		24	350
		NMOS	TMS2716		●		24	450
		HMOS-II	2816, -3	M2816	●		24	250, 350/300
32k (32,768)	4096 × 8	NMOS	NMC2732,-1		●		24	450, 350
		NMOS	NMC2532,-1		●		24	450, 350
		NMOS	NMC27H32		●		24	200
		NMOS	HN462532		●		24	450
		NMOS	HN462732		●		24	450
		NMOS	MBM2732		●		24	450
		NMOS	TMS25L32		●		24	450
		NMOS	TMS2532		●		24	450
		NMOS	MCM2532C		●		24	450
		NMOS	MCM25A32		●		24	350
		NMOS	EA2732		●		24	
		NMOS	Am2732		●		24	
		NMOS	2732, -6	M2732	●		24	450, 550/450
		HMOS	2732A		●		24	250
		CMOS	NMC27C32, -1		●		24	450, 350
		CMOS	NMC6732, -1		●		24	450, 350
		NMOS	TMS2532-35		●		24	350
		NMOS	TMS2532-25		●		24	250
		NMOS	M5L2732K		●		24	450
		NMOS	TMM2732D		●		24	450
64k (65,536)	8192 × 8	NMOS	NMC2764,-1		●		28	450, 350
		NMOS	NM2564,-1		●		28	450, 350
		NMOS	NMC27H64		●		28	200
		NMOS	TMS2564		●		28	450
		NMOS	TMS2564-50		●		28	500
		NMOS	TMS2564-35		●		28	350
		HMOS-II	2764, -2, -3, -4		●		28	250, 200, 300, 450
		NMOS	MCM68764C		●		24	450
		NMOS	MCM68766C		●		24	450, 350
		NMOS	TMM2764		●		28	450
		NMOS	MK2764-8		●		28	450
		NMOS	SY2764		●		28	

NOTES:

① **TECHNOLOGY:** MNOS = METAL NITRIDE OXIDE SEMICONDUCTOR (NONVOLATILE)
PMOS = P-CHANNEL MOS
NMOS = N-CHANNEL MOS
CMOS = COMPLEMENTARY-SYMMETRY MOS
HMOS = HIGH-SPEED, HIGH-DENSITY NMOS (DEVICE SCALING MATCHED WITH OPTIMUM PROCESSING METHODS)
HMOS-II = ENHANCED HMOS

② **MAX ACCESS TIME:** MAXIMUM ADDRESS-TO-OUTPUT-DELAY TIME OVER COMMERCIAL/MILITARY TEMPERATURE RANGE (0 TO 75°C/ −55 TO +125°C)

③ **SUPPLY VOLTAGES:** PERTAINS TO DEVICES REQUIRING OTHER THAN A NOMINAL SINGLE 5V SUPPLY; VALUES INDICATED ARE NOMINAL, ±5% FOR COMMERCIAL, ±10% FOR MILITARY.

SUPPLY VOLTAGES ③	OPERATION (STATIC/ DYNAMIC) ④	POWER-DOWN MODE	POWER DISSIPATION (mW) ⑤		AVAIL IN 1981 ⑥	OTHER COMMENTS, INFORMATION, FEATURES ⑦	MANUFACTURER
			ACTIVE	STANDBY			
	S	●	525	130		INTEL PINOUT	EA
	S	●	525	132		INTEL PINOUT	FUJITSU
	S	●	525	132			INTEL
	S	●	632	165		−55 TO +100°C	INTEL
	S	●	525	132			FAIRCHILD
	S	●	525	132			TI
	S	●	525	132			TI
	S	●	525	132			MOSTEK
	S	●	525	132			MOSTEK
± 5V, 12V	S		700			SECOND SOURCE TI	MOTOROLA
± 5V, 12V	S		800			SECOND SOURCE TI	MOTOROLA
	S	●	525	131		SECOND SOURCE INTEL	MOTOROLA
	S	●	525	131		SECOND SOURCE INTEL	MOTOROLA
± 5V, 12V	S		720				TI
	S	●	495	132		EEPROM, BYTE AND CHIP ERASE	INTEL
	S		750			INTEL PINOUT	NATIONAL SEMI
	S		750			TI PINOUT	NATIONAL SEMI
	S	●	750	165	2Q		NATIONAL SEMI
	S					TI PINOUT	HITACHI
	S					INTEL PINOUT	HITACHI
	S	●	788	158		INTEL PINOUT	FUJITSU
	S	●	500	132		LOW-POWER VERSION OF TMS2532	TI
	S	●	840	131			TI
	S	●	840	131			MOTOROLA
	S	●	840	131			MOTOROLA
	S					INTEL PINOUT	EA
	S					INTEL PINOUT	AMD
	S	●	788	158			INTEL
	S	●	840	131			INTEL
	S	●	50	125 μW	4Q	CMOS VERSION OF 2732	NATIONAL SEMI
	S	●	50	125 μW	4Q	AS ABOVE WITH ADDRESS LATCH	NATIONAL SEMI
	S	●	840	131			TI
	S	●	840	131			TI
	S	●	787	341			MITSUBISHI
	S	●	787	158			TOSHIBA
	S		750			INTEL PINOUT	NATIONAL SEMI
	S		750			TI PINOUT	NATIONAL SEMI
	S	●	750	165	4Q		NATIONAL SEMI
	S	●	840	131			TI
	S	●	840	131			TI
	S	●	840	131			TI
	S	●	840	132			INTEL
	S	●	840	131	4Q	JEDEC-STANDARD, ROM-COMPATIBLE PINOUT	MOTOROLA
	S		840		4Q	COMPATIBLE WITH MCM68366 ROM	MOTOROLA
	S	●	840	132			TOSHIBA
	S	●	525	131		INTEL PINOUT	MOSTEK
	S				3Q	INTEL PINOUT	SYNERTEK

④ **OPERATION:** SOME DEVICES USE CHIP ENABLE ($\overline{CE}$) TO STROBE INFORMATION IN AND OUT; REFER TO COMMENTS FOR DETAILS

⑤ **POWER DISSIPATION:** UNLESS OTHERWISE NOTED, VALUES REFER TO MAXIMUM POWER DISSIPATION OF DEVICE WHEN ENABLED (ACTIVE) AND WHEN DISABLED (STANDBY). DEVICES WITH NO CHIP ENABLE ARE LISTED UNDER ACTIVE — NUMBERS IN THIS CASE REFER TO READ MODE; POWER DISSIPATION IS HIGHER IN WRITE MODE.

⑥ **AVAIL IN 1981:** LACK OF ENTRY SIGNIFIES CURRENT AVAILABILITY. ENTRIES TELL QUARTER IN WHICH SAMPLES WILL BECOME AVAILABLE. SOME DATA NOT AVAILABLE ON THESE LATTER DEVICES WHEN THIS DIRECTORY WAS COMPILED

⑦ **COMMENTS:** UNLESS OTHERWISE NOTED, ALL DEVICES ARE UV-PROMs.

EDN

FUSE-LINK-PROGRAMMABLE, NONERASABLE MEMORIES

DENSITY (BITS)	ORGANIZATION (BITS)	TECHNOLOGY (1)	FUSE TECHNOLOGY (2)	PART NUMBER (3)			NO OF PINS	MAX ACCESS TIME (4) (NSEC)	
				OPEN-COLLECTOR OUTPUT	3-STATE OUTPUT	ACTIVE PULL-UP OUTPUT		COMM	MIL
256	32 × 8	ST	PLAT	Am27S18	Am27S19		16	40	50
		LS	PLAT	Am27LS18	Am27LS19		16	50	65
		ST	Ni	6330-1	6331-1		16	50	60
		ST	AIM	5600		5610	16	50	60
		ST	Ni	82S23	82S123		16	50	60
		ECL	Ni	10139			16	20	
		ECL	Ni	MCM10139			16	20	
		ST	Ti-W	TBP18SA030	TBP185D30		16	40	50
		ST	Ti-W	DM74S183	DM74S288		16	35	45
		ST	Ni	HM7602	HM7603			50	60
512	64 × 8	ST	Ni	HPROM0512			24	140	140
1k (1024)	256 × 4	ST	PLAT	Am27S20	Am27S21		16	45	60
		ST	Ni	6300-1	6301-1		16	55	75
		TT	AIM	5603		5623	16	60	180
		CMOS	POLY		HM6611		16	450	
		ST	Ni	HM7610A	HM7611A		16	45	65
		LS	Ni		29663		16	55	70
		ST	Ni	82S126	82S129		16	55	75
		ECL	Ni	10149			16	20	
		ECL	Ni	MCM10149			16	25	
		ST	Ti-W	TBP24SA10	TBP24S10		16	55	75
		ST	Ti-W	DM74S387	DM74S287		16	50	60
2k (2048)	256 × 8	ST	Ti-W	TBP28LA22	TBP28L22		20	70	75
		ST	Ni	6308-1	6309-1		16	70	80
		LS	Ni		29603		20	60	75
		ST	Ni		82S114		24	45	60
	512 × 4	ST	Ni	93436	93446		16	50	60
		ST	PLAT	Am27S12	Am27S13		16	50	60
		ST	Ni	6305-1	6306-1		16	60	75
		TT	AIM	5604		5624	16	70	90
		ST	Ni	HM7620A	HM7621A		16	50	70
		LS	Ni		29613		16	55	70
		ST	Ni	82S130	82S131		16	60	75
		ST	Ti-W	DM74S570	DM74S571		16	55	65
4k (4096)	512 × 8	ST	Ni	93438	93448		24	55	70
		ST	Ni	MCM7640	MCM7641		24	70	85
		ST	Ti-W	TBP18SA42	TBP18S42		20	75	85
		ST	Ti-W	TBP18SA46	TBP18S46		24	75	85
		ST	Ni	82S146	82S147		20	45	
		ST	PLAT	Am27S30	Am27S31		24	55	70
		ST	PLAT	Am27S26	Am27S27		22	SEE COMMENTS	
		ST	PLAT	Am27S28	Am27S29		20	55	70
		ST	Ti-W	74S473	74S472		20	55	70
		ST	Ni	6348-1	6349-1		20	70	80
		ST	Ni	6340-1	6341-1		24	70	80
		TT	AIM	5605		5625	24	70	90
		CMOS	POLY		HM6641		24	200	200
		ST	Ni	HM7640A	HM7641A		24	50	70
		LS	Ni		29627		24	60	75
		ST	Ni	HM7648	HM7649		20	60	80
		LS	Ni	29620	29621		20	65	80
		ST	Ti-W		TBP28L42		20	60 (TYP)	
		ST	Ti-W		TBP28L45		24	60 (TYP)	
		ST	Ti-W		TBP28P42		20	35 (TYP)	
		ST	Ti-W		TBP28P45		24	35 (TYP)	
		ST	Ti-W		TBP28R45		24	20(TYP)	
	1024 × 4	ST	Ni	93452	93453		18	55	70
		ST	Ni	MCM7642	MCM7643		18	70	85
		ST	Ti-W	TBP24SA41	TBP24S41		18	55	
		ST	Ni	82S136	82S137		18	60	
		ST	DEAP		MB7122		18	45	60
		ST	PLAT	Am27S32	Am27S33		18	55	70
		ST	POLY	3605A,-1	3625A,-1		18	60, 50	
		ST	Ni	6350-1	6351-1		18	60	75
		ST	Ni	6352-1	6353-1		18	60	75
		ST	Ti-W	5163RA441			18	65	
		ST	Ni	HM7642A	HM7643A		18	50	60
						HM7644	18	60	85

POWER-SUPPLY CURRENT (5) (mA)		POWER SWITCH (6)	AVAIL IN 1981 (7)	OTHER COMMENTS, INFORMATION, FEATURES	MANUFACTURER
ACTIVE	STANDBY				
115					AMD
80					AMD
125					MMI
100					INTERSIL
125					SIGNETICS
150				MOTOROLA COMPATIBLE	SIGNETICS
130					MOTOROLA
110					TI
110					NATIONAL SEMI
130			1Q		HARRIS
100					HARRIS
130					AMD
130					MMI
130					INTERSIL
10	100 μA	●		STATIC; TTL COMPATIBLE; CMOS-RAM PINOUT (EXCEPT PE)	HARRIS
130					HARRIS
130		●		SPROM VERSIONS REDUCE POWER BY 75% IN POWER-DOWN MODE	RAYTHEON
130				MOTOROLA COMPATIBLE	SIGNETICS
120					SIGNETICS
125					MOTOROLA
100					TI
130					NATIONAL SEMI
100			2Q		TI
155					MMI
130		●		SPROM VERSIONS REDUCE POWER BY 75% IN POWER-DOWN MODE	RAYTHEON
130				SECOND SOURCE TO HARRIS 7629	SIGNETICS
100					FAIRCHILD
130					AMD
130					MMI
140					INTERSIL
130					HARRIS
130		●		SPROM VERSIONS REDUCE POWER BY 75% IN POWER-DOWN MODE	RAYTHEON
130					SIGNETICS
130					NATIONAL SEMI
175					FAIRCHILD
140			3Q		MOTOROLA
155					TI
155					TI
155					SIGNETICS
175					AMD
185				BUILT-IN PIPELINE REGISTER: ADR TO CLK SET UP = 40 NSEC, CLK TO OUTPUT = 15 NSEC	AMD
160					AMD
160				SECOND SOURCE FOR AMD 27S28/9	NATIONAL SEMI
155					MMI
170					MMI
185					INTERSIL
10 mA/MHz	100 μA	●		PIPELINE PROM; PINOUT LIKE BIPOLAR 7641; ON-CHIP ADDRESS LATCHES	HARRIS
170			2Q		HARRIS
170		●		SPROM VERSIONS REDUCE POWER BY 75% IN POWER-DOWN MODE	RAYTHEON
170					HARRIS
155		●		SPROM VERSIONS REDUCE POWER BY 75% IN POWER-DOWN MODE	RAYTHEON
50 (TYP)			1Q	LOW POWER	TI
50 (TYP)			1Q	LOW POWER IN 300-MIL PACKAGE	TI
100	12	●	1Q	POWER DOWN	TI
100	12	●	1Q	POWER DOWN IN 300-MIL PACKAGE	TI
110 (TYP)			1Q	ON-CHIP REGISTER, 300-MIL PACKAGE	TI
170					FAIRCHILD
140			2Q		MOTOROLA
140					TI
140					SIGNETICS
145				COMPATIBLE WITH 82S137, HM7643 & 6353-1	FUJITSU
145					AMD
145					INTEL
175					MMI
175				SAME AS 6350 BUT DIFFERENT PINOUT	MMI
120				REGISTERED PROM; ASYNC ENABLE; RS VERSION HAS SYNC ENABLE	MMI
140					HARRIS
140					HARRIS

Continued on next page

EDN

FUSE-LINK-PROGRAMMABLE, NONERASABLE MEMORIES

DENSITY (BITS)	ORGANIZATION (BITS)	TECHNOLOGY ①	FUSE TECHNOLOGY ②	PART NUMBER ③			NO OF PINS	MAX ACCESS TIME ④ (NSEC)
				OPEN-COLLECTOR OUTPUT	3-STATE OUTPUT	ACTIVE PULL-UP OUTPUT		COMM
8k (8192)	1024 × 8	ST	Ni	93450	93451		24	55
		ST	DEAP		MB7132		24	55
		ST	Ti-W	TBP28SA86	TBP28S86		24	55
		ST	POLY		3628, -4		24	80, 100
		ST	Ni	MCM7680	MCM7681		24	70
		ST	PLAT	Am27S180	Am27S181		24	60
		ST	Ti-W	DM87S180	DM87S181		24	60
		ST	Ni	6380-1	6381-1		24	90
		ST	Ni	HM7680A	HM7681A		24	50
		LS	Ni		296357		24	70
		LS	Ni		296313		24	70
		ST	Ni	82S180	82S181		24	60
		ST	Ni	82S182	82S183		24	70
		ST	Ti-W		TBP28L86		24	130
		ST	Ti-W		TBP28L85		24	65 (TYP)
		ST	Ti-W		TBP28P85		24	35 (TYP)
		ST	Ti-W		TBP28R85		24	20 (TYP)
		ST	PLAT		AM27S35		24	60
	2048 × 4	ST	Ti-W	TBP24SA81	TBP24S81		18	60
		ST	DEAP		MB7128		18	55
		ST	Ni	MCM7688	MCM7689		20	70
		ST	PLAT	Am27S184	Am27S185		18	55
		ST	PLAT		Am27S185A		18	35
		ST	PLAT		Am27PS185		18	50
		ST	PLAT		Am27LS185		18	60
		ST	Ni	HM7684A	HM7685A		18	55
		ST	Ti-W	DM87S184	DM87S185		18	60
		ST	Ti-W	5/63RA841			20	
		LS	Ni	29650	29651		18	75
		ST	Ni	82S184	82S185		18	100
		ST	Ni	MCM7686	MCM7687		20	70
16k (16,384)	2048 × 8	ST	Ti-W	87S190	87S191		24	80
		ST	Ni	HM76160	HM76161		24	60
		ST	Ni		HM7616		24	60
		ST	POLY		3636B-1, -2		24	35,45
		Ti-W			TBP28P166		24	35 (TYP)
		ST	Ti-W		TBP28L166		24	65 (TYP)
		ST	Ti-W		TBP28R166		24	20 (TYP)
		ST	PLAT		Am27S191		24	40
		ST	PLAT		Am27PS191		24	50
		ST	PLAT		Am27S291		24	50
		LS	Ni		29681,3		24	80
		ST	Ni	82S190	82S191		24	80
		ST	Ti-W	63S1680	63S1681		24	70
		ST	Ni	MCM76191			24	70
		ST	Ti-W		TBP28S166		24	70
		ST	Ni	93511			24	35 (TYP)
		ST	DEAP		MB7138		24	
		ST	POLY		3636,-1		24	80, 65
	4096 × 4	ST	PLAT	Am27S41A			20	40
		ST	PLAT	Am27PS41			20	50
		ST	Ni	HM76164	HM76165		20	60
32k (32,768)	4096 × 8	ST	POLY		3632		24	40
		ST	Ni	HM76320	HM76321		24	65
64k (65,536)	8192 × 8	ST	Ni	93564/65				35 (TYP)
		ST	Ni	HM76640	HM76641		24	85

NOTES

① **TECHNOLOGY:** ST = SCHOTTKY TRANSISTOR-TRANSISTOR LOGIC (STTL)
LS = LOW-POWER SCHOTTKY
TT = TRANSISTOR-TRANSISTOR LOGIC (TTL)
ECL = EMITTER-COUPLED LOGIC
CMOS = COMPLEMENTARY-SYMMETRY METAL-OXIDE SEMICONDUCTOR

② **FUSE TECHNOLOGY:** Ni = NICHROME
Ti-W = TITANIUM-TUNGSTEN
PLAT = PLATINUM SILICIDE
POLY = POLYCRYSTALLINE SILICON
AIM = AVALANCHE-INDUCED MIGRATION (INTERSIL PATENT)
DEAP = DIFFUSED EUTECTIC ALUMINUM PROCESS (FUJITSU PATENT)

③ **PART NUMBER:** NUMBERS REFER TO COMMERCIAL-TEMPERATURE-RANGE ICs (0 TO 75°C). IN MOST CASES, MIL DEVICES ALSO AVAILABLE IF ACCESS TIME QUOTED UNDER MIL HEADING

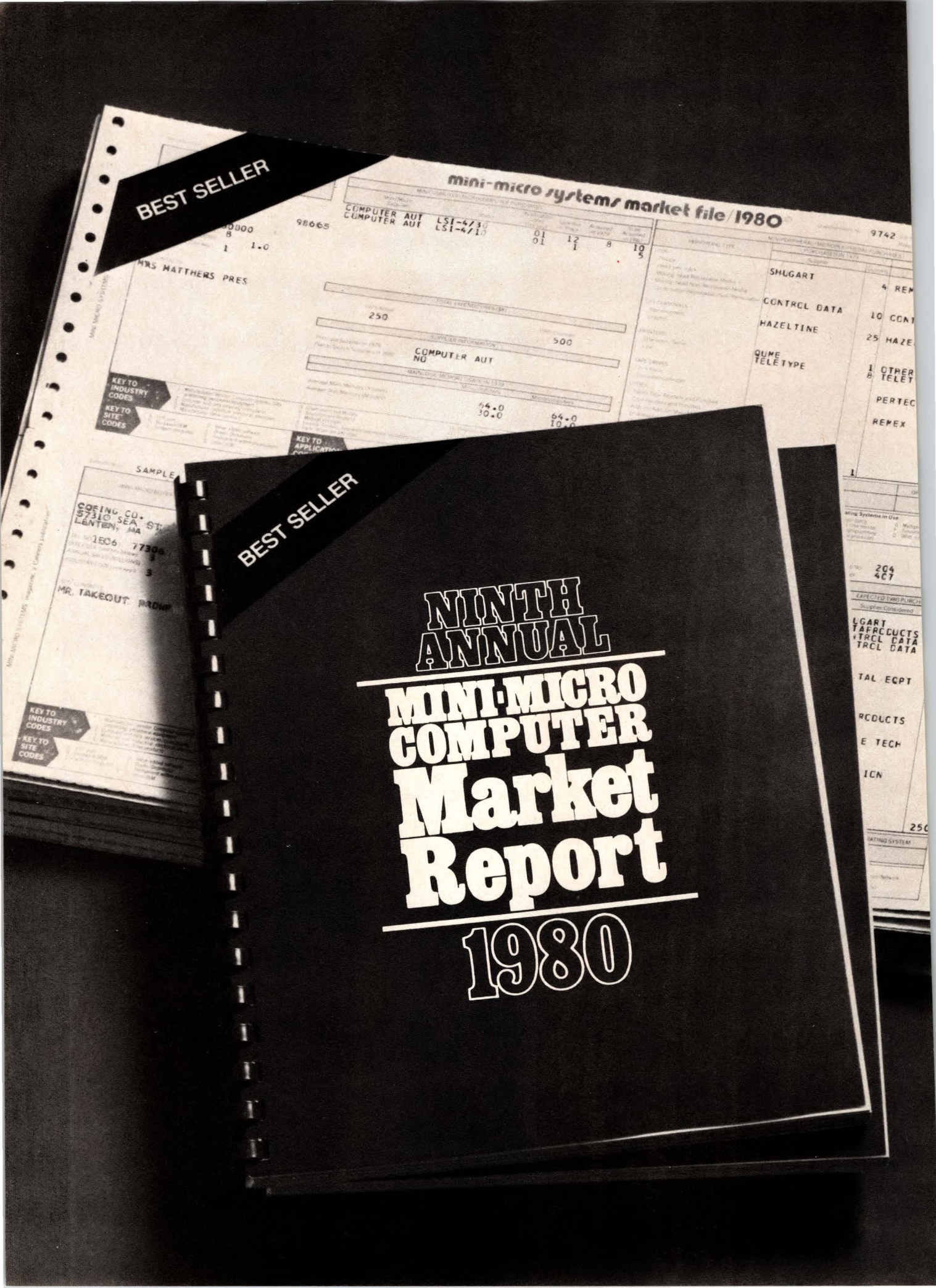
POWER-SUPPLY CURRENT⑤ (mA)		POWER SWITCH⑥	AVAIL IN 1981⑦	OTHER COMMENTS, INFORMATION, FEATURES	MANUFACTURER
ACTIVE	STANDBY				
175					FAIRCHILD
155				COMPATIBLE WITH 82S185, HM7685, 63101-1	FUJITSU
135					TI
190				FOUR CHIP SELECTS	INTEL
150			2Q		MOTOROLA
170					AMD
170					NATIONAL SEMI
180					MMI
170					HARRIS
170		●		SPROM VERSIONS REDUCE POWER BY 75% IN POWER-DOWN MODE	RAYTHEON
170		●		SPROM AVAILABLE; HAS 4 GATED CHIP-SELECT LINES	RAYTHEON
175					SIGNETICS
175					SIGNETICS
100				LOW POWER	TI
55 (TYP)				LOW POWER, 300-MIL PACKAGE	TI
110	12	●		POWER DOWN, 300-MIL PACKAGE	TI
120 (TYP)				ON-CHIP REGISTER, 300-MIL PACKAGE	TI
				REGISTER PROM, 300-MIL PACKAGE	AMD
125					TI
175					FUJITSU
			3-4Q	OUTPUT REGISTERS	MOTOROLA
			1Q		AMD
150					AMD
150	75	●		CS RECOVERS POWER IN 10 NSEC	AMD
120					AMD
170					HARRIS
170					NATIONAL SEMI
130				REGISTERED PROM; ASYNC ENABLE; RS VERSION HAS SYNC ENABLE	MMI
170		●		SPROM VERSIONS AVAILABLE (REDUCE POWER BY 75%)	RAYTHEON
120					SIGNETICS
			3-4Q	OUTPUT LATCHES	MOTOROLA
180				COMPATIBLE WITH HARRIS, SIGNETICS, MMI	NATIONAL SEMI
180					HARRIS
180				STANDARD 2716 PINOUT	HARRIS
185			1Q		INTEL
100	15	●	1Q	POWER DOWN, 300-MIL PACKAGE	TI
50 (TYP)			1Q	LOW POWER	TI
110 (TYP)			1Q	ON-CHIP REGISTER, 300-MIL PACKAE	TI
175					AMD
175	75	●			AMD
175				SLIMLINE PACKAGE	AMD
180		●		SPROM VERSIONS REDUCE POWER BY 75%	RAYTHEON
175					SIGNETICS
180			3Q		MMI
			3Q		MOTOROLA
185			3Q		TI
			1Q		FAIRCHILD
			1Q		FUJITSU
185				THREE CHIP SELECTS	INTEL
175					AMD
175	75	●		CS RECOVERS POWER IN 10 NSEC	AMD
170			2Q		HARRIS
185			3Q		INTEL
190			3Q		HARRIS
			4Q		FAIRCHILD
190			3Q		HARRIS

④ **MAX ACCESS TIME**: MAXIMUM ADDRESS-TO-OUTPUT-DELAY TIME FOR COMMERCIAL (0 TO 75°C) AND MILITARY (−55 TO +125°C) DEVICES OVER FULL TEMPERATURE RANGE

⑤ **POWER-SUPPLY CURRENT**: MAXIMUM SUPPLY CURRENT DRAWN AT NOMINAL 5V SUPPLY VOLTAGE. STANDBY CURRENT, WHEN GIVEN, IS MAXIMUM CURRENT DRAWN WHEN DEVICE IS NOT ACTIVATED (IF APPLICABLE).

⑥ **POWER SWITCH**: BULLET INDICATES AVAILABILITY OF DEVICES THAT SWITCH TO POWER-DOWN MODE WHEN NOT ACTIVATED.

⑦ **AVAIL IN 1981**: LACK OF ENTRY SIGNIFIES CURRENT AVAILABILITY; ENTRIES TELL QUARTER IN WHICH SAMPLES WILL BECOME AVAILABLE. SOME DATA NOT AVAILABLE ON THESE LATTER DEVICES WHEN THIS DIRECTORY WAS COMPILED.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Put theory into practice to motivate your design staff

Novice as well as experienced engineering managers must understand what motivates their employees before expecting increased productivity.

Haluk Bekiroglu and **Carl Hutchison,**
Eastern New Mexico University

One of the most challenging tasks facing you as a manager is finding ways to effectively motivate your subordinates. If individuals are intrinsically motivated, they can creatively use their energies to meet more productive goals. And from an organizational standpoint, because salaries and wages are usually a firm's largest expenditure, such increased *employee* productivity represents the greatest potential source of increased *organizational* productivity and profitability. Therefore, motivation is the key to both individual success and organizational effectiveness.

In the past, motivational methods usually consisted of traditional authoritarian approaches coupled with financial incentives. However, motivating today's employees with these methods alone has become increasingly difficult as employees become more economically secure and less dependent on any particular organization. Of course, financial rewards remain an integral part of organizational motivation—few people are willing to work for nothing. But the traditional authoritarian approach ("I'm the boss and you'll do as I say") is increasingly giving way to managerial theories and practices that take into account more of the employee's needs and expectations.

Theorists have described these needs and expectations, and their relationship to applied motivational techniques, from several perspectives. To effectively motivate *your* staff, you must understand these theorists' work and its implications.

Choose among three theories of motivation

Most currently popular motivational theories used by managers are termed need theories and are based on the premise that internal drives and motives are the primary causes of human action **(Ref 3).** One of the most popular theorists in this school, Abraham Maslow, states that human needs fall into two categories:

- Innate or primary—The unlearned needs that people are born with, including those centering on hunger, thirst, sex and safety
- Acquired or secondary—The needs that people learn to experience, including those for self esteem and self actualization **(Ref 11).**

In the workplace, wages and job security satisfy lower order needs, while intrinsic job satisfaction fulfills those of a higher order. The lower order needs must be substantially satisfied before higher order ones can serve as motivators.

Another theorist, Douglas McGregor **(Ref 9),** has developed two sets of assumptions concerning employees' attitudes toward work: Theory X and Theory Y. Theory X assumes that people basically dislike work and avoid it if possible, while Theory Y states that working is natural and that people generally work to the best of their ability. McGregor believes managers obtain the best results if they base their actions on the latter theory.

Still another theory, formulated by David McClelland and his associates **(Ref 7),** recognizes individual differences in three categories of emotional needs:

- The need to achieve, excel and succeed
- The need for affiliation and close interpersonal relationships
- The need for power.

Individuals' need levels in each of these three categories affect the way they approach their jobs and how well they do those jobs. For example, scientists and engineers generally have a high need to achieve, and that factor significantly accounts for their successful performance in research and development projects **(Ref 13).**

The foregoing motivational theories prove useful only insofar as you can successfully apply them. Consider which of the approaches (or which combinations of them) you can effectively apply to motivate your design-engineering staff.

First, briefly examine the engineering job itself to determine which approach to use. Engineering design has been defined as "a continuous process whereby scientific and technological information is used to innovate a system, device or process that will benefit society in some way" **(Ref 6).** The entire engineering structure is erected for the purpose of bringing into

being the designer's ideas (**Ref 4**). Design is a creative process more akin to invention than research; therefore, design engineers must combine a driving curiosity and willingness to explore the unconventional with the knowledge and skill they have acquired through education or previous experience. They work in a complex, dynamic, rapidly changing technological environment, generally alone or in small groups; thus, they are not required to communicate continuously with others (nor are they usually very much inclined to). Rather, they are much more interested in the technical and mechanical aspects of problem solving.

Design engineers, then, possess a self-disciplined creativity that allows them to become totally obsessed with whatever problem they are working on, never leaving it until they find a solution. They are often unconventional and do not compete with other people as much as they do with nature, materials and their own standards of quality (**Ref 6**). They are usually conservative, work and family oriented, self contained and independent. And although they can accept legitimate authority, they don't worship the powerful organization. They value financial rewards to an extent, but their source of pride and satisfaction stems from the challenge of creating something of quality and seeing it work. They are modern-day craftsmen (**Ref 8**) and realize the differences between themselves and other skilled workers in terms of job approach, personality traits, required supervision and goal setting (**Ref 10**). With regard to Maslow's theory, intrinsic self fulfillment primarily motivates a design engineer.

Despite the predominance of engineers' higher order sources of motivation, a reasonably and equitably administered pay system is crucial to their morale and long-term productivity. Therefore, a company should design a pay system to fit both its needs and those of its employees. Some general characteristics of a good pay plan include:

- Periodic and scrupulously fair appraisals of each individual's performance. These appraisals serve as a basis for promotions and salary increases.
- Fairness in evaluating the job compared with other jobs in the organization. Employees must feel that what they receive for doing their jobs is fair relative to the compensation other employees receive for their work.
- An incentive compensation plan to reward exceptionally hard work, revolutionary ideas or designs that result in profit for the company. Such a plan recognizes people for isolated performances without promoting them to positions for which they might not be ready.
- Promotions accompanied by pay raises. A promotion without a raise is no promotion.

The accomplishment of a company's goals depends upon the smoothness and effectiveness of the interactions between its employees. The organizational structure, consisting of the company's purposes, goals and membership, primarily influences the quality and

A motivation checklist

When attempting to motivate a design-engineering staff, try taking the following actions:

- Don't criticize or otherwise squelch ideas with statements like, "It can't work" or "I've seen it before." You have a responsibility as an engineering manager to praise your designers' good ideas and offer constructive suggestions to those ideas that need improvement. You could greet each new idea with a positive comment, then point out areas you think need work, and end with another positive comment or encouragement.
- Give full credit to subordinates for constructive efforts and ideas, and tell your superiors about them.
- Be consistent. Inconsistent behavior lowers anyone's morale and sense of personal security.
- Don't burden designers with administrative details; technical and administrative functions should remain separate.
- Design engineers often are isolated from the daily routine, assuming that whatever they put on paper will automatically work to perfection. Encourage them to come out of seclusion and interact with the rest of the engineering department to see how the people in the shops and test laboratories work on their creations. In other words, help foster a close relationship between the builders and the intellectual creators.
- Accompany departmental promotions with a company-wide notice and possibly even an item in the local newspaper. Such action tremendously increases the morale of the person promoted and prevents any false rumors by keeping everyone fully informed about any departmental transitions.
- Above all, treat design engineers with the same respect you'd give any professional motivated by the principles of competence and integrity. Merely allowing this intrinsic motivation to blossom in a flexible organizational environment produces much more extensive long-term benefits than does any type of externally administered motivator.

Improve employee morale with strong leadership skills

frequency of these interactions. In an engineering department, individuals often work together temporarily on projects within an organization existing in constantly changing technological environments.

For these reasons, a flexible structure that only loosely defines organizational relationships, increases the natural flow of interactions among its members and fosters an atmosphere of trust and mutual support between managers and their staffs will best motivate an engineering department. Further, a company should encourage open communication, especially among designers within a department, because the strength of the engineering department depends upon close, integrated team play **(Ref 4).**

Leadership style, like organizational structure, varies from company to company. But regardless of the style, leaders must make decisions, right or wrong, without vacillating. A leader's indecisiveness lowers subordinates' confidence, and morale suffers.

By definition, design engineers must often work on their own; therefore, the most effective engineering managers give designers free rein in their creative functions. Achievement motivation (referring to McClelland's need theory) is a desirable trait in the engineering manager, and achievement-oriented leadership thus encourages achievement-oriented behavior in designers. This type of leader sets challenging goals and expects subordinates to achieve them. Generally, the higher the achievement orientation of an engineering manager, the higher the confidence of the subordinates that their efforts will result in effective performance **(Ref 3).**

Allowing subordinates to participate in the decision-making process often improves morale, providing them with a greater sense of control on the job. Participative goal setting has been found to increase job satisfaction among engineers **(Ref 1).** And there are some other concrete actions a good leader can adopt to motivate a staff to do its best work (see **box,** "A motivation checklist").

Most engineering managers, especially at the first (supervisory) level, are competent engineers who have performed well at the bench and have thus been promoted to managerial positions. Suddenly, from a position that deals with objects, materials and designs (a job for which they are eminently well qualified), they enter a position that deals with people and administrative detail—something for which they have almost no experience or training. Yet they must somehow develop these managerial skills, and ideally, management will have the foresight to begin grooming them for the managerial task before their promotion. If you find yourself in such a position, remember that you possess the engineering competence to command the respect of your subordinates. Combining that competence with the motivational theories discussed in this article can improve your managerial ability. **EDN**

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Authors' biographies

Haluk Bekiroglu, professor and chairman of the Business Administration and Economics Dept at Eastern New Mexico University (Portales), earned his PhD in industrial engineering at Iowa State University in 1974. Before joining the ENMU faculty, he taught production-management and quantitative-methods courses at several other universities and provided consultation services for Gusdorf Corp. Author of more than 40 papers, Professor Bekiroglu is also a registered professional engineer and a member of AIDS, AIIE, SCS, TIMS, Tau Beta Pi, Sigma Xi and Beta Gamma Sigma.

Carl Hutchison earned BS and MA degrees in psychology from Eastern New Mexico University. A teaching assistant in ENMU's College of Business while completing his MBA, he plays guitar, reads and enjoys the theatre in his leisure time.

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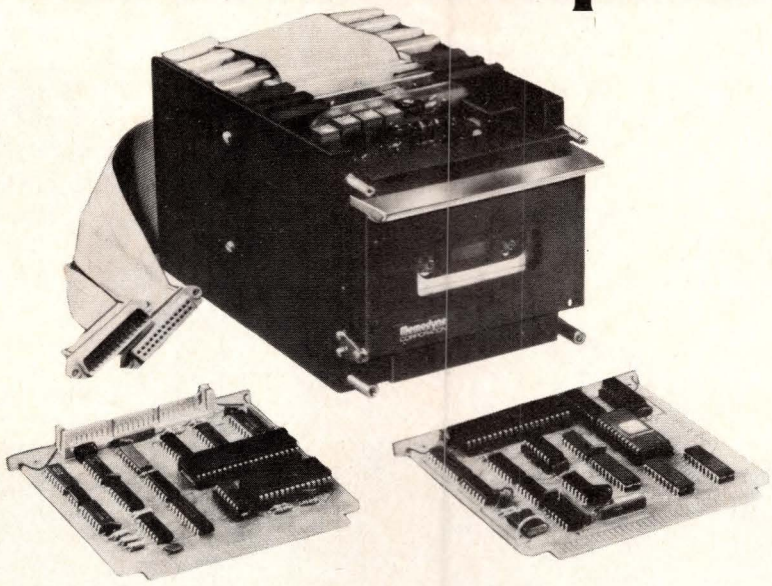

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When your DMM can't handle necessary low-value-resistance-measurement tasks, you can use off-the-shelf components to build a tester that does the job. The circuit presented here (**Fig 1**) permits 2-mΩ FS measurements to 0.001-mΩ resolution; you can select appropriate reference resistances to adapt this design to your range requirements.

The tester incorporates an autocalibration feature that provides two key advantages:

- Traditional methods depend on measurement of the voltage across the resistor under test (RUT), a voltage resulting from a supposedly known test current forced through the RUT. But note that the RUT can change the test current. Although the circuit presented here uses such voltage/current information, the autocal feature makes measurement accuracy independent of these test-current changes.
- The autocal feature also compensates for long-term drifts that contribute error in traditional measurement schemes. Production testers based on this technique exhibit less than ±1 least-significant-digit (LSD) variation per day on the instrument's 3½-digit display.

Shunt provides reference

The heart of the circuit is an accurate reference resistance—a 1A, 1-mV shunt—connected in series with the RUT. (A ±0.25% shunt accuracy yields overall circuit accuracy of ±1 LSD typ and ±3 LSD max.)

Measurement values depend on the shunt and RUT voltages generated in response to 2-msec-wide test-current pulses spaced approximately 500 msec apart. In response to every second such pulse, the circuitry measures the shunt voltage to determine the test-current value; combining this current value with the RUT voltages measured on alternate test-current pulses yields the RUT resistance value.

The current value is determined by regulator chip RG_1 and Q_7, Q_9 and R_{46}. Optocoupler U_{10} controls the current-pulse timing (**Fig 2**) and isolates the test-current circuitry from the analog and digital grounds; to limit noise problems, tie these grounds together only at the power-supply transformer. A 4-terminal test fixture (with two current-injection nodes and two voltage-measurement points) applies the test current to the RUT.

CAL switches measurement from shunt to RUT

A calibration signal (labeled CAL in **Fig 2**) controls the alternate shunt/RUT voltage measurement; a sample/hold circuit consisting of A_1, C_4, Q_2 and A_2 samples the shunt or RUT voltage during the 2-msec test-current application and stores this information for the remainder of the 500-msec measurement cycle.

When CAL is HIGH, relay K_1 directs the shunt voltage to the sample/hold circuitry. Then an autogain configuration (U_1, A_3, U_9, U_{5B}, U_{3C} and U_2) adjusts the circuit's scale factor in response to the test current's measured value. This adjustment technique uses multiplying D/A converter U_1's variable-resistance parameter. The DAC's variable-resistance function controls amplifier A_3's gain by paralleling A_3 input resistor R_{14}.

DAC determines amplifier gain

To determine the correct A_3 gain, the shunt voltage measured during the calibration period—which corresponds to a 1-mΩ resistance level—feeds to the DAC input (pin 15). Oscillator U_8 then increments counter U_2 (which is reset before each self-calibration cycle) via gate U_{3C}. The counter in turn steps the DAC, thus decreasing the DAC's equivalent resistance until comparator U_9 determines that amplifier A_3's output equals the voltage corresponding to 1 mΩ. (You can adjust this voltage via potentiometer R_{38}, which serves as the system calibration adjustment.) Transistor Q_{12} and gates U_{3A} and U_{3B} blank the display during autocalibration cycles.

When comparator U_9 detects that the system gain is

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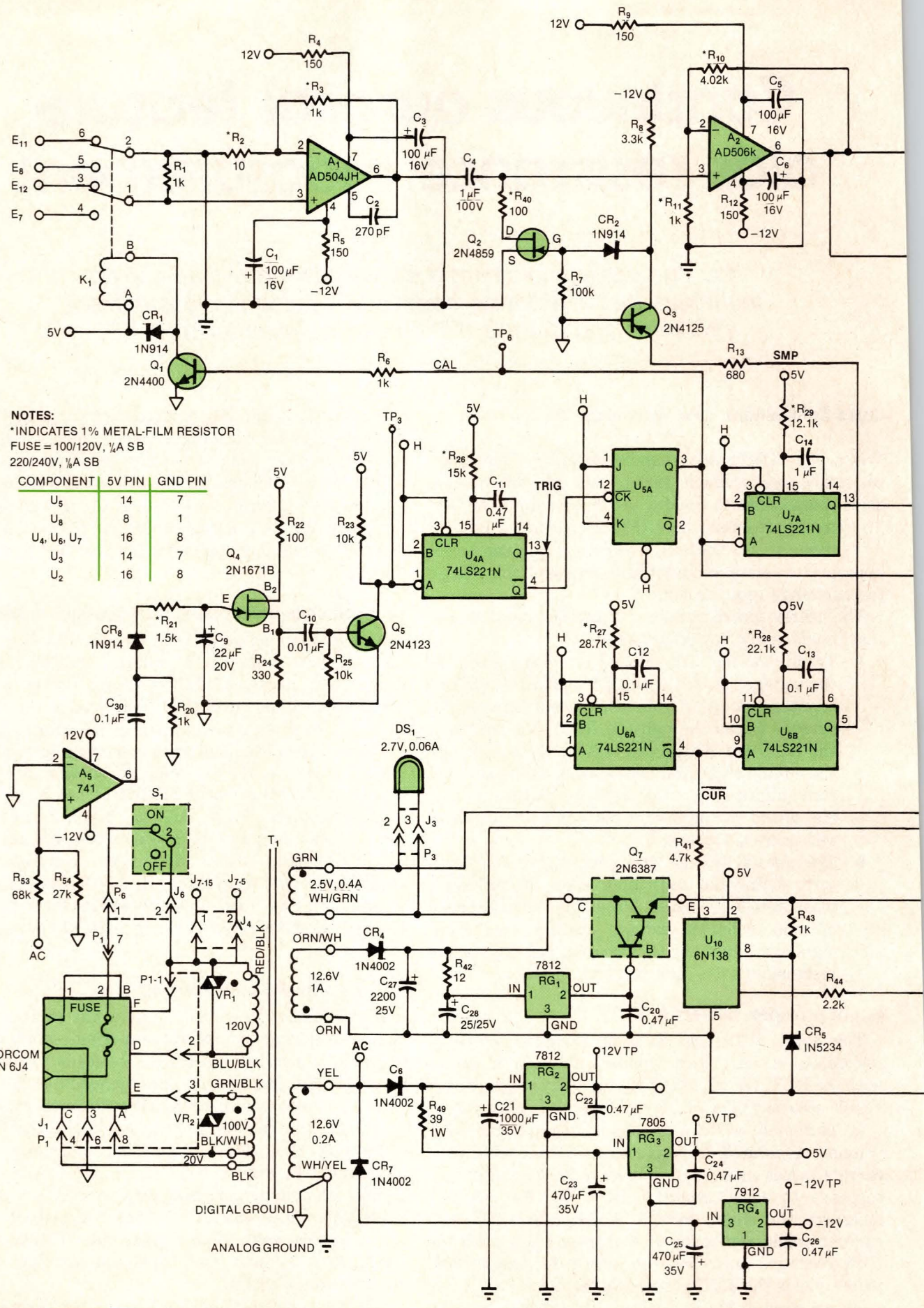
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R4 150
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C5 100 µF 16V
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E8
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R1 1k
*R2 10
A1 AD504JH
C3 100 µF 16V
C2 270 pF
C4 1 µF 100V
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CR2 1N914
R5 150
C1 100 µF 16V
R7 100k
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*R26 15k
C11 0.47 µF
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R23 10k
Q4 2N1671B
*R21 1.5k
C9 22 µF 20V
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C13 0.1 µF
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U6B 74LS221N
CUR
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J3
P3
A5 741
S1
ON
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R53 68k
R54 27k
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P6
J6
J7-15
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5V TP
C23 470 µF 35V
7912 RG4
C25 470 µF 35V
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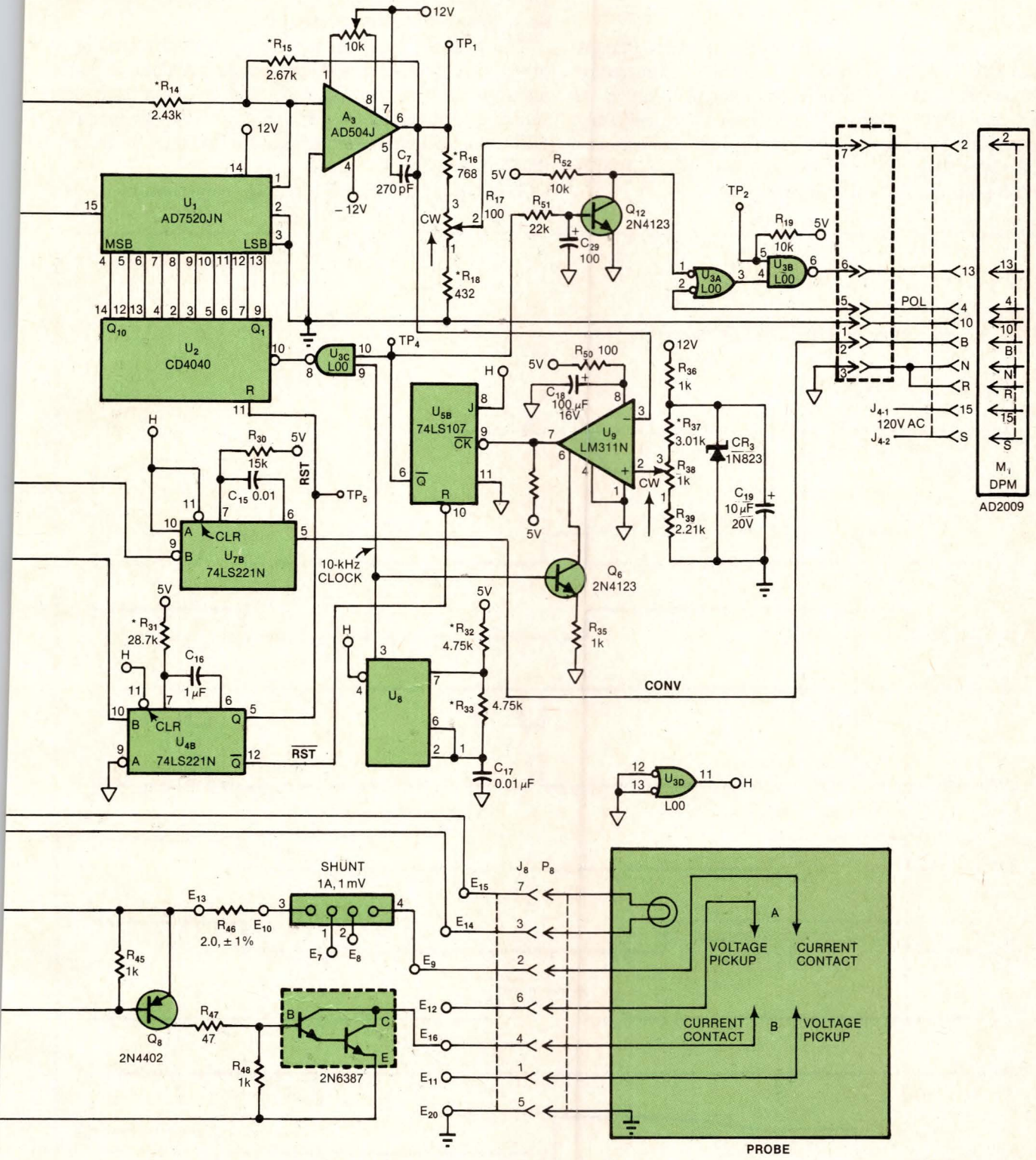

Fig 1—Off-the-shelf components *can implement a self-calibrating resistance-measurement system. Note the separate analog and digital grounds. Although production testers based on this circuit utilize single pc boards, separate ground buses for each signal type improve stability; ground instabilities might otherwise cause the display's least significant digit to flicker. Tie these grounds together at the power-supply transformer, then connect this junction to the input-power connector (Corcom P/N 6J4) and thus to the instrument chassis. If you don't follow such grounding procedures, you could spend more time looking for proper ground points than you do debugging all other problems.*

Self calibration enhances stability

correct, it shuts off gate U_{3C} to prevent further changes in the DAC's output resistance. On the next measurement cycle, CAL switches LOW, causing relay K_1 to apply the RUT voltage to the sample/hold circuitry. The resulting voltage at A_3's output then connects to a DPM via pot R_{17}, which adapts A_3's full-scale output to the full-scale level the DPM requires.

Timing components control measurement periods

Proper timing for these measurement cycles involves the operation of A_5, Q_4, Q_5, U_{4A}, U_{5A}, U_{6A}, U_{6B}, U_{7A}, U_{7B} and U_{4B}. These components constitute the system's sequencer/controller.

The first step in timing control is generation of a signal that defines the 500-msec measurement periods; amplifier A_5 and transistors Q_4 and Q_5 accomplish this function. Furthermore, A_5 monitors the ac line and locks the measurement cycles to the line to reduce 60-Hz-hum effects.

The output of the A_5, Q_4, Q_5 combination drives

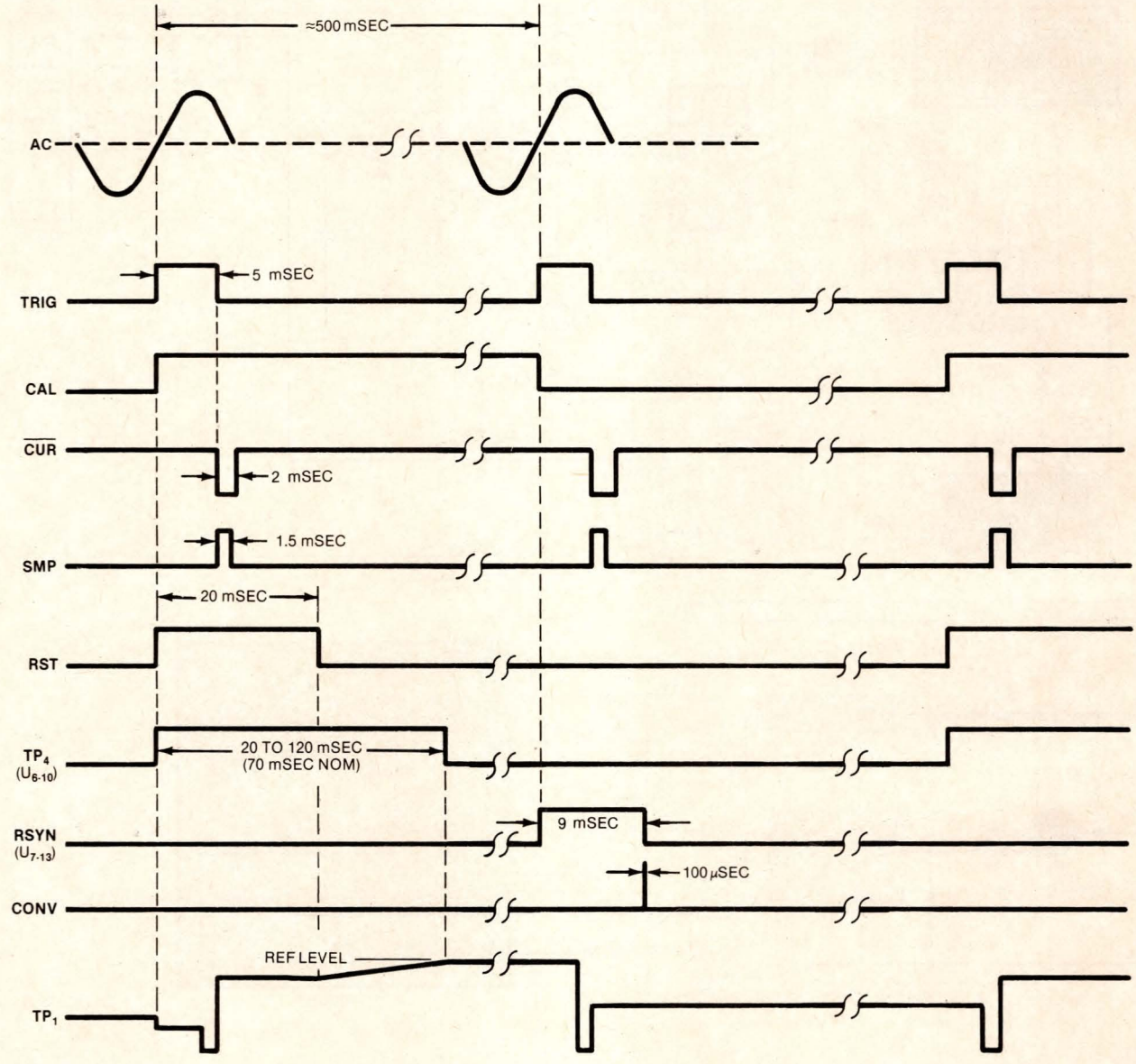

Fig 2—Synchronizing measurement sequences *to ac-line zero crossings reduces 60-Hz-hum effects. The timing signals shown correspond to the signals labeled in* ***Fig 1.*** *The only analog signal in the group, TP_1, shows the adjustment in amplifier A_3's output voltage in response to the shunt voltage generated during the self-calibration cycle. The indicated reference level corresponds to a 2-mΩ resistance; self calibration is complete when A_3's output reaches this level.*

one-shot U_{4A}, which in turn generates a 5-msec-wide TRIG pulse. This signal drives toggle flip flop U_{5A}, in turn driving Q_1 and causing relay K_1 to alternately switch the reference and measurement voltages to sample/hold capacitor C_4.

One-shot U_{6A} furnishes a $\overline{CUR}$ pulse, which controls the test current. U_{6B} generates a signal (SMP) that controls the sample/hold circuitry. U_{7B}'s output (CONV) signals the DPM to begin voltage conversion.

Testers based on this design technique have achieved full-scale ranges to 200 mΩ. You can adapt the technique to even higher ranges depending on your ability to control the smaller test currents required for the larger reference and RUT resistances. **EDN**

Author's biography

Jules Schlesinger, chief engineer at UPA Technology Inc, Syosset, NY, designs instruments for nondestructive test using resistive, eddy-current and beta-backscatter techniques. Before serving 7 yrs at UPA Technology, he worked at Eaton's AIL Div for 14 yrs. Jules earned a BEE and MEE at the City College of New York and has served as an adjunct professor there. He holds two patents and is a member of the IEEE.

Acknowledgment

The author thanks Barry Rutkin, former UPA Technology engineer, for design and development help.

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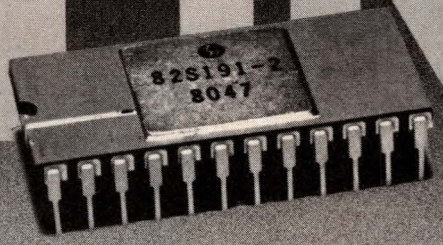

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Memory-error program evaluates reliability tradeoffs

RAM-error-correction procedures provide benefits—and entail problems—that depend on memory organization, failure rate and maintenance. A computer program tells you how these factors influence system reliability.

Steven Grossman and **Fred Jones,** Mostek Corp

Using the computer program presented in this 2-part series, you can explore the system-reliability effects of incorporating single-bit-error correction in RAM arrays.

Small arrays with long mean time to error (MTTE) usually don't incorporate error correction because it contributes little to—and sometimes even reduces—reliability, despite its high cost and complexity. But larger systems with short MTTE profit significantly when error correction combines with periodic hard- and soft-error maintenance.

The Microsoft BASIC computer program described here implements a probabilistic memory-reliability model; it calculates the probability of and mean time to double-bit hard or soft errors in any word of a ×1-bit-RAM array. This first part of the series explains the underlying assumptions and concepts involved in deriving the program. To demonstrate practicality, a sample program run computes a typical memory system's reliability. Part 2 will detail the impact of varying system parameters on reliability.

Start with basic error definitions

Study of a memory system's reliability must begin at the component level. Obviously, reliable memory systems require devices with low failure rates, although even highly reliable devices fail eventually because of internal physical changes (hard-error mechanisms).

Such hard errors become obvious when a memory device yields erroneous data and a rewrite operation doesn't correct the error. The exact number of failed locations associated with a single failure or hard error depends mostly on the failure mechanism and the device's internal organization.

Accordingly, the average percentage of a device lost because of a hard error is an input parameter important to the reliability model presented here. In practice, the distribution of device failures isn't constant; the failure rate generally decreases with time, assuming the absense of RAM wearout mechanisms associated with end of life.

In addition to hard errors, the reliability model also considers soft ones such as those produced by alpha-particle radiation. Because soft errors aren't catastrophic, you can correct them by rewriting the error location. And note that alpha-particle radiation generally affects only one location in a storage device; that location then has the same probability of encountering another soft error as any other location in the device.

Unlike hard errors, most soft errors occur at a rate that remains constant over long periods of time. But while alpha-type error rates don't vary with time, they do change as a function of the device's access rate.

Additionally, soft errors resulting from noisy system environments or vendor-specification violations often remain unpredictable and affect more than one storage location. Thus, the reliability model doesn't include this soft-error type because you can avoid it with careful design.

By using redundant parity check bits, you can readily detect and correct hard and soft errors in memory arrays. Hamming or other single-error-correcting codes (EDN, May 20, 1980, pg 153) find widespread use in RAM systems to correct single-bit errors within a fetched word. Even with single-error-correction capability, though, multiple-bit errors within the same accessed word go uncorrected and can cause system failures. But because multiple-bit-error correction is rarely used, the reliability model focuses on single-bit-error correction. With appropriate system maintenance, single-bit correction generally ensures acceptable reliability.

System reliability model handles hard and soft errors

removes memory blocks containing hard errors from available system memory; data within these blocks is relocated, and the blocks are deallocated from the available memory's page pool. Each time the deallocation process occurs, however, the total amount of available system memory decreases.

Maintenance techniques aid system reliability

The model considers both hardware and software maintenance techniques:

- *Soft-error scrub*—a software or hardware method—purges correctable soft errors from the memory system.
- *Hard-error maintenance*—a hardware service—replaces failed devices—(hard errors only) in the memory system.
- *Memory deallocation*—a software technique for use only with mapped memory systems—

Reliability model aims at memory array

To enhance flexibility, the reliability model allows you to specify individual maintenance parameters such as block size for memory deallocation and time intervals between applied maintenance techniques. And to avoid complexity, the model doesn't consider memory-system support circuits. Instead, it focuses on the system's storage portion to accurately calculate the occurrence

```
50 REM  PROGRAM TO CALCULATE PROBABILITY OF AND MEAN TIME TO SECOND
60 REM  HARD OR SOFT ERROR IN ANY WORD OF A COMPUTER MEMORY SUBSYSTEM

70 REM ** COPYRIGHT STEVEN GROSSMAN/FRED JONES, MOSTEK CORPORATION 1980 **

100 PRINT CHR$(12): REM  CLEAR SCREEN
110 FLAG=0
115 REM  INITIALIZE SYSTEM PARAMETERS
120 P=.10
130 RD=1E8
140 REP=1E8
150 K=2048: DA=1E8
160 INPUT "BITS PER WORD";BW: IF FLAG=1 THEN 440
170 INPUT "WORDS PER SYSTEM (K)";W: W=W*1024: IF FLAG=1 THEN 440
180 INPUT "DEVICE SIZE (K BITS)";N: N=N*1024: IF FLAG=1 THEN 440
190 INPUT "SOFT ERROR RATE (%/1K HRS.)";ES: IF FLAG=1 THEN 440
200 INPUT "HARD FAILURE RATE (A,B,C IN A(T^B-(T-1)^B)+C % IN T'TH 1K HR. PERIOD)
";A,B,C
210 IF FLAG=1 THEN 440

220 PRINT CHR$(12)
290 PRINT "*************************************************************************
**********"
300 PRINT "   PARAMETRIC SUMMARY TABLE": PRINT
310 PRINT TAB(11);"SYSTEM CONFIGURATION"
320 PRINT " 1 BITS PER WORD = ";BW
330 PRINT " 2 WORDS PER SYSTEM = ";W/1024;"K"
340 PRINT " 3 DEVICE SIZE = ";N/1024;"K BITS"
350 PRINT: PRINT TAB(11);"ERROR RATES"
360 PRINT " 4 SOFT ERROR RATE = ";ES;"%/1K HOURS"
370 PRINT " 5 HARD FAILURE RATE = (";A;"(T ^";B;"- (T-1) ^";B;") +";C;") % IN T'
TH 1K HOURS"
380 PRINT " 6 PERCENT OF DEVICE LOST DUE TO HARD FAILURE = ";P*100;"%"
390 PRINT: PRINT TAB(11);"MAINTENANCE PARAMETERS"
400 PRINT " 7 SOFT ERROR SCRUB INTERVAL = ";RD*10;" DAYS"
410 PRINT " 8 FAILED MEMORY REPLACEMENT INTERVAL = ";REP*10;" DAYS"
420 PRINT " 9 MEMORY DEALLOCATION = ";K/1024;"K WORDS PER HARD FAILURE EVERY ";D
A*10;" DAYS"
430 PRINT: PRINT "*************************************************************
**************"

440 PRINT:INPUT "IS A CHANGE TO THE PARAMETRIC SUMMARY TABLE REQUIRED";TC$
450 IF LEFT$(TC$,1)="N" THEN 500
460 PRINT: INPUT "WHAT IS LINE NUMBER OF PARAMETER TO BE CHANGED";PN
470 FLAG=1
480 IF PN>9 OR PN<1 THEN 460
490 ON PN GOTO 160,170,180,190,200,530,550,570,590
500 INPUT "DO YOU WANT AN UPDATED SUMMARY TABLE";ST$
510 IF LEFT$(ST$,1)="Y" THEN 220
520 GOTO 615
530 INPUT "PERCENT OF DEVICE LOST DUE TO HARD FAILURE";P: P=P/100
540 GOTO 440
550 INPUT "SOFT ERROR SCRUB INTERVAL (DAYS)";RD: RD=RD/10
560 GOTO 440
570 INPUT "FAILED MEMORY REPLACEMENT INTERVAL (DAYS)";REP
580 REP=REP/10: GOTO 440
590 INPUT "MEMORY DEALLOCATION (K WORDS PER HARD FAILURE EVERY D DAYS)";K,DA
600 K=K*1024: DA=DA/10
610 GOTO 440
615 TS=1E12: IF ES<=0 THEN 690
620 TS=(100000/240)*N/(ES*BW*W)    :REM  TIME TO SOFT HIT
690 PRINT                          :REM  HEADINGS
700 PRINT "EXISTING","EXISTING","ALLOCATED"," DAYS", " DOUBLE"
710 PRINT "HARD HITS","SOFT HITS","GOOD WORDS","ELAPSED","HIT PROB."
720 PRINT
725 LIM=.999                       :REM  USED FOR DETERMINING WHEN TO PRINT VALUES
740 SWFAIL=0:HWFAIL=0          :REM  BAD WORDS DUE TO SOFT AND HARD ERRORS
750 SPROB=1:HPROB=1:PROB=1     :REM  1 - DBL BIT HIT PROB. DUE TO SOFT,
755                             REM  HARD, AND ALL ERRORS RESPECTIVELY
760 SRD=RD: S=0
770 HREP=REP
780 HDA=DA: ALL=W: HID=0
785 IF K<=0 THEN HDA=1E12

787 REM  SET TIMES TO SOFT AND INITIAL HARD HIT
790 SOFT=TS
795 IF (A=0 OR B=0) AND C=0 THEN HARD=1E12 ELSE HARD=100*N/((A*(.24^B)+.24*C)*BW
*W)

800 REM  NOW ITERATE AT 10 DAY INTERVALS
810 FOR T=1 TO 2000    :REM  UP TO 20,000 DAYS OR 55 YEARS
820 SRD=SRD-1: HREP=HREP-1: HDA=HDA-1
830 REM  COUNT DOWN ITERATIONS TO MAINTENANCE

840 IF SRD>0 THEN 900: REM  SCRUB SOFT ERRORS
850 SPROB=1
860 PROB=HPROB
870 SWFAIL=0: S=0
880 SRD=SRD+RD
890 IF SRD<=0 THEN 880

900 IF HREP>0 THEN 970: REM  REPLACE FAILED DEVICES
910 HPROB=1
920 PROB=SPROB
930 HWFAIL=0: HID=0
940 ALL=W
950 HREP=HREP+REP
960 IF HREP<=0 THEN 950

970 IF HDA >0 THEN 1050: REM  DEALLOCATE FAILED MEMORY
980 HPROB=1
982 DH=HID*K    :REM  DEALLOCATED WORDS
985 IF HID>0 THEN PROB=1 ELSE 1030
990 HWFAIL=HWFAIL-DH
1000 SI=S*(ALL+HWFAIL)/ALL    :REM  TO COMPENSATE FOR DEALLOCATED SOFT ERRORS
1005 IF HWFAIL<0 THEN HWFAIL=0
1010 ALL=ALL-DH    :REM  "ALL" IS ALLOCATED WORDS IN SYSTEM
1012 IF SI<=1 THEN 1028
1015 FOR J=1 TO SI-1
1020 PROB=PROB*(ALL-J)/(ALL-J/BW)    :REM  RECALCULATE PROB. BASED ON JUST SOFT E
RRORS
1025 NEXT J
1028 HID=0
1030 HDA=HDA+DA
1040 IF HDA<=0 THEN 1030

1050 SOFT=SOFT-1: HARD=HARD-1
1060 REM  COUNT DOWN ITERATIONS TO A HIT

1070 IF SOFT>0 THEN 1150: REM  PROCESS SOFT ERROR
1080 SPROB=SPROB*(W-S)/(W-S/BW)    :REM  PROB. DUE TO SOFT ERRORS ONLY
1090 BADW=SWFAIL+HWFAIL
1100 PROB=PROB*(ALL-BADW)/(ALL-BADW/BW)    :REM  PROB. DUE TO ALL ERRORS
1110 SWFAIL=SWFAIL+1
1120 S=S+1
1130 SOFT=SOFT+TS
1140 GOTO 1070

1150 IF HARD>0 THEN 1220: REM  PROCESS HARD ERROR
1160 BH=HID*(P*N*2-1): IF BH>HID*N THEN BH=HID*N: IF BH<0 THEN BH=0
1170 BADW=S*P*N+BH
1180 HPROB=HPROB*(ALL-BH)/(ALL-BH/BW)    :REM  PROB. DUE TO HARD ERRORS ONLY
1190 PROB=PROB*(ALL-BADW)/(ALL-BADW/BW) :REM  PROB. DUE TO ALL ERRORS
1193 HWFAIL=HWFAIL+P*N
1196 HID=HID+1
1200 HARD=HARD+100*N/((A*((.24*(T+1))^B-(.24*T)^B)+(.24*C))*BW*W)
1205 REM  RECALCULATE TIME TO NEXT HIT BASED ON WEIBULL DIST. PARAMETERS
1210 GOTO 1150

1215 REM  PRINT RESULTS AT INCREMENTS OF PROBABILITY SET BY "LIM" BELOW
1220 IF PROB>LIM THEN 1250
1230 IF LIM>.951 THEN LIM=LIM-.001 ELSE LIM=LIM-.05
1235 IF PROB<=LIM THEN 1230
1240 PRINT HID,S,ALL-(SWFAIL+HWFAIL),T*10,1-PROB
1245 IF LIM<.45 THEN 1260
1250 NEXT T

1255 REM  RESTART PROGRAM IF DESIRED
1260 PRINT: INPUT "DO YOU WISH TO RETURN TO THE PARAMETRIC SUMMARY TABLE";T$
1270 IF LEFT$(T$,1)="Y" THEN 220
1280 PRINT: INPUT "DO YOU WISH TO RESTART PROGRAM";T$
1290 IF LEFT$(T$,1)="Y" THEN 100
1300 STOP
1310 END
```

Fig 1—Written in Microsoft BASIC, *this computer program calculates the probability of and the mean time to double-bit hard or soft errors in any word of a ×1-bit RAM array.*

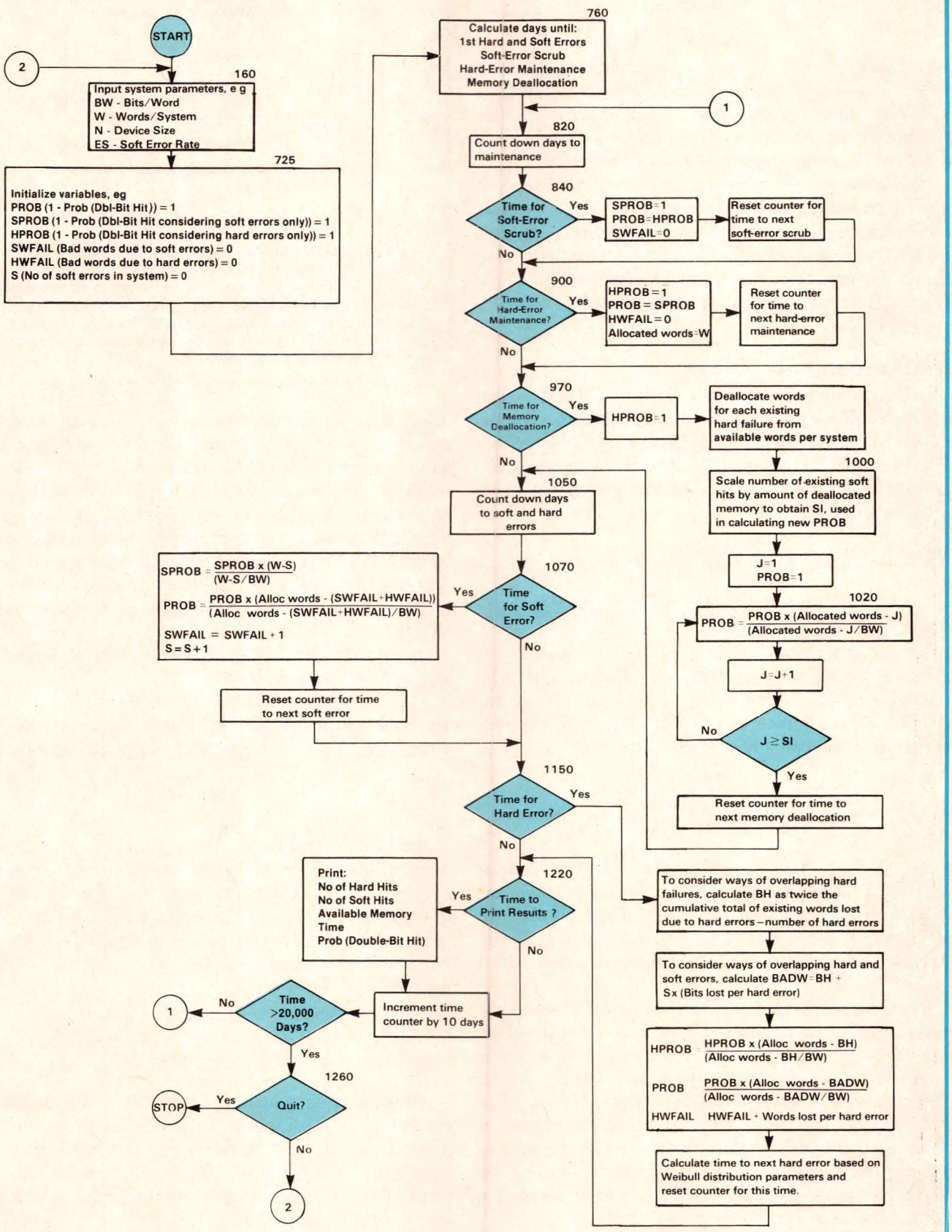


Fig 2—A flowchart *represents the implementation of the memory-system reliability model. Statement numbers outside certain boxes provide correlation with* ***Fig 1****'s program.*

probability of uncorrectable combinations of hard and/or soft errors in a single-error-correcting system. You can then combine this memory-array failure probability with the support circuits' failure probability to establish the memory system's overall reliability.

Because support circuits vary in complexity depending on the application, a generalized support-circuit reliability model is difficult to construct. Support-circuit reliability can be easier to calculate than memory-array reliability, though, because a single error within the support circuits generally causes a system failure.

MTTE predicts error occurrences

Before analyzing a memory array's reliability when it's provided with error-correction capabilities, determine the array's reliability without error correction. You can easily perform this task by computing the array's MTTE as a function of the component error rates. Specifically,

$$\text{MTTE} = \frac{1}{(\text{error rate per device})(\text{devices per system})}$$
$$= \frac{(\text{bits per device})}{(\text{error rate per device})(\text{bits per word})(\text{words per system})}.$$

As an example of such a calculation, consider a 256k×16-bit memory system composed of 16k×1-bit dynamic RAMs. Assume that the system's overall component error rate equals 0.1% per 1000 hrs (one error per 1,000,000 device-hrs). Therefore,

$$\text{MTTE} = \frac{16\text{k}}{(0.001/1000)(16)(256\text{k})}$$
$$= 3906.25 \text{ hrs} = 162.76 \text{ days}.$$

Thus, a 50% chance exists that an error will occur within 163 days of operation. If this memory system has single-error-correction capability, though, an error in one storage device should not cause a system failure. Only two or more errors in the same word would affect system reliability.

Error correction also has an interesting effect on the mean time between device errors (hits). If you add six bits to each 16-bit word to obtain single-error-correction and double-error-detection capabilities, for instance, the system's MTTE with 22-bit words *drops* from 163 to 118 days. Why? Because device errors occur more frequently when you increase the number of memory components. On the other hand, the system reliability model demonstrates that error correction can dramatically improve overall reliability.

Double-bit-hit probability forms model core

System reliability with error correction relies heavily on the occurrence probability of two or more errors in the same memory word. The probability

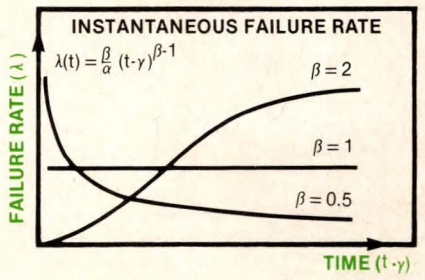


Fig 3—The extremely flexible Weibull distribution *adapts readily to RAMs' infant-mortality and random-failure characteristics associated with the classic bathtub-shaped life distribution curve. α represents a scale factor, β a shape parameter and γ a time-delay parameter. Based on historical failure data, NMOS RAMs' β typically equals 0.5, γ is zero and α is related to device reliability.*

calculation for finding two or more persons with the same birthday in a group closely resembles this double-error probability calculation. In the birthday example, the first person considered has 365 out of 365 days on which to have a birthday without causing an overlap of dates; the second person's birthday can occur on only 364 out of 365 days without causing an overlap with the first person's. Similarly, the third person's birthday can occur on one of 363 out of 365 days, and so on.

Hence, the probability of no overlap of birthdays among three persons is

$$(365/365)\times(364/365)\times(363/365)=0.99.$$

You can calculate the probability of an overlap of birthdays (P) among a group of N persons as follows:

$$P = 1 - \prod_{i=0}^{N-1} \frac{365 - i}{365}.$$

You can extrapolate this equation to one for memory-system reliability by substituting "words per system" for "days per year" and "loss of some number of words per error" for "loss of one available birthday per year for each person in the group." Then, for the basic memory reliability model, the probability of double-bit hits (P_D) is:

$$P_D = 1 - \prod_{i=1}^{\text{NO OF HITS}} \frac{\text{error-free words after hit i}}{(\text{words per system}) - \left(\frac{\text{bad words after hit i}}{\text{bits per word}}\right)}.$$

Although this equation refers to a double-bit-hit probability, it also includes the smaller probability of more than two hits occurring in the same memory word. In most cases, though, by the time the probability of three or more hits becomes significant, the memory system has become highly prone to double-bit hits.

Note that you subtract the second term in the denominator from "words per system" to compensate for the fact that two hits in one memory bit in a word don't create a system failure. That is, if you assign 22

bits per word and an error exists in a word, then on average, one of the 22 additional errors that might occur in this word takes place in this same bit position. But such an occurrence doesn't act as a double-bit error.

This basic double-bit-hit approach provides the nucleus of the reliability-model program. **Fig 1** lists the program, and **Fig 2** presents a flowchart describing its operation.

Reliability model works with ×1 devices

In addition to considering accumulated error effects, the program can examine the effects of the various maintenance techniques that remove memory-system errors. If you want to model the memory-deallocation technique, though, specify at least as many words to be deallocated per hard error (the block size) as are affected by the error. Otherwise, a complete deallocation won't occur.

Because maintenance is periodic, the program iterates over time rather than over the number of hits. Even so, the program can model nonperiodic hard-error occurrences with a Weibull distribution (**Fig 3**). Using this approach, you provide parameters for A, B

```
BITS PER WORD? 22
WORDS PER SYSTEM (K)? 256
DEVICE SIZE (K BITS)? 16
SOFT ERROR RATE (%/1K HRS.)? .1
HARD FAILURE RATE (A,B,C IN A(T^B-(T-1)^B)+C % IN T'TH 1K HR. PERIOD)? .05,1,0
*******************************************************************************
   PARAMETRIC SUMMARY TABLE

          SYSTEM CONFIGURATION
 1 BITS PER WORD =  22
 2 WORDS PER SYSTEM =  256 K
 3 DEVICE SIZE =  16 K BITS

          ERROR RATES
 4 SOFT ERROR RATE =  .1 %/1K HOURS
 5 HARD FAILURE RATE = ( .05 (T ^ 1 - (T-1) ^ 1 ) + 0 ) % IN T'TH 1K HOURS
 6 PERCENT OF DEVICE LOST DUE TO HARD FAILURE =  10 %

          MAINTENANCE PARAMETERS
 7 SOFT ERROR SCRUB INTERVAL =  1E+09  DAYS
 8 FAILED MEMORY REPLACEMENT INTERVAL =  1E+09  DAYS
 9 MEMORY DEALLOCATION =  2 K WORDS PER HARD FAILURE EVERY  1E+09  DAYS

*******************************************************************************

IS A CHANGE TO THE PARAMETRIC SUMMARY TABLE REQUIRED? NO
DO YOU WANT AN UPDATED SUMMARY TABLE? NO

EXISTING      EXISTING      ALLOCATED      DAYS          DOUBLE
HARD HITS     SOFT HITS     GOOD WORDS     ELAPSED       HIT PROB.

 1             2             260504         240           .0119421
 1             3             260503         360           .0178457
 2             4             258863         480           .0587201
 3             6             257223         720           .136062
 3             7             257222         830           .151557
 4             8             255582         950           .236639
 4             9             255581         1070          .254898
 5             10            253942         1190          .351214
 6             12            252302         1430          .470072
 7             14            250661         1660          .584401

DO YOU WISH TO RETURN TO THE PARAMETRIC SUMMARY TABLE? NO

DO YOU WISH TO RESTART PROGRAM? NO
```

Fig 4—A sample run of the reliability program *presents reliability characteristics for the reference memory system described in the* ***table.*** *By plugging in the system's key parameter values, you get a parametric summary table and a listing of applicable hard- and soft-error information.*

Double-bit-hit scheme serves as the reliability program's basis

and C in the following equation:

$$\text{failure rate} = A(t^B - (t-1)^B) + C.$$

This equation defines a failure rate between the (t−1)th and the (t)th 1000-hr period. This rate equals the integral of the Weibull distribution presented in **Fig 3**, in which α equals 100/A (with A a percentage) and β equals B. Assume that the γ term is zero. The C enters a constant offset to the Weibull distribution's failure rate.

Consider further the reliability program's modeling of hard and soft errors. One constant error rate models the soft-error occurrences. Even though the program also uses one hard-error rate to model hard-error occurrences, this rate's meaning is considerably more complicated than that for soft errors. This complication arises because some memory devices, such as dynamic RAMs, are characterized by a variety of hard-failure mechanisms that can affect single bits, rows, columns or larger device portions. Rather than consider a separate rate for each failure mechanism, the program models the hard-failure modes using one failure distribution and an additional parameter associated with the average percentage of device lost due to a hard error.

To elaborate, the percentage of device lost depends on the failure frequencies of the different hard-failure mechanisms and on other orthogonality considerations. (Because one hard error in a memory array utilizing single-chip-wide-word RAMs can affect several bits in one word, you can apply this model only to systems composed of ×1 devices.) With 16k×1 dynamic RAMs (internally arranged in a 128×128 matrix) in a 16k-word system, for instance, an internal row failure in one RAM and a column failure in another almost certainly cause a double-bit hit, even though each hard error affects only 128 out of 16,384 bits.

If, for example, out of all hard errors, 20% are column failures, 10% are row failures and 8% are entire-RAM failures, you can compensate for orthogonality factors by considering 2% (20%×10%) of the 128-bit row and column failures to be entire-RAM failures. In other words, to calculate the average percentage of device lost, consider 10% (8% entire-RAM failures+2% orthogonality adjustment) as affecting the entire device and 28% (20% column failures+10% row failures−2% orthogonality adjustment) as affecting only 128 bits.

The weighted average of these values and those associated with single-bit and other hard-error types helps determine the percentage used in the program. The model thus does not lose significant precision as a result of substituting one hard-error rate and one percentage for multiple hard-failure mechanisms.

Furthermore, the model makes a conservative but realistic assumption that soft errors and hard failures distribute uniformly throughout the memory system. To correctly model hard errors that affect more than one bit, the program must calculate the number of ways such a multiple-bit error can overlap all other existing errors in the system. If a hard error causes n bits to fail, for instance, areas of n bits around each soft error in the system and 2n−1 bits around each n-bit hard error could overlap the new hard error. What's more, if the hard and soft errors lie tightly spaced, so that these overlap areas themselves overlap and are hence partially counted twice in the model, the program slightly overstates the probability of a double-bit hit. This situation usually occurs only when the memory already contains so many errors that the system becomes significantly prone to double-bit hits.

REFERENCE-MEMORY-SYSTEM PARAMETERS

SYSTEM CONFIGURATION
- WORD SIZE: 22 BITS
- SYSTEM SIZE: 256k WORDS
- DEVICE SIZE: 16k × 1-BIT RAMs

ERROR RATES*
- SOFT-ERROR RATE: 0.1%/1000 HRS
- HARD-FAILURE RATE: 0.05%/1000 HRS (CONSTANT)
- PERCENT OF DEVICE LOST DUE TO HARD FAILURE: 10%

MAINTENANCE PARAMETERS
- SOFT-ERROR SCRUB: NONE
- HARD-ERROR MAINTENANCE: NONE
- MEMORY DEALLOCATION: NONE

*CONSERVATIVE INDUSTRY FIGURES

You can change memory-system parameters

Although the flowchart shown in **Fig 2** doesn't illustrate the input procedure in detail, the program contains an input facility that allows you to view the system parameters in a menu format and easily change them. Because the program's output facility isn't as sophisticated, you can change program statements 1220 through 1245 to print the double-bit-hit probability at desired time intervals.

You can also add a facility to graph the results (Part 2 will show results in that form). However, you must smooth the curves because the probability values generated by the model increase only when errors occur and thus don't follow a smooth curve. Note, however, that periodic soft- and hard-error-maintenance techniques correctly cause discontinuities in the probability curve.

Consider a reliability example

As an example of the reliability model's results, consider the reference memory system defined in the **table.** This system is a typical medium-sized array with error-correction and -detection capabilities. Its 22-bit words allow 16 data bits and six check bits for single-error correction and double-error detection. The system's 256k-word size provides storage for 512k data bytes.

The 16k×1 dynamic RAMs that compose the array exhibit a soft error rate of 0.1% per 1000 hrs of operation. A constant hard error rate of 0.05% per 1000 hrs is assumed for simplicity, although a Weibull distribution with a higher early-life failure rate might be more realistic. Employing the calculations described earlier, the weighted average percentage of device lost per hard error is assumed to be 10%. The error rates and percentage presented represent conservative industry figures for 16k RAMs.

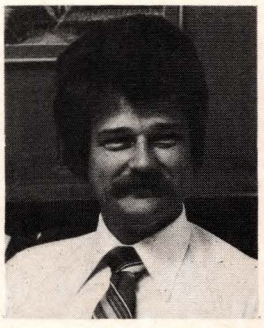
For insight into other system parameters' effects, assume that the reference memory system receives neither a soft-error scrub nor hard-error maintenance. **Fig 4** presents a sample run of the reliability program for this system. Part 2 will examine the effects of varying the system's configuration, error rates and maintenance parameters. **EDN**

Reference

Accelerated Testing Handbook, Technology Associates and Bell Telephone Laboratories, 1978.

Authors' biographies

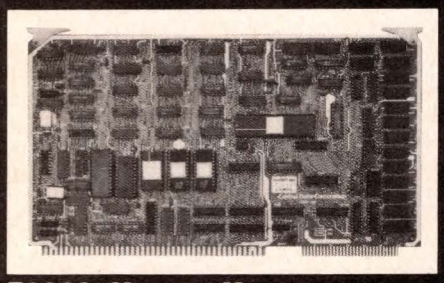
Steven Grossman, a memory-product-line manager at Mostek Corp, Carrollton, TX, handles strategic marketing and financial planning for new devices. Holder of an MBA from the Wharton School of the University of Pennsylvania and a BS in computer science and engineering from the Massachusetts Institute of Technology, he previously worked at International Data Base Systems. Steve maintains membership in Tau Beta Pi and Eta Kappa Nu.



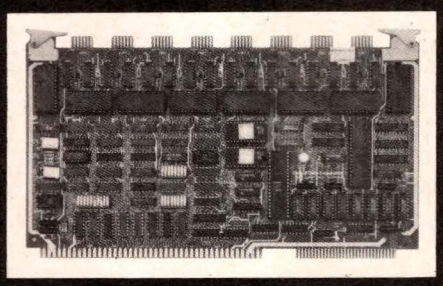
Fred Jones is Mostek's applications-support manager for dynamic, pseudostatic and high-speed ×1 static RAMs. He joined the firm after working for Modular Computer Systems and Motorola Communications Inc. Holder of a BSEE from the University of Florida, Fred belongs to Tau Beta Pi, Eta Kappa Nu and Phi Kappa Phi.

Article Interest Quotient (Circle One)
High **485** ***Medium*** **486** ***Low*** **487**

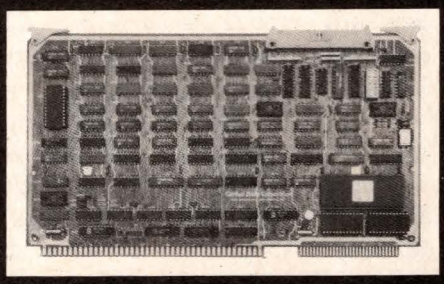
MORE NEW STARS FOR THE MULTIBUS* FROM CENTRAL DATA



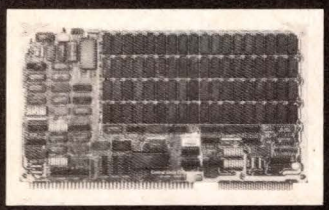
Z8000* Memory Management Processor Board features 4MHz Z8000 running with unique paged/segmented memory management. Includes interrupt controller, interval timers. Can also support PROMs and 9511 APU. Multi-User operating system available. Standard Board $795
Monitor PROMs $90
9511 APU $265



Intelligent Octal I/O Board provides 8: RS-232 ports controlled by on-board 2650 microprocessor. 16K of dual-port RAM allows data transfers with no bus overhead. Includes standard terminal driver program, can hold 4K custom driver program in PROM. $700.



ANSI Winchester Controller fully conforms to the proposed ANSI standard for 8" winchester disk drives. Custom microprogramming available to interface with other disk drive interfaces. Controls up to eight drives. $550.



32K-128K Dynamic RAM Board features low power consumption, standard parity checking, and ultra-high reliability.
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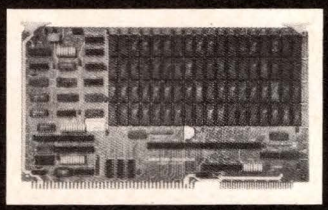
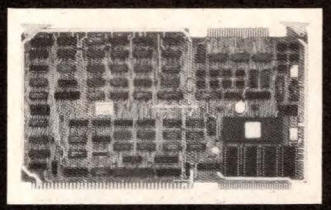
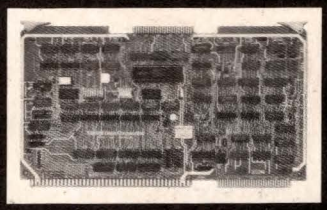
64K-$800 128K-$1350



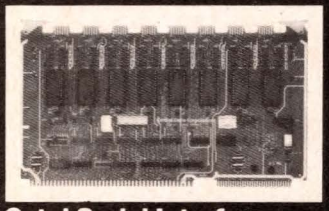
Static Ram Board adds either 16K or 32K of static memory to a Multibus system. 16K—$620
32K—$1100



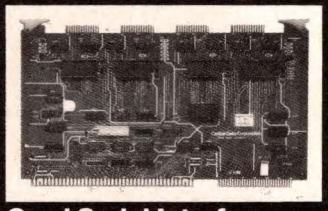
Cartridge Disk Controller Board provides DMA transfers to or from cartridge disk drives with capacities of 10 or 20 Mbytes. $435



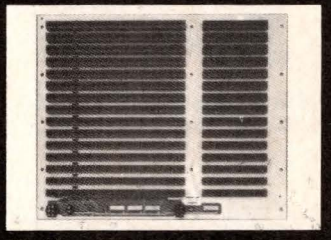
Double Density Floppy Disk Controller adds from one to four double density standard sized floppy disk drives, either single or double-sided. $315



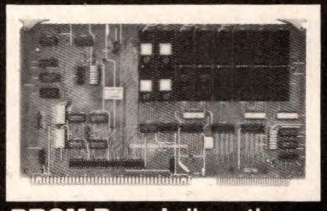
Octal Serial Interface Board allows up to eight EIA RS-232 interfaces. $330



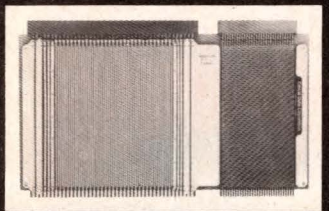
Quad Serial Interface Board hooks up to four EIA RS-232 interfaces to your system. $280



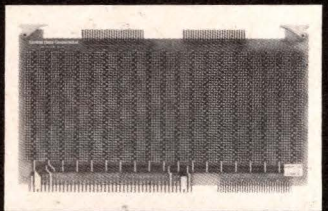
Mother Board can hold up to 15 Multibus cards with both P1 and P2 provided for each card position. $315



PROM Board allows the user to hook between 1K and 128K of PROM to a Multibus system. $140



Extender Board will raise a board being tested up to a height of 6.9 inches. $60



Prototyping Board will accommodate up to 95 16-pin sockets, allowing the user to wire wrap a prototype circuit. $55

*Multibus is a trademark of Intel Corporation
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D (Design Ideas); F (Design Features); M (μC Design Techniques); N (Technology News); P (Feature Products, Editor's Choice)

Circuit Design

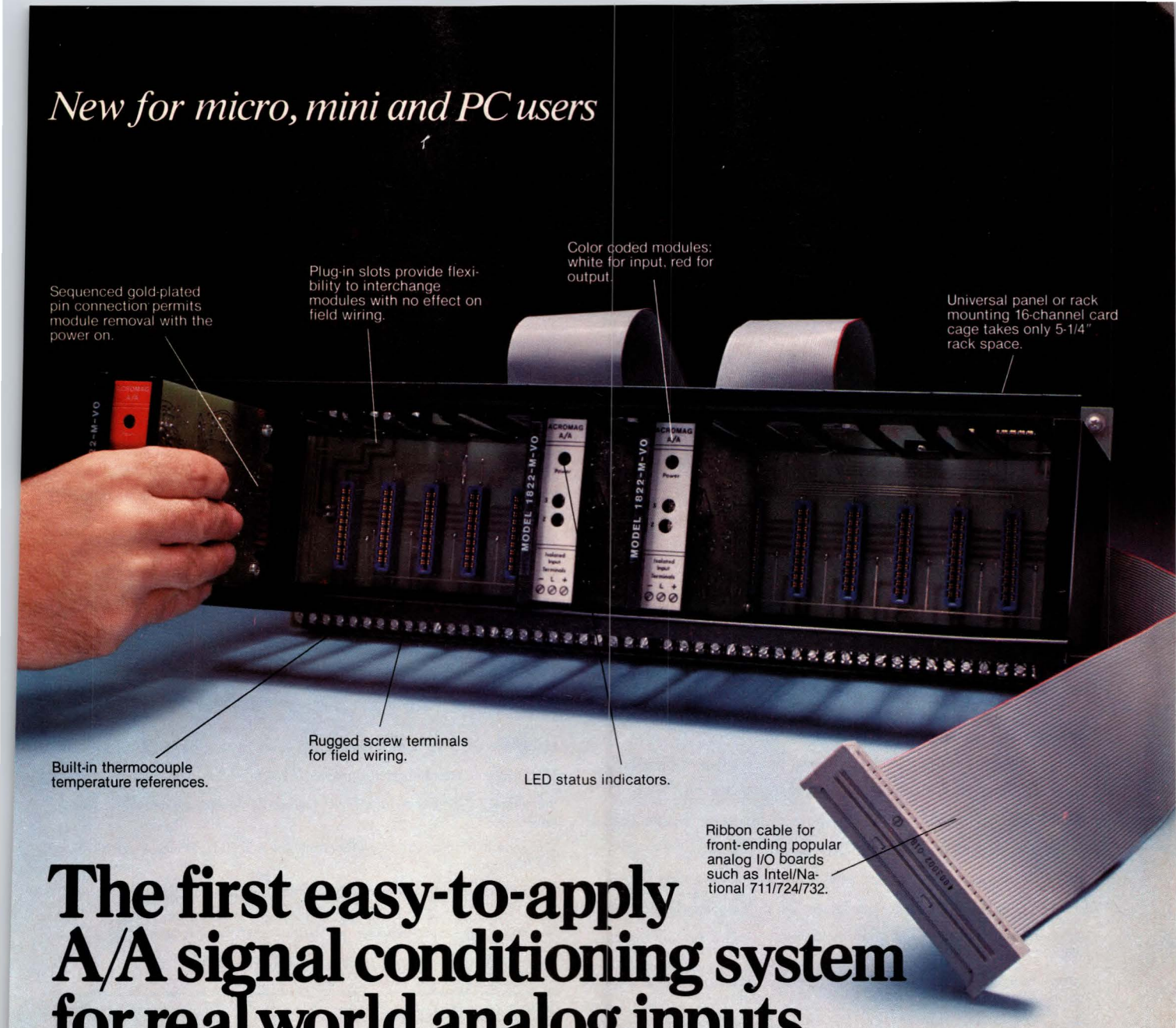
Systems

Article Index
July-December 1980

Semiconductors/ICs

μPs/μCs

New for micro, mini and PC users



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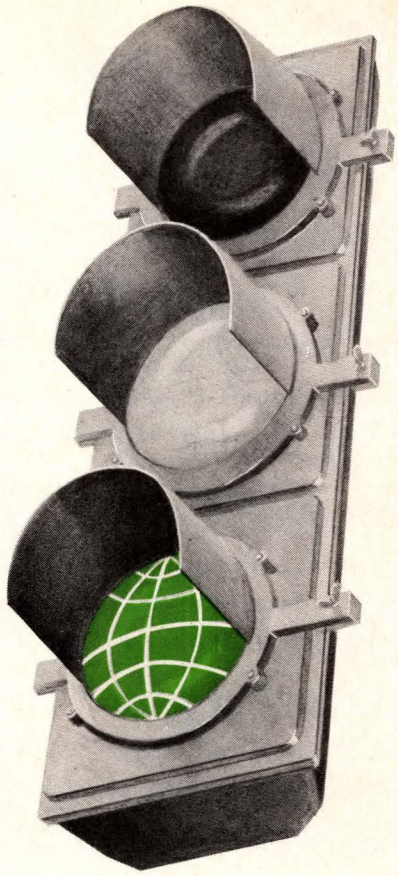
Computers/Peripherals

Instrumentation, Test & Measurement

WE'VE GIVEN THE WORLD THE GREEN LIGHT.



Sprague Electric offers you the finest and broadest choice of interface ICs for driving fluorescent displays.

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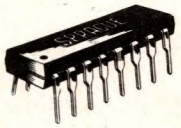
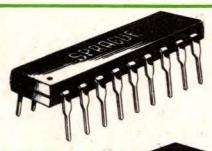
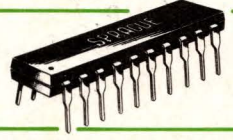
	DEVICE TYPES	CHANNELS/DIP	MIN BV (OUTPUT)	DIP
	UDN-6116A-2, 6126A-2	6	+ 60 V	16 lead
	UDN-6116A, 6126A	6	+ 80 V	16 lead
	UDN-6118A-2, 6128A-2	8	+ 60 V	18 lead
	UDN-6118A, 6128A	8	+ 80 V	18 lead
	UDN-6118A-1, 6128A-1 Anode driver, gas discharge displays	8	+110 V	18 lead
	UDN-6138A-2, 6148A-2 Split supply (+20 V, −40 V)	8	60 V*	20 lead
	UDN-6138A, 6148A Split supply (+40 V, −40 V)	8	80 V*	20 lead

*Output BV referenced to V_{EE} Max. V_{EE} −40 V

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100-MHz stand-alone scope features IEEE-488 programmability. Oct 5, pg 172 (P)

150-MHz multifunction counter/timer features pulse-measurement capability. Aug 5, pg 149 (P)

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Discrete components in chip packages let you put more parts on pc boards. Nov 20, pg 82 (N)

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Fiber-optic flashes: Fibers, connectors, drawing system. Sept 20, pg 94 (N)

Fiber-optic flashes: Link, training program, patents. Oct 20, pg 63 (N)

Fiber-optics/microcomputer combination replaces automotive wiring harnesses. Nov 5, pg 79 (N)

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Wescon/80. Sept 5, pg 104 (F)

Article Interest Quotient (Circle One)
***High* 482 *Medium* 483 *Low* 484**

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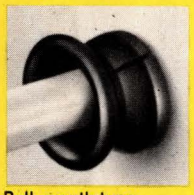
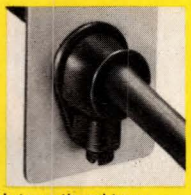

Bell-mouth type


Straight-thru type


Right angle type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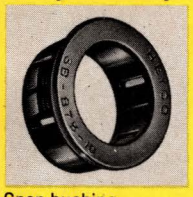
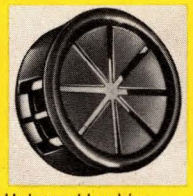

Snap bushing


Shorty bushing


Double insulated bushing


Open/closed bushing


Universal bushing

Snub bushing

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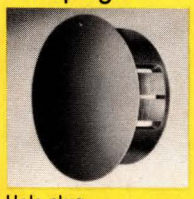
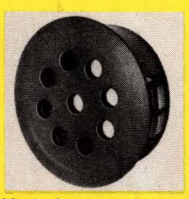
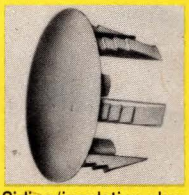

Hole plug


Vent plug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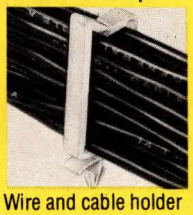
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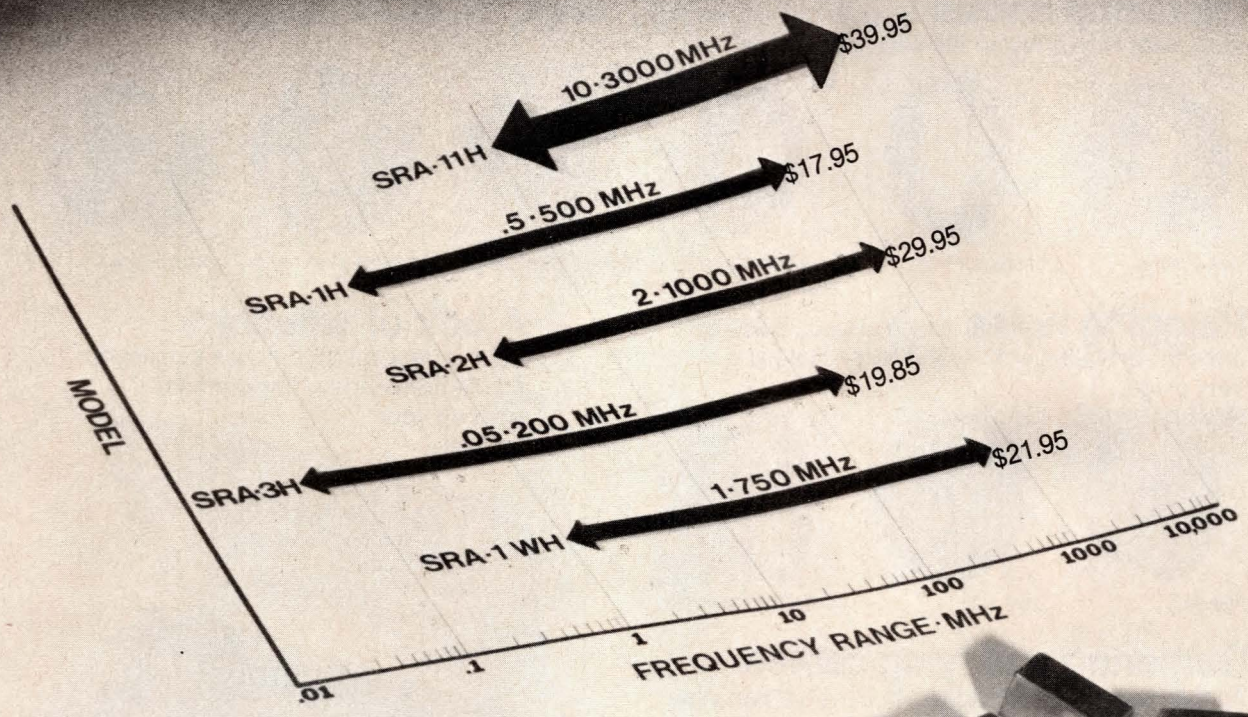

Model	Frequency Range (MHz)	Conversion loss (dB) Total Range	Isolation, dB: Lower band edge to one decade higher LO-RF	Lower band edge to one decade higher LO-IF	Mid range LO-RF	Mid range LO-IF	Upper band edge to one octave lower LO-RF	Upper band edge to one octave lower LO-IF	Price Quant.
SRA-11H	RF, LO-10-3000 IF - 10-1000	9.5 typ. 12 max.	27 typ. 20 min.	27 typ. 20 min.	25 typ. 18 min.	25 typ. 18 min.	23 typ. 16 min.	23 typ. 16 min.	$39.95 (1-24)
SRA-1H	RF, LO-.5-500 IF - DC-500	6.5 typ. 8.5 max.	55 typ. 45 min.	45 typ. 35 min.	45 typ. 30 min.	40 typ. 30 min.	35 typ. 25 min.	30 typ. 20 min.	$17.95 (5-24)
SRA-2H	RF, LO-2-1000 IF - DC-1000	7.5 typ. 9.5 max.	50 typ. 40 min.	45 typ. 35 min.	45 typ. 25 min.	40 typ. 25 min.	35 typ. 25 min.	25 typ. 20 min.	$29.95 (4-24)
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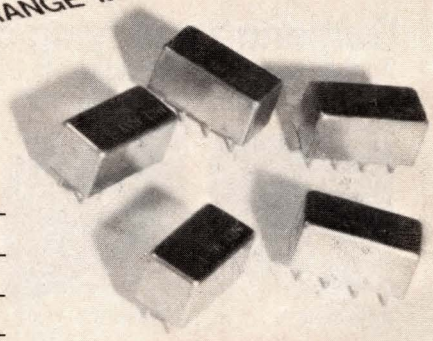
SRA-1WH	RF, LO-1-750 IF - DC-750	5.5 typ. 7.5 max.	50 typ. 40 min.	45 typ. 35 min.	45 typ. 25 min.	40 typ. 25 min.	35 typ. 25 min.	30 typ. 20 min.	$21.95 (5-24)



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15 Rev. F

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Design Ideas

Check memory HIGHs and LOWs in time

William B Fox
Western Electric Co Inc, Columbus, OH

Testing a memory board thoroughly calls for more than just an instantaneous check of the memory's output state. ONEs should be high enough, ZEROs should be low enough and the output should remain within its specifications for a minimum length of time, the data-valid period (DVP). Not all automatic testers can perform these types of checks for each memory read cycle at full speed, but the circuit depicted in the **figure** does the job when used with an instantaneous-check memory tester. You'll need such a circuit for each bit tested.

Input DVP defines the test's time window. When this signal is LOW, both high-speed comparators are disabled and in a 3-state output mode. The pull-up resistors ensure that the state of the leading-edge-triggered data flip flop goes unaltered.

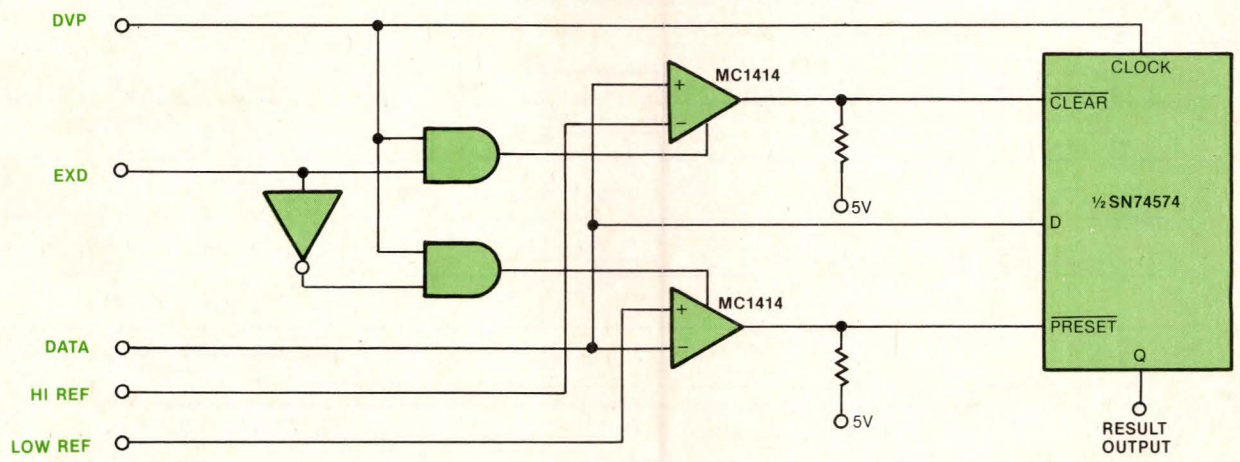
At the beginning of each test cycle, DVP goes HIGH, clocking the data from the memory under test (MUT) into the flip flop—whether that data is correct or incorrect. At the same time, one of the two comparators is enabled, depending on the state of EXD (the data the tester expects to see from the MUT).

Specifically, the high comparator's output goes LOW if the Data line is below the Hi Ref voltage and a ONE is expected, clearing the flip flop and providing the automatic tester with a ZERO when it expects a ONE. The flip flop remains uncleared so long as the data stays above Hi Ref during DVP.

On the other hand, the low comparator's output goes LOW if Data is above the Lo Ref voltage and a ZERO is expected, presetting the flip flop and providing the tester with a ONE when it expects a ZERO. The flip flop is not preset so long as the data stays below the Lo Ref during DVP.

As the test cycle ends, DVP goes LOW, allowing no further state changes in the Result output. Then the tester can check the Result line any time before the beginning of the next time window. **EDN**

To Vote For This Design, Circle No 457



Memory tests are complete *only if each expected ONE or ZERO occurs during the allotted time frame. The Data Valid Period (DVP) input defines the test cycle time by clocking data from the memory under test into the Data input. If a ONE is expected and Data exceeds the Hi Ref level, the flip flop stores a ONE. If the ONE isn't high enough during DVP, a ZERO emerges from the Result output.*

One-shots detect frequency levels

John Dunn
Bertan Associates Inc, Syosset, NY

Fig 1 depicts a frequency-threshold detector you can construct with only two ICs and a "leftover" 2-input AND gate. Four retriggerable monostable multivibrators (one-shots) constitute the frequency discriminator: IC_1, IC_2 and IC_3 determine the threshold frequency, while IC_4 serves as the over/under-flag generator.

The timing relationships shown in **Fig 2** define the design's operation. Below the frequency threshold, pulse E_1's rising edge lags E_3's falling edge. At the threshold, this time lag equals zero. And above threshold, E_1 leads E_3. At the threshold, the AND gate's (IC_5) inputs are driven by the then-coincident E_1 and E_3 signals. The resulting output wave shape ($E_1 \cdot E_3$) triggers IC_4, and the fixed-duration flag (E_4)

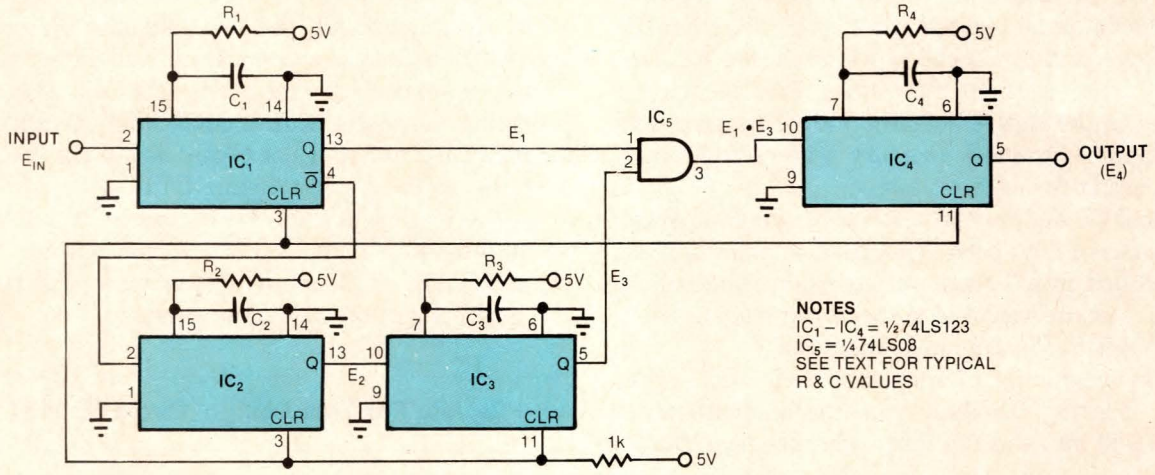


Fig 1—Frequency-threshold sensing *results from comparing a retriggerable one-shot's durations with an unknown input frequency. So long as this frequency is lower than the threshold, the output (E_4) is LOW. But when the input exceeds the threshold, E_4 goes HIGH.*

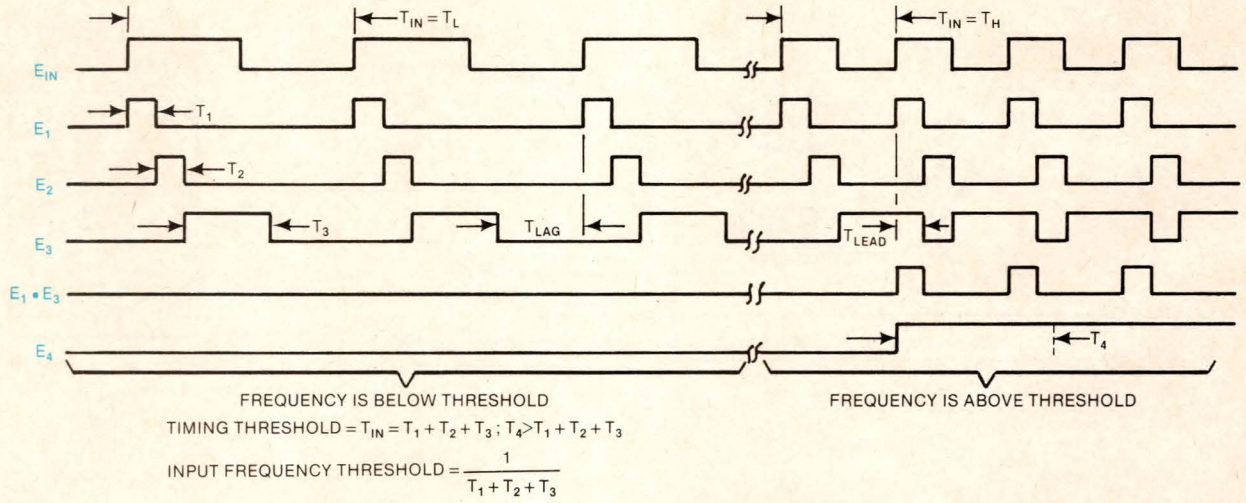


Fig 2—Whenever the input frequency (E_{IN}) is below the threshold frequency, *E_1's rising edge lags E_3's falling edge, and the ANDed result ($E_1 \cdot E_3$) stays LOW. However, when E_{IN} exceeds the threshold, E_1 leads E_3, and the ANDed result is HIGH. This transition triggers the output one-shot (IC_4 in* ***Fig 1),*** *and the E_4 flag goes HIGH for the period defined by T_4.*

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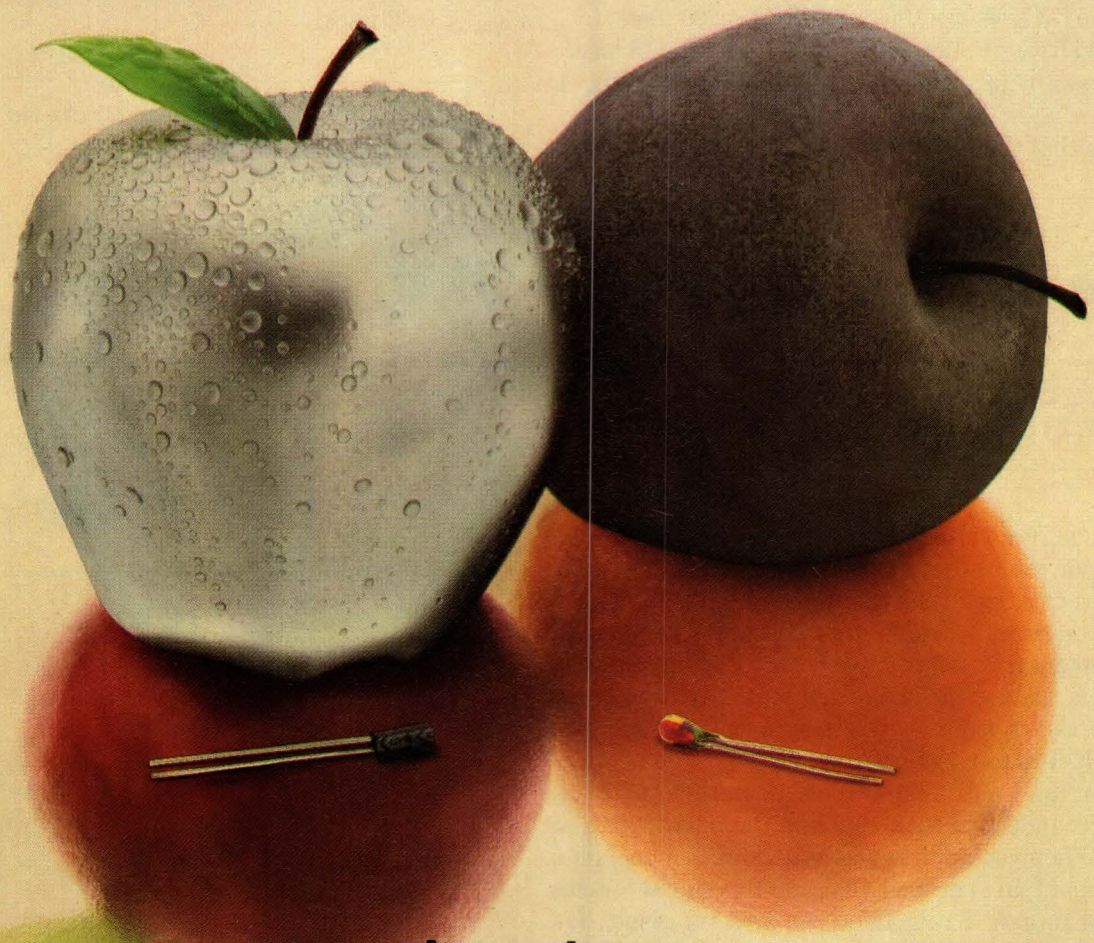

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appears.

Sample calculations of the pertinent time constants (**Fig 2**) demonstrate how you select component values:

$T_1=0.45R_1C_1=0.45\times10k\times220\ pF=0.99\ \mu sec$

$T_2=0.45R_2C_2=0.45\times10k\times220\ pF=0.99\ \mu sec$

$T_3=0.45R_3C_3=0.45\times100k\times0.022\ \mu F=990\ \mu sec$

$T_4=0.45R_4C_4=0.45\times100k\times0.047\ \mu F=2.115\ msec.$

The resulting threshold frequency equals $1/(T_1+T_2+T_3)$ or 1008 Hz.

Note that the factor 0.45 used in these calculations applies only when you employ LS-type one-shot devices. You can use standard 74123 types instead, but then the equation defining the pulse width becomes:

$$T_W=0.28R_XC_X(1+0.7/R_X)$$

Redoing the previous T_1 calculation yields a T_1 (and T_2) of 0.62 μsec. **EDN**

To Vote For This Design, Circle No 458

One IC forms dual-pulse-width one-shot

James L Christensen
Ametek, El Cajon, CA

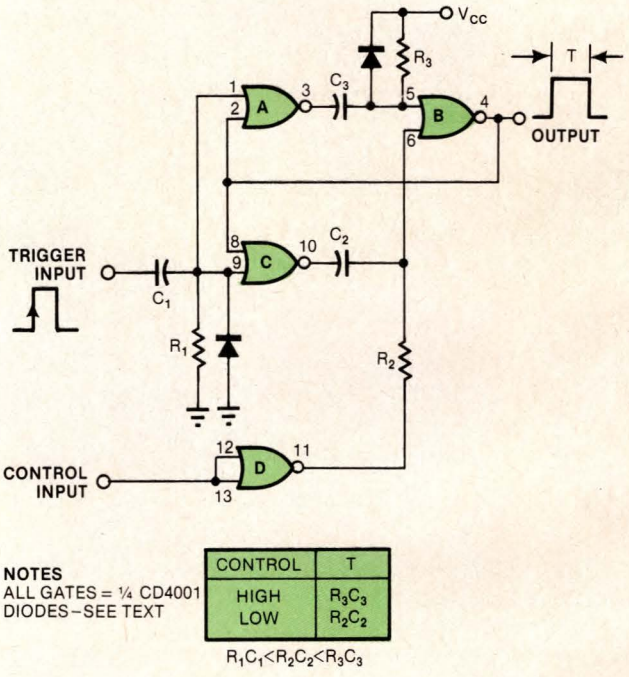
Pulse-width-modulation designs often require a generator whose output pulse width you can shift between two fixed time durations. The circuit shown in the **figure** provides this feature, along with complementary outputs: A positive-going pulse is available at the pin 4 output as a negative-going pulse appears at pin 3. The design calls for only one quad NOR-gate CMOS IC.

When the Control input (pins 12 and 13) is HIGH, R_2 is grounded, in turn enabling the output gate at pin 6. When you apply a positive Trigger input, gate A's output (pin 3) drops LOW, and this signal couples (via C_3) to gate B's input at pin 5. As a result, B's output switches HIGH, holding A's output LOW even after the trigger pulse disappears.

C_3 then starts discharging through R_3, causing the voltage level at pin 5 to decrease exponentially toward V_{CC}. And when the voltage reaches the gate's high input threshold (about $0.7V_{CC}$), the output reverts to a LOW state and terminates the output pulse.

The alternative output pulse width occurs when the Control input is LOW. In that case, R_2 connects to V_{CC} via gate D. The one-shot action in this instance is similar to the HIGH control state, except that now the junctions of both R_2C_2 and R_3C_3 charge toward V_{CC}. However, because the R_2C_2 time constant is the shortest, it reaches the gate's high input threshold first and terminates the output pulse.

You can realize a wide range of timing relationships with this basic design by observing two basic relationships:



Select two different output pulse widths *with this design's Control input. When Control is HIGH, R_3C_3 determines the output's duration; when it's LOW, R_2C_2 applies.*

$$R_1C_1<R_2C_2<R_3C_3.$$

Note that the minimum resistor values should be 10 kΩ. And also note that some manufacturers' CD4001 NOR gates might not incorporate internal input-protection diodes, so you might need to include the optional diodes shown in the **figure** when V_{CC} >9V and/or C_X >0.005 μF. **EDN**

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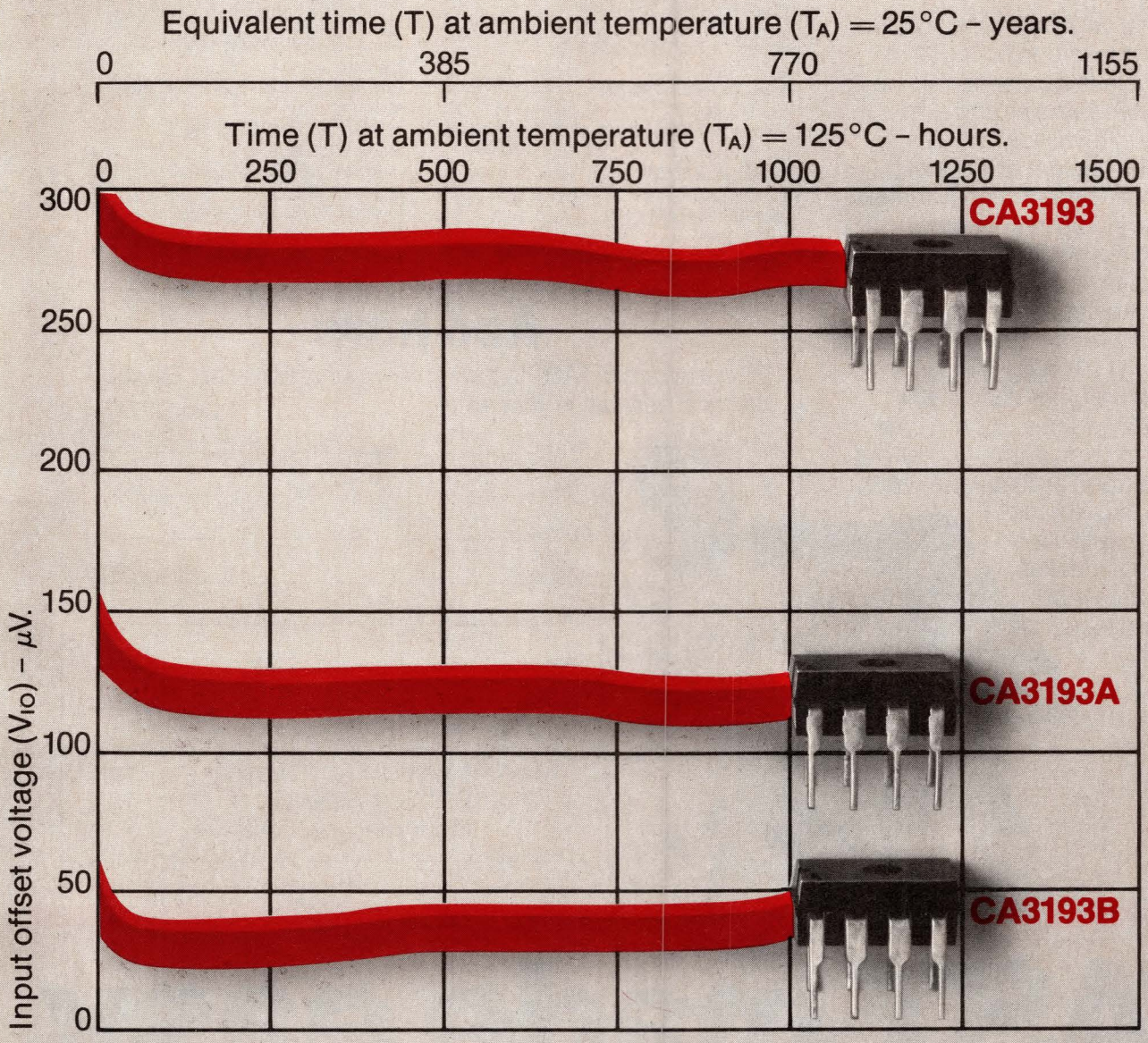

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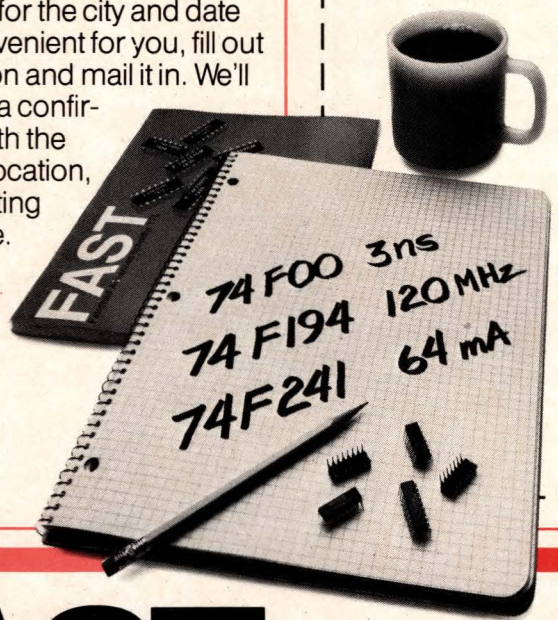

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Switching scheme matches supply to mains

Donald J Brown
db Products, Noblesville, IN

This power-supply design can meet solid-state low-voltage requirements when powered from a wide variety of input-mains voltages—a feature that makes it ideal for any equipment slated for international use. As shown, it provides 12V at 1A. However, changing the components' voltage and/or current limitations alters the design to suit your needs.

Power-supply operation, filtering and regulation all follow well-established rules; the design's novelty lies in the use of switch S_1 to handle wide input-voltage variations while still providing the desired output. Note that S_1 can be either a physically actuated switch accessible to the user or a relay automatically thrown upon insertion of the proper US or non-US (usually 220V ac) cord into a back-apron receptacle.

The design's key feature is simplicity. When the switch is in the 120V ac position, the transformer operates with the full secondary voltage applied to a bridge-rectifier system, whose filtered dc output goes to the regulator.

In the 240V ac position, on the other hand, the transformer is center tapped, supplying the rectifiers with half the transformer's available secondary ac voltage. The bridge thus becomes a full-wave-rectifier system (ignoring two of the diodes), and a filtered dc output at approximately the same voltage goes to the regulator.

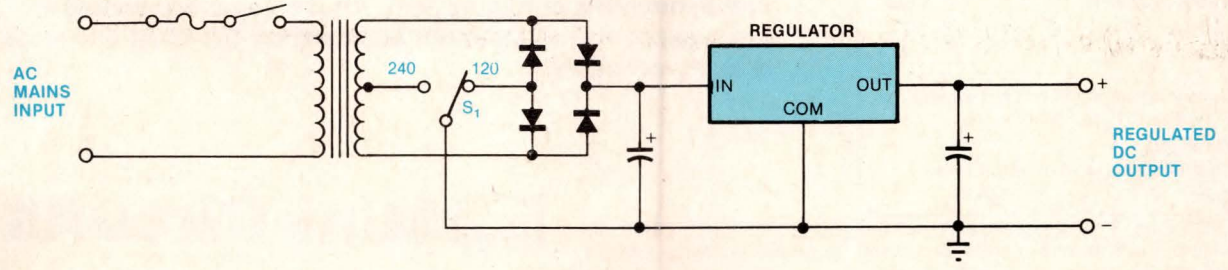
You can redesign the supply to meet your own particular needs by applying textbook design formulas to it in both configurations. Then use the higher voltage and current requirement that each component part requires.

This action satisfies all the requirements for dual-input-voltage use, but what of the variations arising in international usage? The transformer might have to be a 50-Hz unit rather than a 60-Hz model to accommodate the more common 50-Hz mains frequency found in international applications. Additionally, many countries have only 105V ac as the nominal voltage, or perhaps 200V ac as a high tap input. Therefore, calculate the transformer, diode and filtering values to maintain the filtered dc feeding the regulator above its spec'd minimum input. Furthermore, carefully watch diode PIV rating, the filter capacitor's maximum voltage limits and such parameters as the regulator's maximum dc input limits.

Transformer selection is often the most troublesome part of a power-supply design. You could employ a unit designed for international applications, but such units are generally difficult to locate off the shelf and more expensive than domestic versions. Alternatively, nearly all filament or solid-state-rectifier transformers are designed for 50- and 60-Hz operation. And their primary windings—although rated for only 120V ac—can also generally withstand 240V ac.

S_1 offers the other cost-savings feature. By voltage-range switching in the secondary, you no longer need a switch capable of handling the very high voltages employed in Europe. True, S_1 must carry higher currents when used on the secondary side, but because you won't be switching modes during normal operation, this requirement shouldn't present a problem. **EDN**

To Vote For This Design, Circle No 460



Switching the transformer's secondary *offers a simple and cost-effective way of handling the differences between US and European mains voltages. The scheme uses the diode bridge in a 4-diode, full-wave configuration when in the 120V position and in a 2-diode setup in the 240V mode.*

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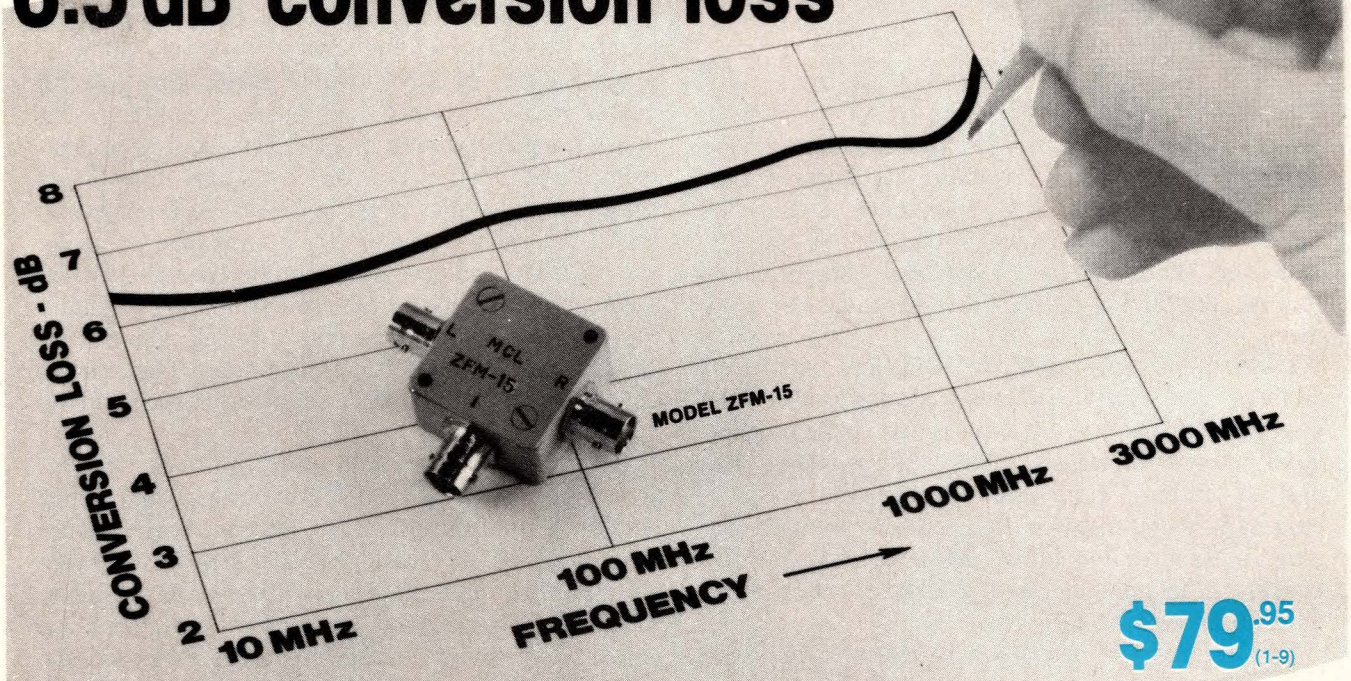

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International Representatives: ☐ **AFRICA:** Afitra (PTY) Ltd., P.O. Box 9813, Johannesburg 2000, South Africa. ☐ **AUSTRALIA:** General Electronic Service, 99 Alexander St., New South Wales, Australia 2065. ☐ **EASTERN CANADA:** B.D. Hummel, 2224 Maynard Ave., Utica, NY 13502. ☐ **ENGLAND:** Dale Electronics Ltd., Dale House, Wharf Road, Frimley Green, Camberley Surrey, United Kingdom. ☐ **FRANCE:** S.C.I.E.-D.I.M.E.S., 31 Rue George-Sand, 91120 Palaiseau, France. ☐ **GERMANY, AUSTRIA, SWITZERLAND, DENMARK:** Industrial Electronics GMBH, 6000 Frankfurt Main, Kluberstrasse 14, West Germany. ☐ **INDIA:** Gaekwar Enterprises, Kamal Mahal, 17 M.L. Dahanukar Marg, Bombay 400 026, India. ☐ **ISRAEL:** Vectronics Ltd., 69 Gordon St., Tel-Aviv, Israel. ☐ **JAPAN:** Densho Kaisha, Ltd., Eguchi Building 8-1 1-Chome, Hamamatsucho Minato-Ku, Tokyo, Japan. ☐ **NETHERLANDS, LUXEMBOURG, BELGIUM:** B.V. Technische Handelsonderneming, COIMEX, P.O. Box 19, 8050 AA Hattem, Holland. ☐ **NORWAY:** Datamatick As, Postboks 111, BRYN, Oslo 6, Ostensjoveien 62, Norway. ☐ **SINGAPORE & MALAYSIA:** Electronics Trading Co. (PTE) Ltd. Suites C13, C22 & C23 (1st Floor), President Hotel Shopping Complex, 181 Kitchener Road, Singapore-8, Republic of Singapore. ☐ **SWEDEN:** Integrerad Elektronik AB, Box 43 S-182 51, Djursholm, Sweden.

U.S. Distributors: ☐ **NORTHERN CALIFORNIA:** Pen Stock, 105 Fremont Ave., Los Altos, CA 94022, Tel: (415) 948-6533. ☐ **SOUTHERN CALIFORNIA, ARIZONA:** Crown Electronics, 11440 Collins St., N. Hollywood, CA 91601, Tel: (213) 877-3550. ☐ **METROPOLITAN NEW YORK, NORTHERN NEW JERSEY, WESTCHESTER COUNTY:** Microwave Distributors, 61 Mall Drive, Commack, NY 11725, Tel: (516) 543-4771.

R30/REV/C ☐☐☐

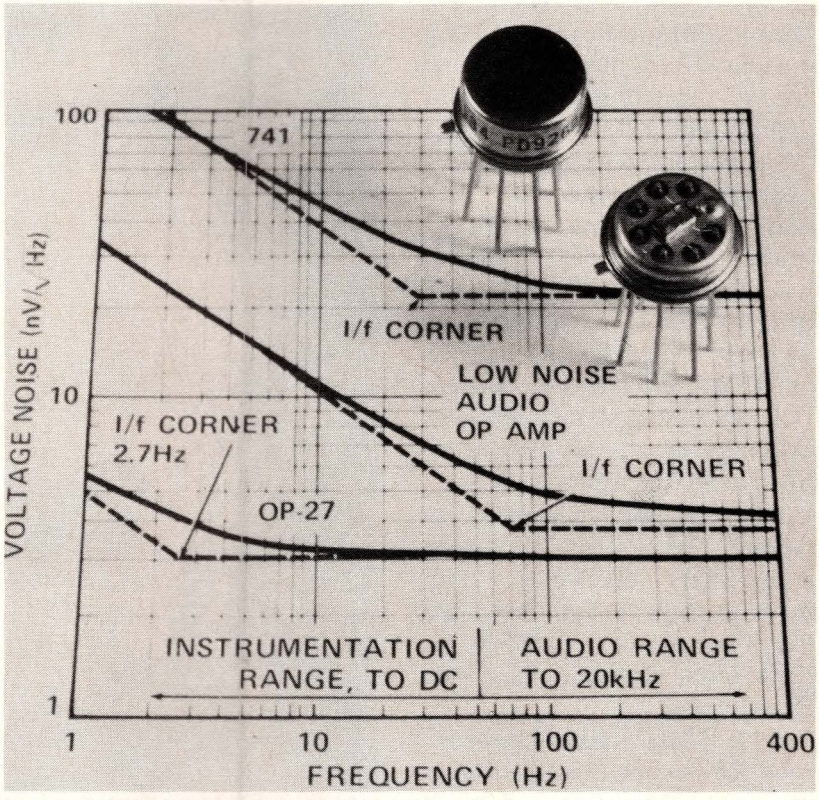
For more information, Circle No 66

Monolithic op amp specs lowest noise, maintains high speed and precision

Coupling the OP-07's dc performance with a 75% reduction in voltage noise, the OP-27 combines precision, speed and low noise in one package.

With 3.8-nV/$\sqrt{\text{Hz}}$ max input noise-voltage density, this device sports the lowest noise of any op amp on the market. But its speed also stands out: Slew rate equals 1.7V/μsec min and 2.8V/μsec typ. And precision is also noteworthy: 25-μV input offset voltage, 35-nA input offset current and long-term V_{OS} drift of 1 μV/month max.

Although such specs are available separately in other devices, this part is the first to successfully combine them in a monolithic chip. Other impressive specs include average input-offset drift of 0.6 μV/°C max, typical large-signal voltage gain of 1 million, 5-MHz min gain-bandwidth product and input noise voltage of 0.18 μV p-p max over 0.1 to 10 Hz.



In one monolithic device, *the OP-27 combines the lowest noise of any op amp with noteworthy precision and speed specs.*

DC specs not compromised

While offering some performance improvements over the OP-07, the OP-27 retains its predecessor's dc performance. For instance, common-mode rejection ratio is typically 126 dB, and power-supply rejection is 120 dB.

Bias current specs at ±40 nA, a low figure attributable to a bias-current compensation network at the inputs. With this scheme, the direction of bias-current flow varies with the magnitude of the current fed to the base of the device's npn input transistors by its pnp current sources.

This characteristic could make the device unsuitable for some applications, such as rectification or precision ac-voltage conversion, where you must know the current direction. However, the part suits applications in which source impedance is very low, such as strain gauges, 3-op-amp instrumentation amps and precision integrators or differentiators. And it also suits production environments where use of a trimming pot is undesirable or too expensive.

Power consumption is 140 mW, slightly higher than that of the OP-07 because of the higher input-stage currents required for noise reduction. Additionally, the OP-27 has diode-protected inputs but no protection resistors, so large common-mode voltages (greater than approximately 12V) could damage the input section.

The OP-27 comes in the same package types as the OP-07 and with the same pinouts. $5.50 to $50 (100), depending on grade and temperature range.

Precision Monolithics Inc, 1500 Space Park Dr, Santa Clara, CA 95050. Phone (408) 246-9222. **Circle No 453**

Large-format Z8000-based plotter departs from conventional designs

Unlike conventional rotating-drum or fixed-bed plotters, Model 7580A moves the plotting medium in one direction over an airfoil-shaped bed while its lightweight pen carriage moves perpendicularly to the medium's direction of motion. The low-mass, low-inertia mechanisms required for this design permit the use of smaller and less expensive motors and drivers. There's no compromise in performance, though: The Z8000-based unit achieves 24-ips maximum speed, 0.001-in. resolution and 0.002-in. repeatability—figures comparing favorably with those of more expensive machines. Pen heights range from 0.032 in. for short movements to 0.065 in. for long ones, ensuring maximum throughput.

The 7580A accommodates plotting-medium sizes ranging from 8×10.5 to 24.5×46.85 in. It holds the paper, vellum or polyester-film medium in place with a microgrip device consisting of a rubber pressure wheel and a textured drive wheel.

Upon loading, the unit senses the medium's size using photocells; a reed relay in the pen carrier is actuated by a magnet in the right-margin adjustment and allows the 7580A to determine the appropriate boundaries and scale.

As the plotting medium moves through it, *Model 7580A moves its pen assembly perpendicularly to the medium's direction of motion.*

Holds eight pens

The manufacturer supplies pen carousels that hold as many as eight fiber-tip, ball-tip or drafting pens. Each cartridge in a carousel employs a pen cap to keep its pen wet when not in use, and each carousel is coded to automatically inform the system of the type of pen in use. The system can then automatically adjust pen pressure and acceleration.

The 7580A permits automatic pen selection under program control. Therefore, it can create multicolor plots such as pc-board layouts.

Joystick control available

The unit's 48k-byte ROM not only supports plotter operation, but also provides six character sets, including special mathematics and centering symbols. Front-panel controls include a joystick that permits movement of the pen carriage to any point on the paper for making critical alignment marks.

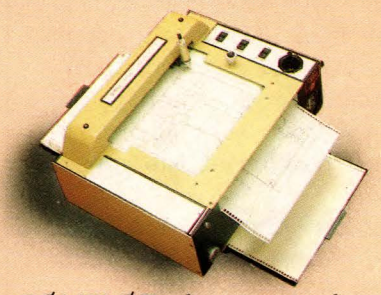
The plotter accepts data inputs and commands from a variety of interfaces, including IEEE-488 and RS-232. If you

Add total graphics capability to your computer

the Houston way

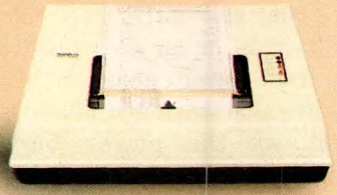
Different plotting, and printing applications often require different instruments. At Houston Instrument we're aware of your computer graphics needs. We listen to your evaluation and then recommend the plotter, printer, or plotter/printer that's exactly tailored to your specific application. Nobody else can do it, because nobody has such a broad selection of graphic output devices.

CØMPLØT® pen plotters are available in fourteen different models with X-Y plotter sizes of 8½ x 11" (DIN A4) or 11 x 17" (DIN A3) and drum plotter sizes of 11" (28 cm) to 42" (107 cm). Pen speeds range from 240 to 4,000 steps/sec. Prices begin at a low $1,085.*



CØMPLØT electrostatic plotters and plotter/printers are available with models for printing (up to 2,400 lines per minute), plotting (up to 2" per second), or simultaneous plotting and printing.

CØMPLØT electrostatic CRT copiers provide fast, quality hardcopies from Hewlett Packard Series 2640 terminals or Tektronix® 4010 family terminals for just a few cents per copy. Prices for the Houston Instrument electrostatic products range from $3,950 to $6,550.*



Our Model 6000 TISPP (Thermal/Intelligent/Strip/Plotter/Printer) allows superior quality graphics output from either an analog or digital source and provides the continuity and clarity of a continuous trace with alphanumeric annotations under intelligent control. It's the versatile graphic output device for the new generation of microprocessor controlled instrumentation. Available in one or two pen versions. Prices start at $1,795.*

When you think of hardcopy graphics, think of Houston Instrument. We offer you the best selection . . . the Houston way.

Examine our selection yourself by getting complete information and descriptive literature. Contact Houston Instrument, One Houston Square, Austin, Texas 78753. (512) 837-2820. For rush literature requests, outside Texas call toll-free 1-800-531-5205. For technical information ask for operator #5. In Europe contact Houston Instrument, Rochesterlaan 6, 8240 Gistel, Belgium. Phone 059/27-74-45. Telex Bausch 81399.

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Circle no. 104 for information on Pen Plotters

Circle no. 105 for information on Electrostatic Products

Circle no. 106 for information on Thermal Plotter/Printers

use industry-standard FORTRAN subroutines, you can obtain several versions of the manufacturer's standard plotting package for use with the manufacturer's computers or those from other firms.

The HP 7580A is fully self contained, including controller. $15,450. Delivery, 8 to 15 wks ARO.

Hewlett-Packard Co, 1507 Page Mill Rd, Palo Alto, CA 94304. Phone local office.

Circle No 454

Universal fiber-optics analyzer handles lab, field measurements

Just attach the FOA-1000 to a suitable oscilloscope and you can measure the attenuation of long fibers, along with spectral attenuation, pulse dispersion, bandwidth, transfer function, numerical aperture (NA), optical power and index profile. The instrument can also perform optical time-domain reflectometry to locate fiber breaks and evaluate connector-splice losses—an especially useful function for evaluating fibers in the field.

The analyzer's emitter section accommodates two semiconductor emitters and a halogen lamp. The standard source is a single heterojunction laser diode and associated pulser electronics, providing a Q-switched pulse with 200-psec rise time and 300-nsec width. You can use this source for all measurements except spectral attenuation; for those, use the halogen lamp.

In addition, you can install your own sources or detectors for evaluation in the unit's source/detector mounts. A knob provides rapid switching between sources, and a launch-NA wheel restricts the angle of a source's light cone as it enters the fiber, controlling mode excitation.

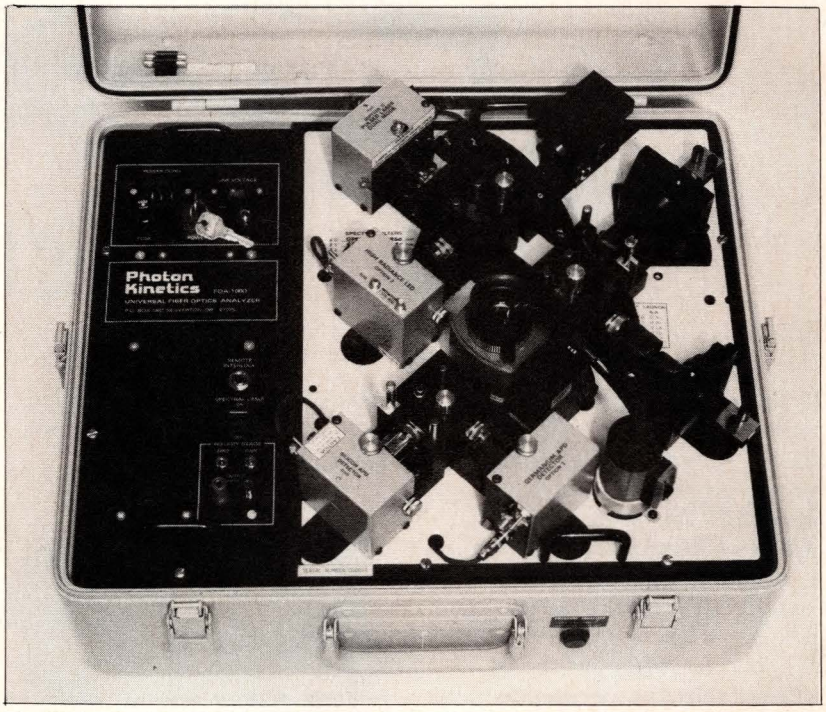
In addition to the standard silicon avalanche photodiode (APD), the FOA-1000's detector section accommodates one optional detector. The standard APD has a 150-psec typ rise time and functions at wavelengths as long as 1050 nm; an optional germanium APD accommodates measurements up to 1700 nm. And with an optional calibrated PIN diode, you can measure absolute optical power emission (both continuous wave and pulsed), as well as the power budget through the fiber under test.

You can mount either of the optional detectors in the detector mount's alternate position and inject its output into the measurement loop with a switching mirror. A set of neutral-density filters keeps each source's dynamic range within each detector's range.

The FOA-1000 operates from 115 or 230V ac and draws 50W. To enhance portability, an optional case locks all components in position for safe transit. $9500.

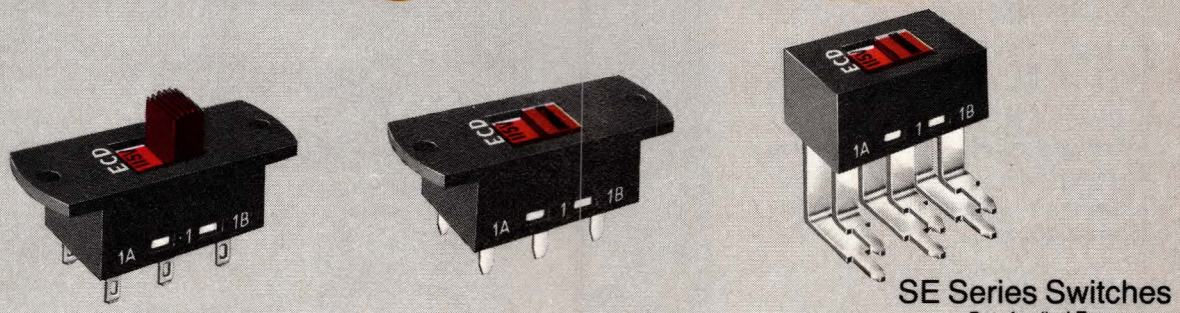
Photon Kinetics Inc, Box 1481, Beaverton, OR 97075. Phone (503) 644-1960.

Circle No 455



Complete characterization of optical fibers *is possible with the FOA-1000 universal analyzer. Equipped with a suitable scope, it measures attenuation, numerical aperture, bandwidth, pulse dispersion, optical power and index profile.*

A FLIP OF THE SWITCH CONVERTS FROM 115V (UL) TO 230V (VDE)



SE Series Switches
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THE ALL AMERICAN SWITCH DESIGNED TO MEET UL AND VDE STANDARDS

SHELF STOCKED FOR IMMEDIATE DELIVERY!

Designed to meet the needs of manufacturers throughout the world, these sophisticated switches are designed to meet requirements of UL, VDE, CEE, CSA, SEMKO and DEMKO.

This new series offers a choice of actuation either by screwdriver slot or raised handle, available with a wide variety of terminal styles.

Contact Walt Dinneen, Switch Product Manager
For Engineering Information & Sample

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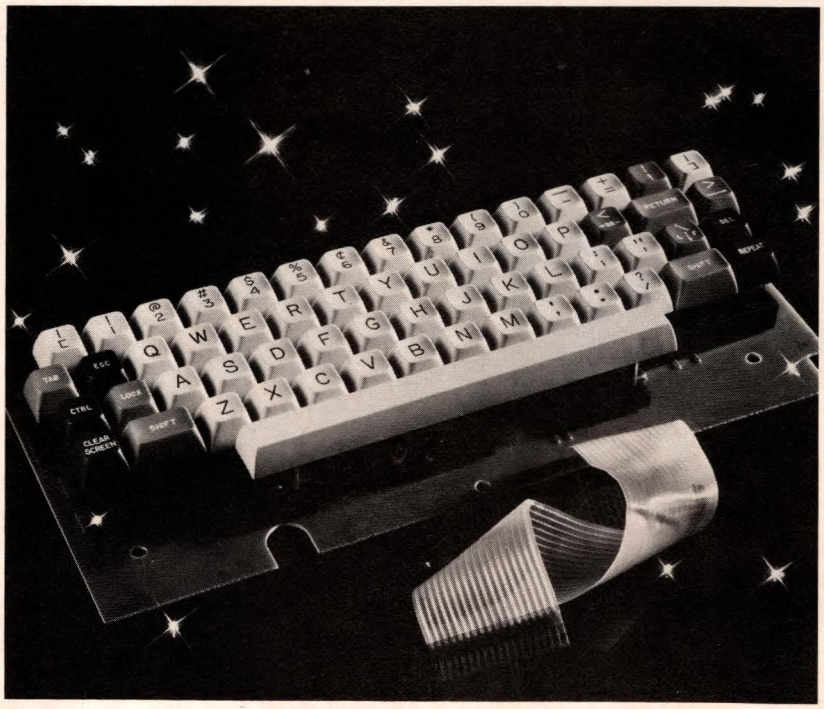
AMF Electro-Components Division manufactures RCL Resistors, Delay Lines, Switches & UID Switches

For more information, Circle No 67

Low-cost mechanical keyboard arrays feature rigid monolithic construction

The KS-200 keyboard arrays' unitized housings lend themselves to inexpensive keyboard-system design. They eliminate the need for pc-board stiffeners, reduce assembly labor and inventory costs and minimize keyswitch- and keycap-alignment problems, according to the manufacturer.

The KS-200 line includes standard 54- and 62-key layouts, numeric pads in 11-, 14- and 18-key formats and ancillary arrays of 1×2 through 5×6 stations. All units employ Form A (spst, normally open) twin bifurcated contacts of phosphor-bronze with a precious-metal inlay, rated from dry-circuit conditions to 10 mA at 5V dc resistive. You can replace contacts with an inserter tool in a few minutes.



The monolithic housing design *of KS-200 arrays provides a low-cost approach to keyboard-system design. Versions include numeric pads and ancillary standard arrays as well as standard 54- and 62-key designs.*

Keyswitch plungers have legs that dampen downstroke to improve feel, and you can specify momentary or alternate action. Lifetime specs at 20×10^6 or 5×10^6 operations, and operating force measures 2 oz or 3.5 oz (to latch).

Additional specs include 100-mΩ initial contact resistance, 5-msec max contact bounce (1 msec typ) and 500V rms dielectric strength.

All arrays are compatible with wave-soldering techniques, and you can choose from a wide selection of double-shot caps in various sizes and colors. You can also purchase the arrays without keycaps and/or pc boards. Less than $30 (5000) for 54-key array with caps and pc board.

Stackpole Components Co, Box M, Farmville, VA 23901. Phone (804) 392-4111.

Circle No 456

Codex cuts weeks off design cycle with PC-800.

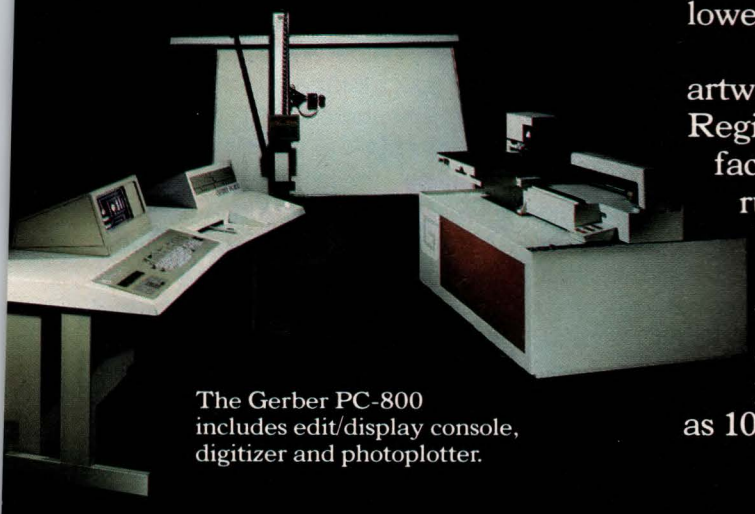
The Gerber PC-800 CAD system is helping Codex, a subsidiary of Motorola, increase its share of the fast-paced data communications market.

How? By speeding up PCB artwork production so much that the critical product development cycle has been shortened by weeks. The result: Codex gets products to market faster – at lower costs.

With PC-800, Codex produces 1:1 master artwork with accuracy hand taping can't match. Registration is perfect, eliminating costly manufacturing errors. And Codex can put more runs in the same space – avoiding the cost of bigger boards.

PC-800. It's the proven CAD system that cuts turnaround, boosts productivity and improves board manufacturability. And you can justify it even if you produce as few as 10 PC designs a year.

It works for Codex. And it can work for you.



The Gerber PC-800 includes edit/display console, digitizer and photoplotter.

Gerber PC-800
The CAD success story of the year.

The Gerber Scientific Instrument Company

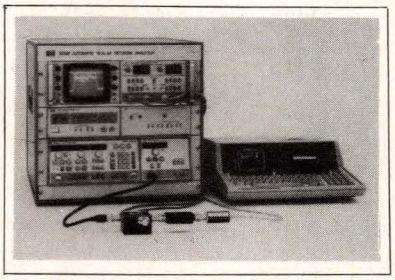
A Gerber Scientific Company,
83 Gerber Road, South Windsor, CT 06074 / 203-644-1551

See us at NEPCON West Booth 2322.

For more information, Circle No 68

New Products

INSTRUMENTATION & POWER SOURCES



SCALAR ANALYZER. Suiting the measurement of insertion loss or gain and the return loss of devices, components and networks, Model 8755P measurement system covers the 0.04- to 18-GHz range.

The system contains a Model 8350A sweep oscillator with its 10-MHz to 20-GHz RF plug-in and a Model 8755S frequency-response tester, both under the command of Model HP85F controller. System control is via the company's HP-IB interface bus.

The IEEE-488-compatible system's standard software permits automatic calibration and measurement of as many as 500 points of either insertion or return loss or as many as 250 points of both; automatic scaling and displaying of a plot of measured parameters versus frequency; and printing or displaying of measured data in tabular format. The measurement program (in enhanced BASIC) permits customizing for specific measurements.

Basic performance characteristics include 60-dB dynamic range for all detector inputs, test-signal-frequency accuracy of ±20 MHz at 20 GHz and power-level accuracy of ±1.5 dB at 20 GHz. $45,930. Delivery, 20 wks ARO. 2- to 18-GHz version, $38,880. Delivery, 8 wks ARO. **Hewlett-Packard Co,** 1507 Page Mill Rd, Palo Alto, CA 94304. Phone local office.
Circle No 181

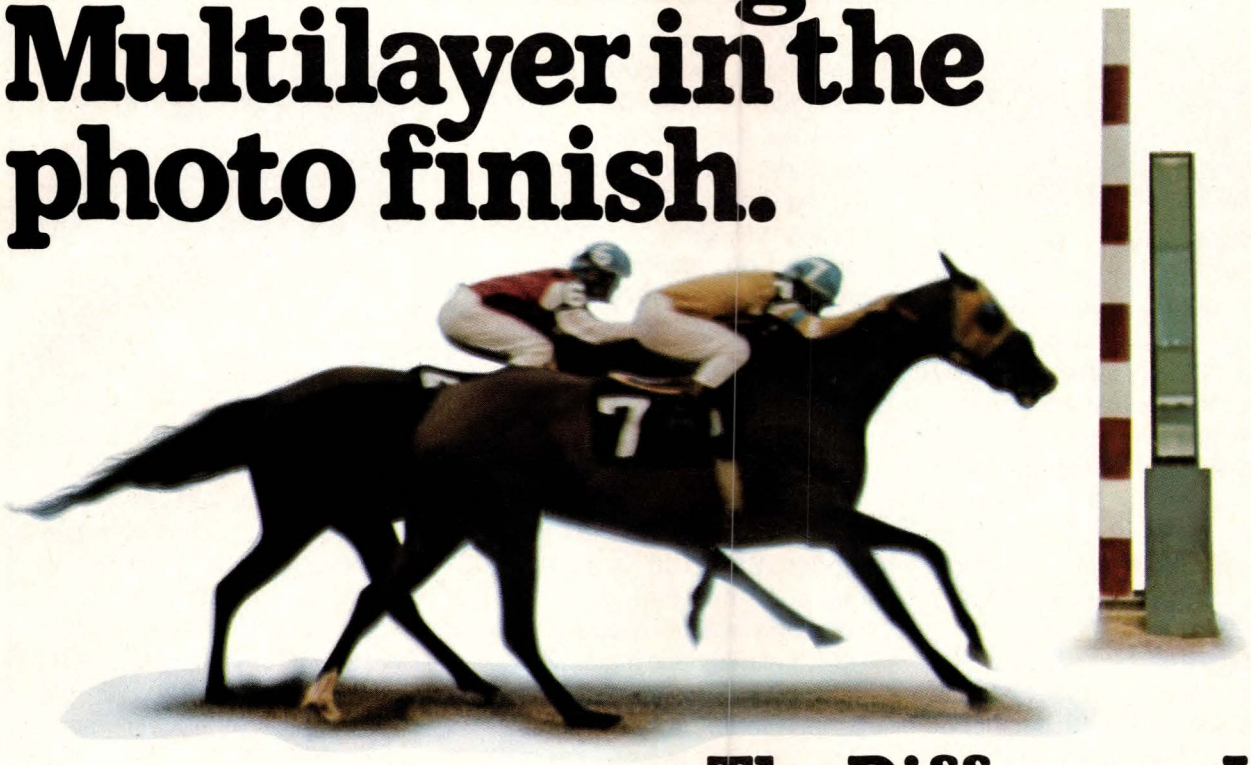
μV ALIASING FILTERS. For use ahead of low-level multiplexers or amplifiers, these capacitively coupled active filters are balanced, isolated and floating. Noise insertion specs at less than 2.5 μV rms. The filters' 7-in.-high rack-mounting modules each accommodate 10 pc boards. 5200 and 5300 Series models include six 2- or 3-pole filters per board; 5400 Series models include three 4-pole filters per board. 5600 Series models provide two 2-pole filters per board. Filter types include Butterworth, Chebyshev, PILAF (phase in-band linear amplitude flat) and Bessel. Rack module, $300; filter board, $685 to $733. **Instrum,** 2738 W Main St, Alhambra, CA 91801. Phone (213) 682-3419. **Circle No 182**

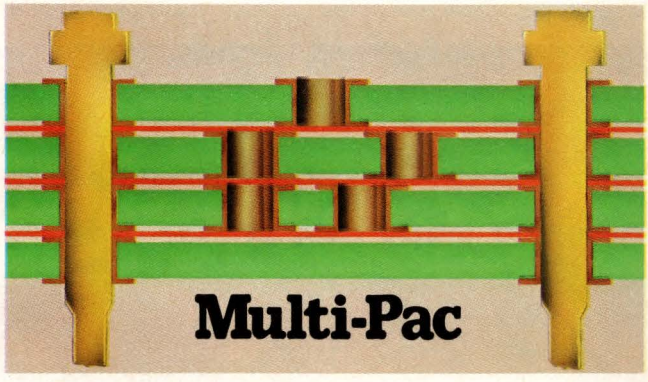
MEMORY ATE. Designed for incoming-inspection and production applications, System 7800 includes one or two fully loaded test heads. It tests most TTL and ECL devices and MOS static and dynamic RAMs and ROMs, and with its complement of 27-input/10-output pins can test 64k×8 RAMs and 64k×10 PROMs. 25-MHz clock rates are standard for all test patterns; a split-cycle technique permits 50-MHz testing. Other features include data-reduction capability, overall system accuracy of 0.5 nsec; 1-nsec I/O switching; 16 timing sets; 32 timing-mask sets; programmable active loads and pin-selectable timing, formats and levels. A DEC LSI-11/23 computer with up to 128k words of memory controls system operation. High-level software is based on DEC's RSX-11/M multitasking operating system. From $250,000. **Accutest Corp,** 25 Industrial Ave, Chelmsford, MA 01824. Phone (617) 256-8124. TWX 710-347-0620. **Circle No 183**

TRANSIENT RECORDER. Model PR-7902 can capture 4096 points of an analog waveform with sample rates to 20M samples/sec and 8-bit resolution. A 10-MHz bandwidth and ac and dc coupling suit it for use with 10:1 oscilloscope probes. Triggering capabilities include autotriggering, adjustable pretriggering and delay triggering. μP control facilitates custom interfacing; RS-232C and GPIB interfaces and an 8192-point memory are optional. $3500. **Micro Pro Inc,** Rte 309 and Advance Lane, Colmar, PA 18915. Phone (215) 822-8971.
Circle No 184

DEVELOPMENT SYSTEMS. Units in the Scoutsystem Series for 6800/6809 μPs provide up to 64k bytes of RAM and 2M bytes of disk storage. Configured with a 1920-character CRT and either dual 5¼- or 8-in. floppy-disk drives, these systems incorporate the firm's Hunter shortcut debugging package, allowing memory, register and stack contents to be inspected and changed. Other features include an assembler that uses standard Motorola assembler directives and provides relocatable code, an MDOS conversion package, text editor and text processor. The units also furnish memory diagnostic routines for identifying failed memory chips. $5700 to $7745. **Smoke Signal Broadcasting,** 31336 Via Colinas, Westlake Village, CA 91362. Phone (213) 889-9340.
Circle No 185

Multi-Pac® edges out Multilayer in the photo finish.





Even though Multi-Pac is used by many O.E.M.'s some people still consider us a dark horse. That's OK ... a winner has to come out of the pack to be recognized. At Elfab, we've done it with press-fit technology. We were the first. And since that time we've set a fast pace as a leader in the industry. Now we want to set the pace with Multi-Pac, our innovative assembly of stacked PC boards held together in a "sandwich" with press-fit contacts.

Multi-Pac or multilayer. At Elfab you can win either way, no matter what your preference, because we do make them both. Examine the competitive differences closely and see if you don't agree with us that Multi-Pac comes out ahead.

The Difference Is:

Pole Position: Multi-Pac costs 10-15% less.

Second: With Multi-Pac you can have via or pass-thru holes from plane to plane. Whereas with multilayer holes must be drilled through all circuit layers prohibiting circuitry in that area.
Multi-Pac gives you up to 8 layers of circuitry, or solid copper sheets can be used in place of PC boards for high current capacity.

Third: Guaranteed controlled impedance with uniform board spacing. Great for high speed logic circuits.

Fourth: Multi-Pac lets you build Hybrid systems into any part or all of the board. Unlike multilayer, with Multi-Pac you can stack additional circuit layers on sections of the backpanel or daughter board where additional density is needed.

Fifth: Because Multi-Pac is a stack of discrete PC boards, any board can be changed right up to assembly time (when the contacts are pressed in place).

Sixth: Repairability — Contacts can be removed with Multi-Pac, and circuit layers can actually be assessed for changes or repairs.

Seventh: Moisture-in-Moisture out. Multi-Pac meets MIL-STD 202 method 103 test B for humidity; and 101 test B for salt spray.

Eighth: Properly done, your art work can be interchangeable with multilayer and Multi-Pac. Thus, you always have two sources.
The odds favor Multi-Pac ... bet on it! Write or call us for additional information.

ELFAB

The Leader in Press-fit Technology

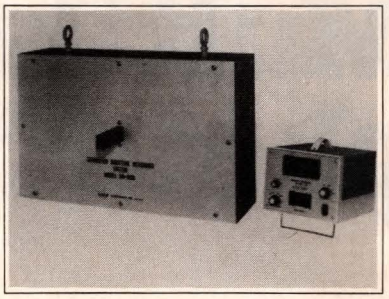
P.O. Box 34555, Dallas, Texas 75234, 214-233-3033

For more information, Circle No 69

New Products

4½-DIGIT DMM. Model 255 features 10-μV sensitivity on its lowest dc-voltage range and permits measurements to 1000V dc at 0.03% basic accuracy. AC-voltage measurement capability spans 10 μV to 5000V. You can measure ac and dc current from 10 nA to 2A; resistance, from 0.1Ω to 2 MΩ. Both ac voltage and current are measured with an average-sensing technique, which furnishes full accuracy from 50 to 5000 Hz and an extended range past 2.5 kHz. The unit's basic TC specs at 30 ppm/°C. Housed in the firm's 5½×1½×3½-in. case, the <1.3-lb instrument includes a 0.4-in.-high black-on-silver LCD and two front-panel rotary switches for 1-function range selection. Overvoltage protection equals 1000V on all voltage ranges and 250V for resistance ranges; an internal 2A fuse protects current ranges. $279. **Data Precision Corp,** Electronics Ave, Danvers, MA 01923. Phone (800) 892-0528; in MA, (800) 343-8150. TLX 921819. **Circle No 186**

INDUCTION MEASURER. Model SM-8100 saturation-induction-measuring system measures electromagnetic units (EMU) of magnetic materials and displays the results on a 3½-digit panel meter. It tests samples with lengths to 1.5 cm and volumes to 15 cm^3. Permanent



magnets and a soft-iron core produce a magnetic field of 9500 Oe that saturates the magnetic sample. A scale factor normalizes the sample's weight, allowing direct readings in EMU. The device suits applications requiring measurement of permeability of weakly magnetic materials such as stainless steel. $8700. Delivery, 12 to 14 wks ARO. **LDJ Electronics Inc,** 1280 E Big Beaver, Troy, MI 48084. Phone (313) 689-3623. TWX 810 232-1509. **Circle No 187**

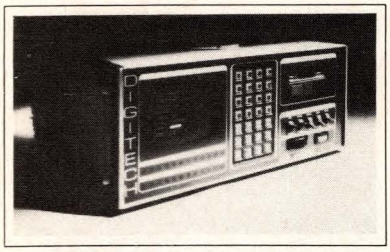
New Products

CALIBRATOR. Suiting the calibration of industrial control devices and meters, Model 334 features 4-digit thumbwheel switches and 0 to ±11.999V dc and <1 to 119.99-mA outputs. Accuracy specs at ±0.01% FS: resolution equals 1 mV, 10 μA. To eliminate transients during level selection, the unit includes a Hold switch that keeps the output near its previous level while you change the thumbwheel-switch setting. When you release the Hold switch, the output immediately steps to its new level. The unit measures 21×8.9×28 cm and weighs 2.5 kg. $795. **Exact Electronics Inc,** Box 347, Tillamook, OR 97141. Phone (503) 842-8441. **Circle No 188**

TEMPERATURE PROBE. To permit accurate measurement of rapidly cooling objects, Model SS-385-4A responds to 90% of the measured temperature within 1 sec and to 99% within 3 sec. It uses a standard DIN 100Ω platinum RTD sensor with a range of −200 to +400°C. The ¼-in.-diameter sensing tip features a spring-loaded ball joint that rotates 25° in all directions to furnish good surface contact. The probe, excluding handle, is

5 in. long and has a 45° bend near the tip to facilitate contact with hard-to-reach surfaces. $245. **Caspar Integrated Systems,** 541 S Franklin St, Ft Bragg, CA 95437. Phone (707) 964-4109. **Circle No 189**

New Products



DATA MONITOR. Aimed at field-technician use, Monitor 200 helps diagnose data-communications line problems. Designed to interface with the firm's Encore 100 analyzer, it features ASCII and EBCDIC formats (with hex conversion), 15 speeds ranging from 50 to 9600 baud and either asynchronous or synchronous operation; you can use half- and full-duplex communication modes. Approximately $5000. **Digitech Data Industries Inc,** 66 Grove St, Ridgefield, CT 06877. Phone (203) 438-3731. **Circle No 190**

LOGIC PROBE. You can use the Model 205 Catch-A-Pulse hand-held unit to analyze and troubleshoot logic gates and sequential circuits such as flip flops, counters, registers and μPs. The pen-sized device provides a bright LED display of HIGH, LOW, pulsing or open-circuit logic states (referred to the unit's truth table) and built-in current limiting. It automatically adjusts to the correct DTL, TTL, MOS, CMOS or μP circuit thresholds when its leads are connected to the IC-circuit power supply; power-supply reverse-polarity protection is provided. The input impedance of the probe's tip becomes a slave to the circuit under test, causing it to react to whatever signal or logic condition is present; the probe's memory automatically resets every 50 μsec. $49.50, including 6-ft coiled cord in clear-plastic carrying case; $59 for Model 205-K, including high-voltage adapter for 15 to 25V applications. **Triplett Corp,** 1 Triplett Dr, Bluffton, OH 45817. Phone (419) 358-5015. TWX 810-490-2400. **Circle No 191**

CLAMP-ON METER. The auto-ranging hand-held Model 2433 measures true-rms voltages, currents and power in single and balanced 3-phase circuits. It uses a patented feedback time-division multiplier circuit to provide accuracies of 1% of reading+0.5% FS. The 243301 version features ranges of 20 to 600V rms, 2 to 200A rms and 2 to 200 kW. Model 243302 features ranges of 20 to 600V rms, 0.2 to 20A rms and 0.2 to 20 kW. Both units furnish an analog output to drive servo recorders. Other features include a Hold switch effective on all ranges and a 3½-digit LCD. $925. **Yokogawa Corp of America,** 2 Dart Rd, Shenandoah, GA 30265. Phone (404) 253-7000. **Circle No 192**

AC-LINE REGULATORS. Line Tamers feature 140-VA to 2-kVA ratings, accept 95 to 130V ac inputs and produce 120V ac±3%-regulated outputs. The 60-Hz units are UL listed and can maintain output voltages within NEMA specifications with input voltages as low as 65% of rated value. Each model rejects common-mode (120 dB) and transverse-mode (60 dB) noise; interwinding capacitance specs at <0.001 pF. Recovery to within the regulating band takes <25 msec for changes occurring within the rated limits of the regulators. Other features include short-circuit protection and the ability to withstand interruptions to 3 msec while maintaining full output voltage. $170 to $852. **Shape Magnetronics Inc,** 901 DuPage Ave, Lombard, IL 60148. Phone (312) 620-8394. **Circle No 193**

AC-LINE REGULATORS. Minigard Series regulators serve computer, data-terminal and word-processing equipment. The ferroresonant devices feature I/O isolation, 120-dB normal-mode attenuation, 60-dB common-mode noise rejection and operation at a 45-dB sound level. The UL-listed units come in plug-in versions rated to 2 kVA and hardwired models rated from 300 VA to 11 kVA. $270 to $3600. **Jefferson Electric,** 840 25th Ave, Bellwood, IL 60104. Phone (800) 323-3293. **Circle No 194**

EAROM
the word erasable memory.

Whenever you want to record data, retain it, or change it in system...that's when you will want to consider General Instrument EAROM.

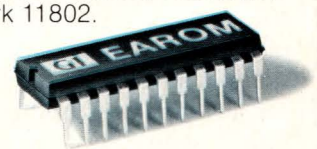
Electrically Alterable Read Only Memories give you the application ease of a RAM, the non-volatility of a ROM...plus electrical erasability, word alterability and in-system reprogrammability. That adds up to an unmatched memory capability...enough for you to provide in-circuit programming and reprogramming control without data loss in power outages.

Unlike other non-volatile memory devices, General Instrument EAROMs provide word erasability. This feature permits select changing of data in system without the time consuming need to erase and rewrite everything each time a change is required.

Our EAROMs, available in many configurations, are being used in control, measuring, recording, metering, and tuning applications, to name but a few.

General Instrument has already shipped over 6-million EAROM devices. That's why we say our EAROMs are: A reality for today, rather than a promise for tomorrow.

To learn more about our EAROM family call (516) 733-3107. Or if you wish to discuss applications call (516) 733-3611. Or write Microelectronics Division, General Instrument Corporation, Dept. EM, 600 West John Street, Hicksville, New York 11802.



We help you compete.®

GENERAL INSTRUMENT

New Products

DATA LOGGER. Series 7240 data-acquisition and control system comprises plug-in function cards for analog and digital signal conditioning plus minidisk-memory and impact-printer options. The IEEE-488-compatible system features BASIC programmability. Standard software permits signal linearization, averaging, multiple alarm limits and data display on the 40-character×24-line CRT. Data tape recorders can independently store programs and data for archival purposes or subsequent statistical analysis; an optional 5¼-in. dual 340k-byte flexible-disk memory serves high-speed applications. Optional printers include an 80-column, 150-cps dot-matrix unit. The basic system incorporates a 12-bit A/D converter; plug-in options include an input MUX, digital I/O and pulse-counting functions. $4200; optional function cards, $300 to $400 each. **FI Electronics,** 968 Piner Rd, Santa Rosa, CA 95401. Phone (707) 527-0410. TLX 337769. **Circle No 195**

UNIVERSAL COUNTER. A member of the firm's TM-500 plug-in line, Model DC 509 makes single-shot time-interval measurements with 10-nsec resolution; measurement averaging provides 1-psec resolution. A μP-based reciprocal-counting technique permits frequency measurements to 135 MHz. μP control furnishes autotriggering that senses applied signals and automatically sets trigger levels to their optimum values. Front-panel jacks permit precise trigger-level adjustment, as well as monitoring of signal-shaping circuits. Other features include an arming input, autoaveraging, probe compensation and a phase-modulated time base that eliminates clock-synchronous errors in time-averaging modes. The standard time base furnishes $<\pm 5\times10^{-6}$ FS variation from 0 to 50°C; an optional oven-controlled oscillator improves this figure to $\pm 2\times10^{-7}$. $1500; optional time base, $275. **Tektronix Inc,** Box 500, Beaverton, OR 97077. Phone (800) 547-1512. **Circle No 196**

DATA-LINE MONITOR. Model 41 line-powered tester monitors an RS-232 interface and indicates whether each of seven signals is a space (3 to 25V), a mark (−3 to −25V) or invalid (−3 to +3V). Seven dedicated LEDs monitor these TD, RD, RTS, CTS, DSR, DCD and DTR signals and indicate mark/space conditions; a bipolar test LED indicates signals >3V in red and signals <−3V in green; an OFF indication shows an invalid signal. The unit derives its power from the signals under test. Constant-current LED drivers limit current through each LED to 3 mA. $99. **Remark International,** 4 Sycamore Dr, Woodbury, NY 11797. Phone (516) 367-3806. **Circle No 197**

POWER CONDITIONER. Providing claimed transient-free, noise-free power for micro/minicomputer systems and preventing mutual interference between as many as 12 different EDP devices within a system, the Voltector Series 7 Model R150 ac power conditioner/distribution center is said to

protect EDP equipment against induced lightning effects, inductive-load switching transients, ac-power-line RFI and EMI in both differential and common modes. The relay-rack-mounting device includes a 15A bidirectional Comtrans filter, circuit-breaker On/Off switch, elapsed-time meter and eight, 10 or 12 independently RF-isolated ac receptacles. $448 (eight outlets) to $497 (12 outlets). **Pilgrim Electric Co,** 29 Cain Dr, Plainview, NY 11803. Phone (516) 420-8989. **Circle No 198**

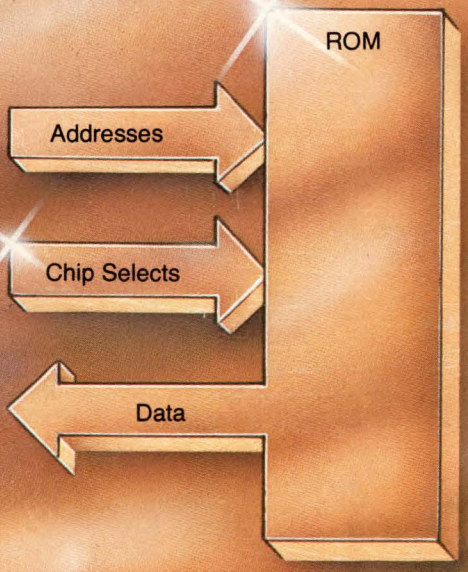
TEMPERATURE-TEST SYSTEM. The μP-controlled 8-kHz to 60-MHz Model 2001 permits the series and load-resonant testing of 78 quartz crystals simultaneously without operator intervention during the test run and provides GO/NO-GO indication against user-keyed-in elements. It records up to 60 temperature points between −55 and +150°C. Temperature accuracy equals ±0.15°C anywhere in the test chamber. A typical test run of 78 crystals tested at 5°C intervals from −40 to +85°C requires <1.1 min per crystal. Standard systems print out complete measurements for failed units as those measurements are made, along with a summary of failures at the end of the test run. $13,000 to $18,000. Delivery, 90 days ARO. **Saunders & Associates Inc,** 7440 E Karen Dr, Scottsdale, AZ 85260. Phone (602) 991-9250. TWX 910-950-0087.

Circle No 199

Hughes Offers More ROMs (4, 8, 16K)... with Less Power Consumption.

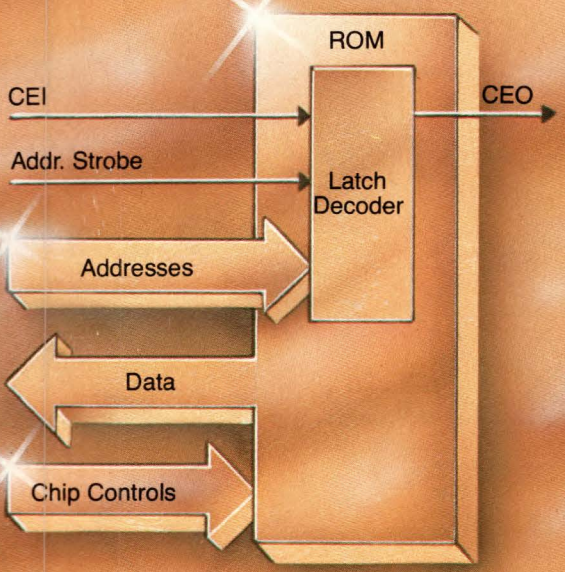
CMOS ROMs

Industry Standard Pinouts



Hughes Part Number	Industry Standard Pinouts	ROM Organization
1832	2704	512x8
1834	2708	1024x8
1836	2716	2048x8

1802 CPU Compatible Pinouts



Hughes Part Number	ROM Organization
1831	512x8
1833	1024x8
1835	2048x8

HUGHES

UGHES AIRCRAFT COMPANY

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)0 Superior Avenue
ewport Beach, CA 92663
00) 854-3515 or
14) 759-2942

Europe
ughes Microelectronics Ltd.
live House
2–18 Queens Road
Veybridge, Surrey KT 139XD
ngland
elephone 932-47262

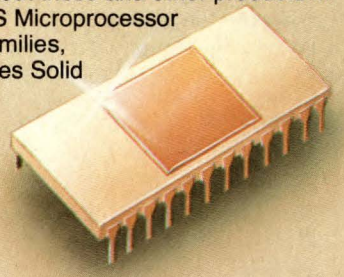
Hughes delivers more of what you're looking for in low-power CMOS memory devices, including static masked ROMs and RAMs (no clock or strobe), very low operating and standby power dissipation (typically 1/40th of NMOS memories), high noise immunity and wide tolerances to voltage and temperature variance.

Hughes 16K CMOS ROMs are available in two versions: the HCMP 1836 which is a pin-for-pin replacement for industry-standard N-channel PROMs or ROMs, and the HCMP 1835 which is 1802-compatible. 4K and 8K units are also available. Hughes offers fast ROM turnaround to prototype and production units.

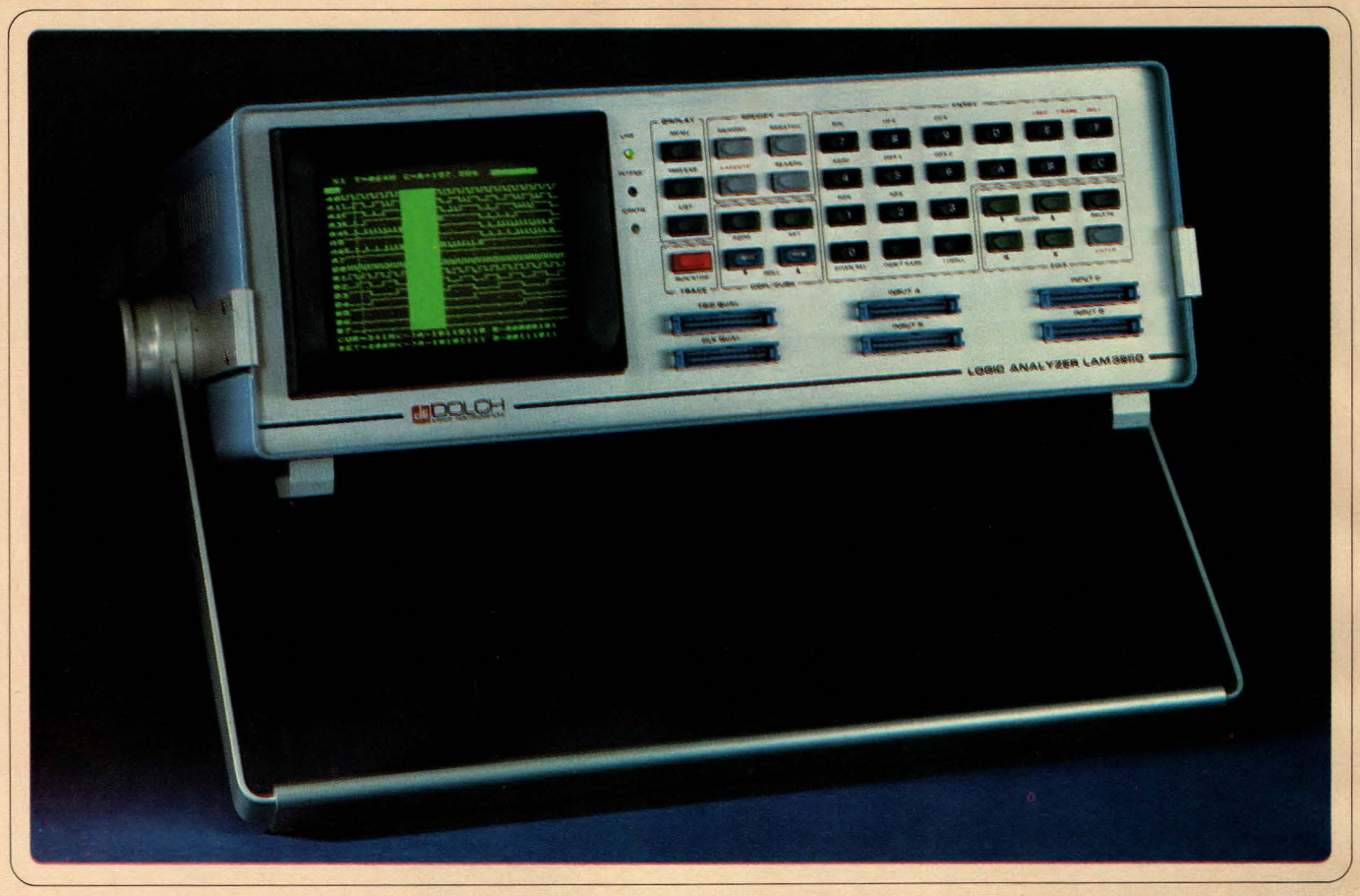
Hughes also delivers CMOS RAMs which are organized 32x8 for small-storage applications or 256x4 (compatible with the industry standard 5101) for larger requirements.

All Hughes CMOS memories are available in economical plastic or standard ceramic packages in high (4–12v) or low (4–6.5v) voltage ranges and in commercial or military (883 tested) versions.

For information about these and other products in the Hughes CMOS Microprocessor and LCD Driver families, call or write: Hughes Solid State Products.



For more information, Circle No 70



32 TO 64
Channels...with a Battery

Dolch Logic Instruments' third generation logic analyzer, the LAM 3250, lets you meet your troubleshooting needs now, and expand for the future. The LAM 3250 records up to 32 channels of information at sampling rates to 50 MHz, and with optional Channel Expansion Probes, its capability can be extended to 64 channels. And there's more.

Sophisticated clocking.
Since it incorporates dual 16-channel X 1000-bit recording blocks, the LAM 3250 can accept up to two independent external clocks for sampling data, letting you independently monitor both address and data on a multiplexed bus.

Powerful triggering.
Four-level sequential triggering, each level with an independent pass counter ranging from 1-255 counts, lets you debug programs containing nested subroutines. There's even a Restart function to guide you through data on the bus. All of this is easily programmed in a separate trigger menu.

Battery back-up.
The LAM 3250's revolutionary new BATTERY-BACKED MENU MEMORY feature allows you to store up to 6 separate files of display and menu parameters in CMOS RAM for up to three months without power. This means that you can recall complete test set-ups in a matter of seconds. No more time wasted rewriting menus.

Check these features and compare:
- 32 channels X 1000-bit memory
- Expandable to 64-channel X 500-bit memory (optional)
- Sampling rates to 50 MHz
- 5 ns glitch capture
- Timing capability for 16 or 32 channels
- Hex, octal, binary and ASCII displays
- Powerful word search feature
- Window triggering
- Real-time trigger tracing
- Non-volatile menu memory
- GPIB and RS-232 interfaces standard
- Personality probes and disassemblers for many popular uP's and bus systems (optional)

This is only part of the story. For more details on this and other dynamic troubleshooting tools, contact the logic analyzer experts today. Dolch Logic Instruments,
230 Devcon Drive, San Jose, CA 95112.
Or call toll free (800) 538-7506. In California (408) 946-6044.

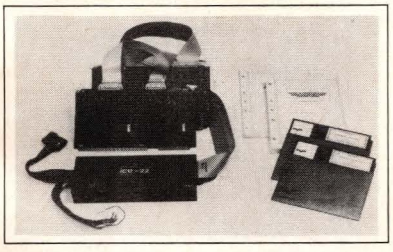
dli DOLCH
LOGIC INSTRUMENTS

Circle no. 107 for more information
Circle no. 114 for demonstration

REPRESENTATIVES: Austria 02236/866310, **Belgium** 022192451-53, **Canada** (514) 336-0392, **Denmark** 02804200, **Finland** 08090520311, **France** 069302880, **Germany** 08931901-1, **Great Britain** 0734694944, **Greece** 0218219470, **Holland** 040533725, **Israel** 03453151, **Italy** 024158746, **Norway** 02356110, **Spain** 052213199, **Sweden** 08879490, **Switzerland** 013632188, **East Europe-U.K.** 093252121, **Singapore** 0637944, **South Africa** 01227739.

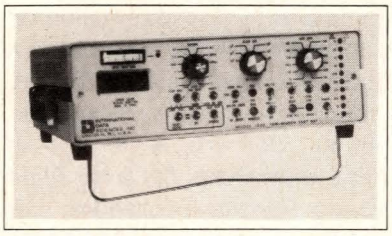
New Products

ERROR MEASUREMENT. For the production testing, field installation and maintenance of Bell digital transmission systems, Model 3781B μP-controlled pattern generator and Model 3782B error detector provide a real-time clock and HP-IB printer output and interface at DS-1, DS-1C, DS-2 and DS-3 levels in the digital hierarchy. Ternary coding and interface-voltage levels at each hierarchical level are selected automatically. Alternatively, binary ECL interfaces can be used at bit rates from 1k to 50M bps. Three pseudorandom binary sequences, six fixed word patterns and a jitter-modulation input facility with peak-to-peak jitter LED readout are also furnished. Binary, code or parity errors can be measured and displayed over a wide range of gating periods. Model 3781B, $7340; Model 3782B, $6895. Delivery, 8 wks ARO. **Hewlett-Packard Co,** 1507 Page Mill Rd, Palo Alto, CA 94304. Phone local office. **Circle No 200**

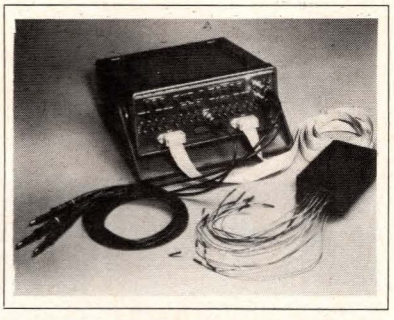


IN-CIRCUIT EMULATOR. For use with Intellec development systems and emulating the 8022 μC at clock rates from 0.6 to 3.6 MHz, Model ICE-22 uses a bond-out version of the 8022 chip, a configuration with on-chip bus lines accessed through additional lead bonds. Programs can be altered directly through the unit using assembler mnemonics, and 8022 characteristics, such as drive, load and timing in real-time operation, are not masked by intervening devices. A high-speed 2k-byte RAM that emulates on-chip ROM is provided in the emulator buffer box. Also featured are a single-line assembler, allowing the alteration of memory using assembly-language mnemonics with a simple emulation command, a HELP file providing command syntax information on the console display screen and a 500-instruction-cycle trace memory with trace-qualifier register. $5950. Delivery, 4 to 8 wks ARO. **Intel Corp,** 5200 NE Elam Young Parkway, Hillsboro, OR 97123. Phone (503) 640-7792. **Circle No 201**

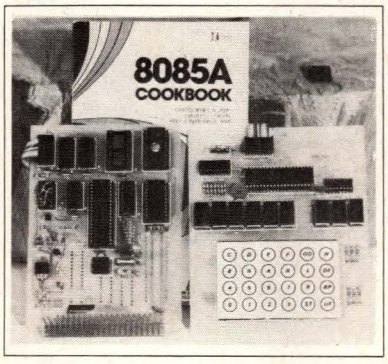
New Products



BER TEST SET. Model 1320 is a portable self-contained unit designed to analyze the error rate of any digital transmission network. It can be used to test synchronous, asynchronous or start/stop character-oriented systems, including time-division multiplexers. Bit, character and block error rates are determined by transmitting pseudorandom test patterns over the communications channel to accurately simulate computer-generated data. A start/stop character can be programmed and transmitted in either a single or continuous format; the unit can also generate special repeating sequences of ASCII or other characters. $3950. Delivery, 60 days ARO. **International Data Sciences Inc,** 7 Wellington Rd, Lincoln, RI 02865. Phone (401) 333-6200. TWX 710-384-1911.
Circle No 202

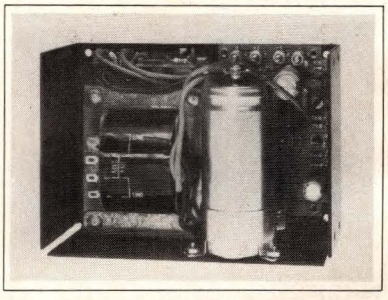


LOGIC - TRIGGER PROBE. Adding 16 channels to the triggering capacity of the company's data test equipment, the 20-MHz 9×4.3×8.3-in. PM 8810 can perform synchronous or asynchronous and parallel or sequential triggering. In Synchronous triggering mode, trigger output occurs when trigger word and clock qualifiers are true with respect to an active clock edge. In Asynchronous mode, trigger output occurs as soon as trigger word and clock qualifiers are true. Parallel triggering can be accomplished in either a Continuous or Latched mode. Setup time specs at ≤30 nsec. Maximum input voltage ranges from −50 to +50V. $1800. Delivery, 60 days ARO. **Philips Test & Measuring Instruments Inc,** 85 McKee Dr, Mahwah, NJ 07430. Phone (800) 631-7172; in NJ, (201) 529-3800.
Circle No 203



μP TRAINING UNIT. Model 8085AAT MTU includes a tested and assembled 8085A μC with 1k of RAM, 1k of PROM, 1k of EPROM, programmable I/O, keyboard unit, CPU card and a display and operating system. Also provided are a 44-pin edge connector, area on the CPU card for custom wire-wrapping design or user-defined interface circuitry and a 20-mA asynchronous port. Software includes a step-by-step instruction manual, user's manual with programs , a 352-pg 8085A cookbook covering μP concepts through design stages and a 334-pg 8080/8085 software design book with >190 executable program examples. $299.95; kit version, $249.95. **Paccom,** 14905 NE 40th St, Redmond, WA 98052. Phone (206) 883-9200. TWX 910-449-2592.
Circle No 204

DIGITAL PRINTER. Initiated at preselectable time intervals to detect transitions in critical data-interface signals, printouts from Model 2010 record the time an event occurred, a channel identifier and three digits of bit, block or character errors. Features of the programmable thermal unit include a presettable real-time clock, six selectable trigger channels and seven selectable print periods. For paper reloading, the printer mechanism is removable from the device's front panel. The unit operates with any of the company's modem test sets. $3650. **International Data Sciences Inc,** 7 Wellington Rd, Lincoln, RI 02865. Phone (401) 333-6200. TWX 710-384-1911.
Circle No 205



OPEN-FRAME SUPPLY. Offering a variety of voltage and current outputs ranging from 5V/9A to 48V/1.5A, Model SOLV45 provides line and load regulation of 0.1% and a temperature range of 0 to 55°C. Overvoltage protection is optional for the 4.88×7×2.88-in. unit. $52 (250). **Elpac Power Systems,** 3131 S Standard Ave, Santa Ana, CA 92705. Phone (714) 979-4440. TWX 910-595-1513.
Circle No 206

Introducing high performance storage for any micro. Ready to roll.

Digital's new TU58-EA will change the way you use tape storage.

Because it combines the convenience and cost advantages of a ready-to-roll tape cartridge, with the performance advantages of random accessing.

The TU58-EA is a compact table-top package, complete with power supply and EIA interface, ready to hook up to any computer.

And it has a built-in MPU that makes it think like a disk. Instead of handling data serially like other tape systems, the TU58-EA reads, writes and searches for data in blocks. So you can use it in more time-critical applications.

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High performance storage is just one of the ways Digital makes microcomputers easier to work with. We offer hundreds of hardware products to choose from. Boards, boxes, and development systems. Memory and interface boards. Terminals and printers. With the widest selection of powerful, proven software in the industry.

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☐ Please send more information on the TU58 family.
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DEC-C-156 ED-1-21-1

digital

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For more information, Circle No 72

New Products

TEST SYSTEM. You can test most 4- to 12-bit bipolar or MOS monolithic or hybrid A/D or D/A converters with the Model 1731's family board without writing elaborate programs. Exchanging the plug-in family boards and tape cartridges containing the 48k RAM-based operating software allows comparator/regulator testing. Parameters measured include gain error (%), zero error (% FS), linearity error (% FS), differential linearity (% FS), power-supply specs, rejection ratio and accuracy of the DUT's internal voltage reference. Current-force and voltage measurement capabilities permit dc parametric measurements on digital-I/O pins. Front-panel pass/fail indicators, manual and automatic binning and summary results on an integral 5-in. CRT are also provided. From $32,500, including program library, and ADC/DAC family board. Delivery, 12 to 14 wks ARO. **GenRad Inc,** 300 Baker Ave, Concord, MA 01742. Phone (617) 369-4400.

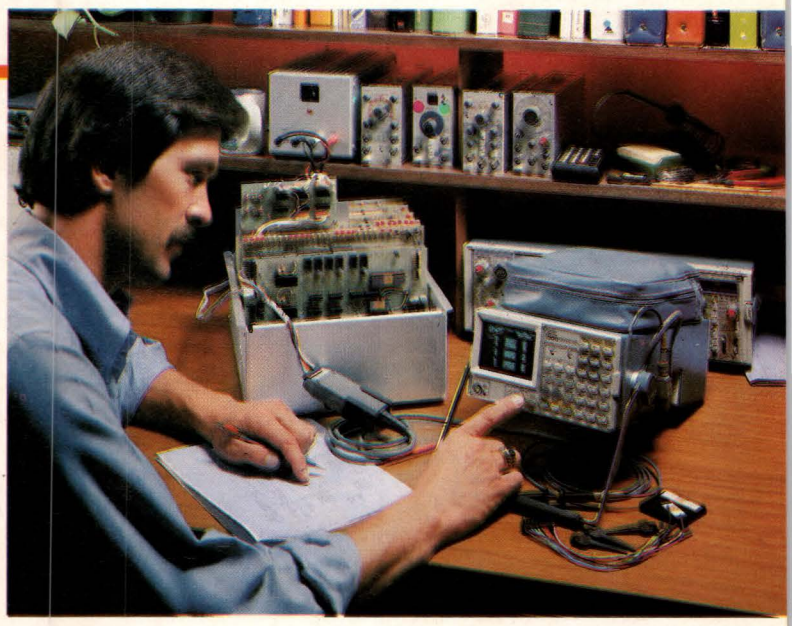
Circle No 207

DC AMPLIFIER. Model 13-4615-20 high-gain unit has a maximum sensitivity of 50 μV FS, a measurement range of 50 μV to 250V FS, claimed low output noise and good zero line stability and calibrated zero suppression for examination of complex waveforms. A solid-state input chopper is included, and an internal master/slave switch allows two or more amplifiers to be operated at maximum sensitivity within the same physical environment. Calibrated zero suppression provides 12 switch-selectable full-scale ranges of +100, +10, +1, −1, −10 and −100 mV or V. A calibrated reading with a resolution of 1 part per thousand is provided on each full-scale range. Other features include differential fully floating isolated input; 5-position low-pass output filter and >160 dB (at dc) and 140 dB (at 60 Hz) CMR. $990. **Gould Inc,** 3631 Perkins Ave, Cleveland, OH 44114. Phone (216) 361-3315. **Circle No 208**

308 DATA ANALYZER

Big power in a small package.

The 308 operates in four modes: parallel state, parallel timing, serial state and signature analysis.



The 308 Data Analyzer. From Tektronix.

The new 308 Data Analyzer packs an impressive array of logic analysis capabilities inside its trim, 8 pound (3.6 kg) frame. For instance, it operates in the serial and signature modes as well as parallel state and timing. And samples both synchronously and asynchronously up to 20 MHz. With a variable voltage threshold that covers all logic families in addition to TTL.

Two separate memories, acquisition and reference, allow automatic data comparisons. If there's no data difference, the sampling process is repeated until a discrepancy appears. And the acquisition memory can be automatically searched for any given word.

Word recognition can be up to 25 bits and includes an external output to trigger other instruments. And the trigger itself can be delayed up to 65,535 clock pulses past the trigger point. The 308 features a latch mode (5 ns), a memory "window" to let you closely examine portions of the memory and state tables which are displayed in binary, hex and octal.

The 308 Data Analyzer, from Tektronix. Performance? Uniquely versatile. Size? Conveniently compact. Price? Exceptionally reasonable.

If you're interested, contact your local Tektronix field office, or write us at:

U.S.A.
Tektronix, Inc.
P.O. Box 1700
Beaverton, OR 97075
Phone: 503/644-0161
Telex: 910-467-8708
Cable: TEKTRONIX

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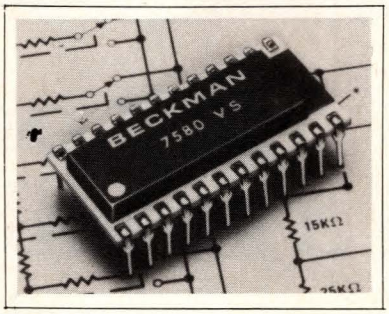
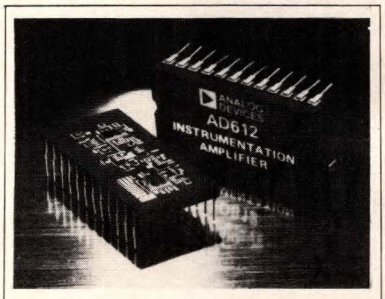
ICs & SEMICONDUCTORS



12-BIT DAC. Model 7580VS sports a conversion time of 6 μsec and includes a voltage reference, output op amp, TTL/CMOS level translators, CMOS switches and a thin-film R/2R ladder network. Five programmable ranges are provided: three bipolar ranges of −2.5 to +2.5, −5 to +5 and −10 to +10V and two unipolar ranges of 0 to 5 and 0 to 10V. Nonlinearity specs at ±0.0125% max, ±0.00635% (±¼ LSB) typ, and the unit is pin compatible with the DAC 80. Operating temperature ranges from 0 to 70°C. Approximately $22 (OEM qty) in ceramic double DIP. **Beckman Instruments Inc,** 2500 Harbor Blvd, Fullerton, CA 92634. Phone (714) 773-8800. **Circle No 234**

BAND-SPLIT FILTER. A dual-tone multiple-frequency CMOS switched-capacitor device for tone-dialing equipment, Model S3525 comes in two versions: One produces a 3.58-MHz buffered oscillator signal; the other, an 894.89-kHz square-wave signal. Operating with tone-decoder chips from Teltone, Rockwell, Mitel and Mostek, the unit uses a standard 3.58-MHz TV crystal with the on-chip oscillator and frequency dividers, provides 52-dB min rejection in the 300- to 500-Hz band and furnishes dc open-loop gain of 80 dB typ and 60-dB typ CMR for the op amps. Overall gain equals 6 dB for both high- and low-group signals with 40 dB of opposite-group rejection. The squaring function is handled by on-chip comparators, externally programmed for sensitivity. $14.50 (100) in 18-pin plastic packages. **American Microsystems Inc,** 3800 Homestead Rd, Santa Clara, CA 95051. Phone (408) 246-0330. **Circle No 235**



INSTRUMENTATION AMPS. These pin-programmable hybrid units permit user selection of either optimized dc performance with good dynamic characteristics or optimized dynamic performance with good dc characteristics. The AD612 provides a guaranteed input offset-voltage drift as low as ±1 μV/°C max (C grade) and a small-signal bandwidth (−3 dB) of 60 kHz. Model AD614 features a bandwidth of 160 kHz and 30-μsec max settling time to ±0.01% at a gain of 128V/V. Both devices also furnish a pin-programmable gain range of 1 to 1024V/V, ±0.001% nonlinearity and a guaranteed gain TC of ±10 ppm/°C max. Input-voltage noise for both models specs at 2 μV rms in a 10-Hz to 10-kHz bandwidth; guaranteed CMR equals 74 dB min at a gain of 1V/V and 94 dB min at a gain of 1024V/V. AD612, $40 to $52; AD614, $49.50 to $61 (100) in 24-pin ceramic DIPs. **Analog Devices Inc,** Box 280, Norwood, MA 02062. Phone (617) 329-4700. **Circle No 236**

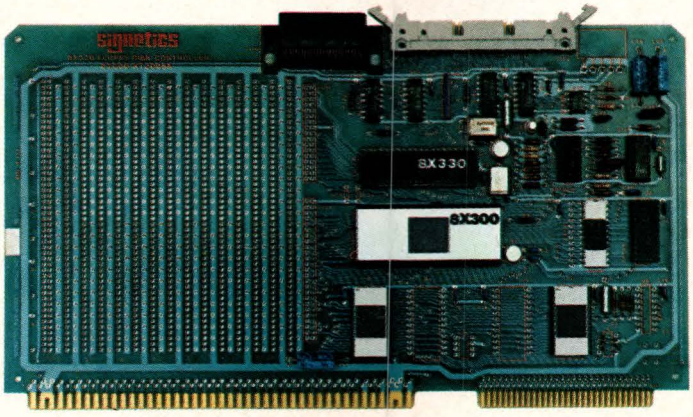
Microcontrol Mastery with Signetics 8X300

Compact floppy disk controller handles multiple drives and formats.

How one design met several goals in firmware.

Today's floppy disk controllers need more than high-performance interface capability. That's why the goals for this design were to maximize flexibility and minimize board space. With performance for tomorrow's needs.

This design—a programmable, intelligent I/O controller built around the 8X300 microcontroller and the 8X330, a new floppy disk controller chip—achieves these goals.



Compact Floppy Disk Controller occupies less than half of a standard 7"x12" PCB. The complete controller, based on Signetics' 8X330/8X300, consists of only 10 chips and a host interface.

Flexibility is achieved because this FDC can handle multiple disk drives in any combination of single/double density on 5¼ or 8 inch media. With either standard or non-standard track formats.

The on-board 8X300 microcontroller minimizes host overhead by implementing user-defined macro commands. Designed-in flexibility also allows error correction within IBM-compatible formats. And, bipolar performance meets next generation drive requirements with 1 megabyte/second data transfer rates.

The 8X330 is the first floppy disk controller chip to integrate the PLL data separator and write precompensation. Result: board space is minimized. An entire double-sided, double-density, dual drive disk controller with RS232 interface requires less than 30 square inches.

Greater flexibility, smaller size, and lower cost. All made possible by the 8X300 microcontroller and the new 8X330 floppy disk controller from Signetics. Find out how you can put Signetics' Microcontrol Mastery to work in your system. Write us today. Or call any Signetics sales or distributor office. *Signetics Corporation, 811 E. Arques Ave., P.O. Box 409, Sunnyvale, CA 94086. (408) 739-7700.*

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To: Signetics Publication Services MS27, 811 E. Arques Ave., P.O. Box 409, Sunnyvale CA 94086

☐ Please send technical information on the 8X300 and 8X330.

☐ I need a more detailed explanation. Please have a Bipolar LSI specialist contact me today at:

( )_____ ext._____

Name_____ Title_____

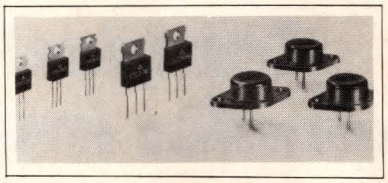
Company_____ Division_____

Address_____ MS_____

City_____ State_____ Zip_____

EDN 120

New Products



SWITCHING TRANSISTORS. Housed in metal TO-3 and plastic TO-220AB and TOP-3 packages, these high-voltage medium-power devices offer collector-to-emitter voltages to 500V and maximum power dissipation (at 25°C) to 100W. Collector currents range from 3 to 20A, leakage currents (I_{CBO} and I_{EBO}) spec at 100 μA, cutoff frequencies run to 3.5 MHz and maximum t_f equals 1 to 1.2 μsec. Collector-to-emitter saturation voltages ($V_{CE(sat)}$) are 1 to 1.5V. The units can be operated at high ambient temperatures when junction temperature doesn't exceed 150°C. From $0.97 (1000). Delivery, stock to 12 weeks ARO. **Panasonic Co,** 1 Panasonic Way, Secaucus, NJ 07094. Phone (201) 348-7842.
Circle No 237

CMOS DIVIDER. For generating decade-related time bases, the 8-pin mini-DIP RDD104 addressable unit divides by 10, 100, 1000 or 10,000. Features of the monolithic device include an active oscillator network on one input controllable by an external crystal or frequency source, an input-shaping network that accepts sine- or square-wave inputs and input clamp diodes that accept overvoltage signals with the aid of a current-limiting resistor. A square-wave output and reset are also provided. Operating-voltage range spans 4.75 to 15V; operating temperature, −40 to +85°C. $1.55 (1000). **LSI Computer Systems Inc,** 1235 Walt Whitman Rd, Melville, NY 11747. Phone (516) 271-0400. TWX 510-226-7833.
Circle No 238

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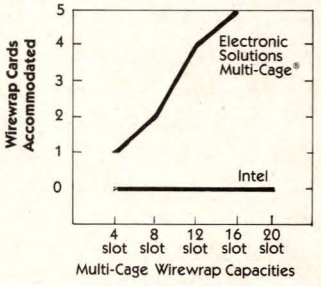

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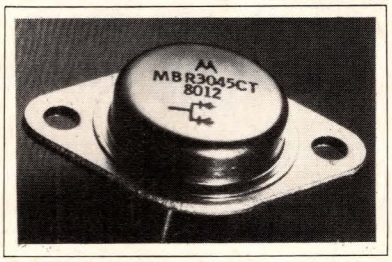
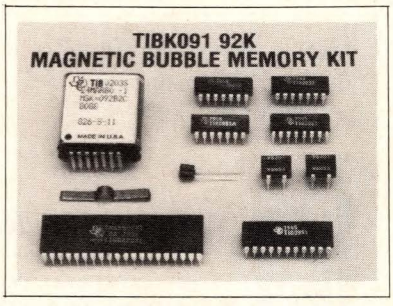
For more information, Circle No 77

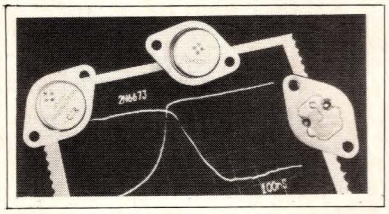
New Products



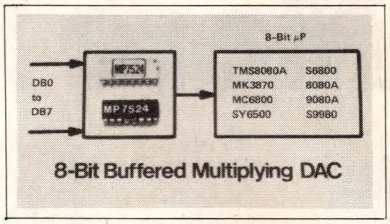
SCHOTTKYS. 30A devices intended for center-tap rectification and for use in medium-power switching supplies, MBR3020CT / 3035CT / 3045CT and SD241 full-wave bridges combine two chips in one TO-3 package. The 20, 35 and 45V units provide an operating junction temperature of 150°C with reverse voltages to 45V. The two dies can be used in parallel, and a built-in guard ring reduces junction stress and operates like a zener for transient protection. 0.45-in. pins and cathode-to-case polarity are standard. MBR3020CT, $5.70; MBR3035CT, $6.35; MBR-3045CT, $7; SD241, $6.70 (100). **Motorola Semiconductor Products Inc,** Box 20912, Phoenix, AZ 85036. Phone (602) 244-4624. **Circle No 239**



BUBBLE-MEMORY KITS. The TIBK091 kit, containing the parts required to construct a minimum memory system, furnishes one 50k-bps TIB0203S 92k-bit bubble memory, a TIB0833 sense amplifier, two TIB0801A coil drivers, a TIB0861 function driver, two VSB53 diode arrays, a TSP102G thermistor, a TIB0951 function-timing generator and a TIB0901 controller. The TIBK090 kit contains all the parts needed to construct a modular memory unit (MMU) and provides all TIBK091-kit parts except the function-timing generator and controllers. Because each function-timing generator and controller pair can drive as many as 10 modular memory units, each containing one bubble memory, the TIBK091 kit's memory capacity can be expanded by using multiple TIBK090 kits utilizing the same timing generator and controllers. TIBK090 $151; TIBK091, $191. **Texas Instruments Inc,** Box 225012, M/S 308, Dallas, TX 75265. Phone local office. **Circle No 240**



SWITCHING TRANSISTORS. High-speed, high-voltage units meeting JEDEC specifications, Models 2N6671, -6672 and -6673 feature V_{CEO}s of 300, 350 and 400V, respectively, and an 8A continuous collector current. Peak collector current is rated at 10A; maximum collector saturation voltage, 1V. Switching speed for all three models specs at 2.5 μsec storage with 0.4-μsec fall time. Minimum gain-bandwidth product equals 15 MHz. The npn devices dissipate 150W and feature an extended turn-off safe operating area, allowing them to switch inductive loads at 5A into the rated voltage without snubbing. 2N6671, $3.18; 2N6672, $3.60; 2N6673, $4 (100) in TO-204MA cases. Delivery, stock to 8 wks ARO. **General Semiconductor Industries Inc,** Box 3078, Tempe, AZ 85281. Phone (602) 968-3101. **Circle No 241**



MULTIPLYING DAC. Replacing the AD7524, the 8-bit monolithic CMOS MP7524 provides accuracy to ±⅛ LSB with a power dissipation of 10 mW. Other specs of the buffered unit include accuracy of ±0.05%, gain TC of 10 ppm and settling time of 100 nsec. The device is available in three temperature ranges, with 883B processing, in die form or to customer specs. $4.40 (100) for typical 16-pin plastic unit. **Micro Power Systems Inc,** 3100 Alfred St, Santa Clara, CA 95050. Phone (408) 247-5350. TLX 910-338-0154.

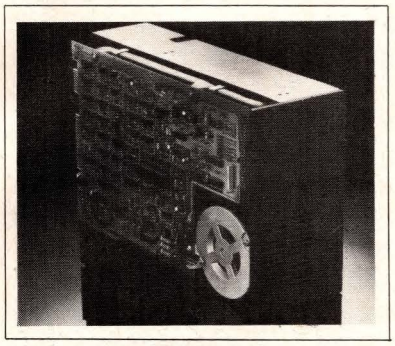
Circle No 242

PREAMPLIFIER. For automotive and other low-noise applications, Model LM1897 stereo-tape-deck preamplifier reduces both the size and number of required external components and eliminates all but the minimum number of external capacitors, thus reducing pc-board space. The tape head connects directly to the IC, eliminating the usual input coupling capacitor and resulting in input noise voltage of 0.6 μV CCIR/ARM. The device uses a 2-amplifier approach to deliver 76 dB at 20 kHz open-loop gain. Operating with any supply voltage from 4 to 18V, the unit provides 105-dB ripple rejection and turns on without a pop after a programmable delay time.<$0.85 (OEM qty). Delivery, 6 to 8 wks ARO. **National Semiconductor Corp,** 2900 Semiconductor Dr, Santa Clara, CA 95051. Phone (408) 737-5000. TWX/910-339-9240.

Circle No 243

New Products

COMPUTERS & PERIPHERALS



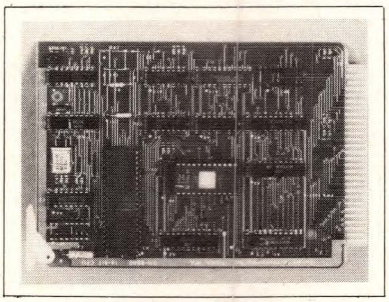
HARD-DISK DRIVES. The Q2000 series of 8-in. hard-disk drives includes the 10.67M-byte (unformatted) single - disk Q2010, the 21.33M-byte 2-disk Q2020 and the 32M-byte 3-disk Q2030. Key features include 4.34M-bps transfer rate, 10-msec average latency and 100-msec max track-to-track access time.

In addition to Shugart Associates SA1000 format and interface compatibility, the drives furnish 6600-bpi max recording density, 6600-fci max flux density, 345-tpi track density and 3000-rpm rotational speed. With the recommended 256-byte 32-soft-sector format, formatted capacities total 8.4M bytes (Q2010), 16.8M bytes (Q2020) and 25.2M bytes (Q2030).

The series comes with compatible controllers, exercisers and data separators. $1200 for the Q2010, $1500 for the Q2020 and $1800 (500) for the Q2030. Delivery, 30 to 60 days ARO. **Quantum Corp,** 2150 Bering Dr, San Jose, CA 95131. Phone (408) 262-1100.

Circle No 244

PAPER-TAPE READER. Model FER 204 features fiber-optic technology and a maximum synchronous bidirectional reading speed of 300 cps. Accepting CMOS, TTL or open-collector logic inputs, it consumes approximately 26W operating and 12W idle with a 24V dc supply, reads 6- or 8-track paper tapes with transparencies up to 60% and conforms to DIN 66014, ECMA-10, ISO R1154-1969 and BS 3380 American and European standards. $415. Manufactured by Ghielmetti Ltd of Switzerland and available from **Sutherland & Associates Inc,** 6290 Sunset Blvd, Suite 1126, Los Angeles, CA 90028. Phone (213) 463-5090. TWX 910-321-2903. **Circle No 245**



16-BIT CPU. The DM-8800 μP board uses an 8088 μP to provide STD Bus systems with 16-bit processing and 1M-byte addressing. Totally software compatible with the 8086, the 5-MHz unit performs a 16×16 multiply in 25 μsec—a 30-fold improvement over 8085 performance. Other features include a 5V supply and an on-board EPROM (either a 2716, 2732 or 2764) for 2k, 4k or 8k memory bytes. The EPROM is decoded at the top of the megabyte address space, leaving the first 64k bytes free for off-board memory. A software debugging monitor is available in EPROM for stand-alone use, allowing programs to download from Intel- or CP/M-based development systems into RAM. $395; debugging monitor, $195. **Desert Microsystems Inc,** Box 1174-D, Pasco, WA 99301. Phone (509) 547-3397.

Circle No 246

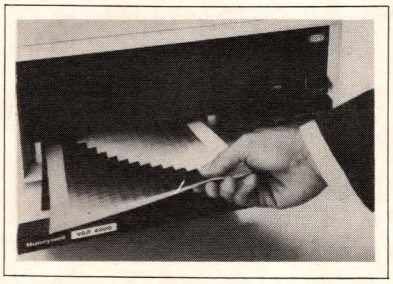
MODEM. Two modems in one, the ACM300/1200 can operate as either a 0 to 300-bps asynchronous full-duplex unit or as a 0 to 1200-bps asynchronous half-duplex device. It transfers low- or medium-speed data over normal-voice grade lines using available telephone handsets, a front-panel switch-selectable feature that needs no adjustment of straps, cables or cards. The handset-coupling design provides positive mechanical locking and noise isolation. The modem comes in an impact-resistant case that suits portable or desktop use. $695. **Rixon Inc,** 2120 Industrial Parkway, Silver Spring, MD 20904. Phone (301) 622-2121.

Circle No 247

DISK DRIVES. TM 600 Series 5¼-in. mini-Winchester units offer unformatted storage capacities ranging from 3.19M to 11.5M bytes. Available in 1-, 2- and 3-platter versions, the drives feature 3-msec track-to-track access time. Average access time specs at 168 msec, including head-settling time (245 msec in the extended-cylinder version). Other specs include 7690-bpi recording density and 3600-rpm rotational speed. Daisy chaining as many as four TM 600s provides up to 46M bytes of on-line storage (unformatted). $1400 to $1600. **Tandon Magnetics Corp,** 9333 Oso Ave, Chatsworth, CA 91311. Phone (213) 993-6644.

Circle No 248

New Products



HARD COPIER. Model VGR 4000 records the displayed image of a broad range of video displays. Warming up in <5 min, it produces 8½×11-in. high-resolution pictures on dry silver paper from most raster-scan units, within 14 sec and in as many as 16 shades of gray. Desktop or rack mountable, the unit features built-in test and diagnostic functions, optional 4-channel multiplex capability, copy counter, platenless operation and (on standby) 100W power consumption. $5000 to $7000. **Honeywell Test Instruments Div,** Box 5227, Denver, CO 80217. Phone (303) 771-4700. **Circle No 249**

ASSEMBLERS. M68 for Motorola's 6800 μC and M18 for RCA's 1802 computer are relocatable assemblers that run on CP/M-based systems. Both provide a macro and conditional-assembly syntax and generate a Microsoft-compatible relocatable object file. Allowing for relocation of 8-bit expressions, each assembler includes a relocatable linking loader and a library manager. $425 on 8-in. soft-sectored diskettes. **Systems Consultants Inc,** 4015 Hancock St, San Diego, CA 92110. Phone (714) 222-6381. TWX 910-335-1660. **Circle No 254**

CPU BOARD. Compatible with the IEEE-696 S-100 bus, the 16-bit Model C-86 operates at 5 MHz in standard configurations; an optional version runs at 8 MHz. The standard board features an 8086 μP, an on-board local bus that contains 2k×16 bits of PROM, an RS-232C serial I/O port, a software-programmable timer, and a special expansion connector that permits the addition of arithmetic and I/O processors. Because the S-100 bus permits as many as 16 bus masters to operate on a single bus, the unit includes a timing scheme that allows free transition from one bus master to another. The board also directly addresses 1M bytes of memory, switch selectable within the full 16M-byte space. Operating-system software and high-level languages are available. $725 (5-MHz unit); $825 (8-MHz unit). **Piiceon Inc,** 2350 Bering Dr, San Jose, CA 95131. Phone (408) 946-8030. **Circle No 255**

PRINTER. Model 85 features 7×7 and 14×7 dot-matrix printing, six character sizes, 100-cps bidirectional operation, selectable tractor or friction paper feed and ribbon-cartridge loading. It also provides variable-line-density and continuous-form-length controls. Telecommunication capabilities include baud rates to 9600, parallel and serial RS-232C-outputs, X-on/X-off transmission controls and a 1k-byte buffer. Furnishing a full 96-character ASCII set, the printer provides both upper- and lower-case printing at 80, 96 or 132 characters/line on a 8½-in.-wide paper. The paper feed runs at 10 lps. $625 (100). **DIP Inc,** 745 Atlantic Ave, Boston, MA 02111. Phone (617) 482-4214. **Circle No 256**

Sometimes inputs and outputs can be a little tricky.

That's why our new 12-bit multiplying doubled-buffered DAC has more pins instead of less – 28 in fact, to give you I/O flexibility, to make data conversion less tricky.

The HS3120 accepts 4, 8, and even 12-bit bytes from the bus in one gulp, without keeping the processor waiting.

Double buffers allow the input and output to be updated independently. Outputs can be unipolar or bipolar, ±10 or ±5 volts.

Getting this all on a single, money-saving monolithic chip wasn't easy. But then neither is technical leadership in data conversion, and we're committed to that.

The HS3120 is only $22.50 in 100s, even less if you want 12-bit resolution with reduced linearity. Call or write so we can give you the complete technical story.

Hybrid Systems CORPORATION

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In the United Kingdom: Hybrid (Component) Systems U.K. Ltd., 12A Park Street, Camberley, Surrey. Tel. (0276)28128 (TELEX 858720 HYBRID G)
In France: Hybrid Systems S.A.R.L. 14 Rue du Morvan SILIC 525, 94633 Rungis CEDEX, France. Tel. (1)-6878336 (TELEX 250969 HYSYS)

For more information, Circle No 79

New Products

CRT DISPLAY. Providing local mass storage with one or two flexible minidisk drives, Model 2642A display station has a dedicated data-file system, text-editing capabilities and a forms-design utility. It furnishes a built-in memory for 88 lines of 80 characters; eight user-definable screen-labeled soft keys to execute predetermined functions; display enhancements that include underline, half-bright, blink and inverse video in any combination; a large-character and math-character set and a line-drawing set. A 270k-byte double-sided, double-density, 5¼-in. flexible minidisk drive for off-line text storage comes standard. With an optional second drive, total disk storage is 540k bytes. $6750 (one minidisk drive); $7750 (two drives); $6250 for tape-cartridge-drive option. **Hewlett-Packard Co,** 1507 Page Mill Rd, Palo Alto, CA 94304. Phone local office. **Circle No 257**

STATISTICAL MULTIPLEXER. The SM/2A 2-channel unit allows two independent asynchronous terminals, such as a printer and a CRT, to communicate simultaneously over one dial-up or leased telephone line. Key features include error detection and automatic retransmission without manual intervention; compression of blank spaces in reports; separate, independent buffers for each terminal; and independent baud-rate selec-

"That's Incredible!!"

A triac driver/SSR rated to 0.5 amp/600 V in a 6-pin DIP. Needs only 5 mA to operate. Choice of zero crossing or random turn-on.

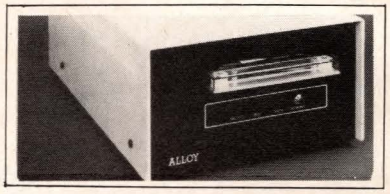
The amazing new TOC-4000 and TOC-5000 triac drivers represent the most advanced solid-state power relays in the industry. They easily replace Motorola MOC3031 or MOC3011 drivers while offering significant increases in current voltage and sensitivity. Continuing evidence that Theta-J is *the* leading edge in SSR technology. As low as $1.48 in 10K quantities! Theta-J Corporation, 208 West Cummings Park, Woburn, Massachusetts 01801. (617) 935-7600

Theta-J Corporation

For more information, Circle No 82

New Products

tion. Compatible with RS-232 asynchronous serial devices, the SM/2A operates with full-duplex modem types, such as 103A (300 baud, dial-up), 212A (300/1200 baud, dial-up) and 202T (1200/1800 baud leased line). It supports data rates to 4800 baud for direct-connect or short-haul modems. $825. Delivery, 30 to 60 days ARO. **Technical Analysis Corp,** 120 W Wieuca Rd Northeast, Atlanta, GA 30342. Phone (404) 252-1045. **Circle No 258**



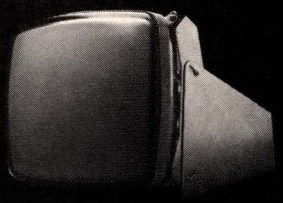
CARTRIDGE SUBSYSTEM. An S-100-compatible 6400-bpi cartridge - tape unit for Winchester-disk backup, Tape Interchange Package (TIP) permits transfer of programs and data files from a Winchester disk to a 13.4M-byte tape cartridge. Linking to the drive under CP/M and MP/M operating systems, it provides a 2-min-per-megabyte backup/restore rate. Software in CP/M format resides on a single-sided, single-density 8-in. floppy disk. $2100 for rack-mounting or $2200 (25) for table-mounting DS-100 controller, cartridge drive and power supply. **Alloy Engineering Co Inc,** 85 Speen St, Framingham, MA 01701. Phone (617) 620-1710. TWX 710-380-7624. **Circle No 259**

ASSEMBLERS. These assemblers convert Data General computers operating under DOS, MRDOS, RDOS or AOS into multiuser μP development systems for 8086, 68000, Z8000 or TI 9900 16-bit μPs.

A video bandwidth of 30 MHz and a 1200-line resolution make this new CRT monitor the brightest and sharpest you can get.

C. Itoh's new model 1201BE in our QDM series is capable of receiving separate horizontal drive pulse, vertical drive pulse and video input at the TTL level. This separate signal mode eliminates composite sync and video signal processing. The CRT is equipped with its own power supply unit. P4 phosphor is standard, but optional P31 or P39 phosphors can be provided. Available options: Dynamic Focus, Skip Scan, a non-glare etched face and a 19.5 KHz horizontal frequency.

The high performance and low price offered with this new CRT monitor give you all you need to really outshine your system's competition. For complete information contact your nearest C. Itoh representative or C. Itoh Electronics, Inc., 5301 Beethoven Street, Los Angeles, CA 90066; Tel. (213) 390-7778;
Telex: (WU) 65-2451; or 666 Third Avenue, New York, NY 10017; Tel (212) 682-0420;
Telex: (WU) 12-5059.



C. ITOH ELECTRONICS, INC.

Introducing the 12" CRT monitor for the systems designer with bright ideas.

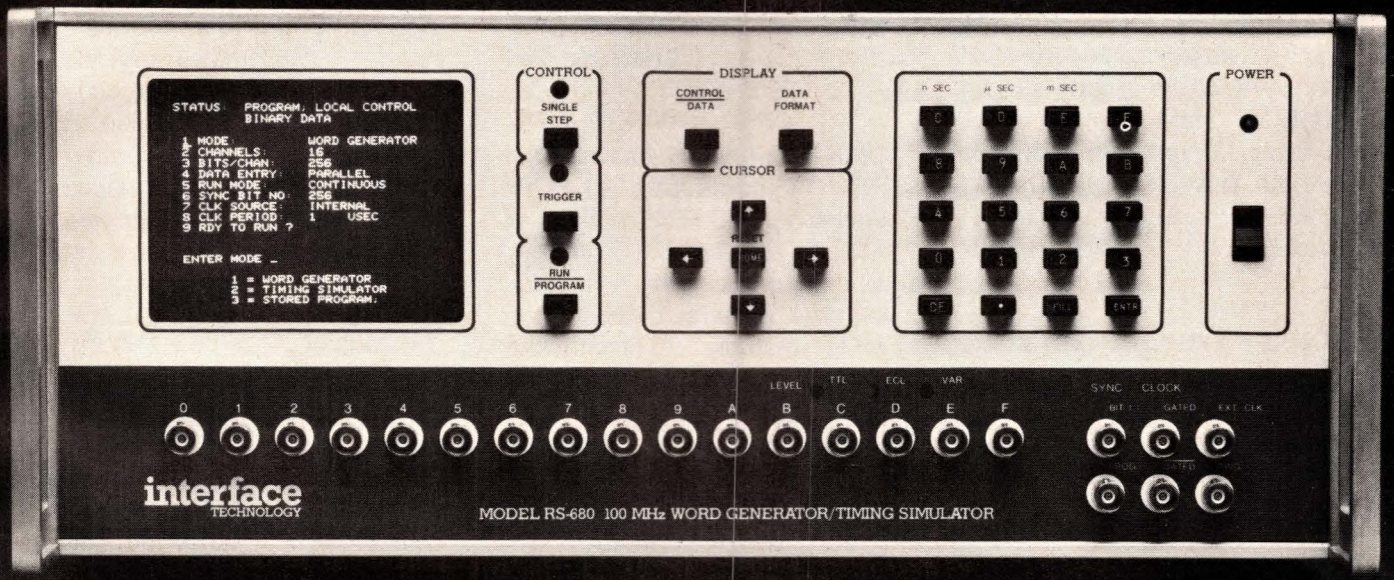
New Products

Operating-system commands as well as utilities remain unchanged. You can add other assemblers as required, creating a universal development system capable of supporting 30 μPs and as many as 128 users. Written in Data General assembly language, the assemblers feature high-speed operation, relocation capability, symbolic cross reference, macro definition and conditional assembly. From $1200 (3). **Boston Systems Office Inc,** 469 Moody St, Waltham, MA 02154. Phone (617) 894-7800. TWX 710-324-0760. **Circle No 260**

PASCAL COMPILER. For use with the company's family of 32-bit minicomputers, this package provides shared access to as many as 64 users for the development and testing of PASCAL programs. Conforming to ANSI's draft language standards, the software offers extensions to support modular program development; separate compilation of PASCAL procedures; easy access to external library routines in PASCAL, FORTRAN or assembly languages; and access to executive-service routines for functions such as time of day, date, device assignments and file positioning. $5250. **Perkin Elmer Corp,** 2 Crescent Pl, Oceanport, NJ 07757. Phone (201) 229-6800. **Circle No 261**

CMOS μC. Multibus compatible, the single-board CBC 800 executes the Z80 instruction set and operates at 2.5 MHz with a 1.6-μsec min execution time. Its 158 instructions provide software compatibility with Z80, 8085 and 8080 μPs. Features include 4k, 8k or 16k bytes of static CMOS RAM (running

Introducing 100 MHz clock rates. The word's getting around faster than ever.



Introducing the RS-680.

You probably think it's enough just to be the electronic industry's first 100 MHz digital signal generator.

But the RS-680 is also the industry's first stand-alone, 8-channel parallel programmable timing generator capable of operating with 10 ns resolution. And the first 16-channel parallel programmable data generator capable of operating at 50 MHz rates.

It will generate even the most complex timing waveforms (perfect for checking out sophisticated IC's). And it has 50 ohm outputs for both ECL and TTL levels. Use it as a bench instrument. Use it within an ATE system as a synchronizer, modulator, trigger or gating generator.

Finally, there's one instrument that does it all. With speed. With power. And with innovative circuitry that combines ECL, MOS and Bipolar technologies for the best of all three worlds.

How do you get one, two, four, eight or sixteen channel operations with up to a maximum of 4,096 bits? Use the RS-680 as a word generator.

How do you get up to 256 states on up to eight simultaneous channels with resolution as low as 10 ns for each state's period? Use the RS-680 as a timing simulator.

Use it in continuous, single cycle, burst (up to 4,096 cycles) or single step word modes. Trigger it automatically or manually.

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For more information, Circle No 86

New Products

without Wait states); sockets for up to 32k bytes of CMOS, NMOS or programmable ROM; two peripheral interface chips incorporating 44 programmable parallel-I/O lines; and four 16-bit programmable counter/timers. A UART furnishes serial RS-232 communication with software-programmable transmission rates to 9.6k baud. On-board logic allows 20 prioritized interrupts in three operating modes. Approximately $1600 for 4k-byte commercial version. Delivery, starting in December/January. **Diversified Technology Inc,** Box 465, Ridgeland, MS 39157. Phone (601) 856-4121. TLX 585326. **Circle No 262**

TAPE SYSTEM. A digital data-storage unit that meets MIL-E-16400, -5400 and -4158 for industrial severe-environment, military and aerospace applications, SETS-1 consists of a compact drive module coupled to a sealed removable tape module. Storing 23M bits at 1600 bpi on 300 ft of ¼-in. magnetic tape, it furnishes bidirectional read/write on four tracks with a 192k-bps transfer rate. The tape module is hermetically sealed to prevent environmental contamination, and the unit has an operating-temperture range of −40 to +71°C. $7200 (OEM qty). **Electronic Memories and Magnetics Corp,** 20630 Plummer St, Chatsworth, CA 91311. Phone (213) 998-9090. **Circle No 263**

DATA-ENTRY SOFTWARE. This package for the company's Flexifile 21 floppy-disk subsystem provides prompted data entry for distributed-data-processing environments. Formatting data on an interactive step-by-step basis and allowing computer operators to input information by responding to prompts displayed or printed by a terminal, it detects syntactical errors, generates corrective messages and features programmable fields and editing capabilities. $200 on diskette for current users of the Flexifile 21. **Tri-Data,** 505 E Middlefield Rd, Mt View, CA 94043. Phone (415) 969-3700. TWX 910-379-6978. **Circle No 264**

DISK EMULATOR. For use with PDP-11 computers and for emulating DEC RF11-A systems (utilizing dynamic MOS memory as the storage medium in place of disk platters), Model PM-RF11 features 10 times the transfer rate and requires 1700 times less access time compared with RF11 systems. Including write-lock switches for memory protection and ECC circuitry, the unit comes in two basic configurations. PM-RF11A supplies 512k bytes of MOS memory in a 5.25-in. chassis. Extra slots accept two additional 512k-byte expansion kits, providing a maximum of 1.5M bytes. PM-RF11B furnishes 512k bytes of memory in a 10.5-in. chassis and accepts up to 4M bytes of dynamic MOS memory via the PM-RF11B backplane and expansion kits. $9733 for basic PM-RF11A with 512k-byte memory. Delivery, 60 days ARO. **Plessey Peripheral Systems,** 17466 Daimler Ave, Irvine, CA 92714. Phone (714) 557-9811. TWX 910-595-1976. **Circle No 265**

M68000 SOFTWARE. Designed to run under the firm's HASP/68000 operating system in 32k-byte-RAM-configured systems, the RA68000ML resident assembler and the LINK68000 linking loader (part of the assembler package) consist of a 2-pass macro assembler and a 1-pass linking loader. Providing full macro facilities and conditional assembly, the RA68000 produces a listing and a sorted symbol table, generates relocatable and linking object code, uses a hash-coded symbol table and binary search of the mnemonic table and allows separately assembled routines to share data and produce ROMable code. EDIT68000, a resident line-oriented context editor providing for the creation and editing of program and data files, contains an extensive set of editing and file-manipulation commands. $350 for RA68000ML with LINK68000; $150 for EDIT68000 including user manual and object code on floppy disk. **Hemenway Associates Inc,** 101 Tremont St, Boston, MA 02108. Phone (617) 426-1931. **Circle No 266**

TAPE SYSTEM. Available in 800-bpi NRZ, 1600-bpi PE and NRZ/PE dual-density configurations, this 75-ips unit comes with interfaces for Nova/Eclipse, PDP-11 and LSI-11 minicomputers. RS-232, IEEE-488 and dual-buffered I/O interfaces are also available. The PDP-11 interface requires one quad peripheral controller; the LSI-11 interface uses two dual slots. The Data General interface comes on a standard 15×15-in. board requiring one slot in its computer chassis. Automatic self test and off-line diagnostics are provided. $6985 for 800-bpi NRZ; $7485 for 1600-bpi PE; $7885 for NRZ/PE dual density. **TDX Peripherals,** 150 New York Ave, Halesite, NY 11743. Phone (516) 423-3232. TWX 510-226-0449. **Circle No 267**

STR® technology for high data integrity. Three major tape formats for design flexibility.

We don't forget the OEM's needs.

The STR-810 digital recorder is designed for data logging, data acquisition and as a system loader. Using either the 3M DC-300A or DC-300XL cartridges, packing density is 1600 bpi, for respective data capacities of 2.3M bytes and 3.4M bytes per cartridge, using four tracks. Features include microprocessor-controlled tape movement and read/write electronics. For maximum versatility, interfaces include RS-232 and IEEE-488. Or, using control and status lines available, you can interface to specific microcomputers such as LSI-11 and 8080. EPI's optional ANSI X3.56 formatter, with NRZI or phase-encoded personality cards, turns the 810 into a plug-in component for industrial instrumentation and mini/microcomputer-interfaced peripheral markets. Price: $756 in quantities of 100. **STR-STREAM** is a high-speed, high-capacity version of the 810 designed for Winchester disc backup. Density is 6400 bpi for 17M bytes capacity per cartridge. Features include advanced head design, MFM formatting and compatibility with 8" or 14" discs.

Circle no. 101

EPI's STR-610 is a compact, low cost digital recorder that's ideal for use with POS terminals, smart CRT terminals and as a general peripheral for mini/microcomputer-based systems. The 610's recording density is 800 bpi for a capacity of 168K bytes/track, using a two-track 3M DC-100 mini-cartridge. Formatting is ANSI Standard and interfacing is parallel, with a variety of options. Price: $280 in quantities of 1,000. **The STR-LINK III** is a high-speed (9600 baud), portable program loader that uses the STR-610's drive system and shares the same specifications. It is used as a field service tool for diagnostic work or as a peripheral in a mini/microcomputer system. STR-LINK III uses a serial RS-232 interface for data communications or data terminal applications, and it can be controlled through RS-232, ASCII control codes, or manually. Price: $1,615 in single quantity.

Circle no. 102

STR-LINK II is EPI's proven medium-speed (1200 baud) universal portable program loader for programmable controllers and process control systems. Using a standard cassette, it features switch-selectable transmission modes for maximum flexibility. Price: $1,889 in single quantity.

For maximum design freedom, proven reliability and high data integrity through Speed Tolerant Recording technology, remember EPI—the company that doesn't forget the OEM's needs. For more information, contact Electronic Processors Inc., P.O. Box 569, Englewood, Colorado 80110. Phone (303) 761-8540.

Circle no. 103

EO/4

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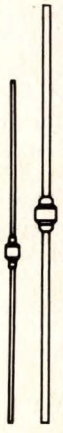
ELECTRONIC PROCESSORS INCORPORATED

IN AXIAL LEADED RECTIFIERS, THE PERFORMANCE STANDARD BELONGS TO UNITRODE.

UNITRODE "UES" AND "SES" 1A-6A RECTIFIER FAMILIES.

At Unitrode, we've brought a new standard to axial leaded rectifier performance: the "UES" and "SES" high performance rectifier families.

Our "UES" (Ultra Efficient Switching) rectifiers deliver a recovery time as low as 25nS max. and a forward voltage drop of less than .85V and .9V at rating. The best in the industry. And you can choose from three series (UES1001, 1101, 1301), 1A to 6A, up to 400V.



And now there's Unitrode's "SES" (Super Efficient Switching) rectifiers. They deliver a 100nS max. recovery time and a forward voltage drop of less than 1V at rating. In two series (SES5001, 5301), at 2A and 5A, up to 150V.

You can get this performance for as little as 25 cents in volume. So you can use "UES" and "SES" rectifiers wherever you need speed and efficiency. In industrial applications like switching power supplies and high speed magnetic switching for print hammers. And in a whole range of military applications, because "UES" and "SES" rectifiers are also available in JAN versions such as the 1N5800 series.

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COMPONENTS & PACKAGING

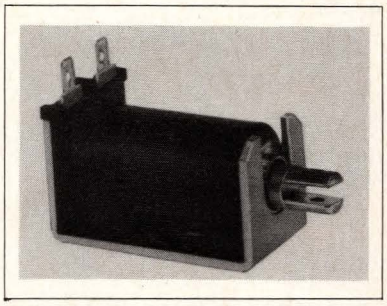
DATA-CONVERTER KIT. An engineering sampler, this kit contains a variety of 8- and 10-bit A/D and D/A converters. It also includes a copy of the company's data-converter handbook (providing appropriate data sheets) along with various booklets and flyers dealing with applications such as μP interfacing.

The kit contains 12 converters. The DAC complement includes two 8-bit ZN426E-8 units, two ZN428E-8 8-bit μP-compatible devices with latched inputs and two ZN429E-8 8-bit designs.

Four ADCs are offered: two ZN427E-8 8-bit units featuring 3-state outputs, one ZN432CJ-10 fast 10-bit unit and the ZN433CJ-10 10-bit monolithic tracking converter. Two dual 8-bit ZN425E-8 A/D-D/A devices complete the converter package.

All converters and literature come housed in a 3-ring binder. $85. **Ferranti Electric Inc,** 87 Modular Ave, Commack, NY 11725. Phone (516) 543-0200. **Circle No 170**

ZIF CONNECTORS. Card-edge designs with accumulated compact 20-position modules, PB18 Series devices feature a sliding-cam stick that sequentially actuates individual contacts as it is pushed through the unit. Regardless of the number of contacts employed, actuation force equals 4.4 lbs. The line includes both top- and side-entry designs. Housings are 15% GF PBT, and the phosphor-bronze contacts spec rated lifetime of 20,000 cycles. **ITT Cannon Electric,** 666 E Dyer Rd, Santa Ana, CA 92702. Phone (714)-557-4700. **Circle No 171**



C-FRAME SOLENOIDS. Compact general-purpose devices, Series S26 units feature an enclosed design that provides coil and terminal protection. The solenoids have pull-on-operate forces >48 oz and holding forces to 72 oz. Standard voltages for dc models equal 6, 12, 24, 110 and 220V; ac designs have 12, 24, 120 and 240V requirements. Maximum stroke equals 0.5 to 1 in. for intermittent dc and ac models, respectively. Coil power ratings range from 7W to 21 VA, depending on model. From $1.82 (500). **Potter & Brumfield,** 200 Richland Creek Dr, Princeton, IN 47671. Phone (812) 386-1000. **Circle No 172**

PRECISION TRIMMERS. Housed in a ¾-in. package, Model 1280 26-turn devices spec setting accuracy of 0.05%. Standard resistance values (with ±10% tolerance) range from 10Ω to 20 kΩ. TCR specs at ±15 ppm/°C over −55 to +125°C. Load-life stability measures

Among the good things that come in small packages are Wavetek's new Ultramin™ RF and microwave filters. They'll reduce weight and save valuable board space when you're designing circuits for anything that flies, swims, or walks.

For example, our T5 Series covers the 25 to 500 MHz range, yet weighs less than 0.046 ounces and is only 0.36 inches in diameter. The T8 Series is only a little larger and covers the 10 to 1,000 MHz range. R and S Series filters cover the full 10 to 3,000 MHz range.

TYPICAL PERFORMANCE

BANDPASS FILTER	HIGHPASS FILTER
f_o = 21.4 MHz	500 MHz
TO-8 Package	TO-8 Package
3dB BW = 2.1 MHz	3dB $f_{c.o.}$ = 450 MHz (and ≈1500 MHz)
40dB BW = 5.5 MHz	f_{80dB} = 400 MHz
Number of sections = 5	Number of sections = 5
I.L. = 4.1dB	I.L. = 0.6dB at 500 MHz
40dB/3dB shape factor = 2.6:1	3dB/40dB shape factor = 1.13:1

Rugged, low-mass Ultramin™ filters can be specified to meet stringent requirements for temperature, humidity, shock, and vibration, including MIL-E-5400, MIL-STD-202, MIL-E-8189, and MIL-F-18327.

They're available in bandpass, lowpass, highpass, and bandstop designs. 0.01 dB Tchebychev response is standard; other responses are available on request.

Write or call for our complete Ultramin™ Series catalog. It's the prescription you've been waiting for.

Wavetek Indiana, P.O. Box 190, 66 N. First Ave., Beech Grove, IN 46107. Toll free 800-428-4424; in Indiana (317) 783-3221.

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Use as directed for weight loss.

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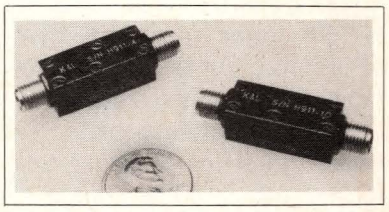
1%ΔR max after 2000 hrs under full-rated power of 750 mW at 25°C. The precious metals in the units' multifinger wiper are alloyed for resistance to wear and conductivity. Torque compensation is provided for the wiper's rider block. $2.92. (1000). Delivery, stock to 8 wks ARO. **Vishay Resistive Systems Group,** 62 Lincoln Hwy, Malvern, PA 19355. Phone (215) 644-1300. **Circle No 173**

I/O BOARDS. Designed to facilitate the implementation of the company's Series 6 I/O modules, MS-H Series boards are available in 4-, 8-, 16- and 24-position configurations. Designed to fit standard relay racks, they feature 5A fuses to protect field wiring and loads, LED status-indicator lights, decoupling capacitors and pads for optional mass-terminated ribbon-cable headers. They also provide sockets that can handle 10,000 insert/remove cycles, solder masks and connector compatibility with industry-standard single-board computers. $22 to $102. **Crydom Div/IRC,** 1521 E Grand Ave, El Segundo, CA 90245. Phone (213) 322-4986. **Circle No 174**

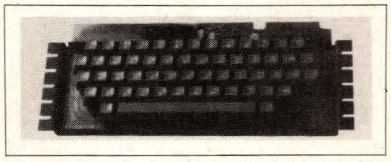
TEST SOCKETS. Offering 21 and 25 positions, respectively, TS-21 and SB-25B-G strip sockets are designed for burn-in test applications. The TS-21 features long contact springs to ease device insertion, while the SB-25-G's narrow profile (0.175 in. max) satisfies high-density applications. Each unit can be cut to any length and is available with ratings of 150°C (beryllium-copper gold-plated contacts) or 200°C (beryllium-nickel gold-plated contacts). TS-21, $1.88; SB-25B-G, $1.09 (1000). **Robinson-Nugent Inc,** 800 E Eighth St, New Albany, IN 47150. Phone (812) 945-0211. **Circle No 175**



BANDPASS FILTERS. A line of microminiature (0.14 in.^{3}) evanescent TE-mode designs, Series FV devices cover 0.5 to 18 GHz. They employ two to 17

resonant sections, and you can specify bandwidths from 4 to 70%. Standard RF terminals are SMA jack connectors; however, pins can be provided to permit microstrip-circuit mounting. From $250. **K&L Microwave Inc,** 408 Coles Circle, Salisbury, MD 21801. Phone (301) 749-2424. **Circle No 176**

CABLE SLEEVES. Insultite ITCSF flame-retardant heat-shrinkable units and ITCSN nonflame-retardant sleeves suit aerial, underground and URD direct-buried applications. Conforming to a wide range of connector and splice configurations, they offer shrink ratios as high as 4:1 and a choice of tubing sizes. Said to provide tight-fitting and water-resistant fits without cracking or splitting, the thick-wall irradiated-cross-linked-polyolefin sleeves come with adhesive sealants or uncoated. Standard cut lengths range from 6 to 48 in. with custom lengths also available. **Electronized Chemicals Co,** Burlington, MA 01803. Phone (617) 272-2850. **Circle No 177**



WORD-PROCESSING KEYBOARD. The standard ASR 33 operates in four modes: unshifted; shifted; control, which generates the code for nonprinting functions; and control shift. Standard features include n-key or 2-key rollover, stepped-keycap arrangement, repeat-function optional keys for assignment to any available code and four function keys for assignment to any of the 90 positions in the encoder. **ITT Datanetics,** 10840 Talbert Ave, Fountain Valley, CA 92708. Phone (714) 549-1191. **Circle No 178**

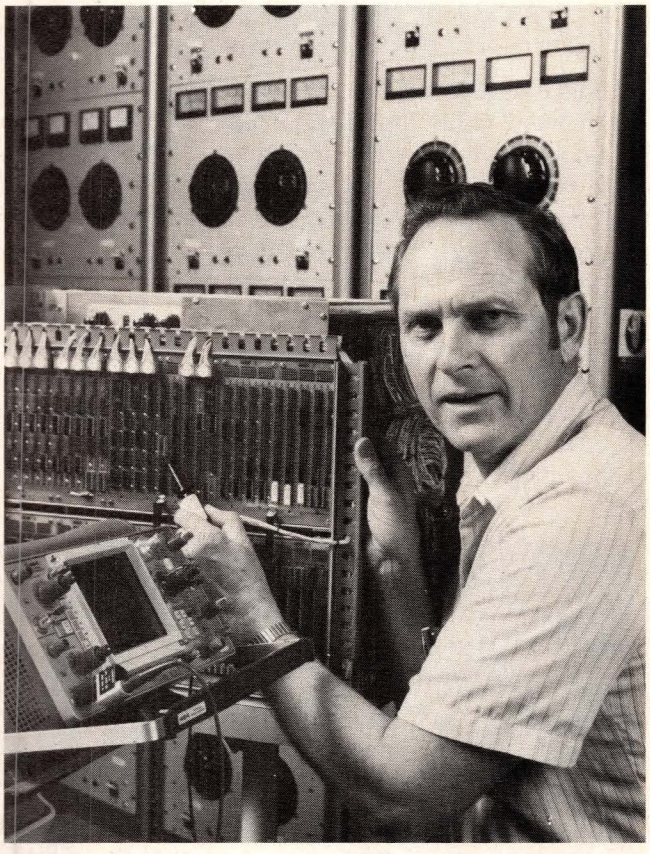
TRIMMER CAPACITORS. Suiting hybrid-circuit applications, these ceramic devices range from 5 mm in diameter and 2 mm thick to 3 mm in diameter and 1.5 mm thick. Available in substrate-mounting and printed-wiring-board-mounting models, they come with values ranging from 0.5 to 2 pF to as high as 5 to 35 pF in the largest model. Very-high-Q designs for UHF and gigahertz applications are also available. Voltage ratings at 25°C span 15 to 50V dc working voltage. $0.68 (1000). **Sprague-Goodman Electronics Inc,** 134 Fulton Ave, Garden City Park, NY 11040. Phone (516) 746-1385. TLX 144533. **Circle No 179**

DETECTOR/PREAMP. For fiber-optic data-communications systems, Model MFOD404F provides the functions of a photosensitive diode detector and a transimpedance amplifier on the same chip. With a responsivity of 30 mV/μW (at V_{cc}=5V), the unit sustains data rates to 10M baud/sec over medium distances, is compatible with the company's MFOE103F and -106F emitters and fits AMP-compatible metal fiber-optic connector barrels. $37. **Motorola Semiconductor Products Inc,** Box 20912, Phoenix, AZ 85036. Phone (602) 244-4556. **Circle No 180**

I never knew a transient suppressor could work this well!

If you're still using MOV's...

It may be that you haven't tried a TransZorb®.



Most people who are still using MOV's just haven't tried our TransZorb transient voltage suppressors yet. It's true that MOV's cost a little less than TransZorbs, but what kind of performance are you really getting? What is the response time when a transient does come along? Will the performance be the same after a few pulses, or does it deteriorate? What happens to its breakdown voltage over time? And, what happens to its clamping voltage when a pulse does occur? If it exceed your maximum voltage ratings, your circuit is in trouble, and you're not getting the protection you need... at any price.

We can offer you the solid protection from transient voltages that we think you want. And, we don't hedge...maximums and minimums are spelled out. We GUARANTEE our products, and have for more than a decade. We have a standard product for almost every transient problem. There are TransZorbs as low as 5 volts for IC protection, 18 volt devices for automotive, 28 volt units for aircraft, 115 and 220 volt suppressors for AC lines, and the list goes on. And, TransZorbs operate from −55°C to +175°C. Just right for those Military applications. Many are UL Recognized, too.

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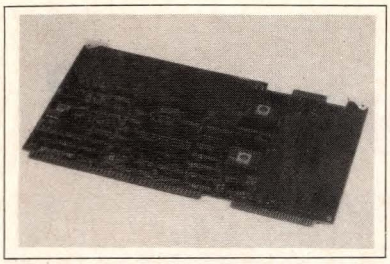
COMPUTER-SYSTEM SUBASSEMBLIES



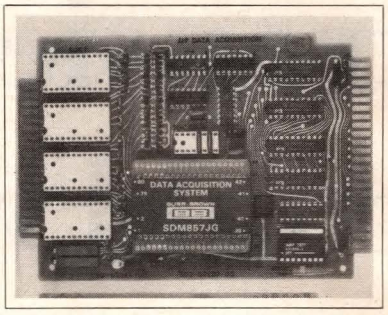
BOARD COMPUTER. Based on an 8086 CPU, the Custom 86 single-board computer conforms to the IEEE-P796 bus standard (Intel's Multibus). And because it provides two breadboarding areas, developing a product with it allows designed-from-scratch flexibility while maintaining the shorter design cycle possible with standard products.

You can use the breadboarding areas for additions such as 128k of PROM, 64k of RAM, A/D and D/A converters, a high-speed I/O bus or battery-backed-up CMOS RAM. Connections for the μC's control lines, chip-select lines for PROM and I/O, interrupt-control lines and some prototyping interconnections are brought out to the breadboarding areas.

Both the address and data lines come out fully buffered to wire-wrapping pins. From $995. **Microbar Systems Inc,** 1120 San Antonio Rd, Palo Alto, CA 94303. Phone (415) 964-2862.

Circle No 209

A/D MODULE. Digitizing as many as eight separate differential analog inputs from such devices as pressure and temperature transducers for



instrumentation and data-acquisition applications, this 4.5×6.5-in. card features 12-bit resolution and gain variable from 2 to 1000. Conversion time specs at 25 μsec for low gains and up to 320 μsec for high gains. Sockets are provided for additional filtering, gain or attenuation. The device handles 4- to 20-mA signals. $690. Delivery, 4 to 6 wks ARO. **Giddings & Lewis Electronics,** 666 S Military Rd, Fond du Lac, WI 54935. Phone (414) 921-9400.

Circle No 210

COUNTER/TIMER CARD. An STD Bus unit providing three 16-bit counter/timer channels and six operating modes, the fully programmable multichannel Model 7309 features a crystal oscillator, a tapped clock divider, an 8-input multiplexer for each channel and programmable logic states at each clock, gate and output signal. Configured independently by the program, each channel provides event counting from dc to 2.5 MHz, marker and square-wave generation, time-interval measurements, one-shot simulation with hardware and software triggering, and retriggering and repetitive interrupt generation. Any channel can interrupt after the nth programmed event of loop iteration. $145 to $195, depending on quantity. **Pro-Log Corp,** 2411 Garden Rd, Monterey, CA 93940. Phone (408) 372-4593.

Circle No 211

SYSTEM 19 NOW PROGRAMS MORE THAN 200 DIFFERENT PROMS WITH ONLY ONE SOFTWARE SELECTABLE MODULE.

Our new System 19/UniPak lets you program most MOS and bipolar PROM'S from AMD, Fairchild, Harris, Intel, MMI, Motorola, National, Raytheon, Signetics and Texas Instruments. UniPak's software assembles the programming algorithm and selects the correct socket for 16, 18, 20, 24 and 28-pin PROMS.

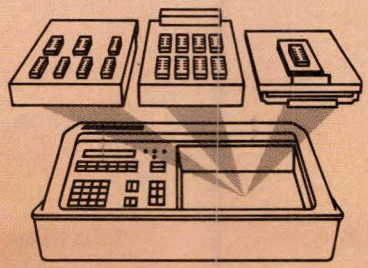
System 19/UniPak gives you design and purchasing freedom. This means you can select the best PROM for each application, and you can second-source for the best price and availability.

Semi-house approvals and easy calibration help maintain higher device yields. UniPak has earned written approval from device manufacturers. And easy calibration lets you keep performance within PROM manufacturers' specifications.

UniPak algorithms shorten programming time enhancing System 19's use as a production tool. UniPak is the first module to use a newly developed algorithm which makes it possible to program a 64K EPROM in less than half the time it takes to program a 16K EPROM using standard methods.

And the System 19/UniPak is easy to operate, with a minimum of operator training.

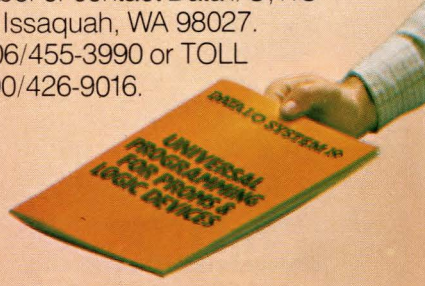
New System 19 concept is open ended to keep it state of the art. The System 19 is designed around a standard main frame and plug-in modules.



Modules available now include the UniPak, a gang programming pak for MOS devices, and a series of programming paks for logic devices and individual PROM families.

23 communication formats including six for development systems. Development systems, computers, teletypes and CRT terminals interface easily with the System 19. The System 19 accepts micro-processor instruction codes from Motorola, Intel, Tektronix, Fairchild, FutureData and other development systems without intermediary equipment.

Let us show you the future. The new Data I/O System 19/ UniPak is available now. To make arrangements for a demonstration or to get your free copy of this valuable 32-page book, circle reader service number or contact Data I/O, P.O Box 308, Issaquah, WA 98027. Phone 206/455-3990 or TOLL FREE: 800/426-9016.



DATA I/O

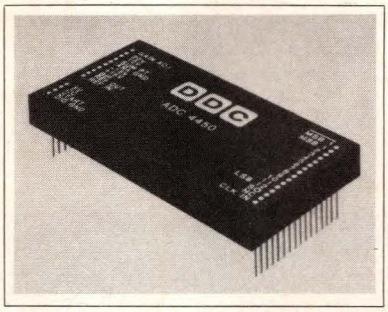
For more information, Circle No 93

New Products

TAPE CONTROLLER / FORMATTER. A fully embedded dual-density device, Model 1521 furnishes complete compatibility with DEC's TU10/TM11 tape subsystems. It works with LSI-11, -11/2 and -11/23 μCs and with industry-standard reel-to-reel transports that operate to 75 ips. You can switch-select recording in NRZ format at 200 to 800 bpi or in PE format at 1600 bpi. Self-test and subsystem diagnostics are included in firmware. $2025 (25). **Datum Inc,** 1363 S State College Blvd, Anaheim, CA 92806. Phone (714) 533-6333.

Circle No 212

A/D CONVERTER. Featuring −72-dB total harmonic distortion and −72-dB intermodulation distortion, this unit runs from either an external (Model



ADC-4450) or an internal clock (Model-4452). Twelve-bit resolution and 1.5-μsec conversion time suit it for use in digital-signal-analysis instruments such as spectrum analyzers and FFT equipment. Packaged in a 2×4×0.4-in. module, the converter provides six unipolar and bipolar input ranges. $99 (100). **ILC Data Device Corp,** 105 Wilbur Pl, Bohemia, NY 11716. Phone (516) 567-5600. TWX 510-228-7324. **Circle No 213**

ANALOG-INPUT BOARD. BLC-8715 contains an 8085 CPU with 1k bytes of RAM, a 64k-byte address space and sockets for up to 4k bytes of user-programmable ROM/PROM. The unit also features an RS-232 serial interface, 22 programmable digital I/O channels and 16 single-ended and eight differential channels, software configurable in any mix or sequence. Analog inputs can be sampled at rates up to 25 kHz; the board can also perform digital processing and storage. BLC-8915 firmware permits rudimentary programming and debugging. A complete source-object listing is included in the firmware manual. $1120 (100). **National Semiconductor,** 2900 Semiconductor Dr, Santa Clara, CA 95051. Phone (408) 737-5000. TWX 910-339-9240. **Circle No 214**

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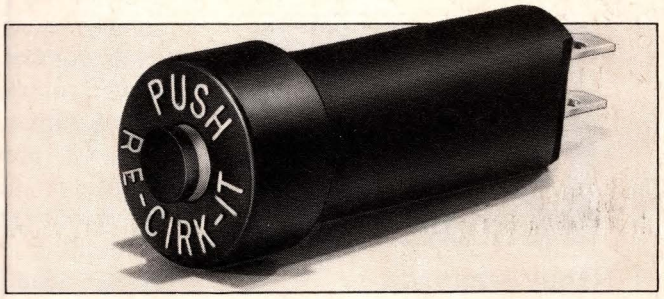

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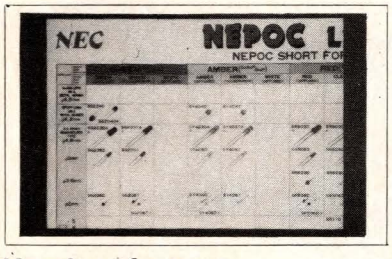
For more information, Circle No 95

Literature

Selection considerations for reed switches

Dimensional drawings accompany specs for a line of reed switches in an 8-pg catalog. Included is data on dry-reed switches in miniature Form A, standard-size and miniature Form C configurations and on miniature Form A and Form C mercury-wetted devices. A stocking-range chart provides data on pull-in sensitivities available for standard, selected or tightened ampere-turn tolerances. The guide explains terms pertinent to reed-switch use, including "voltage hold-off" and "actuate time," and also provides a cross-reference/application-guide chart. **Hamlin Inc,** Lake and Grove Sts, Lake Mills, WI 53551. **Circle No 215**



Handy reference highlights LED lamps

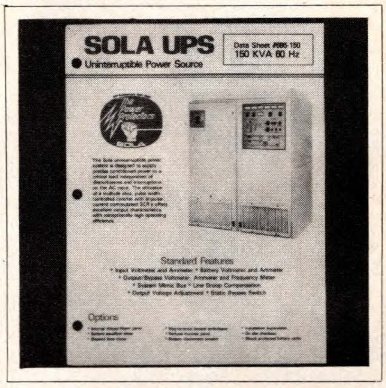
A full-color wall chart features a line of green, amber, red and IR LED lamps. Illustrations of components accompany data on device shapes, mechanical dimensions and ordering information. The reverse side provides specs for photocoupler and photointerrupter devices, detailing external dimensions, pin connectors and applications; and photosensors, outlining metal-header, molded and ceramic-header types. **NEC Electron Inc,** 3120 Central Expressway, Santa Clara, CA 95051. **Circle No 216**

Assortment of control and measurement devices

The 1000-pg "Data-Acquisition Components and Subsystems Catalog" contains product data sheets and tutorial sections and includes information for more than 500 standard data-conversion products, op amps, linear test systems, signal-conditioning products, computational circuits, subsystems for measurement and control and power supplies. Including a list of the firm's technical publications, it provides specs and application information for a line of products ranging from monolithic ICs to complete system-level products. **Analog Devices,** Box 280, Norwood, MA 02062. **Circle No 217**

Using a magnetic-tape controller

A 2-pg illustrated data sheet describes the TC-131, a single-board dual-density magnetic-tape controller for use with the DEC PDP-11 computer family. It details the unit's performance range, highlighting features such as the unit's 33-word data buffer, which allows the controller to be placed anywhere on a Unibus without consideration for bus priorities, and the ability to read and write on the fly. **Western Peripherals Div of Wespercorp,** 14321 Myford Rd, Tustin, CA 92680. **Circle No 218**



Data on line of UPS systems

Data sheets highlight features and options for a line of uninterruptible - power - source systems rated from 25 to 150 kVA and include specs for units that utilize a reserve battery bank for standby emergency power. They also detail standard panel metering, which includes an input voltmeter and ammeter; a battery voltmeter and ammeter; and an output/bypass voltmeter, ammeter and frequency meter. Each 2-pg sheet details operating specs, including input and output voltages, static and dynamic regulation figures, overload and short-circuit limits and operating-temperature range. **Sola Electric,** 1717 Busse Rd, Elk Grove Village, IL 60007.

Circle No 219

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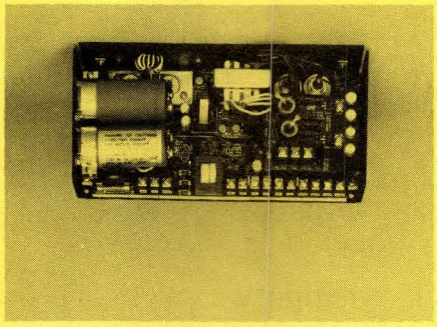

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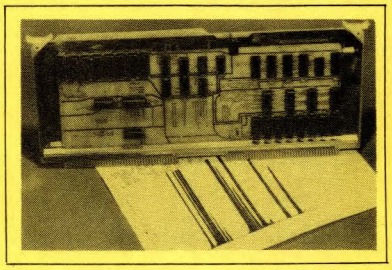

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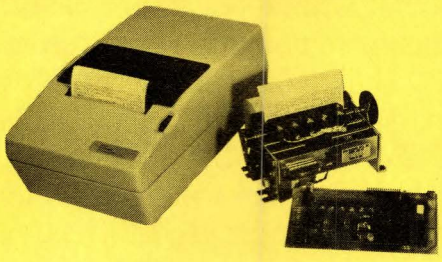

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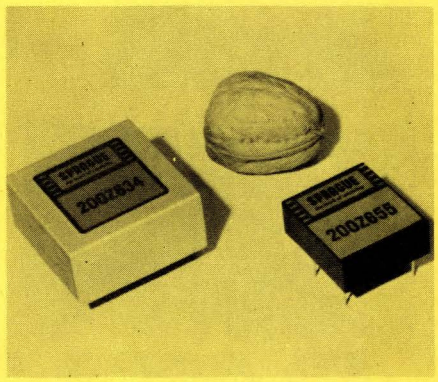
For more information, Circle No 133



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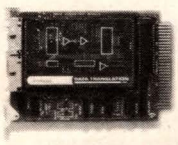
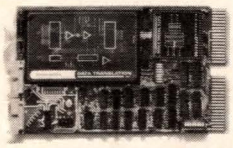
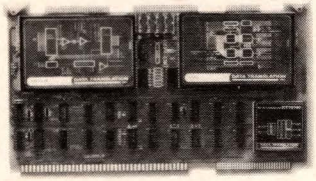
We can deliver dual height boards for LSI-11 and quad-size boards with features no one else has. Like DMA, 125KHz throughput to memory, isolated low level, 64 channel analog input capability and DEC compatibility.



What's more, we have an extensive software library to tie it all together. A new catalog to make ordering easier. And free diagnostics and user manuals.



The performance of our PDP-11 Unibus™ analog boards is also unequalled, thanks to isolated low-level, DMA I/O, 64 channel analog input capability, DEC compatibility, and 8 channel analog outputs.



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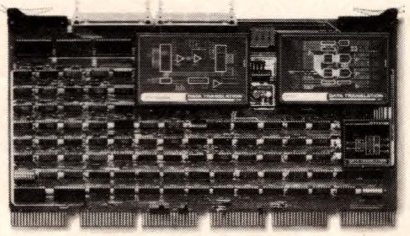

Data Translation, 100 Locke Drive, Marlboro, Mass. 01752, (617) 481-3700, Telex: 951646. In Europe: Data Translation Ltd., Rockwell House, 430 Bath Road, Slough, Berkshire/England SL16BB (06286) 3412. Telex: 849862.

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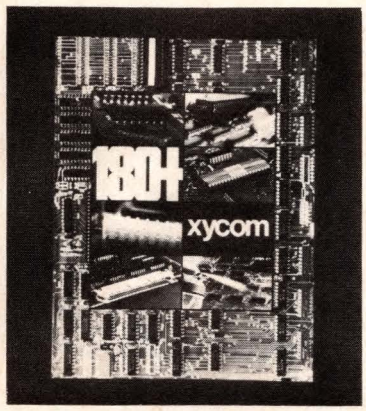
UNIBUS, PDP-11, and LSI-11 are trademarks of Digital Equipment Corp.

For more information, Circle No 96

Literature



Data on modules and controllers

A 6-pg brochure describes the 180+ line of CPU, memory and I/O modules and controllers designed and manufactured for use in harsh industrial environments. According to the brochure, the series features increased mechanical and electrical integrity and greater tolerance of temperature, humidity, vibration and contaminants than its predecessors. Specs for product performance and testing are included. **Xycom,** Box 984, Ann Arbor, MI 48106.

Circle No 220

Detailed specs for coaxial connectors

A 16-pg catalog details 250 standard BNC coaxial devices and illustrates four lines of clamping field-serviceable units (improved and standard Wedgelock, Wedge-eze and improved V groove) and three lines of crimping devices (improved Econo-crimps, X units and Econo-crimps). It describes connectors qualified to MIL-C-39012 as well as pc-board, isolated-ground and RF terminations. **Automatic Connector Inc,** 400 Moreland Rd, Commack, NY 11725.

Circle No 221

Literature

Characteristics of coaxial switches

A 20-pg illustrated catalog details a coaxial-switch line that covers the 0 to 18-GHz range with rotary, bladed and Dynaform-type units in a variety of configurations. A functional selection chart summarizes the products. Switches are grouped by frequency ranges and further categorized by function, size and general characteristics. Specs and line drawings, circuit/schematics and ordering information complete the brochure. **Amphenol North America Div,** 2122 York Rd, Oak Brook, IL 60521. **Circle No 222**

Track down quartz-crystal companies

The "1980 Quartz Crystal Industry Guide and Directory" contains listings of manufacturers in that field and includes names of management personnel as well as data on number of employees, size of facility and products manufactured. Listings are cross referenced by product category (eg, chemicals), chief executive and plant location. A bibliography concludes the 65-pg book. $35 (plus $1.95 postage and handling) for annual subscription, which includes 6-month updates. **GSM Inc,** Box 10121, Ft Lauderdale, FL 33334. **INQUIRE DIRECT**

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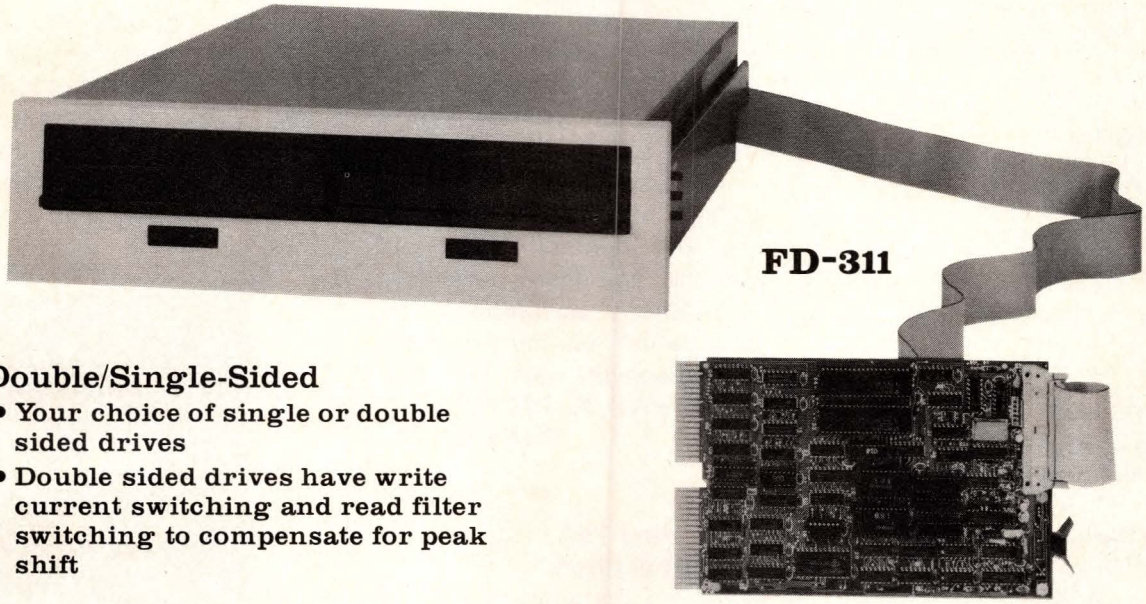

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Literature

30 applications for relays and switches

A 12-pg booklet describes applications for mercury-film relays and switches and mercury-actuated tilt switches. It includes specs for nominal coil voltage, coil resistance, operating and release times and vibration and shock resistance. Illustrations accompany the application examples. **Fifth Dimension Inc,** 801 New York Ave, Trenton, NJ 08638.

Circle No 223

More than 750 technical titles

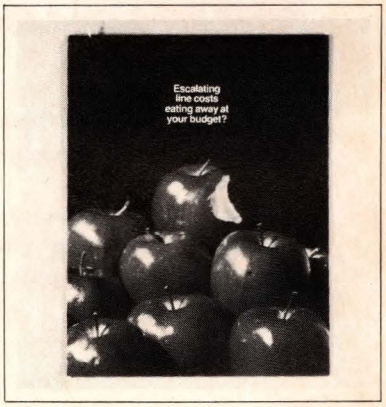
A 96-pg catalog describes technical and "how to" books available on topics such as energy, computers, robotics, electronics hobbies, electronic music, test equipment and servicing and engineering reference. A text summary and prices for hardbound and paperback copies accompany each entry. **TAB Books Inc,** Blue Ridge Summit, PA 17214.

Circle No 224

Using MOSFETs in dc/dc converters

App Note 933 investigates the use of parallel power MOSFETs as the controlled switch in high-frequency, high-voltage and high-power dc/dc power converters. The 12-pg booklet compares the advantages of using MOSFETs rather than bipolar junction transistors in a constant-frequency, 2-winding, voltage or current step-up energy-storage circuit. It also describes the operation of paralleled MOSFETs and the effect on circuit performance of stray circuit inductances in a dc/dc converter. Circuit models that lead to a quantitative analysis and to a computer-simulation study of circuit-parameter variations are also presented. **International Rectifier,** Semiconductor Div, 233 Kansas St, El Segundo, CA 90245.

Circle No 225



Capabilities of a statistical multiplexer

A 6-pg brochure describes the Micro700 Band Splitter, a 4-channel synchronous time-division multiplexer designed to achieve data-transmission economies with DDS circuits or over regular telephone lines by splitting the available data between several terminals. The publication provides specs on the unit, which permits up to four synchronous data terminals to share one telephone line or DDS link operating at speeds to 38,400 bps. **Micom Systems Inc,** 9551 Irondale Ave, Chatsworth, CA 91311.

Circle No 226

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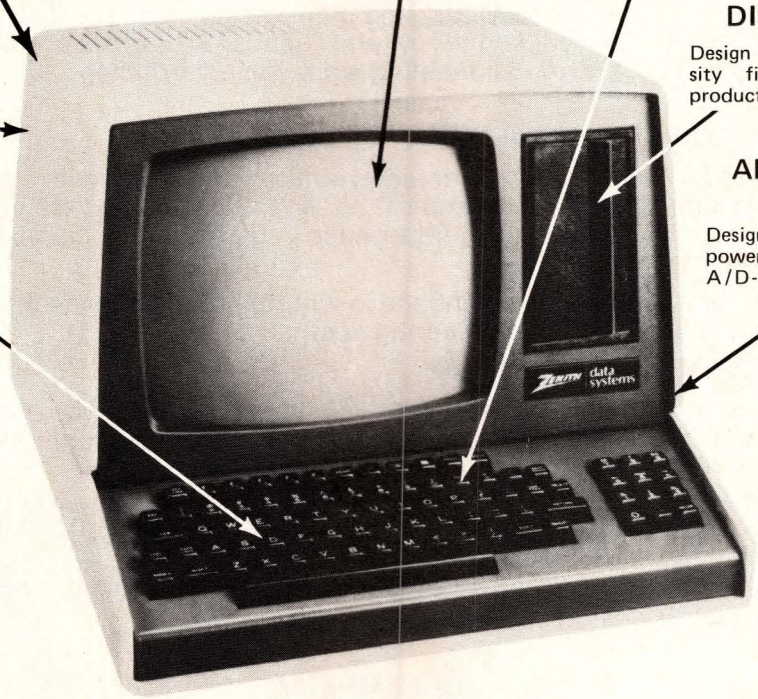

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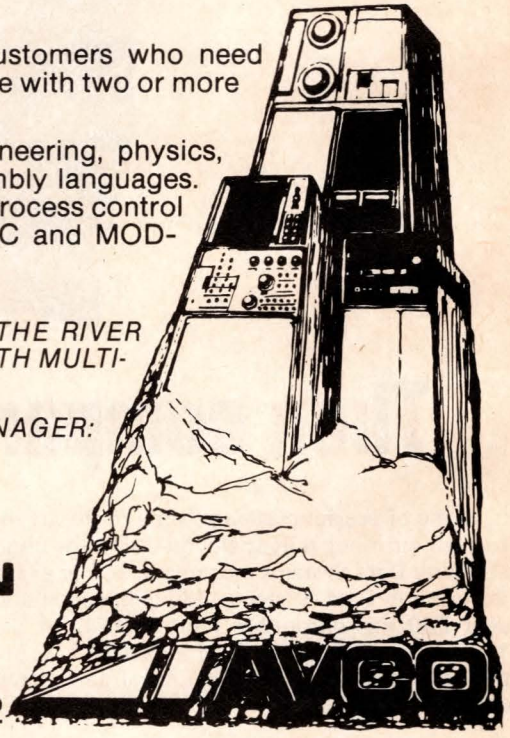

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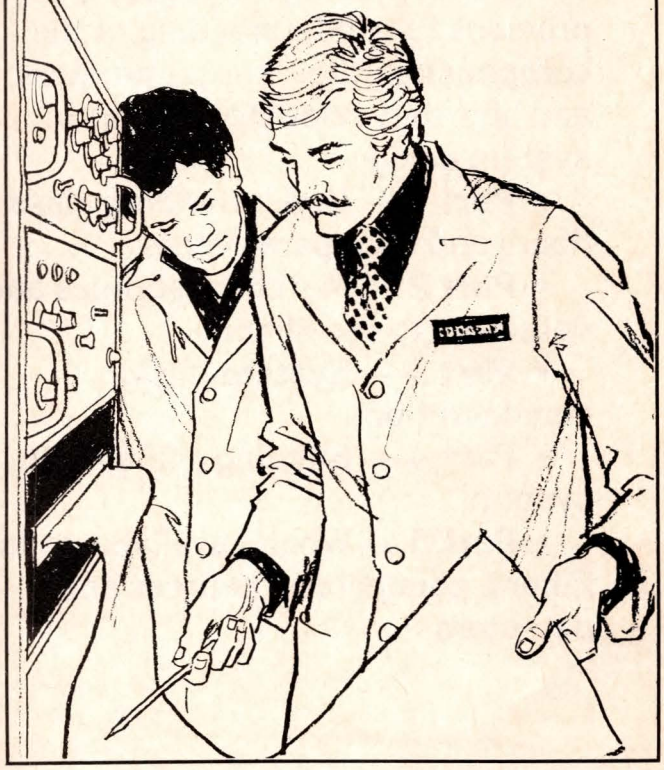

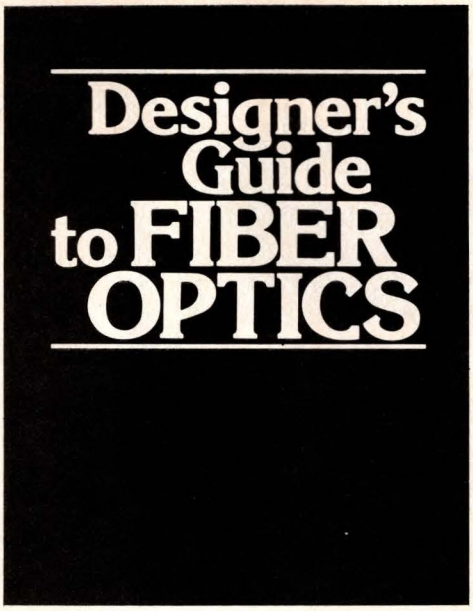

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Looking Ahead: Trends and Forecasts

$9.6B 1984 market seen for 2-way business comm

The market for 2-way business communications—defined as including any electronic communications system that "provides a possibility for conversation"—will increase nearly fivefold over the first half of this decade to cumulatively total more than $90 billion through 1985. This market growth encompasses a $1.8 billion 1980 equipment market expanding to $8 billion in 1984 (constant 1979 dollars), and services will add another $2 billion to that year's revenue totals, forecasts Frost & Sullivan Inc, New York City.

One of the five business-communications market sectors considered, electronic mail will climb from a meager $59 million in revenues last year to $1.5 billion in 1985; the largest revenue share will go to common carriers and suppliers of switching services. And today's fledgling video-conference-service market will soar to $500 million by 1985.

Other market developments include:

- Telephone interconnect—Private automatic branch exchanges (PABXs) now average about 85 lines and cost $950 per line. But prices should decline during the forecast period because of technical advances, competitive pressure and amortization of initial investments.

2-WAY BUSINESS-COMMUNICATIONS MARKET
($ MILLION, CONSTANT 1979 DOLLARS)

PRODUCT CATEGORY	1980	1984
TELEPHONE INTERCONNECT	493	765
TELEPHONE ANSWERING		
SALES TO BUREAUS	77	305
SALES TO COMPANIES	24	460
COMMUNICATING WORD PROCESSORS	617	2940
INTELLIGENT TYPEWRITERS	114	2500
FACSIMILE		
GROUPS 1-3	327	745
ULTRAFAST	—	40

SOURCE: FROST & SULLIVAN INC

Additionally, smart telephones that handle graphics data should become a major revenue source for interconnect suppliers, according to Frost & Sullivan.

- Telephone answering—"The novel notion of using a machine to answer corporate telephones," comments Frost & Sullivan, "will be legitimatized by a forthcoming IBM product."

Electronic Yellow Pages to bill $2.5B by 1990

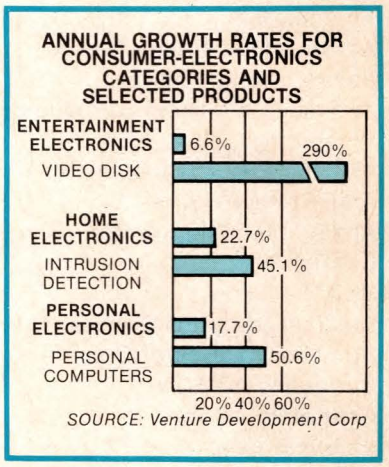
Product and service information of the type found in the telephone-book Yellow Pages will soon appear in electronic form. US operators of such services will derive revenues greater than $200 million by 1985 and more than $2.5 billion by 1990, according to International Resource Development Inc, Norwalk, CT.

Because the advertising furnished by this type of service can be constantly updated, it can also include information such as prices and notices of special sales, data currently the province of other types of advertising.

Japan, US will continue consumer-electronics war

In the 1980s, the greatest Japanese challenge to US electronics manufacturers will not come from vigorous competition in the radio, TV and hi-fi fields as it did in the '60s and '70s. Instead, Japan will focus on other fast-growing entertainment-, home- and personal-electronic-product areas, according to Venture Development Corp (VDC).

Entertainment electronics, the largest of these product sectors, will see the most



SOURCE: Venture Development Corp

intense competition, particularly in the video arena. The struggle among the currently incompatible video-disk systems could easily become the battle of the decade, according to the Wellesley, MA market-research firm.

Competition among US and Japanese firms should be less intense in the home-electronics area, however. The market for electronic intrusion-detection equipment, for example, is still at an early stage of growth: US manufacturers such as General Electric still must work to build up the market. With an expected growth of 45% annually, though, this product area could prove rewarding to companies willing to educate consumers about their products' advantages.

Japanese companies are also maintaining a low profile in retail telephone equipment, says VDC. Despite annual growth exceeding 20% in some categories, Japan is largely leaving this area to US manufacturers.

Material for this page developed from *Electronic Business* magazine and other sources by Joan Morrow, Assistant Editor, and Jesse Victor, Assistant/New Products Editor.

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RF	0.5-500
IF	DC-500

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0.5-500 MHz	6.5	8.5

Isolation (dB)		**Typ.**	**Max.**
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	LO-IF	45	35
5-250 MHz	**LO-RF**	45	30
	LO-IF	40	25
250-500 MHz	**LO-RF**	35	25
	LO-IF	30	20

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