MARCH 15, 1979

ALPHA PARTICLE PLAGUE SPREADS TO STATIC RAMS/85

High-level microprocessor languages, part 3: Forth/114

Porcelain-coated steel: is it the ideal substrate?/125

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Electronics

The International Magazine of Electronics Technology

Vol. 52, No. 6 • March 15, 1979

Highlights

Cover: IBM lays foundation for future design, 101
The recently introduced System/38 features on-chip testability and simplified virtual memory management. A computer-guided electron beam defines interconnections to customize a large-scale integrated gate-array chip.
Cover is by Art Director Fred Sklenar.

Europeans jittery over unsold German TVs, 96
Oil shortage, unemployment, inflation add to component makers' worries evident at Paris show. But though consumer markets look poorly, military and data processing business is looking up.

Language tightens microcomputer programs, 114
Third installment in microcomputer programming series examines Forth, a language organized like a dictionary. The programmer can add his own definitions and intermix assembly instructions.

Porcelain-on-steel entices board designers, 125
The technology for producing porcelain-on-steel circuit boards is coming of age. Tooling costs run high, but ruggedness and thermal properties are excellent.

. . . and in the next issue
A special report on data handling by satellite . . . new op amps that run on 1 volt or less . . . a compact megabyte bubble-memory module.

Electronics

Publisher's letter

Preparing the group of four articles on the IBM System/38 computer (p. 101) almost required a System/38 computer. Besides the introduction written by computers editor Tony Durniak, the project included three different articles prepared by six authors at two separate locations, coordinated from a third.

But the results are worth the effort, providing an early look inside the System/38, which was announced in October 1978 but will not be delivered until August 1979. More than describing a single computer system, the articles point to the directions in which IBM will go in future systems.

A review of the gate-array chips, by Jehoshua Pomerantz, Rolf Nijhuis, and Chet Vicary, came from IBM's Data Systems division in East Fishkill, N. Y. The system's unique built-in testing scheme was produced by Neil Berglund at the General Systems division (GSD) in Rochester, Minn. And the discussion of virtual address translation by Merle Houdek and Glenn Mitchell also came from Rochester. General Systems division headquarters in Atlanta, Ga., did the coordination.

An interesting sidelight on the System 38 project, which took about eight years from inception to product announcement, was the tilt of the design effort in that time from hardware to software. Brian Utley of GSD, project manager for the System/38 for five of those eight years, estimates that by the end of the program there were two and a half to three software people for each hardware designer.

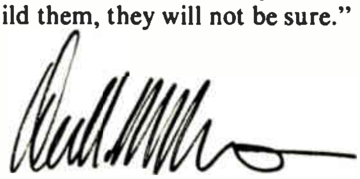
"The real value of this class of product is the software, because that's the function the user sees and interfaces with," Utley comments.

It has been about a year since alpha radiation in dynamic random-access memories became an issue in the semiconductor industry. The questions at the time were: is it serious, can users live with the soft errors caused by alpha particles, and will it be necessary to design around the problem?

Now, as the Probing the News story on page 85 points out, static RAMs heretofore believed to be impervious to alpha radiation have been invaded. The problem has appeared in those statics designed with polysilicon load resistors. Again there is controversy about the seriousness of the problem and what the manufacturers must do about it.

Implicit in a discussion of solutions is the concern among producers that users may eventually demand a specification on soft error rates. If so, it will mean higher costs for increased testing, tighter processing techniques, and the use of premium-priced materials.

"The manufacturers are confident that soft errors in 4-K and 8-K static RAMs can be overcome by proper design," solid state editor Ray Capece observes, "yet many are concerned with alpha-particle radiation in the forthcoming high-speed 16-K statics. Until they actually build them, they will not be sure."



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Readers' comments

Only one of several

To the Editor: A major theme of a recent article in the People column, "West and Nichols count on servicing microprocessors" [Jan. 18, p. 14], was that Millennium Systems Inc. is the only company now making instruments designed exclusively for troubleshooting microprocessor-based products.

In fact, there are many products currently being offered that are alternatives to the Millennium μSA. Included in this category are instruments by Pro-Log, Mupro, Paratronics, and E-H International, as well as by AQ Systems, to name those that immediately come to mind.

We at AQ Systems have been manufacturing microprocessor analyzers since early 1976 and now offer two products in this category: the AQ6800 for 6800 and 6802 applications; and the AQ8080 for 8080, 8085, and Z80 system troubleshooting. Our instruments offer the unique feature of providing in-circuit emulation capabilities without removing the microprocessor chip from the system under test.

Isaac Klinger
AQ Systems Inc.
Yorktown Heights, N. Y.

Not so wonderful

To the Editor: The "wonderful discovery" discussed in the Jan. 18 Engineer's Notebook, "Unspecified 8085 op codes enhance programming" [p. 144], is actually extremely dangerous from a programming standpoint.

Neither Intel nor any second-source vendor is obligated to have these unspecified operating codes function in future or even current 8085 microprocessors in the same way as described.

The result of using these op codes will, in all likelihood, be incorrect functioning when programs are moved from the development system to the application system. They therefore constitute traps to be sprung on unsuspecting persons using such software.

Furthermore, consumer confidence in microprocessor-based products will be damaged when myster-

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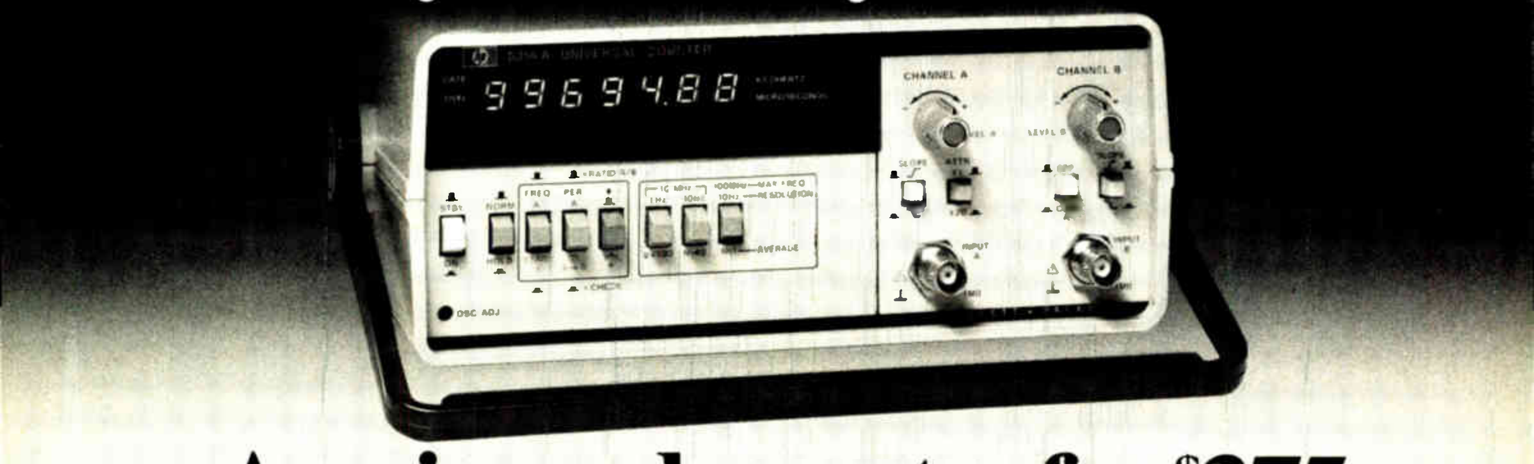

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ious, possibly dangerous, effects result from the use of products containing 8085s employing these op codes.

L. Edward Reich
Arlington, Va.

■ *Intel Corp. does indeed recommend that unspecified operating codes not be used, if for no other reason than that their inclusion (or function) in a particular chip issue is not guaranteed and they may in fact be removed as subsequent masks are made. The situation is roughly parallel to the use of "hidden features" in a particular calculator, where programmers also implement unspecified functions at their own risk.—Ed.*

Clarification

To the Editor: One point in my article, "Two chips, two processes combine in per-channel coder-decoder" [Feb. 1, p. 126], should be clarified. The final paragraph referred to Fig. 11, which was eliminated. Therefore the first sentence should be changed to read as follows:

"Since the codec's internal timing is independent of the data control clocks, the TP3000 can be readily used in a full-duplex single-channel application. That is, each of two codecs can transmit and receive data over a single interconnecting bus. The first codec would transmit PCM data to the second during the first half of the frame, and the converse during the last half of the frame."

The last sentence remains the same.

James W. Smith
National Semiconductor Corp.
Santa Clara, Calif.

Correction

In "ITT Semiconductors gears up for 64-K RAM production" (International Newsletter, Feb. 15, p. 64), the figure of 150,000 for 4-K and 16-K parts is per week, not per month.

1978 Index ready soon

The index of articles published in Electronics *in 1978 will be available shortly. For a copy, circle 340 on the reader service card.*

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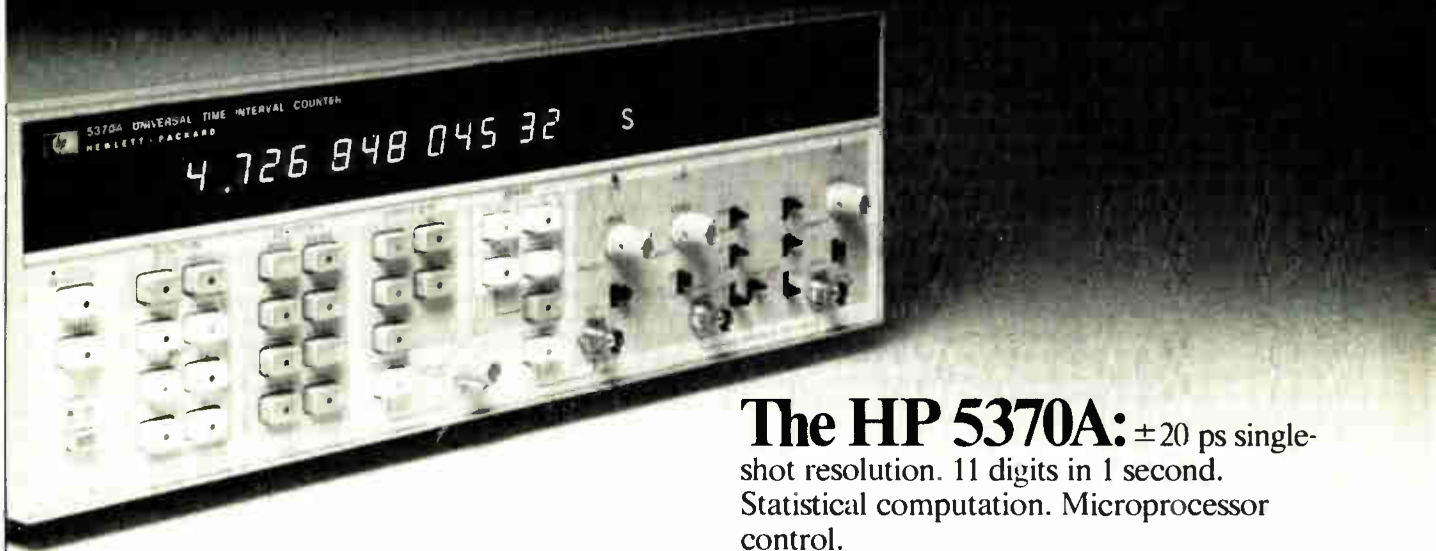

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News update

■ It's beginning to look as if Grumman Aerospace Corp.'s championing of synthetic-aperture radar (SAR) for tactical purposes will pay off. The Navy is allotting $8.9 million for a flight demonstration of the Grumman–Norden Systems Radar-Guided Warning System. The system adds to the radar a new angle measurement technique that has been designed to overcome previous shortcomings of SAR [*Electronics*, March 31, 1977 p. 31].

Other defense agencies are also interested in the RGWS concept, which combines target acquisition and weapon guidance. Grumman, in Bethpage, N. Y., now has a $15 million contract from the Air Force to develop just such an airborne system to work with ground-based weaponry. Hughes Aircraft Co. has a similar Air Force contract.

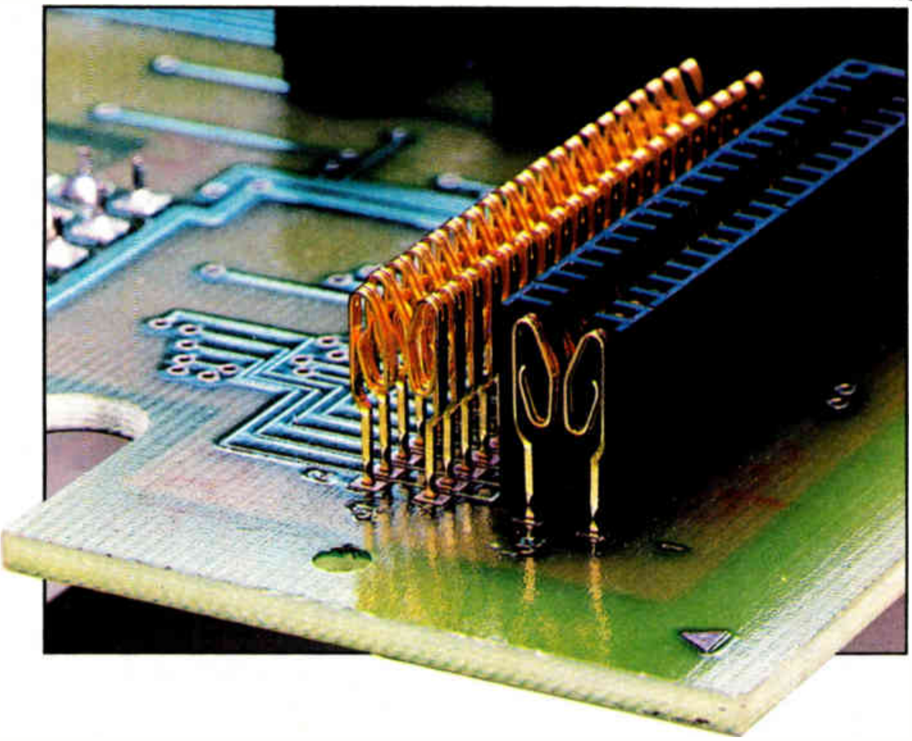
Grumman has been promoting RGWS for several years as a way of adding a long-distance, all-weather attack system to the Navy's A-6E. By providing more precise target information at greater distances, a radar with RGWS capability would enable a plane's pilot to launch weapons before entering the range of surface-to-air missiles.

Only 3 feet in diameter, the SAR antenna operates as though its aperture were several hundred feet wide. Essentially, it processes returning signal information often missed by conventional radars and provides an image of much higher quality. In fact, Grumman expects a 1,500-fold improvement in image detail.

SAR provides a target map, but does not locate area precisely in relation to aircraft. Grumman's solution—developed in conjunction with Norden Systems Inc., Norwalk, Conn., a subsidiary of United Technologies Corp.—is called a relative angle processor. It analyzes angles of arrival at the right and left antenna halves of signals from the target, using them to compute altitude and azimuth data.

A previous Navy contract involved ground processing of the data. Now the companies are working on airborne processing equipment for 1981 flight tests. **Ben Mason**

Expanding the parameters of press-fit technology



Bellows contact now available in economical press-fit backpanels.

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People

Walker hopes to soothe Tektronix' growing pains

Every company has growing pains, even one so long established and well known as Tektronix Inc., the instrumentation manufacturer. When its business surged last year by 32%, there were signs that restructuring of responsibilities was in order, and William D. Walker was elevated to the new post of executive vice president.

"We've grown faster than anticipated, and the old organization could not keep up," says Walker, whose job is to share the load on Tektronix president Earl Wantland's shoulders. The company ended its 1978 fiscal year at nearly $599 million. But another set of figures was an early warning—unfilled orders jumped from $128 million to $179 million.

Prior to the surge, Tektronix had embarked on an aggressive program of increasing its work force and work area. But new money, people, and facilities all require special attention from management, Walker points out. In his new job, he assumes responsibilities for manufacturing operations, marketing and sales, and research and development formerly carried by Wantland, who can now concentrate on long-term strategies and finances.

If anyone knows his way around Tektronix, Walker does. He's a 20-year Tek veteran familiar with its products, people, and goals. He has also had managerial experience in almost every area of the company, including engineering, product planning, and manufacturing. Most recently, he was group vice president of test and measurement products.

No surprises. Walker's plans—those he will reveal, at any rate—contain no surprises. Tektronix will continue fighting to keep its lead in oscilloscopes and low- to medium-resolution computer graphics terminals featuring proprietary storage cathode-ray tubes.

In addition, "we intend to remain in the high-end device test area but prefer not to scale down, for example,

Leader. Leading in scopes and graphics terminals is uppermost in Walker's mind.

to the level of Sentinel," says Walker, alluding to Fairchild's recently introduced medium-sized system for testing large-scale integrated circuits [*Electronics*, Jan. 4, 1979, p. 161]. "We prefer to stay at the high-end line where the degree of capital commitment tends to keep competition down," he continues. Tektronix will continue to support its logic-development systems area, Walker says, and he hints that it will probably broaden its logic analysis and digital test products.

Foster wants Interstate to be *the* plasma display source

Plasma displays are making little headway replacing cathode-ray tubes for lack of a steady supply of flat glass panels and because of sky-high prices—almost $1,000 for the panel alone, with drive and control electronics pushing it to $4,000 and up. But recent moves by Interstate Electronics have whipped the first problem, and the second is under attack, according to Richard A. Foster, new president of the A-T-O Inc. subsidiary.

"We're making a serious commitment to the future of plasma display," says the 43-year-old Foster, who moves up after four years as vice president of operations and 20 years of total service. What he terms "our first true commercial display product" (compared to military versions) will be ready in mid-to-late 1979. It will have a simplified, more compact electronics package that can be located remotely. This is

A Mux in Linear Wonderland

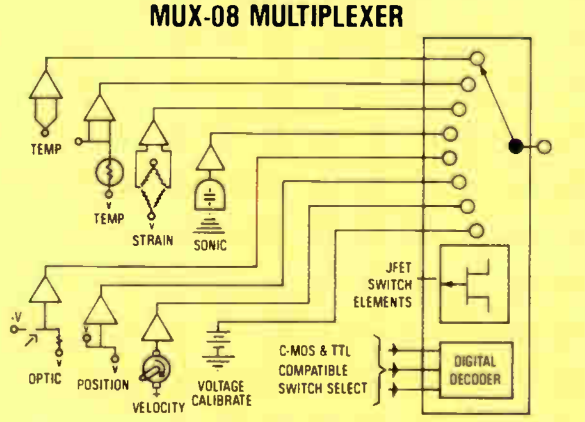
PMI Takes the Nonsense Out of Analog Multiplexers

Alice's nonsensical Wonderland was full of strange names, like Gryphon, and the famous Jabberwock. And slithy toves and borogoves.

In Linear Wonderland designers have a similar situation—like the MUX for instance. There are lots of analog multiplexers—and they're as confusing as Alice's Wonderland when engineers try to compare PMI's BIFET MUXes with other standard BIFET and CMOS versions. But they know that only from PMI "OFF" isolation, crosstalk, overvoltage protection and low cost are available in one component.

They know also that CMOS is known for static blowout and latch up, but PMI's BIFET technology has protection right in the chip, without expensive dielectric isolation, external or internal series resistors—or special handling. No other manufacturer of CMOS or BIFET MUXes offers that.

MUX-08 MULTIPLEXER



As nonsensical as Linear Wonderland is at times, here's some no-nonsense talk about the PMI MUX—like crosstalk and "OFF" isolation at 10 times better than its closest CMOS competitor, with protection against failure during power loss, just like the best (and most expensive) CMOS versions. Switching, at 1.0 μsec, settles fast with no ringing. "ON" resistance is a constant 300 ohms with protected analog and digital inputs plus full compatibility with CMOS and TTL. And, to make upgrading easier, the PMI MUXes are on industry standard pinouts.

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MUX 24	4 Channel Differential	DG 509A, HI 509A, LF 11509
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MUX 28	8 Channel Differential	DG 507A, AD 7507, HI 507A

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MUX-16/28/F	2.1	165	11.00

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People

On display. Big price drop is still needed for commercial plasma displays, Foster says.

a big plus, says Foster, since the panel (12¼ inches square and only ½ inch deep) will be able to fit into tight spaces. Other advantages make the gas-discharge units attractive as CRT replacements—simple display, low power, no flicker. They are also easy on the eyes.

Potential. Foster sees a potentially large commercial market for them, especially for computer terminals. But his studies show the displays must be in the $1,000 to $3,000 range to tap the big market. Interstate's commercial unit will come in higher, but will get down in three to five years, Foster estimates.

Interstate, in Anaheim, Calif., began military versions of plasma displays (at $6,000 up) several years ago. It mainly builds test instrumentation for submarines, missiles, and electronic warfare systems—the source of $60 million in sales. But it lost its supply of plasma panels when manufacturer Owens-Illinois dropped the line in 1977. At Interstate's urging, parent A-T-O financed a new firm with people who left Owens-Illinois.

Foster's charter with Interstate is to push diversification out of military work, and panel business plays an important part. Indeed, one of the reasons he reportedly got the job was that his predecessor, David T. Scott, moved too slowly in this area. Foster has great expectations for plasma in 1979, hoping to sell $6 million in displays, initially in military units. "We want people to recognize us as *the* source of plasma display technology," he says. □

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The Teledyne 615 Series is available in 10, 25 and 40 amp versions. Contact us for full technical details or see your local Teledyne distributor for off-the-shelf delivery.

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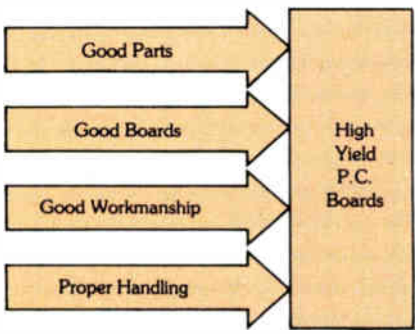
Circle 17 on reader service card

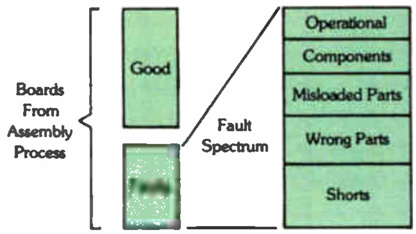
THINGS TO CONSIDER BEFORE YOU MAKE A DECISION

Is automatic testing a panacea? With today's PC volume and complexity, it's not so much a panacea as it is a necessity. But to implement a test solution requires a thorough understanding of the available test systems and your production environment.

When to test?
That's as important as how. The cost of fault identification increases dramatically with each production step. Thus, you want to catch faults as early in the production process as possible, but it doesn't necessarily follow that extensive incoming parts inspection is the answer. Your real goal is high turn-on rates in final test. That demands high-yield PC boards. And as the diagram below shows, several factors including good parts go into high-yield PC boards.



A PC board assembly process will produce anywhere from 20% to 80% good boards. A typical number is 60%. Of the faulty boards, a fault spectrum might look like this:



With a good board yield of 60% and no PC board testing, even a simple product with five boards would overload final test. Nine out of ten units would fail. This makes board level a good place for thorough testing. For this is the first opportunity to locate faults across the entire fault spectrum. But which tester is for you?

Choosing a circuit board tester.
There are no simple answers to selecting an automatic circuit test system. But, from our experience, we know that these are some of the factors involved: Production yield, test yield, fault spectrum, PC volume, board type, and anticipated new products.

Will the system test for the spectrum of faults that you will encounter? Will it generate component level diagnostic information? Will it test present and future board types and do it fast? Is it easy to expand and adapt to changing requirements?

What are the true costs? How much time and effort is involved in programming, debugging, fixturing and training? And will you get prompt, competent service if you need it? HP can help you answer these key questions.

Over two million boards worth of experience.
HP's new Automatic Circuit Test Systems are the result of our extensive in-house experience with automatic circuit testing.

In fact, we were spending such large sums on dedicated equipment and manual test stations that back in 1970 we developed an automatic circuit test system called Optest I. This system, along with its more recent companion Optest II, is still in operation today. Optest I and Optest II are now testing over 100,000 printed circuit boards annually. Our new circuit test system is, in reality, a third-generation product, which originated from over eight years' experience in actual in-use operation. Today, HP is using 46 of these new automatic test systems within our own plants.

The case for in-circuit plus functional testing.
The marketplace has many potential test solutions. You can choose from simple shorts testers to completely automated systems. From testers that measure components in-circuit to functional test systems that verify dynamic performance of complete circuits.

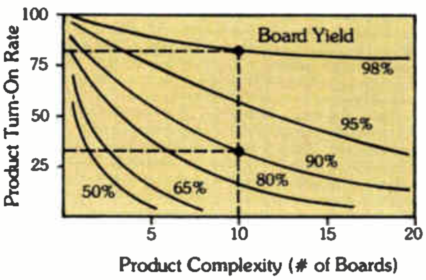
HP's new 3060A Board Test System ($74,000* for standard operational system) is an advanced system that combines the latest in-circuit technology with functional testing. It includes a comprehensive software package for fast program development. It is a proven package, which combines ease of use with flexibility to handle tough test problems. The addition of functional testing to in-circuit testing may provide a relatively small increase in board yield. But that small increase can

3060A

ON AUTOMATIC TEST EQUIPMENT.

result in large improvements in product yield, as shown below. For example, in a ten PC board product, increasing board yield by only 8% (from 90% to 98%) will leverage product turn-on rate from about 35% to 80%. That's a large payoff, and an excellent reason to consider HP's 3060A.

PRODUCT YIELD VS. PRODUCT COMPLEXITY



The standard 3060A has a full set of analog and digital functional testing tools for testing most analog, digital or combined boards including at-speed testing of microprocessor-based boards using signature analysis techniques.

Some boards, such as large complex logic boards, will benefit from the use of HP's DTS-70 Digital PC Board Test System ($90,350* for standard operational system). This simulator-based tester tells you how effective your test programs are and identifies the portion of the circuit not completely tested. This is important feed-back permitting better program development. A useful tool in R&D, the DTS-70 can model your designs and help you produce better products. Your test engineer will appreciate its ability to model feed-back loops, find open traces and identify intermittent faults.

Just as important, the DTS-70's power and flexibility comes from its controller, the HP 1000 Computer System. Using a Real-Time Executive operating system, you can simultaneously test PC boards and develop new programs. As your testing needs expand, two more test stations and several programming terminals can be added without the expense of additional computer power. The operating system is compatible with data-base management software to keep track of your test data and help you better manage your production. The DTS-70 will easily fit into your long range computer network plans providing distributed processing and communication to your data processing center.

DTS-70

The bottom line.
Can automated PC board test equipment save you money? Again, there are no simple answers. But it has saved us money and chances are it will save you money, too, if any of these conditions exist in your plant: high PC volume, complex boards, production testing backlog, low turn-on rates of complete systems, high in-process inventory costs and high warranty costs.

Your production operation is unique, but we can help you characterize it by comparing the cost of testing, or not testing, at each level to arrive at your best test resource allocation. Let us help you answer these key test questions. Call your HP field engineer today.

* Domestic U.S.A. price only.

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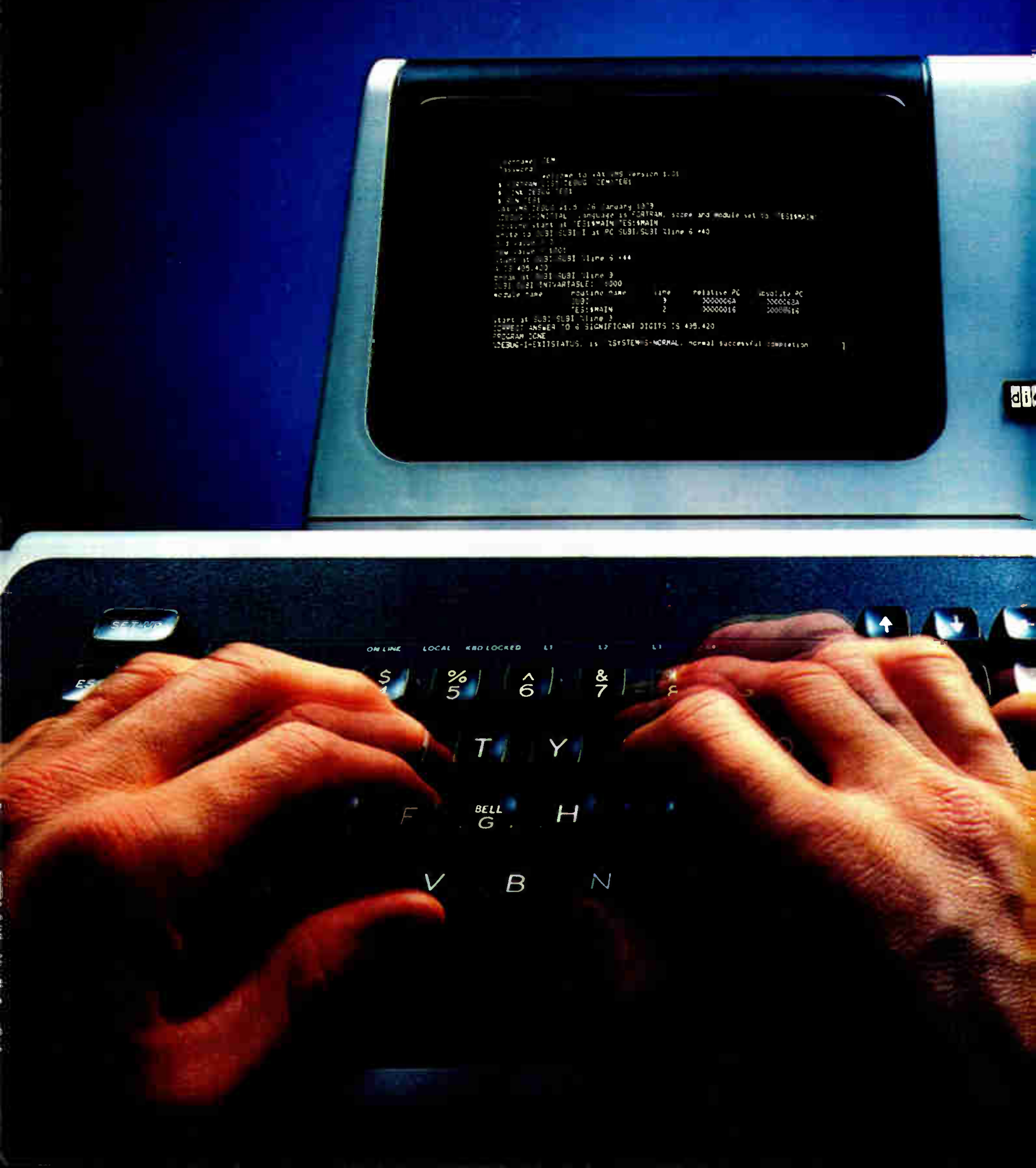
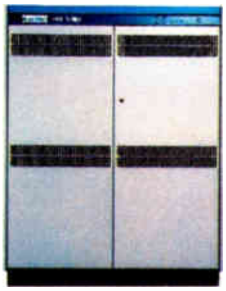
Circle 19 on reader service card

VAX 32-bit software. It lets you write your programs in record time.





How Fairchild Takes the Thorns out of LSI Testing.

Choosing the right LSI test system is tough. There are many things to consider, and one of the most important is customer support. Here's how Fairchild makes the difference. Whether you buy our Sentry general purpose LSI tester or our Xincom memory test system, we'll back you with the largest and most professional service and support team in the industry.

Applications Engineering. Our team of applications specialists will program our systems to give you all the information you need about how to test your device. Whether you buy a system or not. If you do buy, all that information and programming are yours.

A world of training. Even the best system is only as good as the people who run it. To make sure your people know everything they have to about LSI testing, we've built the largest and most comprehensive training center in the world. With every Sentry or Xincom system, you're covered with course credits. Even before your system is installed, your people will learn operation and maintenance, basic programming and assembly language. They can also take special courses in programming and advanced LSI testing techniques. And they'll get all the hands-on training they'll need in our test lab.

On-site preparation. While your people are training at one of our centers in the U.S., Europe or Asia, our engineers are at your plant helping you get ready for delivery. Our product specialists help you find the best locations for your system. They make sure all your device programs have been checked out. And they make sure your system gets up and running fast.

Service is our specialty. No matter where you are, we've got you covered. More than 100 field engineers around the world assure fast response whenever you need help. You can choose from a variety of service contracts. One gives you complete calibration and servicing, free parts replacement and a guarantee to be there within 24 hours. Another provides a spare parts kit that offers even faster turnaround. And if your operation needs it, we can provide a resident service or applications engineer.

We won't let you forget. If you need additional or special training, we can help. Our programmed learning center offers video tapes, audio cassettes and special workbooks. On-site courses can also be arranged. Nearly a hundred application notes are available to help you solve almost any LSI testing problem. There's even a User's Club, which gives you a chance to exchange programs and experiences with others in your field.

There's more. Whether you choose Sentry or Xincom, we'll make sure you don't get stuck. We'll help get rid of the thorns all along the way. Before, during and after your system arrives.

Find out more about Fairchild's total support program. Mail the coupon today.
Or contact: Fairchild Systems Technology, 1725 Technology Drive, San Jose, CA. 95110 (408) 998-0123

Fairchild: First in LSI testing

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FAIRCHILD

Editorial

Are 'they' in trouble?

The language may be different, but the theme surely is familiar. Japanese newspapers recently were enlivened with large advertisements decrying the move to open phone company purchases to international bidding. Sponsored by two trade groups of equipment makers serving the Nippon Telegraph and Telephone Public Corp., the ads were headlined "We are in trouble."

"We," it turns out, means not just NTT and its suppliers but every Japanese citizen. Should the government decide to open NTT equipment to general bidding [*Electronics*, March 1, 1979, p. 63], the results would be "devastating," says the ad. "Service expected by the nation could not be maintained, and service cost itself would go up." This is a rough partial translation of the ad, but to many observers of the telecommunications industry it must sound like a reprise.

Remember the Carterfone decision of the U. S. Supreme Court, which threw open American Telephone and Telegraph Co.'s lines to competitive equipment? That decision was preceded by manifesto after manifesto from AT&T arguing such equipment would degrade the U. S. telecommunications system. The dust has settled now, and to no one's surprise (maybe not even Ma Bell's), the American phone system is alive and well. It has accommodated itself to equipment from all over the world—even from Japan.

Implicit in the ad is the notion that NTT and its suppliers are sacrifices in the tense trade negotiations. By permitting open competition, the Japanese government will satisfy the U. S. negotiators' demands for greater market access—so runs the undercurrent.

To put it politely, this attitude is completely unjustified. Telecommunications everywhere is a growth industry with rapid technological development the order of the day. NTT is no pawn in the trade debate; it is a major market in itself, one that can best be served by unfettered competition. The sooner that realization comes, the better—for the Japanese people, as well as for telecommunications suppliers around the world.

Finally, the specter of technological disaster needs to be exorcised once and for all. No one doubts that NTT operates a fine voice and data communications system, with rigorous demands on its equipment. But so does AT&T, and outside suppliers are living up to its requirements.

Fiber optics in the cold light of day

A market research firm not usually known for its bearish outlook has cast more doubt on the rapid acceptance of fiber optics. In "Fiber Optic Technology and Markets," New York researcher Frost & Sullivan Inc. questions the idea that a major commercial boom in fiber is just around the corner. Think more in terms of 10 years, F&S advises. Indeed, the field is already overcrowded with competitors touting real or imagined products, as we pointed out in a special report on data links late last year [*Electronics*, Dec. 21, p. 89].

Not that fiber won't grow. Frost & Sullivan estimates that military sales will be worth $20 million by 1987. Telephony will come to $22 million and telecommunications to $10 million by then. As for the fiber-optic–wired home, sales may not get much higher than $2 million by 1987.

Let's face it, there are problems. One is the lack of long-lasting light sources and good connectors for easy systems hookup. Even standards of design are lacking for most applications.

Yes, fiber optics will take its place in the electronics industries. But it's not going to be a panacea nor an overnight bonanza. Therefore, it is well that manufacturers and users avoid the hyperbole that blew millimeter waves and the wired-nation concept out of proportion.

PRO-LOG makes it easy to board the STD BUS.

Introducing the STD BUS, the simplest bused microprocessor system ever made. STD means Simple To Debug, Simple To Develop, Swift To Deliver.

The new STD BUS—8-bit microprocessor systems built around a standard bused motherboard which allows any card to work in any slot. Thus you can change the function of your system, the memory type, even the

microprocessor type by simply exchanging one card for any other. The STD BUS is 56 lines wide and is compatible with Pro-Log's standard 4½-inch by 6½-inch edge-connected cards.

It's supported by both Pro-Log and MOSTEK and freely available to the industry.

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Z-80 PROCESSOR • 8085 PROCESSOR
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MOTHERBOARD ½ RACK • MOTHERBOARD ¼ RACK
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Watch for announcements as new cards become available.

A whole new card series available for use with the STD BUS.

Our new 7000 Series 8-bit systems were specifically designed for use with the STD BUS. We have cards in limited quantities now, in production quantities in January.

Buy 250 of any one card, and we give you free the plans for that card and non-exclusive manufacturing rights so you can build it yourself.

In addition to cards, we also make a ½ or ¼ rack card cage. It includes motherboard, card edge connectors and mounting brackets.

Every part in our systems is or soon will be a second-sourced industry standard which means that if you produce our systems yourself, you'll never have to worry about the availability of sole-sourced parts. Through cross licensing arrangements, MOSTEK will also be building most of our cards giving you yet another source of supply.

Learn about the STD BUS and our 7000 Series Systems.

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Meetings

Corporate-Wide Packet-Switched Data Networks Seminar, Data Communications Magazine and McGraw-Hill Publications Co. (New York), Capital Hilton Hotel, Washington, D. C., March 26–27.

Trends in On-Line Computer Control Systems, Institution of Electrical Engineers (London), University of Sheffield, UK, March 27–29.

29th Vehicular Technology Conference, IEEE, Arlington Park Hilton Hotel, Arlington Heights, Ill., March 27–29.

International Standard X.25 Interface Protocol for Packet Nets and Related Protocols Seminar, Data Communications Magazine and McGraw-Hill Publications Co. (New York), Capital Hilton Hotel, Washington, D. C., March 28–29.

Southeastcon—1979 Southeastern Conference, IEEE, Hotel Roanoke, Roanoke, Va., April 1–4.

Acoustics, Speech and Signal Processing Conference, IEEE, International Inn, Washington, D. C., April 2–4.

Spring Conference, EIA, Shoreham Americana Hotel, Washington, D. C., April 2–5.

Technical Symposium East '79, Society of Photo-Optical Instrumentation Engineers (Bellingham, Wash.), Hyatt Regency Hotel, Washington, D. C., April 2–5.

22nd International Electronic Components Exhibition, Société pour la Diffusion des Sciences et des Arts (Paris), Parc des Expositions, Paris, April 2–7.

"The DOD FY '80 Research, Development, Testing and Evaluation Budget in Perspective," EIA conference, Shoreham Americana Hotel, Washington, D. C., April 3–5.

Specifications of Reliable Software, IEEE, Hyatt Regency Hotel, Cambridge, Mass., April 3–5.

Seminar on Microprocessor Applications, Continuing Education Program, Pratt Institute (Brooklyn, N. Y.), Essex House Hotel, New York, April 6.

Interface '79—Seventh Annual Interface Data Communications Conference and Exposition, The Interface Group (Framingham, Mass.), McCormick Place, Chicago, April 9–12.

International Symposium on Computer Architecture, IEEE, Marriott Hotel, Philadelphia, April 23–25.

16th Annual Rocky Mountain Bioengineering Symposium, IEEE, Fitzsimons Army Medical Center, Denver, Colo., April 23–25.

27th Annual Relay Conference, National Association of Relay Manufacturers (Elkhart, Ind.), Oklahoma State University, Stillwater, Okla., April 23–25.

1979 Photovoltaic Solar Energy Conference, IEEE and the Commission of the European Communities (Brussels), Kongresshalle, West Berlin, April 23–26.

Electro/79 Show and Convention, IEEE, New York Coliseum and Americana Hotel, New York, April 24–26.

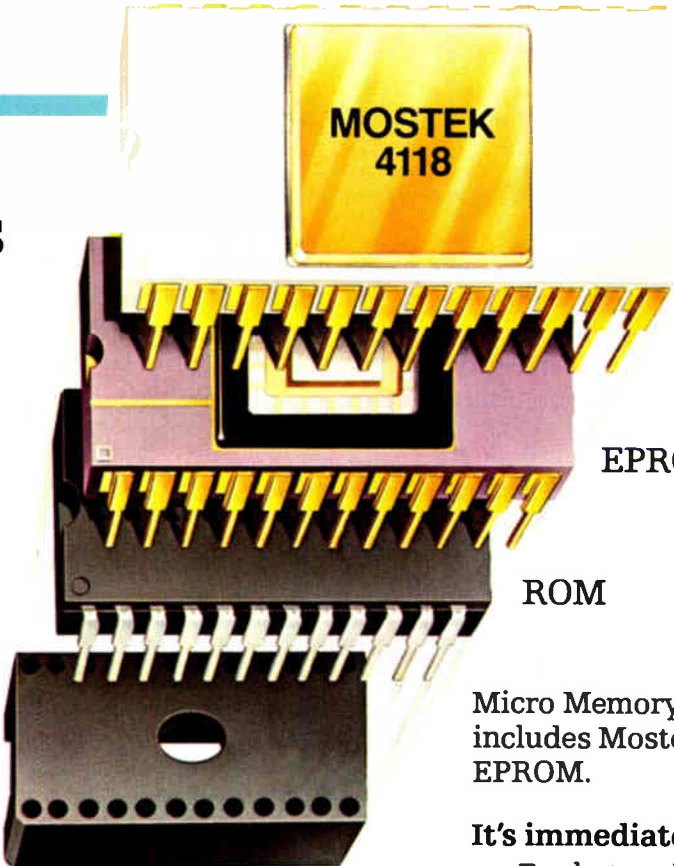
Reliability Physics Symposium, IEEE, Airport Hilton Hotel, San Francisco, April 24–26.

Newcom—The 1979 Electronic Distribution Show, Electronic Industry Show Corp. (Chicago), Las Vegas Convention Center and Las Vegas Hilton Hotel, Las Vegas, Nev., May 1–4.

International Microwave Symposium and Workshops, IEEE, Sheraton Twin Towers, Orlando, Fla., April 30–May 4.

25th International Instrumentation Symposium, Instrument Society of America, Sheraton Hotel, Anaheim, Calif., May 7–10.

Finally. Compatibility.



With Mostek's new 8K static RAM.

Compatible with ROMs and EPROMs. Compatible with microprocessors. Mostek's new 8K static RAM offers total flexibility for your system. Organized as 1Kx8, the 4118 is a next generation Micro Memory,™ available today.

It's a Micro Memory!

Designed for 8-bit and 16-bit systems, the 4118 interfaces directly with all present and future generation microprocessors. A Chip Select control is provided for easy memory expansion and decoding, and internal latches are available to latch the Address and Chip Select inputs. If the Latch function is not needed, it can be easily bypassed. An Output Enable control provides easy user control of the bus in all bus configurations. System design is simplified with the MK4118.

It's more than common!

With a pinout common to standard 24-pin ROMs, PROMs, and EPROMs, the 4118 still has more. Access time is a fast 120ns (max.) and power dissipation a low 200 mW (typ.). The 4118 is the newest addition to our compatible Micro Memory family which includes Mostek's 2716 EPROM.

It's immediately available!

For byte-wide, memory applications requiring density, flexibility, and immediate availability, Mostek's 4118 is the one to choose. For the location of your nearest distributor, call 214/245-0266, Mostek Corporation, 1215 West Crosby Road, Carrollton, Texas 75006. In Europe contact Mostek Brussels; phone (32) 02/660.25.68.

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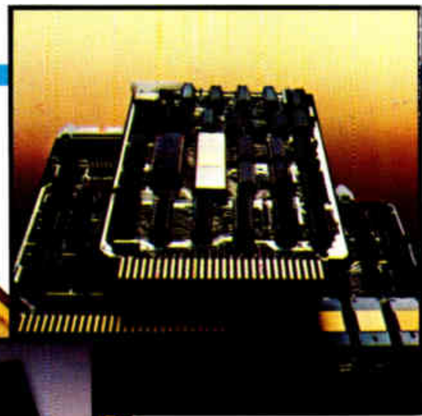
The quick step to Z80 power.



Get on the fast track to Z80 power with your local Mostek distributors. They have everything you need, including factory trained engineers and demonstration centers at many locations.

Start with our MK 3880 line of Z80 components, industry's most powerful 8-bit microcomputer family.

Or begin with our MD Series™ of OEM microcomputer boards. It features our MDX-line of STD-Z80 BUS compatible modules for building your system one function at a time. You buy only what you need, and reduce hardware design time.

Plus you only need one development system, Mostek's AID-80F,™ to develop and debug software for all our microcomputer products. BASIC and FORTRAN are also available for use on the AID-80F.

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In logic design, production or service,

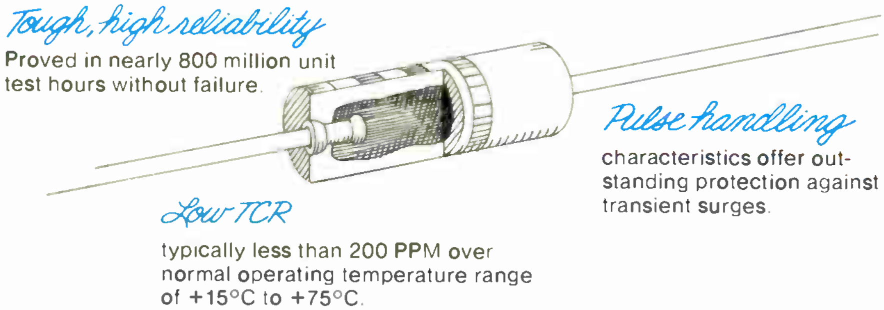
If your product or service depends on logic, you should know about HP's constantly expanding family of logic-test equipment.

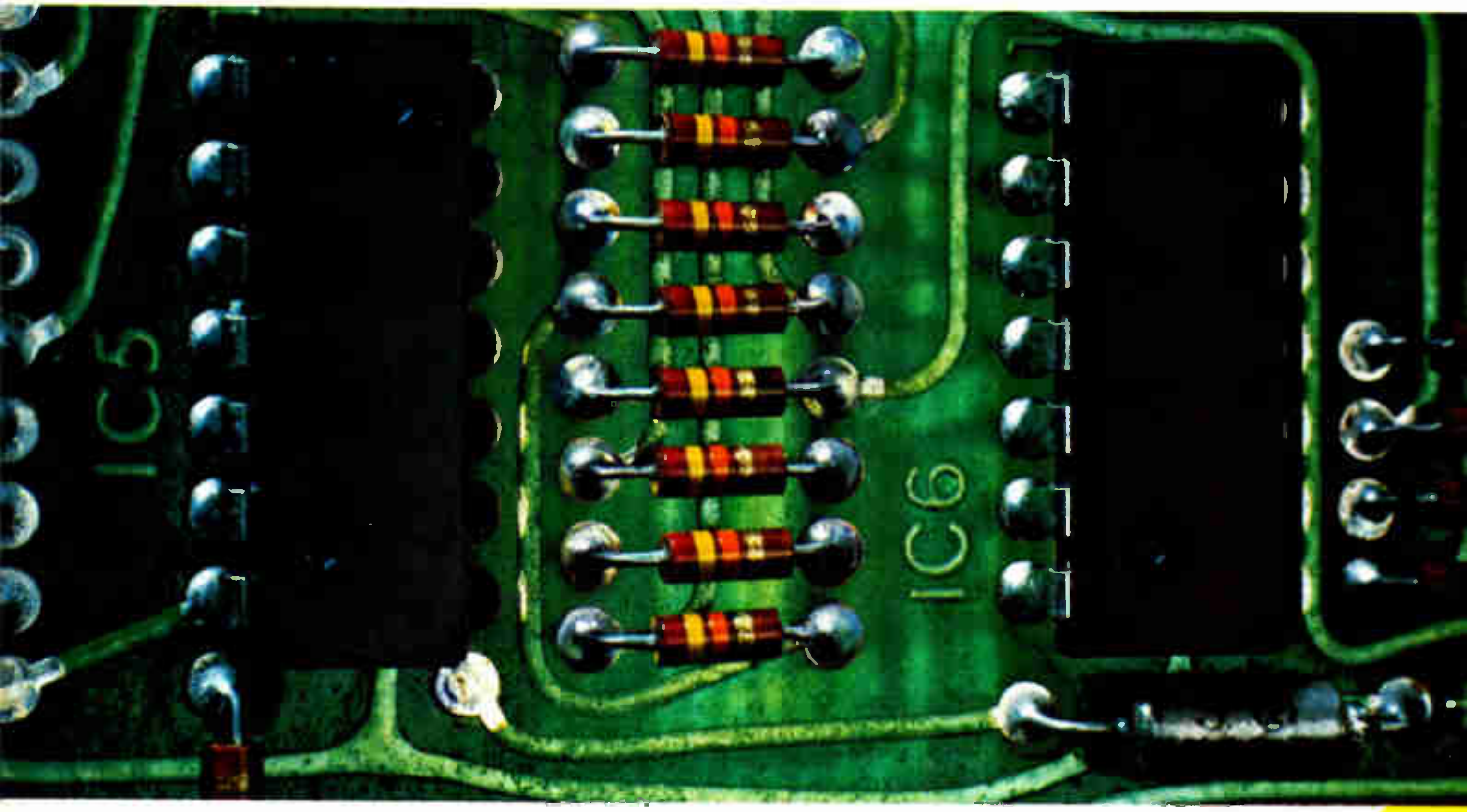
You'll find a wide choice of measurement solutions designed to make logic analysis, testing, troubleshooting and servicing easier, more efficient and more cost effective than ever before.

HP logic-test equipment offers capabilities ranging from hand-held troubleshooting tools to automated instrument systems . . . instruments for stimulus and instruments for monitoring . . . dedicated instruments and multipurpose in-

When you're small you've got to be tough to last.

This rugged little ⅛-watt fixed resistor (.145 L x .062 D) is hard to beat in durability. It's the Type BB . . . part of a family that has passed nearly 800 million unit test hours without a single failure. It's small enough to be mounted on .300 by .100 hole centers, eight in the same space as one dual in-line package. It takes transient pulses that would knock out most any film resistor of similar dimensions. Performance is exceptionally consistent from one resistor to the next. We have the space-saving resistors you need. Our distributors have them when your need is now.





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MC14-1000 redesign seeks to hurdle yield obstacles

With a crash program aimed at a silicon-gate redesign of its MC14-1000 microcomputer, Motorola is hoping to correct a severe backlog that has arisen from yield deficiencies with the company's metal-gate version of the 4-bit complementary-MOS machine. Limited samples of the silicon-gate redesign may be available late this month, says an official at the firm's Austin, Texas, integrated-circuit operation. **In going to the denser silicon-gate technology, Motorola expects to be able to move the part quickly down the learning curve.** That has not happened with the metal-gate version. The result has been supply problems for customers whose low-power applications can't use the n-MOS or p-MOS versions of the popular TMS1000 design supplied by other firms.

Bubble memory tester coming from Xincom

With memory device testing leading the way, the automatic test equipment market is living up to predictions that it will enjoy a healthy 1979. The latest evidence is the first crop of bubble memory testers, one of which is coming from the Xincom division of Fairchild Camera and Instrument Corp.'s Test System Group in Chatsworth, Calif. **The new Xincom tester will be able to operate as a stand-alone unit or interface with the host computer** of a large Xincom test system. Fairchild hopes to introduce it at the Semicon West show that is scheduled to be held in San Mateo, Calif., May 22–24.

Linear IC tester checks more than 3,000 device types

Built around two microcomputer chips, GenRad Inc.'s new model 1731 linear integrated-circuit tester may be one of the most comprehensive systems on the market even though it fits on a benchtop and costs only $22,900. With a Z80 chip to control its test, calculation, display, and keyboard functions and a Rockwell 6502 to control its tape-drive functions, the Concord, Mass., firm's model 1731 **checks out operational amplifiers, voltage comparators, voltage regulators, voltage followers, and current mirror op amps**—perhaps more than 3,000 device types.

Software, stored on magnetic-tape cassettes, specifies program generation and entry plus system setup. The test software literally prompts operators through the correct sequence of tests; because it is so interactive, it could save much of the personnel component of testing costs. But the initial payoff will be a level of performance and features similar to those found on systems with six-figure price tags.

TI prepares to ship 1-Mb bubble boards

Texas Instruments Inc. says it will begin limited shipments during the second quarter of a 1-megabit magnetic-bubble memory board and associated controller board for purposes of evaluation, prototyping, and small production runs. Expected to find early use in industrial control systems and small data-processing applications, **the bubble board will be the first to incorporate TI's 256-K bubble memory chip**—the TIB0303—announced last August. With four TIB0303s on it, the 11-by-7½-inch board is designed to work with the controller board as a general-purpose operating subsystem—expandable to an 8-million-bit system—for use not only with the company's microcomputer and minicomputer lines, but with other manufacturers' machines as well.

Electronics newsletter

AMD readies programmable power controller

To protect the sensitive parts of computer and memory systems, Advanced Micro Devices Inc., Sunnyvale, Calif., plans to come out this summer with a power supply controller chip that features these programmable functions: delay and rise time for the power supply, ±5% or +10% over-voltage protection, current limit detection, delays for over-voltage and over-current shutdown circuits. Moreover, the bipolar AM6800, due to be shipped in sample numbers in May, **also monitors the power supply and informs the computer of the status.** The device is TTL-compatible and is housed in a 20-pin dual in-line package. It also boasts a 2.5-V reference characterized to within 0.25%.

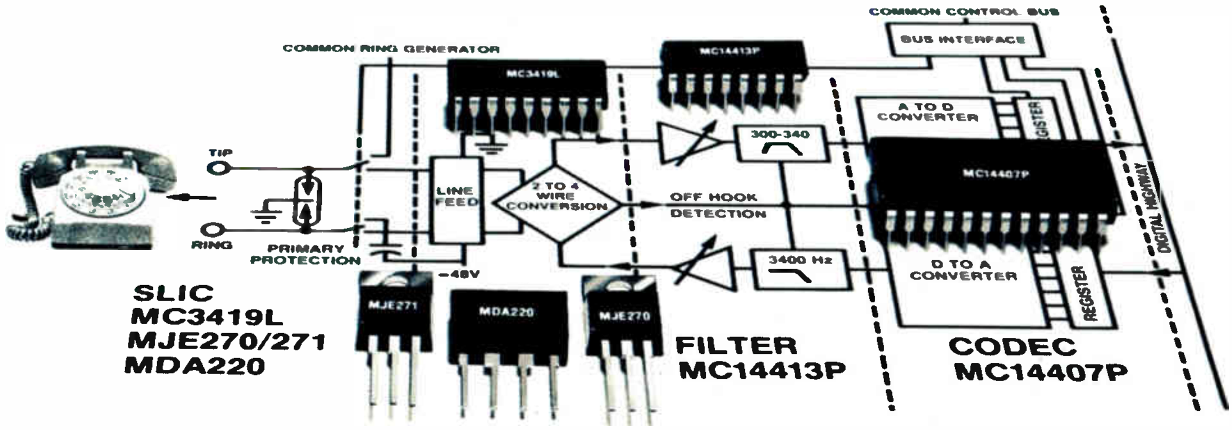
CBS to test French and British video text systems

Will it come down to a shootout in St. Louis? **The CBS Broadcast Group will conduct technical tests of the rival British and French television text information services** at its station there, KMOX-TV. Planned tests of the French system, Antiope, have been discussed [*Electronics*, Jan. 18, p. 33], but plans for the face off with the incompatible British Teletext system emerged only when CBS filed with the Federal Communications Commission for authority to conduct the over-the-air tests. Because special decoders are needed for the signals, sent on one line of the TV-field blanking interval, the tests will not interfere with home viewing. CBS Broadcast Group president Gene F. Jankowski says the tests are "an effort to determine which system will provide the best and most reliable teletext service."

Addenda

Now that Bell Canada has a full-feature fiber-optic system operating in 40 Toronto homes [*Electronics*, Jan. 4, p. 33], Manitoba telephone, which is independent of Bell, **is going to wire 150 homes in the rural Manitoba town of Elie.** The $6.1. million feasibility study—there is no similar project in the U. S.—will offer multichannel television and fm radio plus a variety of other services. . . . Dictaphone Corp. of Rye, N. Y., is jumping into the market for pocket-size dictating machines with an 8-oz unit **that offers such features as fast forward and fast erase.** Using the minicassette developed by market leader NV Philips, the Dictamite costs $195. . . . Solid State Scientific Inc. of Montgomeryville, Pa., has agreed to sell its Radio-Frequency Transistors division to DuMont Electronics Corp. of Clifton, N. J., a wholly owned subsidiary of Thomson-CSF of France. The division will be renamed the Solid-State RF and Microwave division **and will sell French-made high-frequency devices in the U. S.** . . . As part of a $160 million demonstration program subsidized by the Department of Energy, New York City's **Consolidated Edison Co. has purchased 40 electric vehicles,** modified AMC Pacers, from Electric Vehicle Associates of Cleveland, Ohio. The cars are powered by 20-horsepower, SCR-controlled dc motors and 20 lead-acid batteries rated at 145 ampere-hours. . . . **General Motors Corp. has agreed to purchase at least 7,000 commercial video-disk players** from Universal Pioneer Corp., the joint venture of Pioneer Electronic Corp. of Japan and MCA Inc. of Universal City, Calif. . . . Look for Texas Instruments Inc. to second-source Intel Corp.'s codec. **Such a big-name alliance should go a long way toward breaking down the reluctance of telephone companies to switch to solid-state devices. . . Actually saying for the first time that it plans to market a home computer,** Texas Instruments has asked the FCC to temporarily consider rf modulators and video sources as separate items.

Technological leadership



It's the great Codec-based transformerless telephone subscriber channel unit.

Now, for the first time, a low-power, low-cost, space-efficient telephone Subscriber Channel Unit (SCU) without transformer or hybrid circuit is more than a vague hope for the future.

Motorola has developed a unique complement of three reliable monolithic LSI circuits and three specially-designed discretes. Our PCM Codec, PCM Filter, and Subscriber Loop Interface Circuit (SLIC) will produce the least-expensive, lowest-power, most-compact SCU for future Class 5 Central Office, PABX and carrier equipment designs.

Codec and discretes are available. Filter and SLIC sampling is firm for early 2nd Quarter, '79.

SLIC banishes transformers

It's the SLIC that displaces transformers, saving both money and space. In it, the MC3419 provides signal separation for 2- to 4-wire conversion plus suppression of longitudinal signals at the 2-wire input. Two specially-designed power Darlingtons, MJE270/271, and the MDA220 transient suppressor complete the circuit. The SLIC provides hook-status outputs and operates at near-zero on-hook power. It's the only monolithic semiconductor SLIC designed to fully meet Class 5 Central Office specs.

The MC14406 and MC14407 are full-duplex 8-bit companded PCM Codecs designed for 8K samples per second. The 24-pin MC14407 provides pin selection of A-law or Mu-law companding, and the 28-pin Mu-law MC14406 offers two-way LSB signaling. On-hook power drain is just 1 mW. Less than any other Codec.

Like the Codec, the MC14413 PCM Filter is manufactured with our time-proven standard metal-gate CMOS process. Both bandpass transmit and low-pass receive filters are on the chip. The MC14413 requires no external precision components. On-hook power use is only 1 mW.

Total on-hook power requirement of the entire card as illustrated is just 10 mW, max. Off-hook power also is superior. The SCU operates with the standard −48 V and a single 12 V supply.

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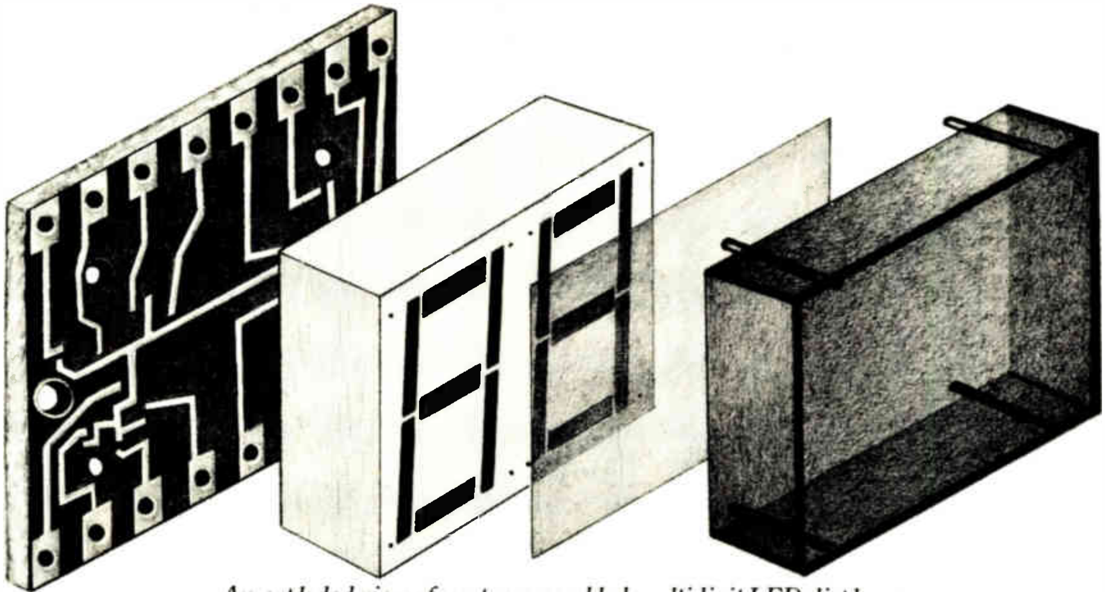

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Put all these time and work saving features together and you have the bottom line to this easy installment plan. It'll save you money.

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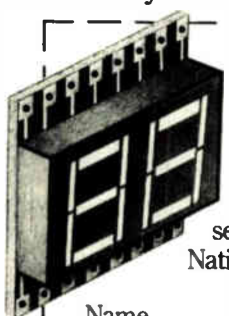

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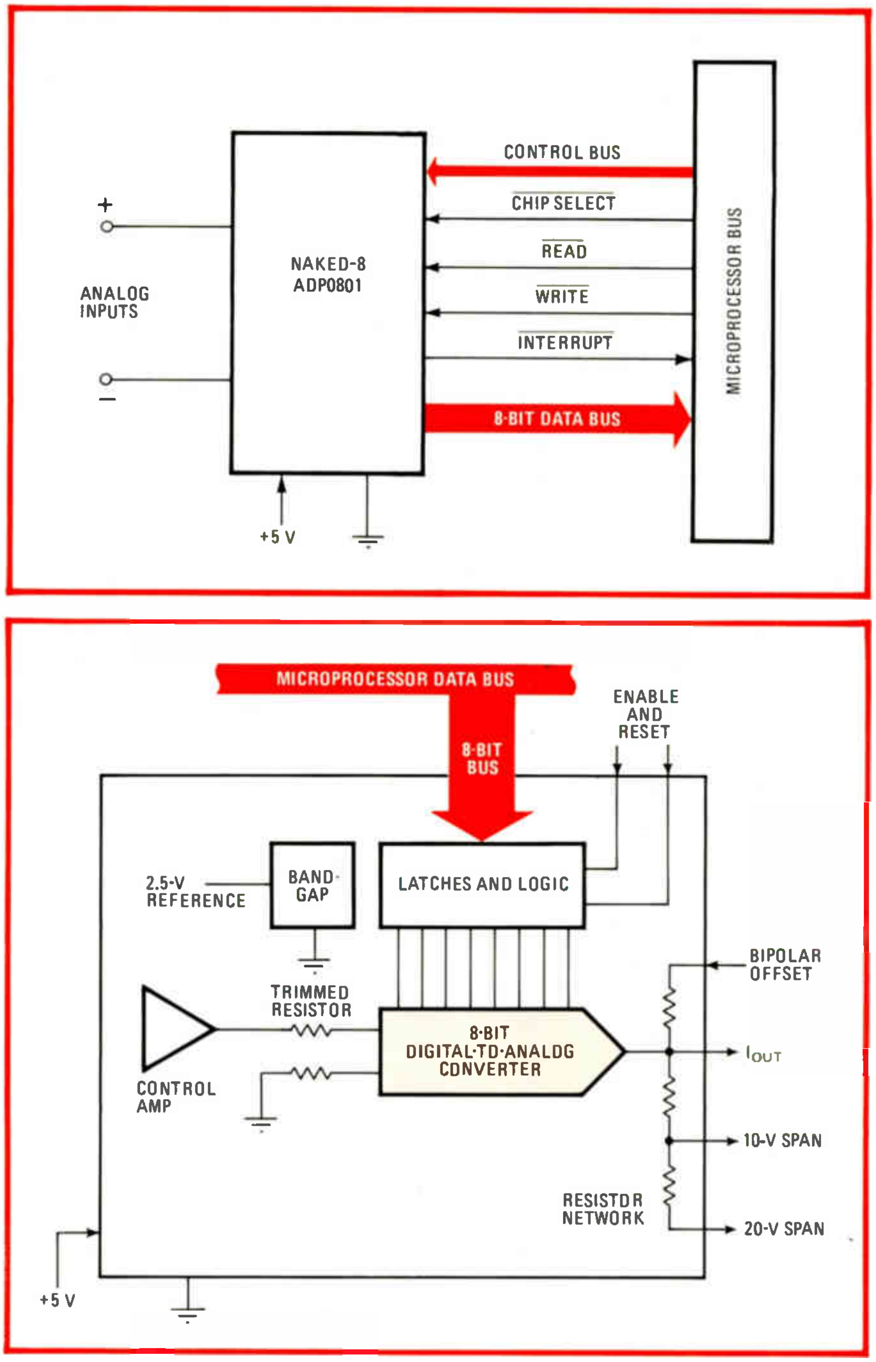
IC makers ready converters for 8-bit processors

Motorola, National talk of one-chip devices that connect to data bus, simplifying system designers' chores

Data converter makers—most of them specialized houses whose hybrids hotly contest each other in the market—are facing intense new competition. A wave of integrated-circuit makers are joining Signetics Corp. [*Electronics*, July 21, 1977, p. 139] in bringing to market monolithic analog-to-digital and digital-to-analog converter chips that can be connected directly to microprocessor buses. All three main-line silicon technologies—complementary metal oxide semiconductor, standard bipolar, and integrated injection logic are being applied to make the parts.

Motorola Semiconductor Group's Integrated Circuit division will have three d-a converters by midsummer, including the 8-bit microprocessor-compatible MC6890, a universal bus-oriented bipolar model that needs no external parts to plug into any 8-bit microprocessor (see p. 40). Motorola is already selling in volume the first of its new breed of converters—a blazingly fast, d-a unit that converts at a speed in excess of 25 megahertz. However, this unit, the MC10318, which has been on the



Direct connection. National Semiconductor's Naked-8 (top) needs no interfacing logic to operate with 8-bit microprocessors like the 8080. Motorola's answer to a bus-compatible d-a converter is the MC6890 (bottom). It catches data on the fly, latches it, and converts it into varying analog signal.

National puts all logic on its a-d chip . . .

National calls its ADP0801 the first truly bus-compatible analog-to-digital converter because all the logic to interface with a microprocessor is on chip. At a price of $2.75 in 100-piece quantities, National believes the part meets a need for a low-cost a-d converter no one else has addressed, according to linear marketing manager David Whetstone. With a maximum error from ¼ least significant bit down to ±1 LSB, it will replace 10-bit a-d approaches used to get equal accuracy and costing up to 10 times more, he says. This was achieved with a new design using a charge-balance comparator and on-board thin-film silicon-chrome resistive ladder, which in combination reduce the component count and active area size. The complete converter uses only 16 discrete resistors, 4 capacitor arrays, and 32 switches.

National thinks the ADP0801, which it refers to as the Naked-8 because it needs no external components, will find volume applications in home computing, instrumentation, low-end process control, equipment monitoring, and other areas. National will put the part in production soon.

Other features include a 100-microsecond conversion time, an on-chip clock generator, a differential 0-to-5-V analog input range, a single 5-V supply, and compatibility with transistor-transistor logic. Moreover, the 0801 provides the digital output code in a true 2's complement format.

. . . while Motorola crams its d-a chip full, too

Motorola expects its universal bus-oriented MC6890 to be its best shot in the digital-to-analog converter market. According to the company, it will be loaded with features Motorola thinks will appeal to 90% to 95% of the 8-bit d-a market. Foremost is an on-board 2.5-volt precision voltage reference for the laser-trimmed thin-film resistors. This does away with the common external 10-V references and corresponding potentiometers, says design engineer Gregory Smith. The monolithic converter also has master-slave registers, or double-buffered latches, to make data glitches in the processor transparent to the converter. Settling time is 120 to 140 nanoseconds. Another feature is a reset pin that overrides stored data and forces it to 0.

Price of the MC6890 8-bit converter, on the market sometime in the third quarter, is expected to be in the $5 to $7 range, for quantities of 100 and up. That's as specific as Motorola can be for now.

market since January, is aimed at video applications, rather than microprocessor applications.

On the analog-to-digital end, National Semiconductor Corp. is providing samples of, and will soon have in production, the industry's first 8-bit monolithic a-d converter with on-chip microprocessor-interfacing logic. Called by National the Naked-8, the model ADP0801 C-MOS part (see above) contains the protocol, signal levels, and bus timing to interface directly with such popular 8-bitters as the 8080, 8085, and Z80 (see diagram). And, with an additional external logic gate, it can also hook up to a 6800.

In an approach typical of National to gain a share of the market, the price will be as low as $2.95 per 100 units in plastic packages. Other monolithic a-d and d-a units are slated to follow from the Santa Clara, Calif., chip maker, as well. Its goal, says National, is to have the high-volume end of the data-conversion market well covered. In advanced development is a 12-bit-plus-sign a-d chip that will potentially have better conversion and accuracy specifications than the 0801. A 10-bitter is also likely, and the d-a end is not being overlooked either, according to the company.

As for Signetics, it is filling out its family of I^2L bus-compatible chips that began with the 2-microsecond settling time model NE5018 in July 1977. In its new 5019, the Sunnyvale, Calif., company is managing to reduce the maximum error of the d-a converter to 0.1% from 0.2%, making a ¼-least-significant-bit part out of the now-available chip.

Moreover, Analog Devices Inc., Wilmington, Mass., the leader in data-conversion products, which has in the last several years added semiconductor processing capabilities to its bag of design tricks, has its eyes on Signetics' 5018. It plans to offer a functionally compatible device by late fall. (For about a year, the company has offered the C-MOS microprocessor-compatible AD7524, which needs an external voltage reference.)

For designers of microprocessor-based systems, the new monolithic converters will simplify their jobs by incorporating all the logic that they need in order to interface with 8-bit microprocessors. In effect, the converters can be just plugged into the microprocessor bus.

Like National, Motorola is also ready to leap into the converter marketplace. "Last year we created a manufacturing base; this year we go for market share," says Henri Jarrat, IC division vice president and director of bipolar operations, Mesa, Ariz. This plan, incidentally, applies across the board to all Motorola's linear products.

TV in view. Motorola's MC10318, which is aimed primarily at television broadcasting systems, is catching on fast, claims Michael Henry, design manager for linear interfaces. Especially useful is a complementary current output of 51 milliamperes. "This allows direct driving without using an operational amplifier," Henry says.

Critical to Motorola's growing significance in converters and other linear ICs is its newly established precision thin-film processing capability—put into operation during 1978—which is finding its way into many of its linear products, according to Jarrat.

Although Motorola calls itself a "dark horse" in converters, its d-a units of the early 1970s, especially the 8-bit 1508, still sell. But the present program is "a major thrust to get a leadership position in this market, which will amount to $70 billion by 1983," Jarrat says. □

Military

DOD will request proposals next month for VHSIC project

The Pentagon is now ready to roll on its VHSIC program for very high-speed integrated circuits. In early April, it will publish its first request for proposals for nine-month definition studies to be awarded by late summer. Formerly known as VHSI, the triservice effort [*Electronics*, Sept. 14, 1978, p. 81] is expected to cost $198 million over six years and will get under way with up to $6 million this year.

Looking for partners. As the DOD moves to convert its VHSI concept into contract dollars, industry interest is intensifying: prime systems contractors are scrambling to team with semiconductor houses and universities having expertise in the field.

TRW, for example, is reportedly teamed with Motorola and is working on lining up both Control Data and Digital Equipment to handle systems architecture. It is also said to be negotiating with California Institute of Technology and Carnegie-Mellon University.

Hughes Aircraft is talking with both National Semiconductor and Signetics, according to program sources, whereas Fairchild is reported to have discussed working with such prime contractors as General Electric, Raytheon, and Westinghouse, as well as Stanford University. Rockwell International is also showing strong interest, but less is known about its plans.

Loners. A number of other large manufacturers are expected to go it alone. Included in that list are such corporate giants as IBM, Texas Instruments, and Western Electric, AT&T's manufacturing arm.

How many proposals does the DOD expect? "Less than 15, maybe 10," says Larry W. Sumney, VHSIC project manager in the office of Leonard Weisberg, director of electronics and physical sciences.

Perhaps the only major semiconductor house not expected to enter the VHSIC competition is Intel Corp., where vice chairman Robert Noyce (see p. 46) and others have expressed concern about the program's drain on the industry's already short supply of good integrated-circuit design talent.

Asked about such concerns, Sumney notes only that the issue has not been raised with the Pentagon by other manufacturers. He points out that annual semiconductor R&D by private industry now runs about $300 million, not counting outlays by IBM and AT&T. The DOD's proposed expenditures through fiscal 1980 for VHSIC "will total about $36 million—roughly 10% of what's spent by industry."

Plans. Each of the VHSIC program's three parts will get approximately equal budget shares, Sumney says, and run in parallel. VHSIC-I is expected to run for four to five years, with perhaps as many as six contractor teams striving for circuits with 1.25-micrometer minimum feature sizes (see "The payoff for VHSIC").

Between two to four contractors would then be selected to continue as finalists. VHSIC-II will push to extend the state of the art to submicrometer dimensions, nominally 0.5 to 0.8 μm. Both efforts, Sumney says, will be vertically integrated, combining circuit design, architecture, software and testing—referred to as DAST by the Pentagon—with fabrication, production and systems demonstrations in a single program.

VHSIC-III will support the technology developing in the other two program segments with shorter-term projects. Labeled the program's catchall area by some industry observers, VHSIC-III "is essential to provide flexibility and stimulate innovation, as well as attract the broadest possible group of performers," Sumney explains. □

The payoff for VHSIC

The achievement of truly "smart" military systems and weapons will be one measure of the DOD's success with its VHSIC program. The second measure will be dollars saved in systems' life-cycle costs. "Besides savings as a result of reduced size, weight, and power consumption," says VHSIC program manager Larry Sumney, "reliability should significantly increase because of reduced parts counts and reduced interconnections in electronics systems. We must have VHSI circuits that are readily available in quantity, affordable because they are not custom-designed but broadly applicable."

Sumney lists several future applications areas where VHSIC could pay off. They include:

- Ground radar that could distinguish between friendly and enemy aircraft by performing fine-grained intrapulse analysis of radar returns in real time.
- Airborne synthetic-aperture radar able to function during evasive maneuvers and still deliver a radar-guided missile accurately.
- Intelligence receivers able to handle over 1,000 signals and provide highly accurate direction location yet fit into a small truck.
- Satellites able to perform extensive on-board processing and reduce the bandwidth of signals relayed to the ground.
- Accurate positioning and tracking of all submarines in an ocean basin, and small, low-cost manpacks providing precise positioning and allowing selection and transmission of preset digital messages in a netted system.

Peripherals

Data station offers OEMs flexibility

Is it an intelligent terminal? Is it a desktop computer? It is almost impossible these days to tell by its hardware or its appearance just what a microcomputer-based system is

Station master. By supplying lots of software tools along with his model 3500 data station, Perkin-Elmer's James Folts hopes to tap many different applications.

designed to do. With current programmability, the same unit can be set internally to perform over the entire spectrum of terminal and computer functions.

That is why Perkin-Elmer's Terminals division has created a new classification, the data station, for the desktop system it is bringing to market. Perkin-Elmer is aiming it at original-equipment manufacturers, supplying them with software development tools to assist them in customizing stations to a host of possible applications.

Industry giants like IBM and Xerox are concentrating on supplying large-volume terminals for applications like word processing, says James R. Folts, vice president and general manager of the Randolph, N. J., division. "That leaves hundreds of applications they won't touch, and that's hundreds of opportunities for OEMs to make specialized data stations."

Indeed, market consultants International Data Corp., Waltham, Mass., predicts the market for applications-unique terminals—for tasks like stock transfers, mortgage closings, and word processing—will hit $5.3 billion yearly by 1982.

6800 micro. Perkin-Elmer has built a programmable system, called the model 3500, around a Motorola 6800 microprocessor. The Terminals division had already used the 6800 in previous products, so "several hundred thousand dollars of software development tools" would have been scrapped if another microprocessor had been chosen, says Folts.

The secret of the station, which supports up to 48 kilobytes of random-access memory, 30 kilobytes of read-only memory, two single-sided, single-density 5¼-inch diskettes, and a high-resolution cathode-ray-tube display, is its software: its multiprogramming operating system offers many software features of larger systems.

Residing in ROM, the operating system can support overlapped, device-independent input/output, for example, and has complete file-management capabilities, including handling fixed or variable record lengths with direct or sequential access. The station also has a command substitution system that acts as a job-control language to refer to frequently used sets of commands with a single statement.

For programming, Perkin-Elmer offers a macro-assembler and extended Basic, and a set of utilities including copying, dumping, and diagnostic software modules. There are also five communications packages and a debugging utility.

Perkin-Elmer also tried speeding things up by modifying the microcomputer architecture in the station by off-loading the I/O tasks from the central processor and its bus. Instead of the CPU controlling the I/O, the 3500 relies on separate floppy-disk controller chips from Motorola to handle the two diskette drives.

Moreover, each drive has an independent direct-memory-access path allowing concurrent operation.

Making it. Volume production starts this month. Without diskettes, the 3500 will sell for $2,995 for 100 or more. A fully configured unit with two diskettes goes for $3,995 in similar quantities. Display and keyboard are separate to make it easier for the OEM to configure the station as a customer requires.

Following the lead of minicomputer and mainframe companies, Perkin-Elmer includes the operating system in the system's hardware price, but prices the rest of its software separately. These one-time software licenses will have quantity discounts like hardware, Folts says. Their prices range from $150, for a Binary Synchronous Communications protocol in quantities of 50, to $395 for the Basic package. □

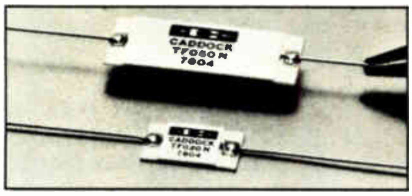
Integrated circuits

CDC says Soviets make good chips, seeks to sell them bigger computers

With 11 integrated-circuit samples obtained from the Soviet Union, Control Data Corp. is trying to convince the Federal government that Soviet IC technology lags behind the U. S.'s by only about two years instead of five and is closing the gap fast. The computer maker wants to make the U. S. recognize Soviet technological advances and thus permit sale of more sophisticated computers to the USSR.

CDC executive vice president Robert D. Schmidt led a team of the Minneapolis-based company's executives to the Pentagon at the beginning of March to brief senior research and development officials there on the Russian circuits and turn the samples over for further analysis [*Electronics*, March 1, p. 58]. Long in favor of relaxing export controls on electronics sales to Warsaw Pact powers, Schmidt believes the Office of Export Administration's upper limit of 32 on a U. S. computer's processing data rate, or PDR, is unrealistic. This

New film resistor replaces precision wire-wounds.



Caddock's Type TF Low TC Ultra-Precision Film Resistors.

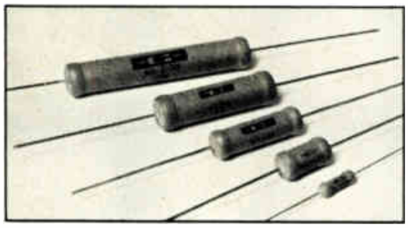
Utilizing Tetrinox™ film technology, the Model TF 050 N resistors combine TCs as low as 5 ppm/°C, values from 2 Megohms to 10 Megohms and tolerances to ±0.1% to surpass the performance of high-value wire-wound resistors.

Caddock's monolythic design and non-inductive resistance patterns eliminate fragile, 'high-L' coiled-wire construction.

Laser production techniques keep these Type TF resistor prices *below* the basic material cost of fine resistance wire!

For Type TF data, circle Number 108.

Non-inductive precision resistors for power switching circuits.



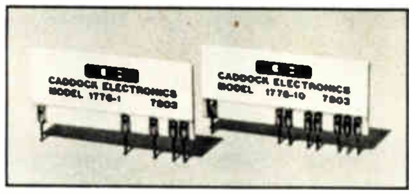
Caddock's Type MS Power Film Resistors.

Caddock's patented Non-Inductive Design in power ratings from 2 watts to 15 watts assures minimum voltage transients in all types of power switching circuits.

High stability Micronox® resistance films operate to +275°C and years-long load-life tests demonstrate extended-life stability better than 0.05% per 1000 hours.

For Type MS data, circle Number 103.

Off-the-shelf precision decade voltage dividers.



Caddock's Type 1776 Precision Decade Resistor Voltage Dividers.

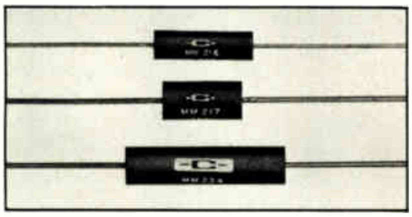
When used as a 10 Megohm input voltage divider, the Type 1776 family can provide high accuracy voltage division in ratios of 10:1, 100:1, 1000:1 and 10,000:1.

The Type 1776 is available in 14 standard in-production models, and OEM quantity prices are low.

For Type 1776 data, circle Number 105.

CADDOCK Resistor Technology solving problems across the board!

High temperature, miniature axial-lead resistors.



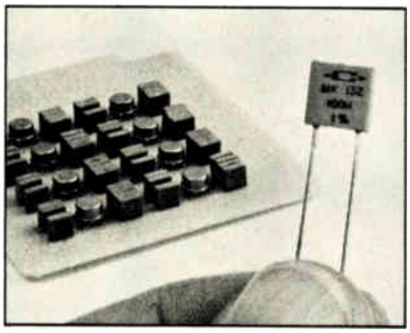
Caddock's Type MM Precision Film Resistors.

The Type MM is a family of precision film resistors in a molded silicone case that is rated at .12 to 3.0 watts and at operating temperatures as high as +275°C.

Many years of use and testing have demonstrated outstanding reliability in geophysical 'down-hole' instruments, heart pacemakers and advanced aerospace systems.

For Type MM data, circle Number 102.

100 Megohms in a miniature package.



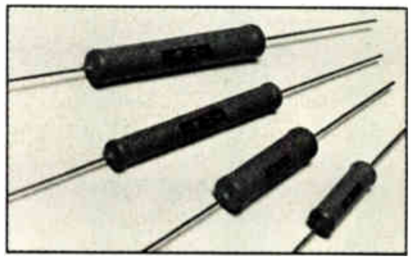
Caddock's Type MK Precision Film Resistors.

Precision values to 100 Megohms in a miniature CK 06 case make the Type MK ideal for low current designs.

These non-inductive resistors find wide application in high-impedance analog circuitry.

For Type MK data, circle Number 104.

High stability resistors for very-high voltage control and measurement circuits.



Caddock's Type MG High Voltage Resistors.

High voltage probes and control circuits make wide use of Type MG resistors for precision high voltage regulation and high voltage measurements.

Long-term stability—plus proven reliability—have also made these precision resistors first choice in communications satellite voltage control circuits.

For Type MG data, circle Number 106.

Caddock's latest General Catalog provides complete performance data and specifications on over 100 models of these outstanding 'problem-solving' resistors.

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Circle 107 on reader service card

equals the power of a CDC 170 or 171 machine.

The Government computes PDR from factors such as processing speed, instruction lengths, and storage capacity. CDC estimates the Soviet's Ryad-2 computer models, the ECS-1060 and ECS-1065, have respective PDRs of 98 and 325.

Schmidt thinks the U.S. could easily raise its PDR upper limit to 75, opening up a Soviet market for sales of 100 CDC 172, 173, and 174 model computers worth $400 million to $500 million over five years. Additional sales for Honeywell, IBM, and Sperry Univac could raise total computer exports "to four to five times that amount."

Cocom, the international coordinating committee comprising the U.S., its partners in the North Atlantic Treaty Organization, and Japan, meets in April to consider raising the PDR to 45 for computers exportable to Eastern Europe.

Public display. The Soviet ICs, the first publicly displayed in the U.S., appear not to have altered the Pentagon's views, according to insiders there. Among the 11 circuits, some of them duplicates, is a 16-K dynamic random-access memory in a 16-pin side-brazed ceramic package somewhat larger than the Mostek 4116 model from which, CDC says, the Russian device was designed. This was the only chip CDC tested for electrical performance.

Among the ICs physically evaluated are a 4-bit microprocessor and a peripheral controller. They are complementary-metal-oxide-semiconductor devices and are housed in 42-pin top-brazed ceramic packages.

Other circuits are a 4-K dynamic RAM using n-channel silicon-gate technology packaged in a 22-pin side-brazed ceramic package and four emitter-coupled-logic circuits. CDC calls the latter similar to the 10-K series ECL devices.

Asked whether the Soviet circuits given to the company by the Ministry of Electronics in Moscow are production models or advanced prototypes, CDC's Lynn Gallup, manager of East-West technical strategy, said he was not certain, although he believes they are production models. Schmidt also conceded that the company does not know Soviet circuit yields or reliability.

Capable. As Gallup sees it, the fact that the Soviet Union "is capable of manufacturing complex integrated circuits" is more important than advanced production capability. "The Soviets obviously have developed the semiconductor process and know-how sufficient to make devices very close to the leading edge of technology."

CDC's inch-thick technical evaluation of the ICs notes significant differences between Russian and U.S. technology. The best Soviet device is the 16-K dynamic RAM, which U.S. companies, now moving on to 64-K parts, have made for about two years. The smallest dimension of the device is 5 micrometers versus 3 μm in the U.S., he says. And the Russian 4-bit microprocessor has no memory on chip, unlike U.S. 8- and 16-bit units.

Analysis and tests of the Russian 16-K memory against Mostek's 4116 by CDC's Microcircuits division also show "noticeable differences between the two circuits" in favor of the 4116. Mask alignments for the Soviet K565PY3 models A and B are inferior to those for the Mostek 4116P revisions 2 and 3, the report says. The transfer gate of the Soviet RAM, for example, "is shifted from one side of the bit line to the other and the contacts to metal are not as well centered as they could be." □

Computers

Plug-compatibles fight back

If IBM's aggressive price/performance approach to the recently announced 4300 series mainframe computers was meant to intimidate its competitors [*Electronics*, Feb. 15, p. 85], it is apparently not succeeding. Major plug-compatible mainframe vendors have already begun a counteroffensive, its most recent manifestation the announcement earlier this month by Magnuson Systems Inc. of three new machines and price cuts on two existing ones. Before this came Itel Corp.'s new AS/3-5 machine, made by National Semiconductor Corp. and pitted directly against IBM's new 4341.

But an examination of the new offerings seems to confirm feelings of industry observers that the plug-compatible computer game is not as lucrative as it once was [*Electronics*, March 1, p. 81]. However, despite the apparent squeeze by IBM, executives of plug-compatible competitors Itel, Magnuson, and National Semiconductor still maintain they can compete with the 4300.

Magnuson's new units—the M80/32, M80/42, and M80/43—are said to range from 300% the performance of the IBM 4331 at a price of $185,000 to 30% over the 4341's performance at $315,000. These join the almost-year-old M80/3 and M80/4 machines that compete against the IBM 370/138 and 148 respectively.

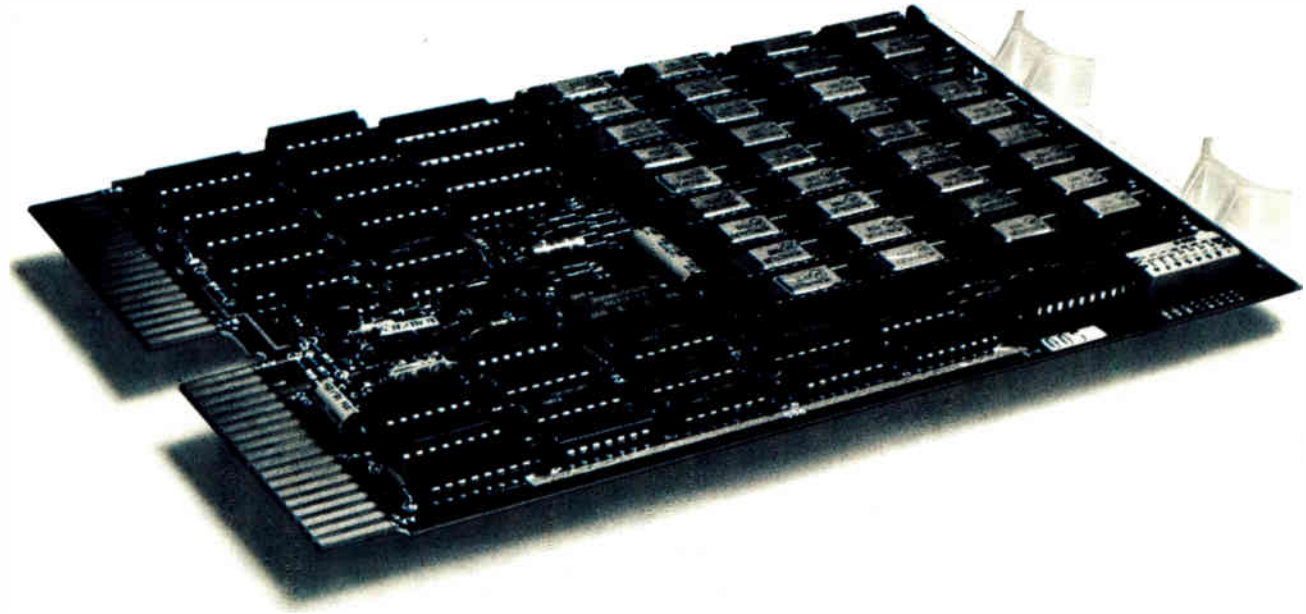
Claims. Magnuson's president, Joseph L. Hitt, says the Santa Clara, Calif., company's new units offer users not only price/performance advantages but also easier expansion to more powerful computers than is available from IBM. But is he overly optimistic?

The M80/3 and 4 were originally priced about 30% below IBM's and offered 1.2 to 2 times the throughput, whereas the three new Magnuson units come in roughly comparable to IBM's. Magnuson says its middle M80/42, for example, has 10% more throughput than the 4341. But its price of $275,000 with two megabytes of memory and three channels is also 5% more than a similarly configured IBM unit.

L. James Beckman, Magnuson's marketing vice president, says his company can deliver sooner than IBM and by the time IBM begins volume deliveries of the 4300 next year, Magnuson will be able to drop its prices.

Also reflecting the narrowing of the competitive margins is Itel's new AS/3-5 built by National Semiconductor. Itel says the AS/3-5 offers

Technological leadership.



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Decode 18-bit address. Recover 3K words of I/O page.

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For immediate price and delivery information, call Motorola Memory Systems, (512) 928-6776, or your local Motorola sales office. To get an MMS1102 data sheet, write Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, AZ 85036, or circle the reader service number.

The MMS1102 is only one of the broad line of Motorola add-in, add-on memories available now for new and expanding systems everywhere. And, leading-edge storage capability is but one of the many technologies in which Motorola is providing service to the designers of

Innovative systems
through silicon.

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22% higher performance than the 4341. Its basic price of $600,000, however, is about 2.4 times that of the IBM unit.

But even with the dulled competitive edge, the plug-compatible computer makers maintain that only non-IBM-compatible computer makers will be hurt by the 4300. Speakers at the IEEE Computer Society's Compcon Spring '79 conference in San Francisco earlier this month felt IBM is creating a market for the 4300 that it will not be able to fill by itself. This means more business for the vendors, even with price/performance close to IBM's. They also feel the 4300 shows IBM will keep its existing System/370 architecture, which has become an industry standard since IBM has an estimated 60% to 70% of the computer market. □

Packaging & production

E-beam annealers are being readied

Heat is a necessary evil in semiconductor making. Manufacturers use annealing ovens to repair crystal lattice damage caused by ion implantation, yet the 550° to 1,000°C temperature of these ovens creates problems of its own, notably wafer warpage.

Never a desirable byproduct, warpage will be anathema in the coming era of very large-scale integration. "High temperatures can ruin a VLSI wafer," notes Anton C. Greenwald, director of pulsed electron-beam processing at Spire Corp, Bedford, Mass. With present-day lithographic equipment, "you can kiss submicron geometry good-bye if there's wafer deformation."

Solution. What looks like the way out of this dilemma is a precisely controlled method that heats only the surface of the wafer, minimizing lattice deformation. Such a method, using pulsed electron beams, has been developed by Spire to the point where the company is ready to market equipment.

"Pulsed electron beams heat the

News briefs

High-speed Marisat service may be near

Prospects are brightening for 56-kilobit-per-second ship-to-shore satellite-based communications over the Marisat satellite system. Satellite tracking of shipboard antennas during rough seas proved to be no problem, so the present 2,400-bit/s service could be supplemented as soon as enough users sign up. Speaking at Intelcom 79, the international telecommunications conference in Dallas, David W. Lipke, maritime systems engineering director at Marisat's owner, Comsat, says 56-kb/s tests in the turbulent North Sea show bit error rates better than 10^{-6} attainable 95% of the time with ship rolls as great as 10° to 15°.

SBS to get high-speed facsimile prototypes

AM International Inc. will develop and build two prototype high-speed facsimile communications terminals for the Satellite Business System Inc.'s new domestic network. The helium-neon input laser built by subsidiary ECRM Inc. will scan two pages a second, while the store-and-forward minicomputer module, made by AM subsidiary Jacquard Systems, will transmit the compressed bit stream at 8 million bits per second. Los Angeles-based AM International says production versions will cost about $75,000 each. A less sophisticated version, for narrower-bandwidth telephone lines, will be offered in the more lucrative market for 4,800-baud systems.

New Burroughs architecture revamps mid-range

A building-block architecture, new transistor-transistor-logic chips, and 16,384-bit memories are features of two new Burroughs Corp. computers that boast two to five times the performance of the previous mid-range computers. The B 2930 and B 3950 central processing units consist of six modules dedicated through microcode to particular functions that operate concurrently and asynchronously. The Detroit firm says the new 3950 offers up to five times the performance of the B 2835, yet is priced between $230,000 and $399,640, only about 27% more.

NCR replaces its intermediate line

Also modernizing its intermediate line of mainframe computers is NCR Corp., with five new machines available in multiprocessor versions. The largest, the V-8585M, offers 65% more power than the previous V-8580, but at $375,000 is 20% less expensive. The units are all based on 10K emitter-coupled logic and use 16,384-bit random-access memories. Reflecting the memory price war shaping up in the computer industry, the Dayton, Ohio, firm prices its add-on increments at $20,000 a megabyte.

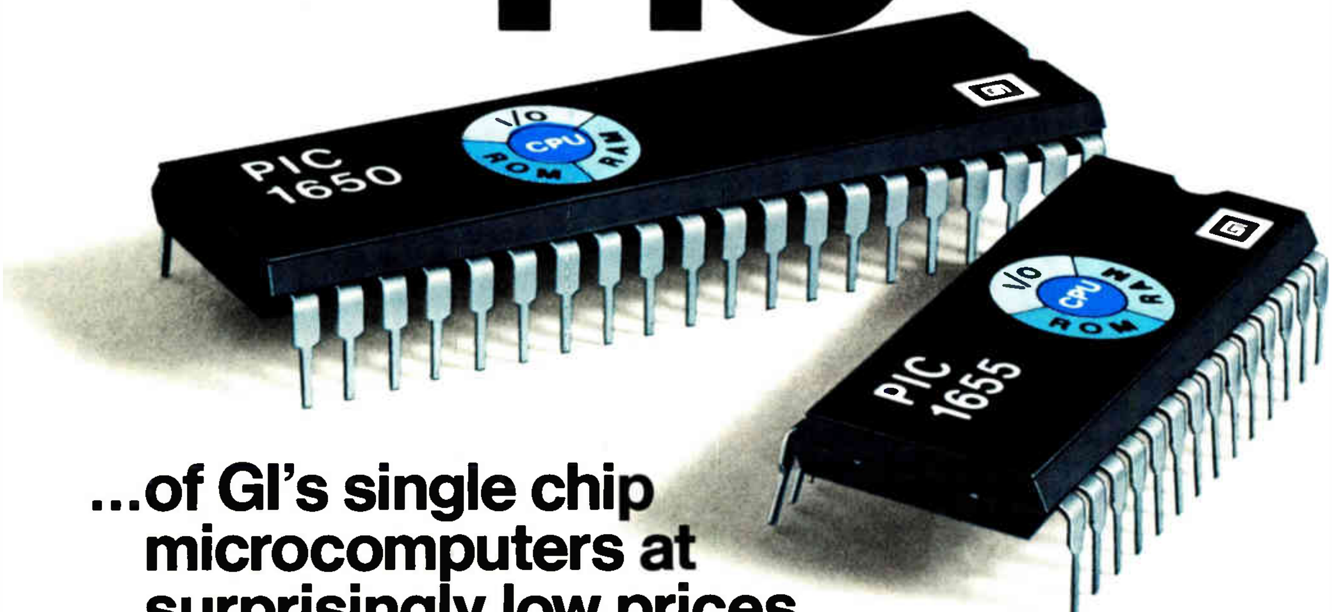
Top executives change titles at Intel

Founders Andrew Grove, Gordon Moore, and Robert Noyce have changed titles at Intel Corp. The move more closely reflects their duties at the growing Santa Clara, Calif., microcomputer systems company. In the new lineup, Grove, as chief operating officer, moves from executive vice president to president; Moore, as chief executive officer, becomes chairman instead of president; and Noyce, who represents the company to the financial and Government communities, moves from chairman to vice chairman.

Riding high, Motorola boosts production capacity

By year's end, Motorola Semiconductor Group's Integrated Circuits division will have more than doubled its manufacturing capacity, with growth of capacity in the key n-channel metal-oxide-semiconductor area "exceeding a factor of three," reports Alfred J. Stein, division vice president and general manager. Expansion took place at four sites, including Mesa, Ariz., where a high-density H-MOS facility starts turning out 68000 16-bit microcomputers and MOS memories in the second quarter of this year. Other new production will be in Austin, Texas, and East Kilbride, Scotland, for both n-MOS and complementary-MOS circuitry and in France for bipolar parts. Almost all Motorola ICs will be made on 4-inch wafers, says Stein.

Take your PIC



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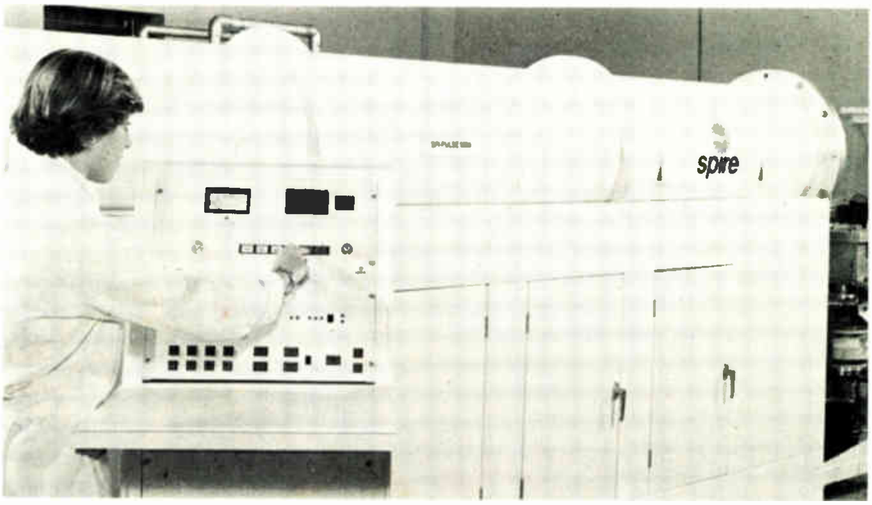


Beamer. Spi-Pulse 6000 Prototype from Spire Corp. aims electron beam inside tube at semiconductor wafers for annealing. Unit is 3 ft in diameter, 15 ft long. Price: $170,000.

surface of the wafer very quickly," Greenwald says. "If the surface is heated quickly enough, the heat flow through the rest of the material is very low."

Spire has been working on the process for several years under a U.S. Department of Energy contract to develop electron-beam annealing of silicon solar cells. It has been doing test batches of wafers for semiconductor makers for some time. Now it is introducing a machine for research work, with a larger one aimed at the production line in prototype.

Achieving marketable equipment appears to put the Spire process ahead of a strong contender for the same jobs: laser-based heating processes that aim at the same degree of control and precision [*Electronics*, March 1, p. 88]. Theoretically, the electron-beam approach should produce more pulses per minute because of the physics involved. Also, the wafer should absorb more of the pulsed energy than with a laser, which involves some reflection because it is a light beam.

Equipment. What Spire has available is a $60,000 Spi-Pulse 300, intended to introduce the technique into laboratories and research and development centers. In prototype is the scaled-up Spi-Pulse 6000, to cost about $170,000 when semiconductor firms begin to order them—as Spire is confident they will.

Operation of the two models is essentially the same. From a field-emission cathode, a pulsed 100-nanosecond beam covers the wafer (up to 3 inches in diameter with the 6000; up to 1½ in. with the 600). The goal is 300 wafers an hour, provided makers of wafer-handling equipment come up with holders.

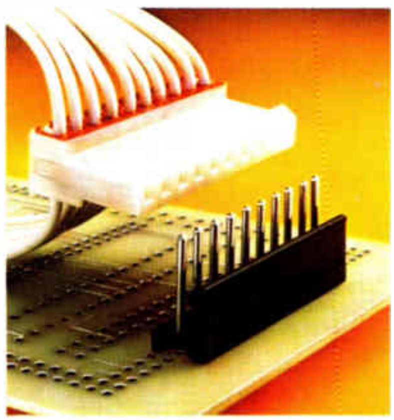
Beam energy and fluence, the power per square centimeter, are adjustable to vary the depth of heat. This adds versatility, because it permits different operations on different materials.

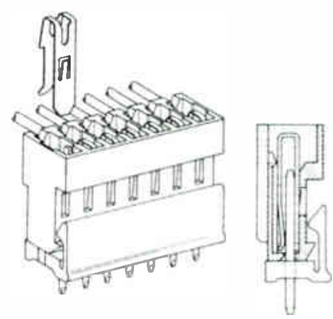
Annealing ion-implantation damage promises to be the most immediate application for the pulsed electron-beam process. "With E-beam, you can melt the surface without puddling it," Greenwald says. "The regrowth [into a single-crystal structure] is exceedingly good, and final crystal quality is as good as the virgin material."

Other uses. Another use involves epitaxial growth of semiconductor films on bare silicon. Silicon films can be grown at much lower temperatures than the 1,100°C that is required in ovens. Another task will be to form metal welds between metal contacts and silicon. Tantalum, tungsten, or platinum and the silicon immediately below may be fused by heat from the beam.

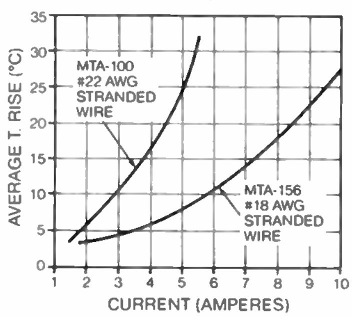
At least one researcher sees an exciting application ahead. "The pulsed electron-beam process gives

AMP MTA.





CURRENT VERSUS TEMPERATURE RISE ABOVE AMBIENT



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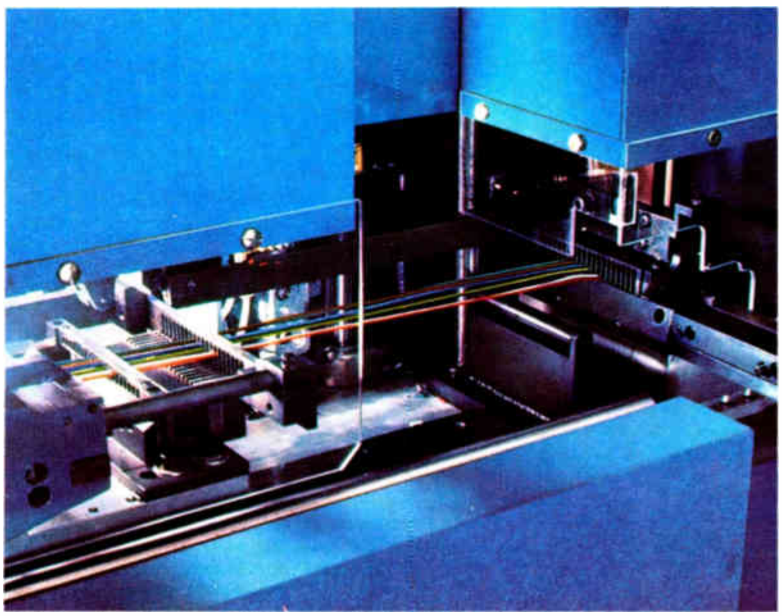

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very uniform annealing for gallium-arsenide wafers," says Piero A. Pianetta, a technical staff member at Hewlett-Packard's solid-state laboratory in Palo Alto, Calif. □

Charge-coupled devices

CCDs receive two-pronged boost

There's a growing contention among some mainframe computer makers that the once-bright promise of charge-coupled-device technology is in danger of being ended by rampaging n-MOS random-access memories on one side and magnetic bubbles on the other. But CCD advocates believe two recent announcements will pump renewed vigor into the technology: Fairchild Camera and Instrument Corp. is designing a quarter-megabit device for early 1980 introduction, and at this month's Compcon conference, NCR Corp. unveiled a novel concept for putting 64-K CCDs in packages having only four pins (see below).

Fairchild's upcoming 256-K part represents a substantial upgrade from its current 64-K devices, using an interlaced-ripple, serial-parallel-serial internal multiplexing scheme that it employs on the 64-K memories, according to Gilbert Amelio, division vice president and general manager of the MOS products group, San Jose, Calif. But unlike the 64-K devices, which require four external clocks, the new 256-K devices generate two transfer clocks on chip to free up the two address lines needed on the 16-pin package.

Shrunken. Fairchild, one of two remaining CCD vendors in the U. S. (Texas Instruments is the other), has also reduced the 64-K part's design rules to 5 to 6 micrometers in some cases—close to the shrunken dimensions of 3 to 3.5 μm of n-channel metal oxide semiconductors, Amelio says. This gives the new part an area of 40,000 mil^2, not much larger than some 64-K RAMs, he adds. The architecture is organized as 64 4,096-by-1-bit blocks, the same size blocks as in the 64-K memory. The access time, too, remains the same, about 800 microseconds for the worst case, and 400 μs average to get to any bit in a 4,096-bit loop in the best of the 5-megahertz parts.

"People who say that CCDs are being squeezed out by n-MOS RAMs and magnetic bubbles don't know what they're talking about," Amelio declares. "We had an early entry into the field in 1972, so we had an early understanding of the marketplace. There are some performance features offered by CCDs that can't be touched by RAMs or bubbles."

One of those features, according to Amelio, is access time for computer applications. "In such applications, where data is being transferred 12 to 18 pages at a time, it's how fast

NCR plans four-pin, 64-K CCD

Intended for bulk memory storage, NCR Corp.'s proposed 64-kilobit CCD would reside in a 4-pin single in-line package designed to increase board density, according to Don Lauffer, manager of NCR's technology center in San Diego. Sixteen of these 4-pin CCDs could fit into the space occupied by two 16-pin devices, which means that on an 11-by-14-inch board designers could stuff 1,152 of the packages for over 9 megabytes. With 16-pin packages, only 144 would fit, for 1 megabyte of storage.

According to Lauffer, NCR's concept makes 4 pins do the work of 16 by integrating some simple circuitry onto the chip to time-share the pins, eliminating twelve bonding pads and associated input drivers. Two of the four pins are for power and ground. Another, the "F" pin, is used for the address, read/write, and data in/out functions. The last pin, labeled "S," handles the chip-select and clock functions.

Lauffer claims that by having 4 pins instead of 16, the chip's performance is degraded by only slightly more than 0.1%.

you get the data from one memory to another that is important." The block-oriented nature of CCDs is more suited to this application, so it is faster than competitive devices. □

Automotive

TI ships Delco carburetor control

Driven by tougher Federal emission and fuel economy standards, the market for semiconductor products in automotive engine-control systems is expected to spurt dramatically during the next few years. Disclosure of one large pact came late last month, when Texas Instruments Inc. revealed a major automotive deal with General Motors' Delco Electronics division.

Neither company is talking dollar amounts. But at TI in Dallas, vice president Charles M. Clough is calling the deal "one of the most significant contracts for semiconductor parts that Texas Instruments has ever signed." At least one knowledgeable industry observer notes that the contract could well boost TI into second place behind Motorola among leading suppliers of integrated circuits to Detroit.

Support. Delco is the prime contractor to supply the electronic control module, or on-board computer, in GM's new C-4 (computer-controlled catalytic-converter) emission-control system. Its parts will serve as support circuitry for a microprocessor (most of which will come from Motorola) in the module.

The module adjusts the air-fuel mixture in the carburetor on the basis of signals received from an oxygen sensor in the exhaust manifold. The C-4 system, which includes the control module as only one of its components, is scheduled to be installed on about 400,000 of GM's 1980 cars and on all of its expected 5 million to 6 million 1981 cars.

The TI devices contracted for include three bipolar programmable read-only memories, eight low-power Schottky logic parts, eight linear

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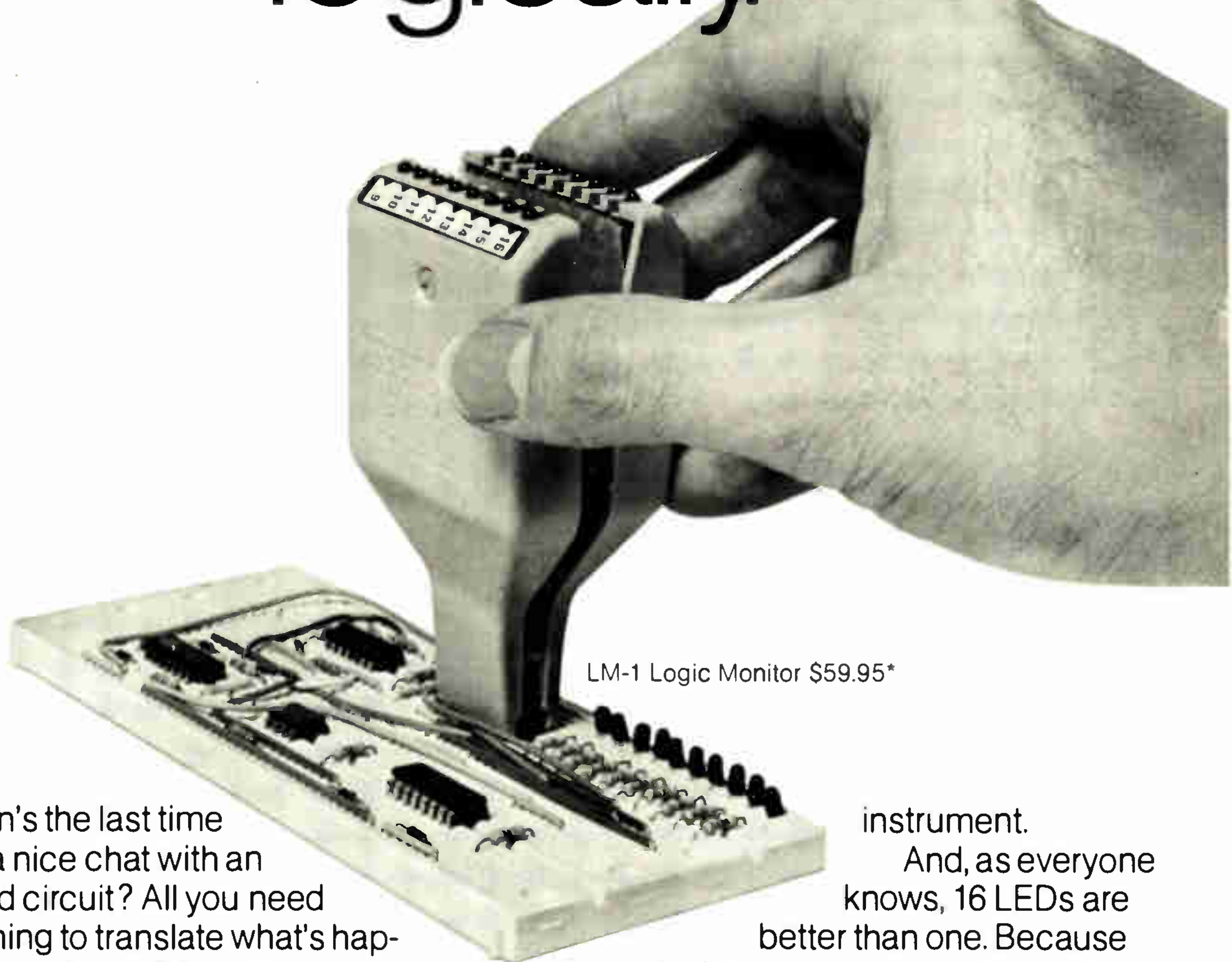

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control ICs, eight power transistors, and 32 diodes. Signetics and National Semiconductor, said to be among other suppliers for the C-4, have declined to comment. ☐

Microprocessors

Italians to make Zilog Z8000

Chalk up another one for Zilog—another second source, that is. SGS-ATES Componenti Elettronici SpA, Italy's largest semiconductor manufacturer, has agreed in principle to become a supplier of the 16-bit Z8000 microprocessor in Europe, which the Cupertino, Calif., firm began supplying in sample quantities March 1. The Milan company will also produce the older Z8 single-chip 8-bit microcomputer, as well as the peripheral circuits for the Z8000, which include a memory-management unit, buffer memories, serial and parallel input/output chips, and random-access memories. SGS-ATES obtained the rights four years ago to build Zilog's 8-bit Z80

With Advanced Micro Devices Inc. already a second source for the Z8000, Zilog has two. That's as many as Intel Corp. has for its 16-bit 8086. Intel, in Santa Clara, Calif., has so far won second-source agreements with Mostek Corp., Carrollton, Texas, and Siemens AG of Munich. Both agreements spurred controversy—the one with Mostek because the company had earlier agreed to make Zilog's Z80 [*Electronics*, Nov. 23, 1978, p. 46], and the other because Siemens had previously formed a company called Advanced Micro Computers with AMD [*Electronics*, March 1, p. 48].

Texas Instruments has on its side American Microsystems Inc. for its 9900. Standard Microsystems Corp. also has rights to make TI's 9980, but so far has opted not to build any. Other 16-bit devices—the 9440 from Fairchild, the 68000 from Motorola, and a device coming from National Semiconductor—have no official second sources yet. ☐

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—Gambera

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"We looked at Basic, Fortran, Pascal. They were all too complex. Then we looked at FORTH's micro package. At first we were skeptical. But we were faced with an urgent need. We figured 'What do we have to lose? If FORTH can do what they say, we can make it'."

Armand Gambera, Engineering Supervisor/Portable Products. Larry Morris, Engineering Supervisor/SAS Systems. Telecommunications Technology, Inc., Sunnyvale, CA.

"Within two days we were writing routines in FORTH that would have taken two to three weeks to write in assembler." *—Morris*

"That's when we decided to use FORTH. We were impressed by how quick and easy it is to use. A good programmer should be up on it in two days. We had all kinds of fun. Inside a month we were really confident with it."

"In three months, two of our people completely rewrote the program with significant enhancements." *—Gambera*

"We couldn't have delivered on our commitment without FORTH. Everyone in our organization is now using it for all but the most trivial routines."

"It's amazing the impact programming speed has had on our ability to work with customers." *—Gambera*

"FORTH programming is fast. We can be much more responsive now. FORTH's programming speed more than offset the cost of rewriting our first program. Target-compiling and de-bugging are quicker too. We target-compiled FORTH in one day. It would have taken a week in assembler. And something that might take 30 hours to debug in another language takes two hours in FORTH. Editing is extremely simple."

"FORTH gives us the nuts-and-bolts control of Assembler without all the tedious coding." *—Morris*

"FORTH gives us better control over run time. It's very close to the microprocessor in terms of definitions so you can configure as you like, right at the hardware level. That's especially important to us since we have a lot of interfaces, a lot of driver routines.

"My advice to others is: 'Try It'." *—Gambera*

"You won't believe it until you do. We all know how stubborn people can be when it comes to trying something new. Engineers can't afford to be. If a tool works, you use it. FORTH works for us. We wouldn't consider going back to assembler or switching to some other high-level language. We're sold on FORTH. We only wish we'd tried it sooner."

"Engineers can't afford to be stubborn about trying new tools. If it works, you use it."

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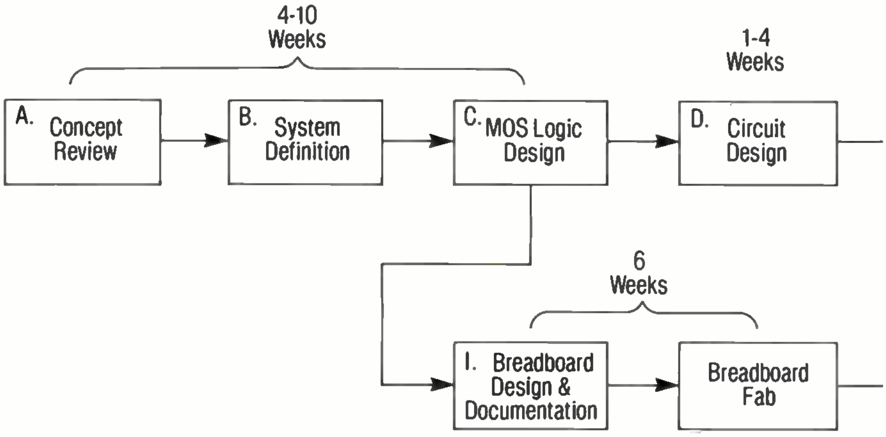
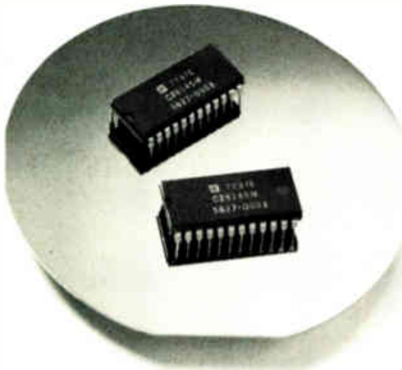


When to go custom. When a single custom circuit can replace hundreds of individual components, the benefits are obvious. But the cost of developing that single custom circuit is high, and only becomes practical if the volume you will actually use is significant. At Synertek, the first stage in custom circuit evaluation is a cost-versus-volume analysis.

Some applications, such as digital watches, would be impossible without a single custom circuit. In other cases, the performance and reliability advantages may outweigh the initial higher cost considerations. In any case, it's a simple matter of economics. With fewer parts, lower assembly and inventory costs, smaller size, less weight, less heat to dissipate, greater reliability and a competitive edge to help build that crucial volume requirement, savings are enormous in a successful custom program.



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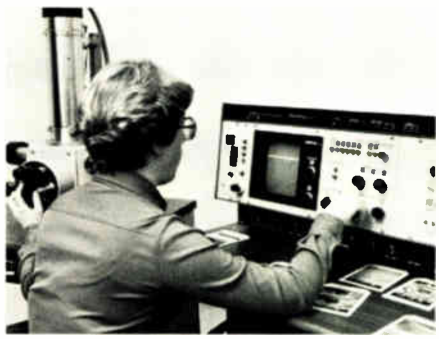

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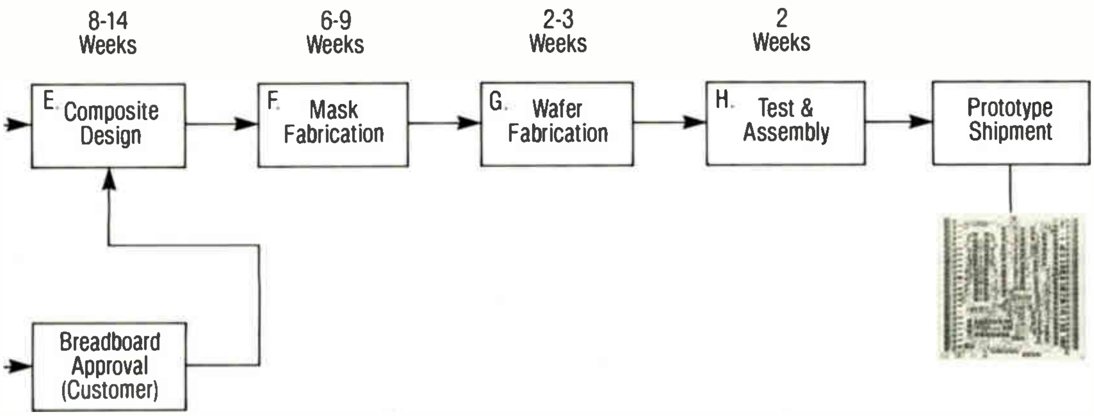

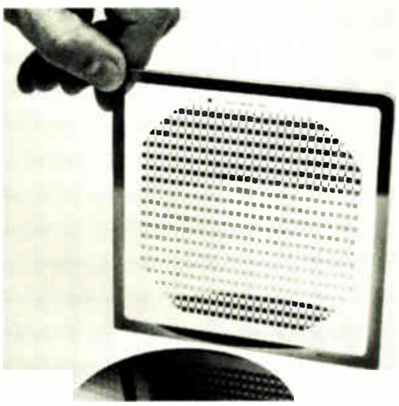

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Washington newsletter

Air Force picks three to build Seek Talk models

Air Force contracts are going to E-Systems Inc.'s ECI division, St. Petersburg, Fla. ($4.1 million); General Electric Co., Fairfield, Conn. ($4 million); and Hazeltine Corp., Greenlawn, N. Y. ($5.4 million), to competitively design, build, and test advanced development models of Seek Talk, **the jam-resistant voice system for tactical air-to-air and air-to-ground communications planned for 1983 production.** Eliminated from the competition was Magnavox Corp., which participated in last year's design stage. Rome Air Development Center, N. Y., is overseeing the program.

FAA orders removal of $LiSO_2$ batteries from all planes

Lithium–sulfur-dioxide batteries have become a literally explosive issue at the Federal Aviation Administration. **A series of six explosions, plus spontaneous fires and corrosive leakage problems caused in the last six months by aging** $LiSO_2$ in aircraft emergency locator radio transmitters (ELT), has spurred the agency to order their removal by owners and pilots within 30 days from March 28. About one third of the 180,000 U. S.-registered planes (except scheduled airliners) that have been required since 1974 to carry automatic ELT units use $LiSO_2$ batteries, the FAA estimates; the remainder have alkaline or magnesium batteries. The agency identified six ELT equipment makers, some of whose models used $LiSO_2$ batteries. They are: Communications Components Corp., Cessna Aircraft Co., Dorne and Margolin Inc., Garrett Manufacturing Ltd., Leigh Systems, and Pointer Inc.

Pascal people make progress toward standard

In marked contrast to the stormy meeting of the American National Standards Institute's X3J9 committee held last December, the meeting on Feb. 20 in Costa Mesa, Calif., was a model of progress toward a candidate standard for the Pascal high-level language [*Electronics*, Feb. 15, p. 96]. One result was that two joint meetings of X3J9 and the Institute of Electrical and Electronics Engineers' P770 task group are now scheduled: one for April 26 and 27 in Boulder, Colo., and the other for June 6 and 7 in New York after the National Computer Conference. **"If the trend continues, we'll have a candidate standard in June,"** Bruce Ravenel, chairman of P770, told a gathering at the IEEE Computer Conference in San Francisco. Ravenel says the standard most likely will be the same as that described by Niklaus Wirth and Kathleen Jensen in their 1974 "Pascal User Manual and Report."

Sanders, ITT teams developing jammer for Navy, Air Force

Two teams are ready to do battle in the final rounds for contracts for the joint Navy–Air Force Airborne Self Protection Jammer (ASPJ). Sanders Associates and Northrop Corp. as the first team and International Telephone and Telegraph Corp. and Westinghouse Electric Corp. as the second have received sustaining engineering contracts. Later this spring the Defense Systems Acquisition Review Council will look over the ASPJ program, and each team should receive a first-phase development contract of $10 million to $15 million. **The final development contract will go out in 1980 to one of the two.**

The ASPJ will provide on-board protection for fighters and attack aircraft against radar-guided weapons systems and will be viable from the mid-1980s through the year 2000. Industry observers place a price of $1 billion to $1.6 billion on the production award, scheduled for 1984.

VHSIC's takeoff roll looks good

Six months ago the Department of Defense first announced its plans to advance the semiconductor art with a program to develop very high-speed integrated circuits [*Electronics*, Sept. 14, 1978, p. 81]. The question at that time was: will VHSIC fly? Now we have at least part of the answer: the program is about to take off (see p. 41).

How well, how far, and how fast VHSIC flies is still uncertain. That will depend as much on the performance of the program's pilots in the Pentagon and the congressional support they receive as on industry's ability to innovate.

Pentagon performance so far gets good marks from industry, where interest in VHSIC is running high. "I'm impressed with DOD adding a program-definition phase up front before charging ahead," says one prospective bidder's representative in Washington. "It shows that they are listening." Another potential competitor observes, "The program people are hanging loose, encouraging comments. I just hope they can remain flexible."

DOD's management plan

Final DOD approval of VHSIC plans for source selection and business management is just about complete at this writing. That will be followed by establishment of a program structure to include appointments of three military representatives to a VHSIC source selection acquisition council, balanced in turn by a separate source selection evaluation board. The Air Force, Army, and Navy representatives have yet to be named, but DOD program manager Larry Sumney indicates they will have ranks equivalent to two- or three-star generals—a sign of the importance the Pentagon attaches to the effort.

The lead military commands responsible for implementing VHSIC within each service also have to be officially named, although these are likely to be the Air Force Avionics Laboratory (AFAL), the Army Research and Development Command (Aradcom), and either the Naval Air Systems Command (Navair) or the Naval Electronics Systems Command (Navelex), or both, depending on the nature of the weapons systems selected for VHSIC demonstrations. While the individual services will choose their own candidate systems for demonstrations, company recommendations on which systems could benefit most from VHSIC technology will have significant bearing on those choices.

Keeping options open is crucial to DOD's success in developing VHSI circuits. The task of reducing minimum features on a chip to less than a micrometer is enormous, of course; but to do that and then carry it forward to mass production of such circuits represents a staggering challenge that will not be overcome with money alone.

Leaders of the Pentagon program appear to have recognized that need when they established VHSIC-III as a parallel six-year effort to support the technology of parts I and II, the development of the circuits themselves. In contrast to those large, vertically integrated programs, VHSIC-III "will consist of many shorter programs with a more limited scope, concentrating on key technologies, equipment, or tools" that Sumney says will provide "alternative directions not specifically included" in the larger efforts at the start. If, for example, a university or corporate laboratory comes up with a new and unanticipated development, it could be funded under VHSIC-III to pursue that effort. Should further development prove successful, the technology could then be incorporated as appropriate into VHSIC-I or -II. What's more, says Sumney, an organization bidding as a team member on the larger circuit development segments would not be precluded from bidding separately for VHSIC-III funds.

An uncommon commendation

That DOD approach is to be commended. It seems to recognize that the semiconductor industry, perhaps the most innovative segment of electronics, is anything but static. By making VHSIC-III a separate parallel effort, the Pentagon is also accommodating those design specialists who find it difficult to function effectively within the constraints mandated by a large, coordinated multicompany team working toward a specific program goal.

All these points must be made to Congress when it comes to a vote on the VHSIC appropriation. If DOD can get away from costly, custom-designed circuits and advance the state of the American semiconductor art at the same time, both the nation and the industry will be better for it.

Ray Connolly

ANOTHER ACE FROM THE INTERFACE PLACE

A new series of vacuum fluorescent display drivers that simplify the design of many applications, including . . . POS systems, cash registers, clocks, scales, automotive displays, appliances, and pinball machines.

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For application engineering assistance on these or other interface circuits, standard or custom, write or call George Tully or Paul Emerald, Sprague Electric Company, Semiconductor Division, 115 Northeast Cutoff, Worcester, Mass. 01606. Telephone 617/853-5000.

For Engineering Bulletin 29313A and a 'Quick Guide to Interface Circuits', write to: Technical Literature Service, Sprague Electric Company, 35 Marshall Street, North Adams, Mass. 01247.

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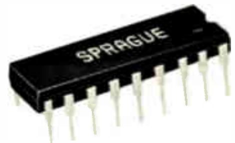

Type No.	UDN-6116A	UDN-6126A	UDN-6118A	UDN-6128A
No. of Pins	16	16	18	18
Sustaining Voltage	85V	85V	85V	85V
Source Current	40mA	40mA	40mA	40mA
No. of Drivers	6	6	8	8
Input	5V	6-15V	5V	6-15V
Compatible with:	TTL, Schottky TTL, DTL, and CMOS	MOS (PMOS or CMOS)	TTL, Schottky TTL, DTL, and CMOS	MOS (PMOS or CMOS)

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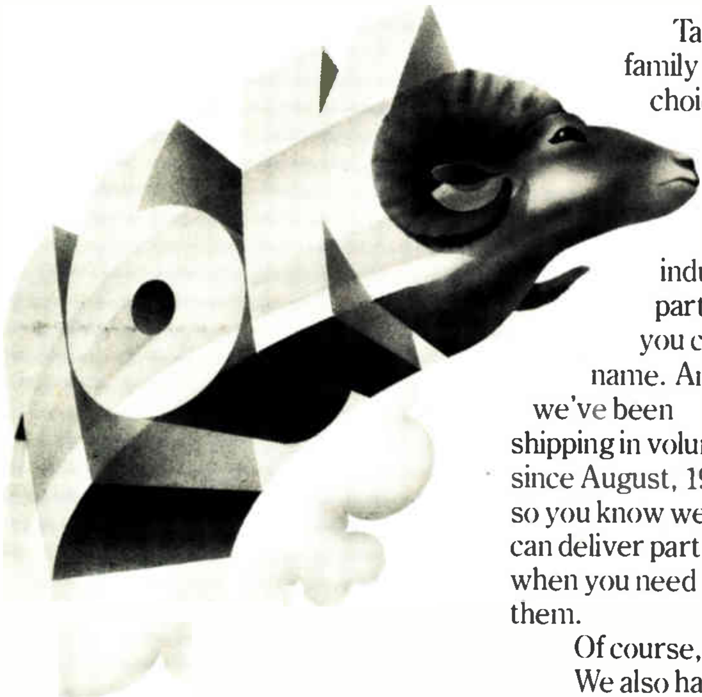

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μPD416-2	200 ns	375 ns	35 mA	1.5 mA
μPD416-1	250 ns	430 ns	35 mA	1.5 mA
μPD416	300 ns	510 ns	35 mA	1.5 mA
$t_a = 0°C$ to $+70°C$				

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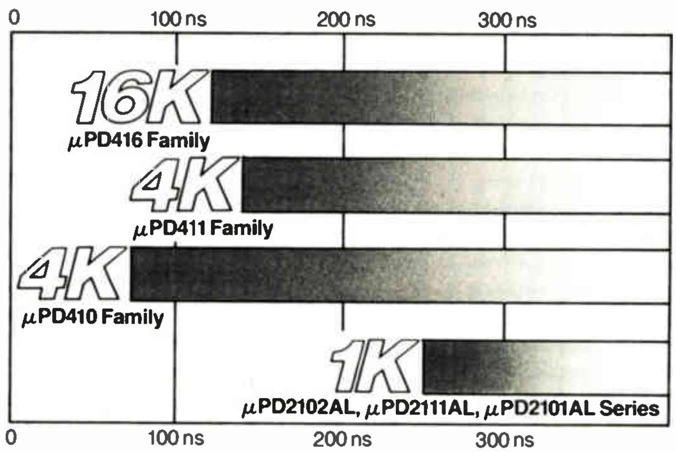

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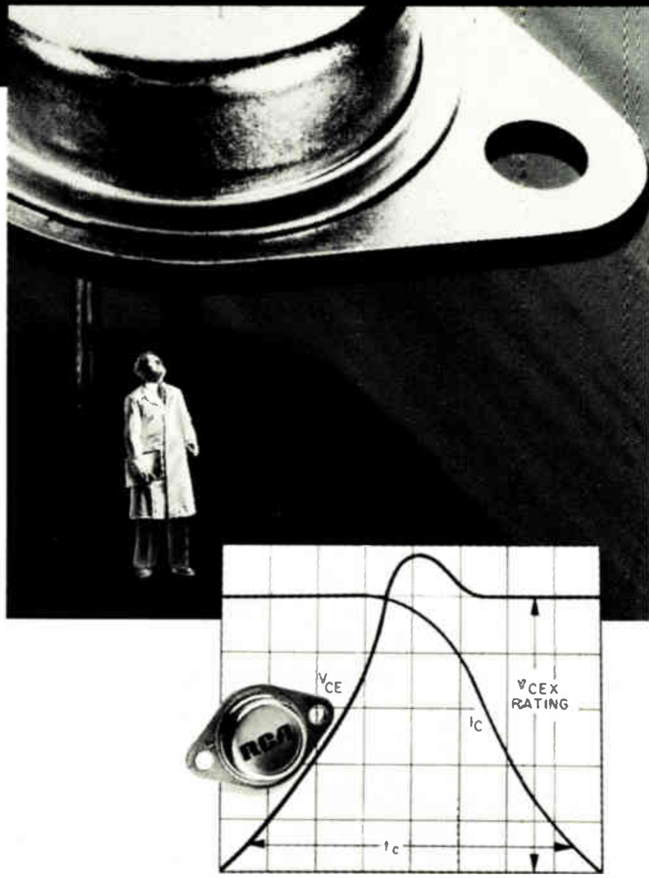

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With the SwitchMax power transistor booklet and RCA Application Notes, you'll be armed with facts to insure your protection in the hot-temperature zone.

Types	V_{CEV} Rating	I_{CEV} (max) at $V_{CE}=V_{CEV}$ mA	V_{CE}(sat) max at I_C(sat) V	I_C(sat)	t_c(max) at I_C(sat) µs
2N6671 2N6672 2N6673	450 V 550 V 650 V	0.1 (25°C) 1 (125°C)	1 (25°C) 2 (125°C)	5A	0.4 (25C) 0.8 (125C)
2N6674 2N6675	450 V 650 V	0.1 (25°C) 1 (100°C)	1 (25°C) 2 (100°C)	10A	0.5 (25C) 0.8 (100C)
2N6676 2N6677 2N6678	450 V 550 V 650 V	0.1 (25°C) 1 (100°C)	1 (25°C) 2 (100°C)	15A	0.5 (25C) 0.8 (100C)

Switch Max Booklet 2M1217 gives you full details on how these new transistors are designed, made, tested and characterized. There's also a designer's guide chart suggesting optimum transistor types for typical switching power supply circuits.

Application Note AN-6741 describes the use of the RCA 2N6676 15-ampere SwitchMax power transistor as a driven pulse-width-modulated flyback converter stage, in a 20-kHz off-line power converter providing 340 watts output.

Application Note AN-6743 is a description and analysis of a 900-watt off-the-line half-bridge converter using two 15-ampere SwitchMax high-voltage power transistors. This Note, too, demonstrates the outstanding capabilities of SwitchMax in a typical switching application.

For all this information, contact your local RCA Solid State sales office or distributor. Or write RCA Solid State, Box 3200, Somerville, NJ 08876.

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SGS-ATES to introduce nonvolatile 1-K RAM at Paris show . . .

The Italian semiconductor house SGS-ATES Componenti Elettronici SpA feels it has a winner in its M 120 nonvolatile 256-by-4-bit random-access memory for read-mostly applications. Set to bow at the early April Paris components show, the bit-alterable part is an outgrowth of electrically erasable programmable read-only-memory technology and can store data for an estimated 100 years. Yet to a microprocessor **it looks like a regular static RAM** with an access time of 450 ns. SGS-ATES managed this feat with double-polysilicon-gate technology and on-chip control circuits that accept write data at a normal bus speed of 300 ns and then float the input/output pins while the slower internal modify cycle is carried out.

. . . while Siemens will present three memories

Look for Siemens AG to come out at next month's Paris components show with three parts: two random-access memories using emitter-coupled logic and an electrically erasable programmable read-only memory for which the Munich-based company guarantees a storage time of more than 10 years. The two ECL RAMs, designated the GXB100473 and GXB100475, have a capacity of 256 bits and 4,096 bits, respectively. The former has **a maximum access time of 8 ns and a power consumption of 2.7 mW per bit**; the latter accesses in 25 ns and consumes only 0.2 mW/bit. The EE-PROM, called the SAB 2808, uses double-polysilicon-gate technology and can store 1,024 8-bit bytes. With a 450-ns access time, the device needs 12 V for read-in, 25 V for programming, and 33 V for erasing, which takes only 60 seconds.

Toshiba makes C-MOS logic family 10 times faster

Toshiba Corp. has jumped the speed of its complementary-MOS logic family, which it calls C^2MOS, with the announcement of its new HS-C^2 series. The company, which will supply samples of 10 different parts starting in April, plans to fill out the line with a total of 50 parts by the end of this year, and more the next. The new series is **an order of magnitude faster than the standard C-MOS logic family,** with a typical gate propagation delay to 5 to 15 ns. A decrease in channel length to about 4 μm and simplification of circuits both contribute to increased speed. The devices are designed to operate from power supply voltages of 5 $\pm$ 3 V, with an absolute maximum of 10 V. Initially, Toshiba hopes to take business away from TTL, including Schottky, rather than from its standard C^2 MOS parts.

UK viewdata module gets character set for 28 different languages

Character sets for up to 28 different languages, complete with accents and other language-specific features, can now be displayed with the addition of just one extra chip to the teletext-viewdata decoder set developed by GEC Semiconductors. The new G2 international character set implementation has been developed by the Wembley, Middlesex, company to meet a growing international interest in teletext and viewdata systems. GEC has already made its **first sale of the new implementation to Bell Northern Research Ltd. in Canada for a proposed viewdata trial** displaying both English and French in a 32-character-per-row, 20-row format. GEC says decoder sales have now taken off: it has booked $800,000 worth of business, with the same amount again in view. The two-chip implementation works by storing English language characters in one read-only memory and language-specific characters and accents in a second. A shift instruction preceding the English language character causes the corresponding character in the second ROM to be selected.

International newsletter

nese 2-min fax p...ts in two colors with ink-jet units

A two-color, 2-minute analog facsimile system shown in prototype by Matsushita Graphic Communication Systems Inc. today should be on the market before the end of the year. **The standard text in black, together with corrections, revisions, additions, or other information in red,** is sensed at the transmitter and recorded at the receiver by separate black and red on-demand ink-jet printers. In addition to linking with other terminals of the same type, the new terminals will communicate in black only with other Matsushita terminals using four amplitude-modulation transmission modes and all terminals using the 3-minute CCITT T3 recommendation for group 2 fax unit transmission, which employs a signal with vestigial-sideband phase-modulation–amplitude-modulation characteristics. The new terminal will cost less than $10,000.

Chip off new block expands French family of fast ECL logic

RTC–La Radiotechnique-Compélec has in mind a rapid expansion this year for its 100-K family of emitter-coupled logic, **notable for its gate propagation time of 0.75 ns and a power-delay product of 28 pJ.** The Paris firm, the major French components producer for the Philips group, expects to have a total of nine parts by year-end, plus samples of compatible gate arrays and matrixes of 24 or 36 basic cells whose functions can be defined by metalization. Also to come are two ECL 1,024-bit random-access memories, one with an access time of 10 ns, the other with 13-ns access time but lower power consumption.

Liquid crystals look good for pocket scopes

A pocket liquid-crystal-display oscilloscope with a storage scope capability, a 500-mW power consumption, and a 2.5-MHz bandwidth—possibly extensible to 50-MHz—that's the long-term goal of a research program at Britain's Royal Signals and Radar Establishment, Malvern. The basis for the project is a novel technique for addressing twisted nematic liquid crystals that **allows the display matrix to be driven continuously over its entire area, thus eliminating the flicker** associated with multiplexed displays. In a prototype, the 5-kHz 100-by-100-element matrix is driven directly by 15-V complementary-MOS logic circuits, but RSRE researchers say that the technique can be readily extended to 512 by 512 elements and ultimately to 1,000 by 1,000 elements. A RAM provides storage.

France firms plans for early 1980s telecomm satellite

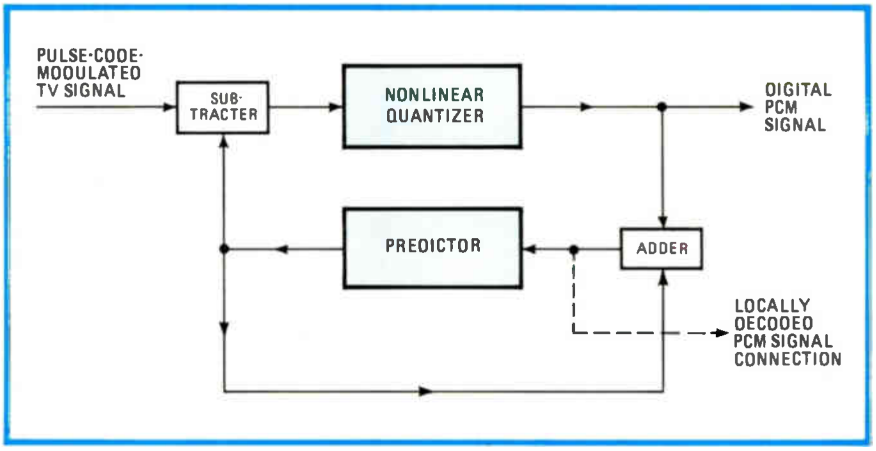
A French telecommunications satellite will go on the air in mid-1983 unless there's a hitch in the government's Telecom 1 project. In a bid to get a piece of a market for satellite telephone circuits that it estimates will run some $230 million annually during the 1980s, **the government will spend roughly $350 million to put up a pair of satellites**—one of them a backup—into a geostationary orbit. Each satellite will have 12 transponders, half working in the 12-to-14-GHz band for high-speed digital transmission between points in France and half working in the 4-to-6-GHz band for transmission between France and its overseas territories.

IBM announces 4300 series in Japan

International Business Machines Corp. announced its 4300 series computers in Japan on March 1. Price of the basic 4331 is ¥14.9 million, and of the basic 4341 ¥56 million. At the current exchange rate of ¥202.5 to the dollar, these amount to about $73,000 and $273,000, respectively—**13% higher than the U. S. prices.**

BBC codes composite color TV signal to achieve 34-Mb/s rate

Researchers prepare for all-digital television environment using standard telephone lines



Savings. By predicting the input signal, comparing it with the prediction, then quantizing and transmitting the error, BBC researchers reduce the data rate in coding a composite TV signal.

Because high-quality digital television transmission using conventional pulse-code modulation consumes a colossal 100 megabits per second—which could not be handled by the conventional telephone lines proposed as economical distribution links—research teams in Europe and Japan have been trying to reduce the data rate and still maintain acceptable broadcast quality. Now, the British Broadcasting Corp. claims to have succeeded.

BBC researchers have recently demonstrated a method of differentially pulse-coding a composite phase-automation-line (PAL) TV signal that cuts the bit rate by two thirds to 34 Mb/s [*Electronics*, Feb. 15, 1979, p. 64].

This fits neatly into European telephony data-rate standards of 8, 34, and 140 Mb/s and is in fact the rate the European Broadcasting Union is considering as a standard for exchanging international broadcasts accommodating the video signal and all its ancillary services. It could therefore lead to major economies in the use of standard PCM telephone links to distribute studio broadcasts to the BBC transmitter network, in the opinion of Paul A. Ratliff, who heads the digital program at the BBC's Kingswood Warren, Surrey, laboratories.

The big technical advantage of a move to digital transmission, says Ratliffe, is that "the video quality is determined at the coding end in the studio and will be unaltered throughout the distribution network." But there are also long-term strategic reasons. For one, as European countries move steadily toward an all-digital telephone network, high-quality video links that accept the full bit rate will become both scarcer and less economical.

For another, there is a strong move to go digital in the TV studio because editing is easier with digital video recordings [*Electronics*, Feb. 5, 1976, p. 94]. It thus makes technical and economic sense to move to digital transmission as well.

Different. The BBC has taken a different route than other groups by processing the composite PAL signal directly. Others have concentrated on coding the separate color components, with the exception of Britain's Independent Broadcasting Authority, which uses composite PAL coding in its digital video recorder system [*Electronics*, Oct. 12, 1978, p. 63].

Apart from immediately cutting the data rate because only one signal is being coded, composite coding has the additional advantage that such systems can interface directly with analog PAL systems without the impairment associated with transcoding separate components.

Three more ways. Further bit-rate savings come from three separate sources. First, as in all digital coding schemes, removal of the blanking interval reduces the bit rate by about 24%. In practice, though, about 1% or 2% of this savings may be sacrificed in order to transmit blanking format and control information.

Second, the researchers cut the bit rate by sampling below the minimum required Nyquist frequency. However, doing so introduces spurious, or aliasing, frequencies, which are then removed by comb filters.

Savings also result from another common practice, reducing the number of bits per sample allocated to the signal. In linear PCM, 8 bits, or quantizing levels, are usually considered adequate for broadcast standards, but by employing differential PCM, the number of quantizing levels can be cut.

Prediction and comparison. In operation, a prediction is made of the input signal level, which is compared with the input signal itself (see figure). The error between the predicted and real signals is then quantized and transmitted. By transmitting the error signal, the number of quantization levels can be reduced. The better the prediction, the smaller the error and hence the smaller the number of bits that it is necessary to transmit.

But since quantization is nonlinear, small differences are transmitted with full accuracy and larger differences with progressively less accuracy. In this way, much of the picture information will be conveyed with no appreciable loss at a modest reduction in bit rate.

Ratliff says that with sufficient work the BBC technique could be applied to the U. S.'s National Television System Committee (NTSC) standards. He adds that it could also be applied in digital video tape recording to save tape. □

West Germany

MBB agrees to provide China with electronics gear and know-how

The People's Republic of China's new open-door policy continues to generate business—or at least the prospects for it—for Western electronics firms. One of the latest deals is between various technical institutions in China and West German aerospace and electronics firm Messerschmitt-Bölkow-Blohm GmbH. A series of preliminary agreements, signed in Peking late last month, involves television satellites, medical apparatus, and aircraft support equipment.

The most spectacular of the three agreements promises to be one between Munich-based MBB and the Chinese Academy for Space Engineering that aims at the joint development and construction of one or more TV satellites intended for live transmissions. Details have not yet been worked out, but the accord could entail as many as 20 satellites, each expected to cost from $40 million to $50 million.

The satellites, MBB says, would be developed in phases, with the goal of each phase jointly defined. Either party could terminate the agreement at the end of any phase.

Coming home. Initially, the academy will send groups of specialists to MBB's facilities in Munich for study, training, and participation in developing and building the first satellites. In later phases, the Chinese will transfer production, with diminishing West German assistance, to their own country.

The first satellite is to be ready by 1983 for launching by the Ariane rocket currently being developed by France with support from other European countries. From a geostationary orbit, this and subsequent satellites would broadcast mostly educational programs, presumably to ease the shortage of teachers brought on by China's Cultural Revolution a few years ago.

Medical gear. The second agreement is in the medical sector. Made with the Chinese Association for Medical Equipment, which employs some 70,000 people and is responsible for all equipment installed in Chinese hospitals, it entails cooperation in producing and applying medical gear. This deal, too, also provides for training Chinese specialists at the Munich facilities.

Part of the accord involves the delivery of a number of MBB's medical lasers, called "Medilas." These lasers, developed a few years ago and now being marketed by the Medical Equipment division of Siemens AG, are used in the treatment of various diseases and in stopping internal bleeding. They also perform various tasks in neurosurgery, dermatology, urology, and other fields.

Aviation. The third preliminary agreement involves aviation engineering. According to its terms, MBB will support the Chinese Association for Aircraft Construction and Equipment in designing rigs for fatigue tests and instrumentation for flight trials. It will also provide helicopter technology by transferring know-how, awarding licenses, and training Chinese personnel.

MBB says that both parties term the three agreements "extremely successful and trend-setting." They are the first results of a technology exchange pact negotiated in October of last year between China and West Germany's Ministry for Research and Technology. Close contacts between the Chinese and MBB were subsequently established during the visit of Fang Yi, deputy minister–president of China's Council of State and chairman of the National Commission for Science and Technology. □

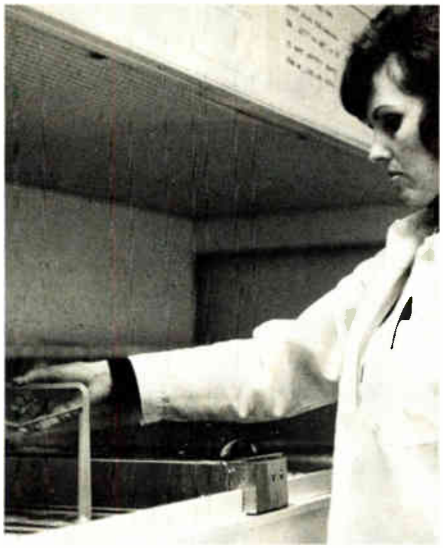
Japan

Fixed-head VCR fills a (loop)hole

A cassette with a continuous loop of tape that feeds into the cavity in the center of its hub is the key to an experimental fixed-head video cassette recorder developed at Toshiba Corp.'s Consumer Products Engineering Laboratory, Kawasaki. Toshiba's design enables the tape to move at 6 meters per second, the speed required to record the 3.9-to-5.4-megahertz band of the video luminance signal.

It thus eliminates the need for the complicated mechanical helical-scan arrangements used in other video recorders to obtain the necessary relative speed between tape and video heads [*Electronics*, Feb. 15, 1979, p. 64; Nov. 24, 1977, p. 106]. These designs both are difficult to manufacture and create a number of problems in operation.

For one, the new design eliminates


Ultratech counts on Culligan ultrapure R/O water for precision manufacturing

Water purity is an absolute must for Ultratech of Santa Clara, California. Their only business is the manufacturing of photo masks for integrated circuit production. Even the smallest impurity in the emulsion can cause rejection of the end product.

So Ultratech relies on a Culligan-designed system to prevent any impurities from endangering this precise manufacturing process. Included is filtration, softening, deionization, reverse osmosis, ultraviolet light sterilization and submicron filtration.

The importance of this system is pointed out by Ultratech's emulsion production manager, David Lee. "Any serious problem with the quality of our water could possibly cause us to lose a valuable customer, not just a few rejects."

Culligan even installed conductivity monitors to make sure quality water standards are maintained. And a Culligan dealer is always nearby to handle emergencies at once.

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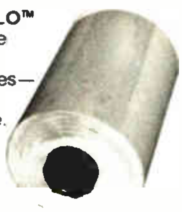

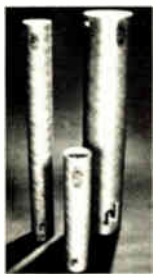

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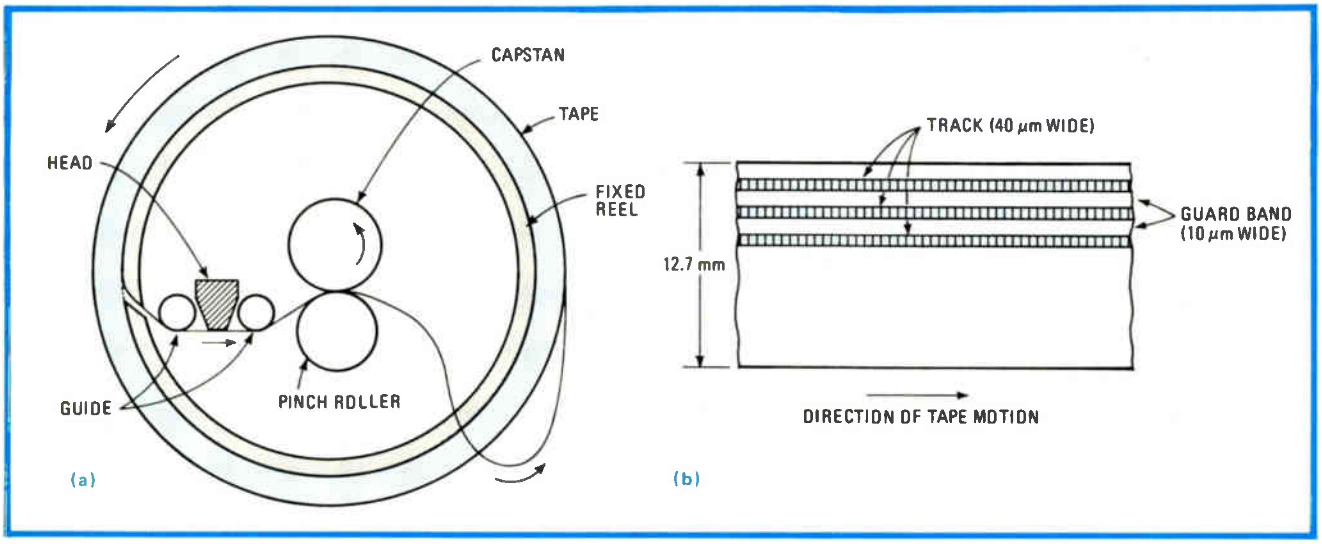

Endless. Toshiba's experimental VCR feeds a continuous loop of tape into the center cavity containing the head and the pulling mechanism (a). The tape contains the equivalent of 220 tracks (b), for a tape consumption comparable to that of present consumer VCRs.

the switching transients that occur between TV fields in the helical-scan units. Thus, it is suitable for recording other types of high-frequency signals in addition to video.

For another, changes in tape speed do not present the tape-tracking difficulties associated with the other designs. Thus variable speeds, as in audio recorders, are possible for other applications.

The 100-meter loop of tape has a continuous recording track that yields a long playing time—about one hour—despite the high tape speed. In operation, the tape is pulled through a slit in the stationary reel into the central cavity by the capstan and the roller (see figure). After gliding past the head and between the capstan and the roller, the tape loops over the reel and winds onto its outside.

Gentle. A mere 30 grams of tension—slightly more than 1 ounce—is sufficient to pull the graphite-lubricated tape from the reel, making it possible to use a pressure-sensitive-tape splice in the experimental units. Because the pull is straight, no distortion of the tape occurs, which is possible with the schemes used in continuous-loop audio systems. Also, since there is almost no tension at the take-up point, no damage occurs there either.

Further, the head is flanked by two guides that have ridges to fix the height of the tape, and the shortness of the distances between these elements reduces any tendency of the tape to vibrate—a common problem of helical-scan units. Therefore, the complex stabilizing mechanisms of the latter are unnecessary.

Head up. Elevating the head by means of a stepping motor results in a recording track that winds around the tape 220 times with a total width of 50 micrometers. Since the tape width is 12.7 millimeters (1/2 inch), an ample margin is left at the two edges. Each turn of the track has a playing time of 16 2/3 seconds.

The track is parallel to the edge of the tape except for a portion that curves during the 20 milliseconds that is required to change the head elevation at the end of each turn. This curve occurs at the splice, which is detected by an optical sensor (not shown).

The head can be shifted vertically, and a complete traverse of the width of the tape takes 4.4 seconds. This permits material at any point on the tape to be accessed in a maximum of 21 seconds. In contrast, rewinding or fast winding of a helical-scan cartridge averages about 3 minutes.

The recording format is conventional except for the audio track. This track is recorded as an audio signal along the edge of the tape in other video tape recorders, but that is clearly not possible with this unit.

Instead, the audio signal is recorded as an fm signal with a carrier frequency of 1.5 megahertz and a deviation of ±100 kilohertz and is multiplexed with the luminance signal, which is an fm signal in the 3.9-to-5.4-MHz range. The chroma signal is translated down to a 688-kHz carrier—which is common in VCRs.

The track width of 40 μm is somewhat wider than the approximately 29 μm of long-playing VHS and Betamax units, but it seems good for an early prototype. On the other hand, the 10-μm guard band—in contrast to the lack of guard bands in the latest two-headed helical-scan units—is inevitable because azimuth shift is not possible with a single head. Still, the 1.27-m^2 area of tape per hour of playing time is very close to that of extended-play consumer units and in fact is better than that of the regular-play ones.

Longer. Although playing time of the prototype is only 61.1 minutes, Toshiba engineers say that they have successfully loaded 200 meters of tape into a standard cassette for 2 hours of playing time.

Elimination of the helical-scan mechanism has enabled Toshiba engineers to reduce the weight and size of the unit to about half those of consumer recorders. The area of the cassette is about midway between those of Betamax and VHS cassettes,

and its height is 40% greater. It may be possible, though, to twist the tape somewhat and cut the height without degrading performance. □

West Germany

Magnetically soft alloys are strong, too

Magnetic softness and high mechanical strength, both desirable properties for the materials used in everything from transformers to relays, are seldom found together in metals with a crystalline structure. A metals producer in Hanau, West Germany, has therefore found a way to make them with an amorphous structure.

The Vitrovac group of amorphous metals was developed by Vacuumschmelze GmbH, a subsidiary of Siemens AG. Their magnetic softness means that the materials can be easily magnetized even at high frequencies; and their mechanical strength translates into good dimensional stability, high elastic limits, and high resistance to wear and abrasion. In contrast, conventional magnetic materials are either soft magnetically and mechanically not very strong or magnetically hard with good mechanical properties.

Soft. Magnetically, the Vitrovac materials have not only a high maximum permeability, with values of better than 500,000 easily obtainable, but also a low coercive force of less than 10 milliamperes per centimeter and high saturation induction values ranging from 0.6 to 1.2 tesla. Further, the magnetic hysteresis losses are lower than those of comparable magnetic materials such as Permalloy and silicon iron.

Mechanically, the Vitrovac group has a tensile strength better than 3,000 newtons per square millimeter—comparable to that of high-quality steel. In addition, the materials have high elastic limits and are insensitive to rough handling, even to sharp bending.

As for electrical characteristics, the temperature coefficient of the materials' resistivity can be set at between −100 parts per million per Kelvin and +500 ppm/K simply by changing the composition of the materials. The resistivity is from two to three times higher than that of crystalline magnetic materials.

Handy. These properties will come in handy in many applications, says Hans Warlimont, the project manager for Vitrovac. The materials' high saturation induction, he points out, will make it possible to design smaller inductive components. The high resistance to wear suits them for use in magnetic pickup heads for, say, tape recorders, while their low magnetic losses should benefit transformer cores.

Furthermore, their dimensional stability and elasticity should make them popular for magnetic shielding devices, because, unlike conventional high-permeability materials, they do not lose shielding properties in response to the bending forces common in this application.

Cooling. Vacuumschmelze squirts a fine stream of melt onto a rotating drum to form strips of magnetically soft yet strong amorphous material. The induction coil around the tube heats the melt.

The new materials are alloys of iron, nickel, and cobalt in varying proportions, plus nonferromagnetic metals like chromium and molybdenum. Additives such as boron, silicon, phosphorus, carbon, or aluminum help impede crystallization.

Chilling. To obtain an amorphous structure, the mixture is melted and then cooled at a rate of about 1,000,000 K per second. To cool it that rapidly, Vacuumschmelze uses a melt-spin process, which squirts the melt through a tiny nozzle onto a fast-spinning drum (see photo). Upon contact with the drum, the thin stream solidifies so suddenly that crystallization cannot take place and the desired amorphous structure is obtained instead.

Because the drum rotates, the melt solidifies in the form of thin strips, typically from 20 to 50 micrometers thick, depending on the drum's rotational speed and the melt's flow rate. These strips, which are from 1 to 25 mm wide, may then be mechanically compressed into small blocks.

Generally, amorphous metals can be made only in strips not much thicker than 50 μm. Any thicker, Warlimont explains, and the heat transfer from the strip's interior to its surface during cooling would take too long, resulting in a crystalline structure. In addition, the material's amorphous state is maintained only up to a certain crystallization temperature, which may be anywhere between 300° and 600°C, depending on the composition of the material.

The result of a three-year development effort at Vacuumschmelze, the two or three kinds of Vitrovac materials will be offered in small amounts beginning in April, Warlimont says. As production increases, larger quantities and more types will become available.

It is too early to talk about prices, Warlimont says, but the cost should be low. This, he points out, will result from large-scale production of strips directly from the melt in just one fairly simple and fast step. Also contributing is the relatively low cost of most of the raw materials. □

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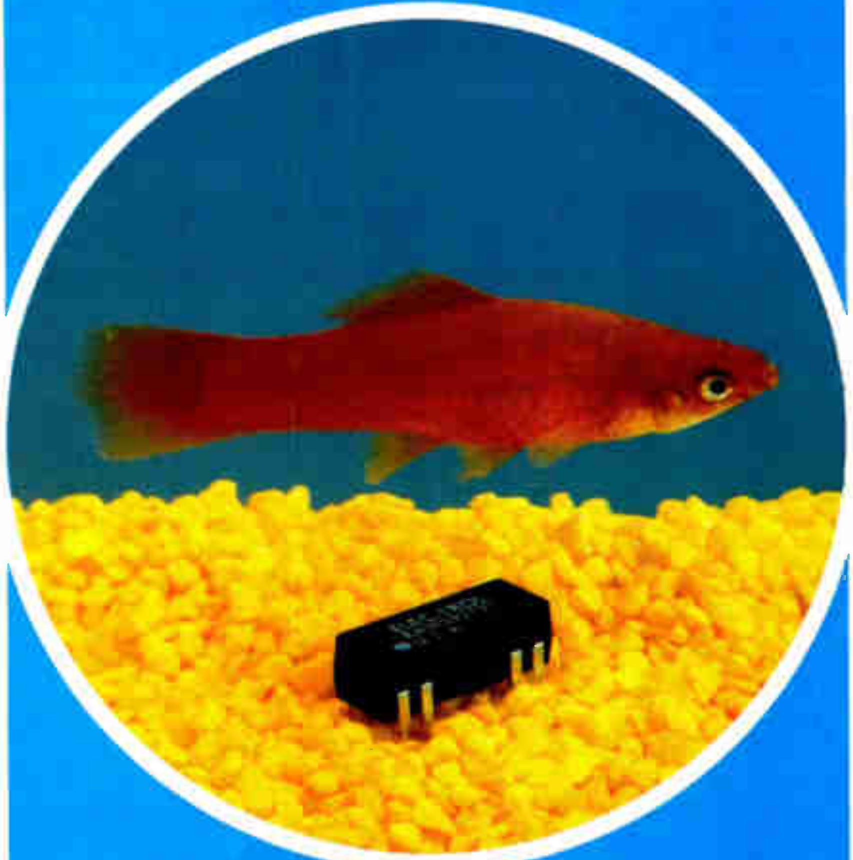

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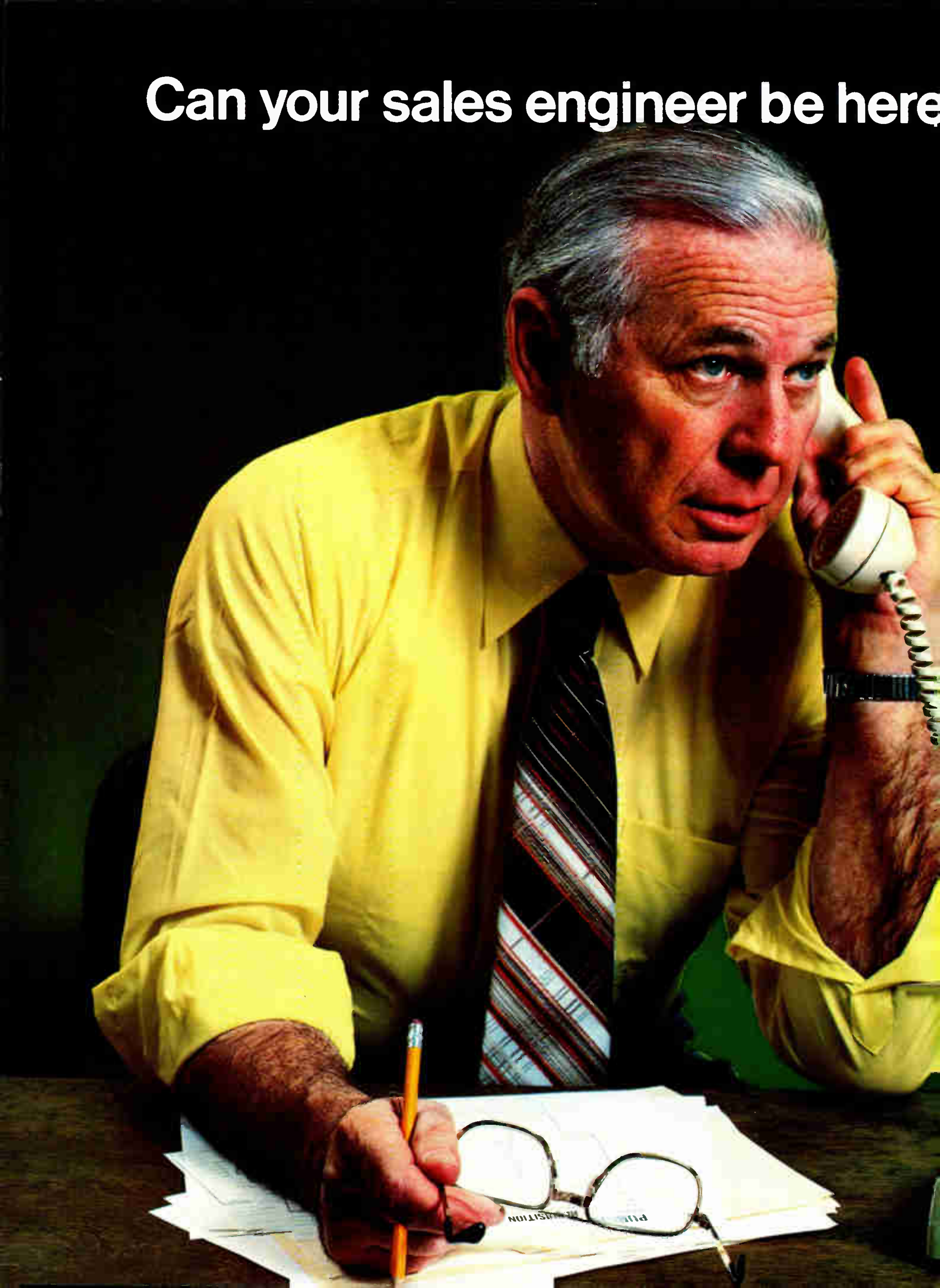
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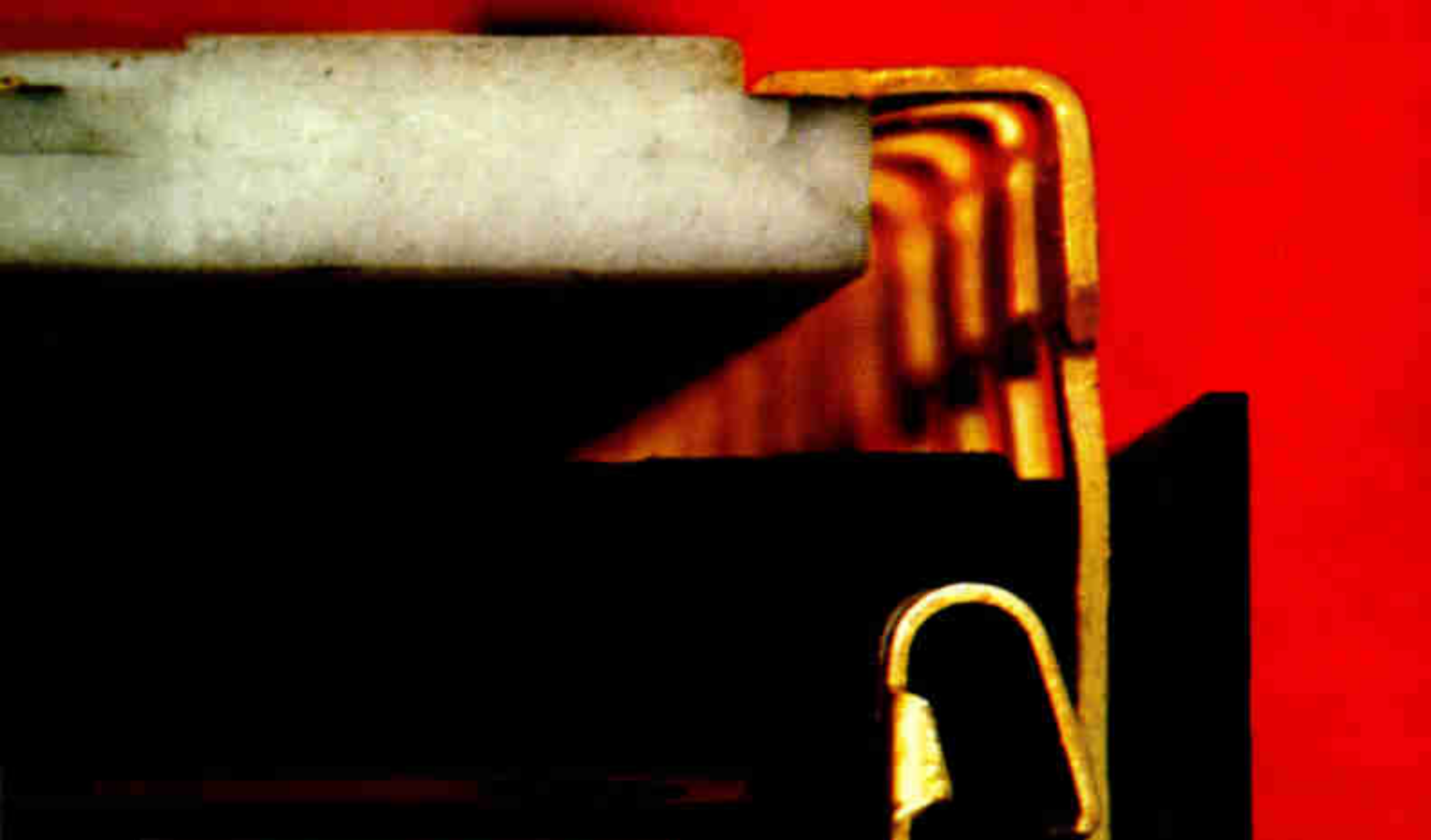

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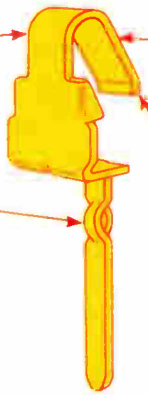

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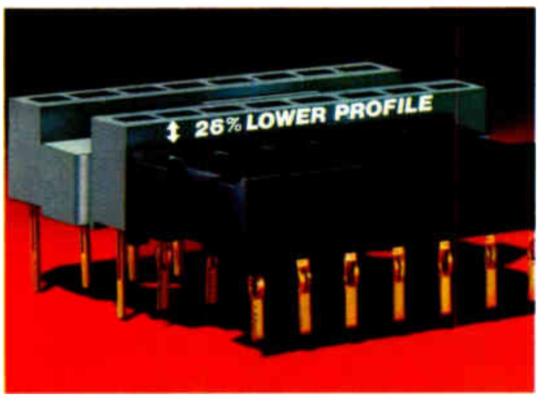
Surprisingly, a **low profile** (.150" high) DIP socket is a different breed of cat when it comes to engineering in contact reliability. Most standard DIP sockets have dual contacts. (R-N's dual "side-wipe" contacts are among the most reliable in the industry.) But, when you **shorten the contact length** to achieve the "low profile" you lose a great deal of contact force and IC retention strength. So, to achieve effective low profile socket reliability you must **redesign the contacts** and make them out of the **strongest contact material available.**

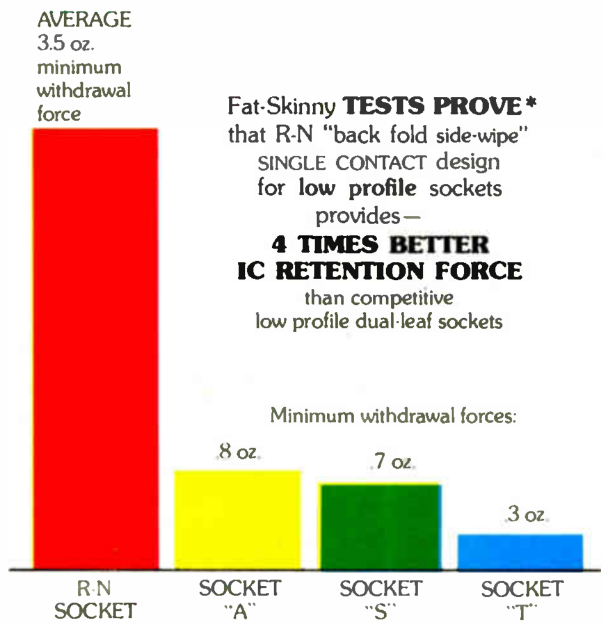


Low .150" profile of ICL socket reduces board density by 26%.

Fat-Skinny **TESTS PROVE*** that R-N "back fold side-wipe" SINGLE CONTACT design for **low profile** sockets provides—

4 TIMES BETTER IC RETENTION FORCE

than competitive low profile dual-leaf sockets



* In "Fat-Skinny test," withdrawal forces are measured using the smallest size (.008") lead after insertion of largest size (.012") lead.

Representative NORMAL FORCE Test Scores for 10 R-N ICL low profile sockets

TEST SOCKET	NORMAL FORCE *
1	410 grams
2	465 grams
3	480 grams
4	465 grams
5	395 grams
6	425 grams
7	465 grams
8	395 grams
9	410 grams
10	425 grams

AVERAGE – 430 grams

This force is 4 to 5 times greater than average dual contact socket NORMAL FORCE

* NORMAL FORCE means force perpendicular or at right angles to IC lead. The single ICL contact exerts this kind of force against the IC lead when inserted into the socket.

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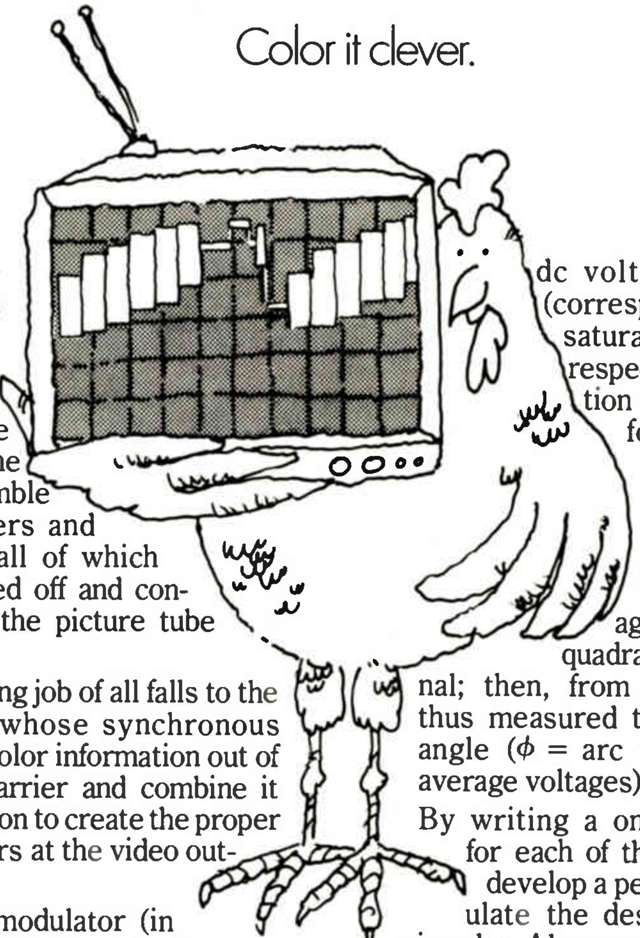
No. 10 in a series.

The chroma generator

Color it clever.



Converting a color television signal into a screen full of "The Muppets" is only slightly less complicated than unscrambling an egg. The rf signal appearing at the receiver front end is a jumble of modulated subcarriers and synchronizing signals, all of which must be delicately picked off and converted into information the picture tube can handle.

The toughest unscrambling job of all falls to the chroma demodulator, whose synchronous detectors must pull the color information out of a phase-modulated subcarrier and combine it with brightness information to create the proper mixtures of primary colors at the video output stage.

To test the chroma demodulator (in today's TV sets, integrated circuits), it is necessary to apply a modulated test signal at the appropriate subcarrier frequency and then accurately measure a number of phase-sensitive output voltages at the device output.

In practice, most of today's chroma demodulators are tested on Teradyne J273 Linear IC Test Systems equipped with a "chroma generator" specially designed to develop the convoluted waveforms that are required. The output of the chroma generator's output consists of 16 segments, each of which is programmable in time, dc level, and subcarrier level. In addition, three separate "event" outputs can be programmed to provide keying pulses wherever they are needed. Finally, a gated voltmeter can be programmed to measure, in any given segment, dc voltage, ac voltage, or phase (corresponding to brightness, color saturation, and color information, respectively). Since color information is actually transmitted in the form of phase angles, phase measurement is especially critical in chroma testing.

The chroma voltmeter is more than equal to the task. First it measures the average values of the in-phase and quadrature components of the signal; then, from the ratio of the two values thus measured the voltmeter derives phase angle (ϕ = arc tan of the ratio of the two average voltages).

By writing a one-line software instruction for each of the 16 segments, the user can develop a periodic waveform that will simulate the desired range of chroma input signals. Also under software control are a number of other variables, including voltmeter operating modes, subcarrier frequency and amplitude, and scale factor and attenuation of the video waveform. Test procedures differ for the American and European systems (NTSC and PAL), and this choice is also made in software.

Thanks to the J273 and its chroma generator, today's chroma demodulator can be rigorously tested on the production line in well under a second. The story doesn't end there, of course, for device designers are now busy adding more circuits to the same chip, while Teradyne's linear-test engineers are just as busy developing new automatic test techniques.

After all, once you have unscrambled an egg, why not build a hen?

TERADYNE

Alphas stymie statics

Research in soft-error phenomena reveals new alpha particle mechanisms and indicates certain static designs may be susceptible

by Raymond P. Capece, Solid State Editor

One semiconductor giant has assigned it top priority. Another has built a special memory-test system for it. And a third brought in 20 tons of lead to research it. "It" is the soft error effect in memories caused by alpha particle radiation.

Bad enough that the problem was uncovered in dynamic random-access memories and charge-coupled devices [*Electronics*, June 8, 1978, p. 42]; now evidence shows that those gremlins can also attack static memories. To complicate the situation, memory makers cannot agree on the importance of the problem.

At a conference last year, a question from the audience about alpha particle errors in statics brought a roar of laughter. But when Richard D. Pashley, head of static memory design at Intel Corp.'s Aloha, Ore., Memory Products division, mentioned the effects of alpha particles on his company's forthcoming high-speed 16-K static, he was deadly serious: "We haven't compiled any figures yet," he said at the International Solid State Circuits Conference in Philadelphia last month, "but alpha-particle hits have affected data in our 16-K RAM."

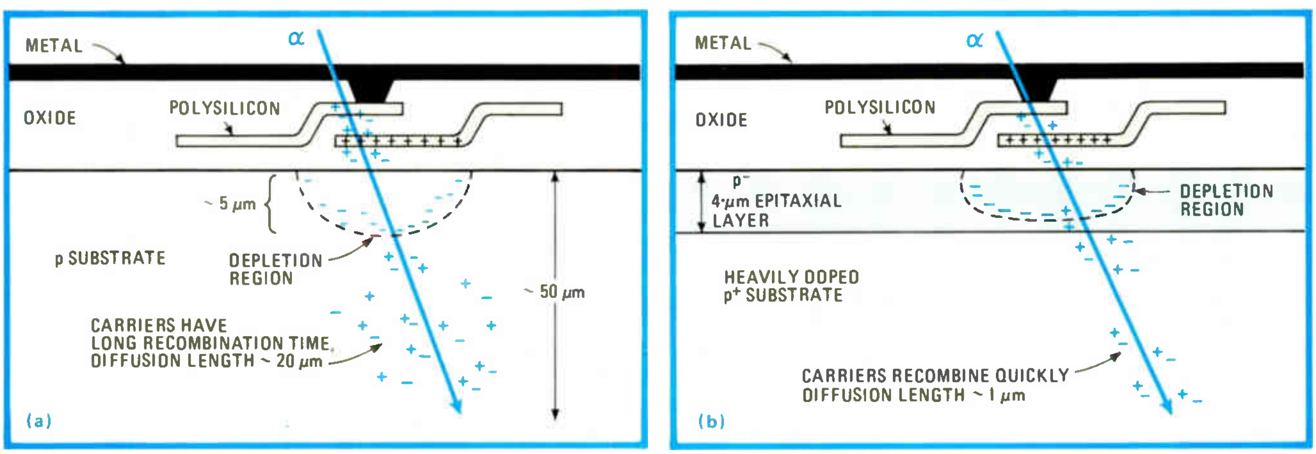
Pashley's revelation had to do with the fact that the 16-K part was Intel's first production static designed with polysilicon load resistors. The memory cells of most statics are flip-flops, which can be built with either six or four transistors and a pair of load resistors; alpha particles bother only the polysilicon-load designs. The tiny current normally flowing through the load can be overpowered by the charge flow that occurs when an alpha particle hits—and the result is that the flip-flop gets flipped.

Consequences. Several memory makers have switched to the polysilicon resistor in the past few years to reduce chip size and power dissipation over six-transistor designs. The polysilicon loads can cut power dramatically, but if that resistor is too large, the RAM falls prey to alpha radiation.

The developer of polysilicon loads, EMM Semi Inc., Phoenix, Ariz., which has five years of experience with the resistors, smells a red herring: "We found the problem years ago and licked it," claims John Hartman, product development manager at EMM Semi. "By bringing it up, Pashley may be making trouble for the whole static-memory industry," he charges.

Hartman says that EMM Semi makes its parts alpha-immune by limiting resistor values. "We hold loads in the lowest power parts to 50 megohms and in the highest speed parts to 1 megohm," he explains.

To many memory makers, low-power parts have been a particular problem. To reduce power, some chip makers resorted to undoped polysilicon resistors that squeeze current down to a few picoamperes. Mostek Corp., Carrollton, Texas, had problems with its 4104, the lowest-power 4-K static on the market—it seems the difficulty was with the part's 2-gigohm load resistors—



Alpha blues. Research on alpha errors in dynamic RAMs reveals problems beyond those in (a), where 1s flip to 0s. Bit-sense lines are also vulnerable, and alphas can even attack static RAMs. Good news: RAMs using an epitaxial process (b) may reduce soft errors by 100 times.

and, says Darrell Rinerson, senior product engineer, Mostek has since had no alpha-radiation problems with other 4-K parts; nor have any cropped up with the company's 4118 8-K statics. "But it has not yet been determined whether soft errors will be a problem with 16-K statics," he warns.

High-speed trap. To date Texas Instruments Inc. makes only moderate-speed 4-K statics with poly loads. According to Dick Gossen, manager of MOS memory development, alpha particle problems do not yet exist, though he expects some changes: "We haven't seen soft errors yet, but I'm sure we will."

Gossen worries that the high-speed designs of future statics will be susceptible to radiation. "One way to boost speed is to reduce the voltage swings of the flip-flop; with the states of each half of the circuit separated by only a volt or two, the margins will get uncomfortably close." This may in part be why Intel's 16-K part, which aims at a 55-nanosecond access time, encountered difficulty.

Coincidentally, the same mechanism by which alpha particles affect statics has produced previously unexplained errors in dynamic devices. At first it was believed that the main cause of soft errors in dynamic RAMs was alpha particles coming to rest near charge-storage wells. The alphas crash through the silicon, producing numerous electron-hole pairs—a million or so—that are swept by the electric field to fill potential empty wells. This action changes 1s to 0s.

New evidence, however, indicates that alphas stopping near bit-sense lines are really the major culprits. (Statics, too, have bit-sense lines that can be susceptible to alphas.) "If only wells were involved, the errors would show as 1s becoming 0s," explains Intel physicist Timothy C. May. "But we see a significant number of 0s becoming 1s."

The discovery led Intel to try to find new solutions, mostly through the use of "cooler" (more radiation-free) packaging material. "Even with package material that's one tenth as radioactive as today's," cautions May, "a 64-K dynamic RAM built simply as an extension of 16-K rules will have significant soft-error problems."

Intel's newest approach involves timing on the bit-sense lines. According to physicist May, the charge would have to be collected on the sense line during the brief period—about 10 to 40 nanoseconds—when the line is essentially floating or in a high-impedance state, making the source of error dependent on the chip's cycle time. Intel's tests on 16-K dynamic RAMs have indeed confirmed that soft errors increase with increased cycles.

Use the dependency. Thus, says May, designers should take advantage of that cyclic dependency in the sense lines. "Shortening the time the sense lines are floating, as well as making changes in the layout of the lines, will significantly decrease the error rate," he declares.

Of course, it's all a percentage game, and coupling May's design techniques with others should stave off radiation. "If you include error-correcting memory system designs, then the alpha particle problem will definitely be under control into the next generation of dynamic RAMs—the 256-K chip," Mostek's Rinerson maintains.

To muddle the situation further, however, some new data on alphas has been compiled by Bell Laboratories. At a meeting before ISSCC last month, D. S. Yaney and J. T. Nelson of Bell Labs, Murray Hill, N. J., revealed that the troublemaking electron-hole pairs produced by the particles, which travel 50 micrometers or more through silicon, recombine within as short a distance as 1 μm in a heavily doped region. That news elated Bell, since it builds its dynamic memories with an epitaxial process that puts a thin (4-μm) p^- layer on top of a p^+ substrate. Bell's findings: a soft error rate one-hundredth that of industry-standard RAMs.

The news also excited T.J. Rodgers, manager of the memory department at American Microsystems Inc., who developed AMI's V-groove MOS—which also uses an epitaxial process. "V-MOS just might be inherently less susceptible to alpha particles, but I've got a bit of experimenting to do before I'll be able to find out for sure," Rodgers says.

Packaging materials still play the most important role in securing minimal-error devices. "At the very high end of the radiation range of packaging materials we're getting a probability of two alphas per refresh cycle per cell and the likelihood of very high error rates," Intel's May explains.

Ceramic materials are an Intel target. "Even though they may be cooler than other materials in the package, most of the dice area is exposed to the ceramic," he explains. Intel's May claims that Japanese ceramics are running cooler than those from the U. S.

Many manufacturers and users believe the alpha particle problem is inflated. "There are many other sources of soft errors," says one MOS marketing manager, "like power-supply fluctuations and all kinds of system noise; alpha radiation is just one small part." A failure is a failure, however, and memory makers are finding their image at stake. Customers might even begin to specify a maximum allowable soft-error rate on the chips they buy. The gravity of the problem is indicated, though, by the papers to be given at the International Reliability Physics Symposium in San Francisco on April 24–26: at least a half dozen will focus on alphas.

Changing needs. Therefore, MOS memory makers now realize that new test and measurement equipment as well as new techniques will be needed to sell RAMs. Chip manufacturers must be able, for example, to measure radioactivity down to flux values lower than 0.1 alpha particle per square centimeter per hour to isolate the coolest packaging material.

At first, Intel was counting alpha particles directly with various scintillation counter schemes, finally settling on one that was 75% to 80% efficient and had resolution of 0.01 alpha per square centimeter per hour. May says now that better resolution can be achieved by counting gamma radiation from high-energy sources and then by extrapolating back to obtain a picture of the alpha radioactivity. □

Microcomputers

Chip, mini makers squaring off

While computer companies are slicing silicon, semiconductor houses are boxing systems and selling software

by John G. Posa, Microsystems & Software Editor

Digital Equipment Corp. in effect puts its PDP-11/34 central processing unit onto a single board. Data General Corp. announces a new microNova chip as well as two new computer families that triple the performance of previous microNova products in less than a third the space [*Electronics*, March 1, p. 182]. And semiconductor houses like Intel Corp. are bullish on 16-bit devices and related software.

What's behind these role reversals in the world of microcomputers? Some competitors say they are not significant—that markets are and will continue to be clearly segmented into well-defined slots for the minicomputer companies and the chip makers. Others, however, contend that a real battle over markets is in store.

These markets have been traditionally separated for a variety of reasons. For one, the chip makers have just recently begun to move their devices and board products into the 16-bit minicomputer arena. But other factors, including type of user, software support, peripheral products plus service and distribution channels, not to mention expertise in large-scale integrated circuitry, have also kept the two sides apart.

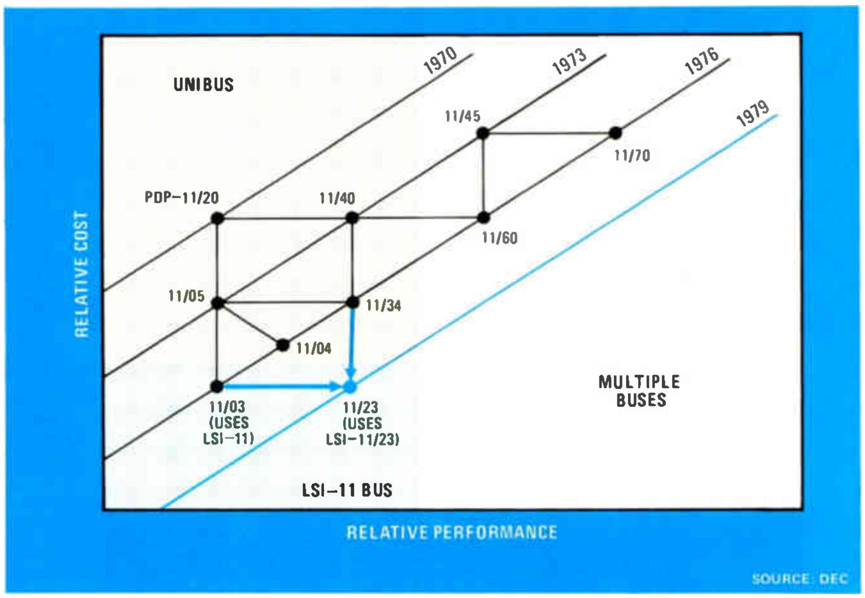
With the advent of 16-bit devices, these distinctions are blurring. Silicon houses are getting more aggressive with chip and board performance and software support. Indeed, at least one promised part, the M68000 from Motorola Microcomputer Group in Austin, Texas, will sport numerous 32-bit attributes. Soon after the devices are introduced, they are incorporated onto board computers by the chip makers themselves.

The iSBC 86/12, a 16-bit CPU board from Intel Corp., Santa Clara, Calif., is nothing for the mini makers to scoff at. It features a dual-port RAM and an architecture well suited for master-slave configurations. Meanwhile, in the past year, Zilog, an Exxon affiliate, Cupertino, Calif., announced Cobol, Fortran, and Basic for its Z80 processor; later this year, it will also support Pascal. This is quite an arsenal of applications languages for a semiconductor company.

Switching. On the other hand, the integrated circuits being produced by some of the minicomputer manufacturers in their own fabrication plants are both sophisticated and competitively priced. Data General of Westboro, Mass., has microNova chips that execute the 16-bit Nova instruction set and have hardware multiply and divide. DEC of Maynard, Mass., is also toying with selling its new chip set, created with n-channel polysilicon-gate depletion-load MOS technology—not unlike that used by Intel, for example, to make its 8086.

"Minicomputer manufacturers have backed down on some of their policies," comments Ed Zander, marketing manager for microproducts at Data General. "We are making chips. But the chip makers are doing things differently now too—they're designing a lot of software and they're licensing it."

Clearly the minicomputer manufacturers are not going to scale down to 8 bits. That is a high-volume, second-source business that they want no part of. The competition, if



Down and over. The LSI-11/23 16-bit microcomputer can execute programs two to four times as fast as earlier LSI-11s and is 90% as fast as the PDP-11/34.

Inside the LSI-11/23

With DEC's LSI-11/23 comes a number of product announcements [*Electronics*, March 1, p. 34]. The heart of the system is a 16-bit central processing unit called the KDF11-AA. But also involved are a multifunction board, a universal programmable read-only memory board, an erasable-PROM/PROM/ROM board, and a low-cost mounting chassis with power supply included.

The CPU board, designed for the LSI-11 bus, uses three new custom DEC chips. Two of them, for data and control, implement the basic processor. They are both in one 40-pin dual in-line package. The data chip takes care of math and logic functions, address- and data-bus transfers, and most interchip communications. The control chip contains the control store ROM; it sequences through the microprograms.

The third chip is a memory-management unit (MMU). It makes available two multiuser software modes (kernel and user), ups the addressing range from 16 to 18 bits (64 to 256 kilobytes), allows more than one program to reside in memory at the same time, and protects resources.

With an optional double IC, 46 floating-point instructions (the same found on the PDP-11/34, /60, and /70) are also provided. This allows floating-point math to be performed 5 to 10 times faster than if written with basic instruction-set software. Because the routines are in microcode rather than a higher-level language, memory space is also conserved. The MMU contains the floating-point registers and accumulators, so it must be installed before this option can be used.

The multifunction board contains 8 kilobytes of ROM, 32 kilobytes of RAM, a crystal-controlled 60-Hz clock, and a serial input/output line for connection to a data terminal, mass-storage device, or the new PROM programmer. In conjunction with any LSI-11 CPU, this creates a compact and capable computing machine. The LSI-11/23 has the total functionality of the PDP-11/34. It is capable of running real-time, multitasking software during development and run time.

any, will occur as the silicon vendors grow up to meet the minis. "Microprocessors are basically applied in two ways," says Thomas Walton, marketing manager for microproducts at DEC. "One is for logic replacement, and the other is for data processing. We can apply minicomputer performance against the middle and upper ranges of microprocessors used for data processing, but we do not want to be in the logic replacement business."

"Our 16-bit boards are an extension of our existing Multibus-compatible product base as opposed to a scaled-down minicomputer," remarks Jim Lally, Intel's operations manager for microcomputer systems for original-equipment manufacturers. "There will always be some fractional overlap—people buying more capability than they need—but in general the market is cleanly segmented due to strategies that are totally different. For instance, our operating system is PROM-based—it resides in read-only rather than random-access memory."

Existing markets may be distinct. But new markets are always being created as the present ones expand, and it is not yet clear who will get that business.

Niche hunting. "There are application areas, like small business systems, where computing has been alien either conceptually or because of high cost," observes Charlie Bass, general manager of Zilog's system division. He believes that this market and others are still up for grabs. "We're looking at the way minicomputer people have handled their traditional marketing and distribution, and they're looking at the technology," he says. "We're converging and it's going to be head to head."

The migration by the chipmakers into more powerful hardware really began with the advent of the development system. Bass feels the next step is to provide for multi-user interconnection "to begin doing some geographically distributed networking." Beyond that is the next generation of 16-bit processors. "When that product hits the street, the overlap will be even more dramatic," Bass contends. □

Communications

Military acts in digital Drama

The services are falling into line behind digital radios for both line-of-sight and tactical troposcatter units

by Harvey J. Hindin, Communications & Microwave Editor

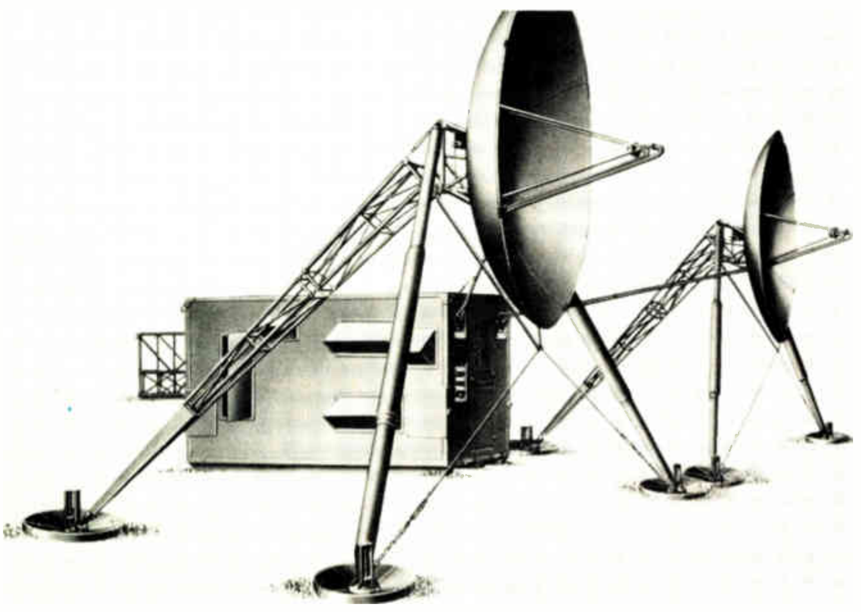
Military communications has come a long way since the 1850s when on a good day the U.S cavalry was able to use a sun reflector to send a message 125 miles without a relay station. That manual system used a Morse-like digital code and was easily encryptable.

Today the military is using digital procedures again and encryption is even more popular, though the equipment of course wears a modern uniform. Sometimes it is upgraded commercial equipment, like new digital line-of-sight gear; at other times it is custom-designed, like a new troposcatter system. In fact, military digital microwave radio equipment, more often than not, is the catalyst for advances in the commercial state of the art.

The swing to digital technology is due simply to the availability of inexpensive large-scale integrated circuits for system implementation. Perhaps even more important from the military point of view, digital coding makes for easier encryption than do analog procedures.

Compatibility. Just like any other organization with a substantial base of installed equipment, military services have to amortize their communications equipment over a long period. So, compatibility with existing equipment and cost-effectiveness is very much the name of the game.

Digital line-of-sight microwave radios are well-suited for interfacing to the overseas portion of the U.S. Defense Communication System (DCS) where U.S. Government-owned facilities are extensively used. Under the Digital Radio and Multiplex Acquisition program (Drama), the Army is responsible for acquiring suitable modified, commercially developed digital communications equipment. The acceptance criteria included achievement of desired performance, operational capability in host countries, and ability to operate in conjunction with other systems.



One of three. Depending on requirements, the military can choose from three different AN/TRC-170 troposcatter systems. This one has the maximum range—200 miles.

Drama. The first result of this effort is the Drama digital radio. This radio is expected to be tested in prototype form in 1979, go into production in 1980, and be installed first in Germany and Hawaii. It can handle a maximum data rate of 26 megabits per second using conventional multiplexing hierarchies such as the Bell System T1 standard.

Depending on the digital modulation scheme used, the digitization of radio channels doubles or even quadruples radio-frequency spectrum requirements compared to the equivalent analog frequency-modulation approach. Spectrum is therefore provided by agreement with the host nation, because bandwidth conservation is important. So Federal Communications Commission Dockett 19311, intended for spectrum control of high-capacity systems, was imposed on Drama since there were no applicable European standards at the time it was specified.

Again, keeping compatibility in mind, the radio system amplification was chosen to allow digitization of 90% of the existing fm links with no antenna reconstruction. The radios are being produced by TRW's Defense Systems and Space Group in Redondo Beach, Calif. and according to J. R. Mensch of the Defense Communications Engineering Center in Reston, Va., they will meet the

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Probing the news

requirements for digital line-of-sight transmission in the defense communication system for many years in the future. "The current anticipated production price for the radio is very compatible and competitive with the center's existing fm standard radio. Operation and maintenance costs, however, are expected to be considerably less," Mensch states.

The cost-effectiveness of the digital conversion is very good in this case. When this benefit is added to the radio's state-of-the-art capabilities in space and frequency diversity, ready interface with standard military KG-81 cryptographic equipment and low probability of failure (once per 100,000 hours), it's clear why Mensch is enthusiastic.

Troposcatter next. In use since the mid-1950s, the military's tactical troposcatter communications system is an analog design that is getting harder to maintain and "even if retrofitted can accommodate only very low data rates," says Walter J. Conner of the Raytheon Co. in Sudbury, Mass. To solve this problem, Raytheon developed the all-digital AN/TRC-170 troposcatter radio for the Tri-Service Tactical Communication Program (TRI-TAC).

This radio, in contrast to the older analog radio, which suffers performance degradation due to multiple propagation-caused time delays, can compensate for the delay. Available in three versions, depending on range (100, 150, or 200 miles), the 4.4-to-5.0-gigahertz radio achieves a bit error rate of 1 in 10^5.

The key to this performance, unheard of for a troposcatter radio, according to M. G. Unkauf of Raytheon, is a distortion adaptive receiver (DAR). This receiver minimizes modulator-demodulator blurring or intersymbol interference between adjacent or closely spaced data bits that the delay causes.

At the transmitter the data stream is gated to produce an off time between adjacent bits. If the effective duration of the multipath delay encountered in the troposphere transmission is less than the off time—a typical case—the pulses may be distorted, but the intersymbol interference will be small and the pulses will not overlap. Since the distortion effects change very slowly compared to the megabit data rate of interest, the received signal looks like a data stream of identically distorted, nonoverlapping data bits.

"The system was designed for multipath experimental data that was available to us," says Geoffrey Smith of Raytheon. "Typically, this means delays from 0.1 microsecond to 0.3 μs."

The receiver looks like an adaptive matched filter, which means that each received data pulse is multiplied by a receiver-generated replica or reference signal. The resulting product is then put through an integrating circuit that operates over the time duration of each pulse.

Examination of the sign of the in-phase and quadrature components of the result of the integration lets the final level—a 1 or a 0—of the data pulse be determined and reproduced. The advantage of the DAR approach is that it does not require sophisticated and expensive adaptive equalization—a signal-processing technique—at the receiver for intersymbol interference correction and yields near theoretically optimum performance anyway. Since the DAR is also quite suitable for digital implementation, it turns out to be another cost-effective solution.

The only problem, says Smith, is that the transmitter gating about halves the net transmitted power, causing reception problems. Raytheon therefore recovers most of the lost power by sending two signals at a time by means of two properly interleaved subcarriers.

Narrow. Some 99% of the transmitted power is confined in either a 3.5- or 7.0-MHz band around the carrier, so that spectrum utilization is minimized. The radio can handle up to 2.048 Mb/s and encryption can be readily provided by external, Government-furnished equipment. And it is all rugged—antenna wind-loading specifications call for operation in 115-mile-per-hour winds.

All three radios are under full-scale development; test units will be complete in a couple of months, says Smith. He anticipates service use in 1982 and gradual replacement of the existing analog radios. □

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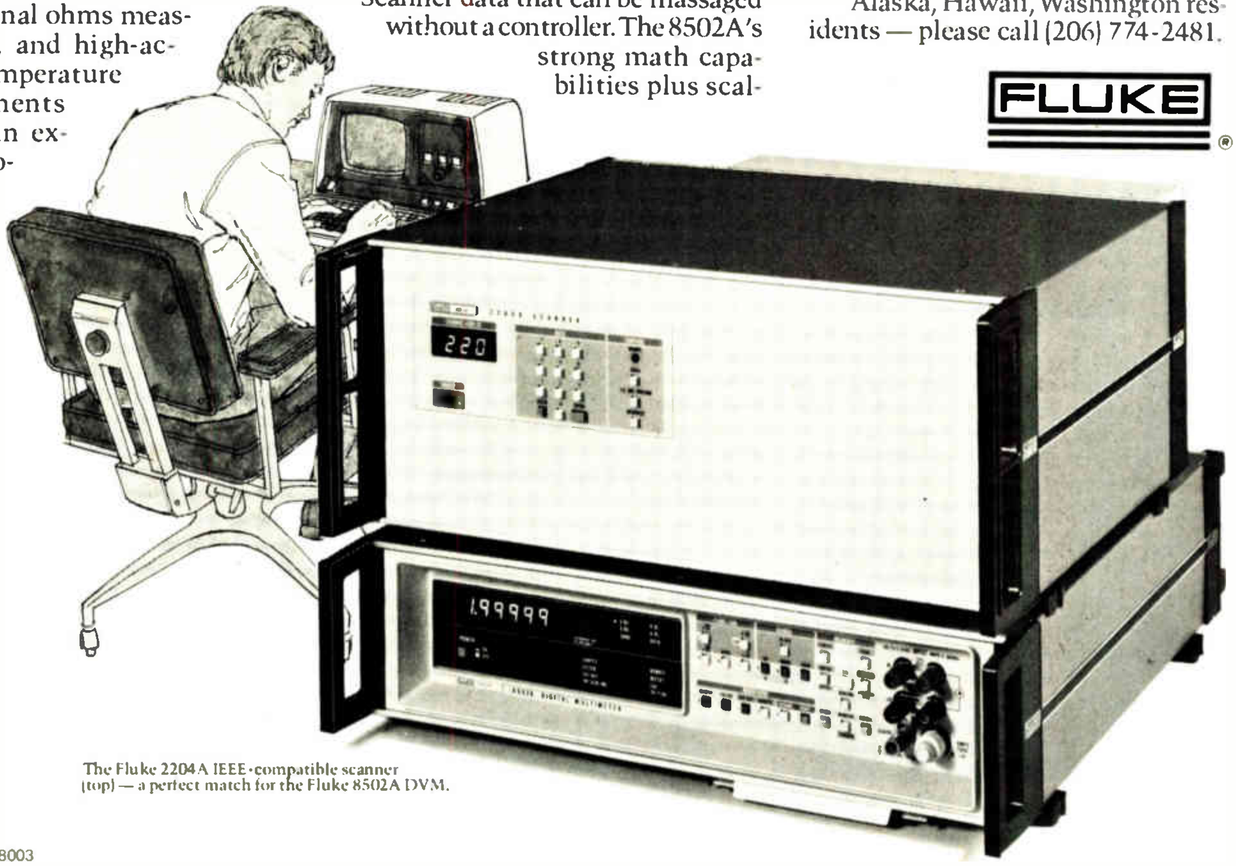

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Trade

Japan's markets less inscrutable

Although Japan is pushing exports and slicing imports, opportunities still exist for foreign firms, says report

by Ben Mason, New York bureau manager

Quick now, what country, a major factor in the worldwide semiconductor industry, is both a major importer and exporter of semiconductor products? There are two right answers: Japan and the U. S.

Furthermore, the countries are good customers of each other, says a statistics-laden report from BA Asia Ltd., an affiliate of the giant Bank of America. Yet this relationship is hardly static, it adds, for Japanese semiconductor makers are well launched on aggressive export drives, while imports into the country are starting to drop.

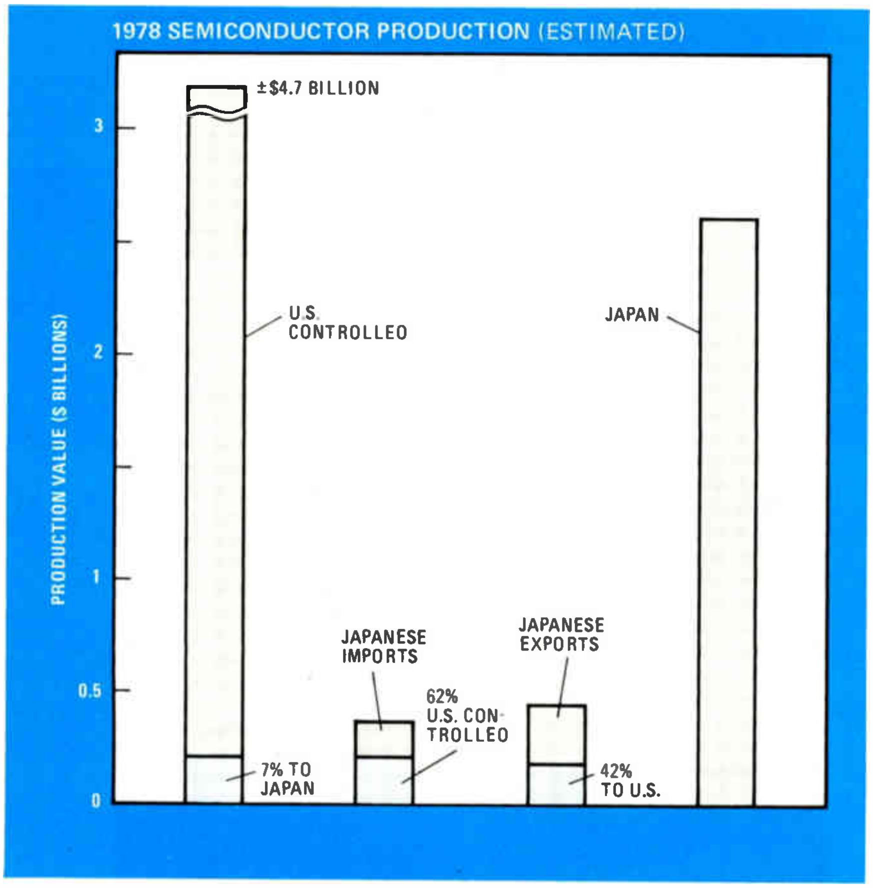
The report [*Electronics*, March 1, p. 33] surveys the prospects for every major electronics industry in Japan in coming to its conclusions. In sum, it says that, at least in the near future, there remain significant market segments open to U. S. semiconductor producers.

To reach that conclusion, Robert H. Silian, head of the Consultancy Group at Hong Kong–based BA Asia, and his co-workers took a hard look at where the Japanese producers are spending their funds for semiconductor research and development, both in discrete devices and integrated circuits. "Within the total spectrum of Japanese IC capability, there still exist certain areas that appear to be receiving relatively less emphasis and where imports may still represent an important resource," Silian says. These include:

- Monolithic and hybrid analog-to-digital and d-a converters, especially high-performance devices.
- Wideband, high-power radio-frequency circuits, hybrid or monolithic in type.
- Digital electronic tuning ICs for television receivers.
- Bipolar programmable read-only memories and metal-oxide-semiconductor erasable PROMs.
- Nonvolatile random-access memories and electrically erasable ROMs.

However, these opportunities will replace lost Japanese market sectors for foreign semiconductor makers, who will also face increased competition for their traditional markets from Japan. Exports already outrank Japanese imports (see chart) and are rising at about a percentage point a year as imports drop sharply from 20% of domestic production in 1974 to perhaps 14% in 1978.

The exchange between the two countries consists mostly of high-technology items; in fact, the U. S. had an estimated 19% of the Japanese IC market and only 2% of the discrete market. Similarly, IC exports to the U. S. are high-technology items, like 4,096- and 16,384-bit RAMs, and they are climbing from



Giants. The world semiconductor industry is dominated by the U. S. and Japan, with over 50% and 30% of total production, respectively. Each buys from and sells to the other.

34% of the 1977 IC exports to perhaps 40% in 1978.

The future. With price competition less of a factor in Japanese purchasing decisions than in the rest of the world, the report anticipates domestic semiconductor makers will stay competitive with the foreign competition as long as the exchange rate does not reach 160 yen to the dollar, which Silian's group thinks unlikely. Moreover, the growth areas for ICs—computer, communications, industrial, etc.—are precisely those that the strongest Japanese producers can best serve.

Also, the Japanese semiconductor industry is in the midst of an ambitious effort to upgrade Japan's computer technology, with the VLSI project [*Electronics*, June 9, 1977, p. 99, and Nov. 23, 1978, p. 119]. The immediate aim of the very large-scale integration project may be superpowerful computers, but there will be quick fallout into other electronic areas.

Concentration. The report points out the obvious reason: the traditional major electronics manufacturers in Japan seized the IC lead there and have no intention of dropping it. Thus the top IC makers tend to be the leading computer makers, as well as being the leading manufacturers of telecommunications equipment, consumer electronics, and the like. (It adds up to a 30% share of the $9 billion 1978 free world consumption of semiconductors—and hardly a percentage point of that went into military products.)

One result is that the top five semi producers make 66% of the sales, while at the same time using probably 60% of the total production. Although the Japanese semiconductor market is slowly moving out of its captive status, buyers still tend to patronize the home teams.

Given the strong vertical and horizontal concentrations of the Japanese electronics industries and the "Buy Japanese" policies, foreign producers always have had their work cut out for them. Moreover, the turn toward outside purchases will tend to provide a mutual strengthening of the semiconductor makers, as well as whetting their appetites for foreign markets, the report says. □

Components

Why Europeans are on edge

Getting ready for the annual Paris components show, parts makers are troubled by uncertain business in the second half

by the European editors of Electronics

As always, the stands at the annual Salon International des Composants Electroniques at the Paris fairgrounds will be laden with new hardware this year. But, more than ever, the thousands of components buyers and sellers who flock to the April 2–7 show at the Port de Versailles on the outskirts of Paris will come for a view of what is ahead in components markets, as much as for a look at the wares to be displayed by more than 1,300 companies.

The reason for the sense of urgency is uncertainty concerning the last half of the year, although business will not be at all bad during the first six months in the $8.7 billion components markets in Western Europe. There is nevertheless uneasiness about the turn world business may take if the oil shortage persists. Then there is the nagging problem of unemployment throughout Western Europe. That problem will be compounded by inflation, particularly in Great Britain and Italy. The dollar is another source of apprehension; when it slides, the prices of U.S. suppliers decline.

But particularly worrisome to components suppliers are the big piles of unsold color-TV sets in West Germany, and the most anxious group at the show will be those doing a good part of their business with set makers. Sooner or later the glut in West Germany will put pressure on components markets in neighboring countries as suppliers try to offset their slowing deliveries to German set makers. Purveyors of professional-grade parts, in contrast, are likely to do well.

"There is an increase in defense spending everywhere," says Peter Fredholm, sales manager of Sivers Lab AB, a Swedish company in the Philips Gloeilampenfabrieken group. "The trend has been good for the last three to four years and it is still good," he adds. Telecommunications producers and computer makers are doing well, too, so there will be some semiconductor high fliers.

Flocking. Like last year's show, the components exhibit in Paris, April 2–7, should draw a large turnout of European shoppers.

Although it is truly international, with wares from some 30 countries on the stands, the Components Show has heavy French participation. And for that reason optimism may seem high to visitors from across the Rhine or the other side of the English Channel. Unlike the Germans, the French are fairly far from a saturated color-TV market. At the end of 1978 only about a third of the country's nearly 19 million households had color sets. Sales this year will probably reach 1,650,000 units, up about 8% over last year's 1,532,000.

Computers selling well. What's more, the computer sector is running particularly strong. The flagship "French" computer company, CII-Honeywell-Bull, for example, bounced up its sales by nearly 18% last year. The backlogs of companies like Thomson-CSF and Electronique Marcel Dassault, world-class manufacturers of professional hardware such as radars, avionics, and broadcast equipment, will keep them good customers of components suppliers through the year. The same goes for producers of telephone switchgear.

And there is a good chance that French components suppliers can do as well this year as last. Then, according to the trade association for active and passive components, sales ran some $1.865 billion (calculated at the rate of 4.25 francs per dollar). That is close to 14% above the $1.637 billion for 1977.

French semiconductor suppliers outperformed the averages, lifting their sales figures last year by nearly 19% to $457 million. And it could happen again. So far this year the book-to-bill ratio for Thomson-CSF's

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Circle 97 on reader service card

Probing the news

Sescosem Semiconductor division has stayed above one, reports Guy Dumas, who runs the division. But Dumas will keep a close watch on the far side of the Rhine.

West German stall. As they stroll through the stands, West German components people will be mulling over the flip-flop in their home market. Once it was the set makers who kept them riding high. Now the strong demand comes from producers of industrial equipment. A turn for the better, say suppliers of state-of-the-art semiconductor devices. Meanwhile, these are tough times for companies trying to sell passives, electromechanical devices, and picture tubes. And no one expects it to get better soon. There is a stock of more than 500,000 color sets waiting for buyers in producers' warehouses.

As set makers consume about half the components sold in the country, the troubles with TV mean "a contraction of demand for semiconductor products from the entertainment sector by more than 10%," says Fritz-Georg Höhne, director of worldwide marketing at AEG-Telefunken. Höhne sees the demand dropping even more in the near future, possibly 15%.

"Except for the TV dark zone, the overall semiconductor market isn't performing all that badly," comments Dirk G. Vogler, manager for marketing administration at Texas Instruments GmbH. In this assessment TI's man is not alone. As do his counterparts at AEG–Telefunken and Intermetall GmbH, lead house of the ITT Semiconductors Group, Vogler sees strong impulses coming from data processing, industrial electronics, and telecommunications gear manufacturers. They provide a big enough push "to make this year's semiconductor market at least as good, if not better, than last year's," Vogler estimates. The gain could be

10% and he notes that shortages have developed for some TTL devices, for low-power Schottky circuits, and for memories.

British chill. Artic weather conditions and a blizzard of strikes have set the British economy shivering. Although there are some chill-proof sectors in semiconductors, the outlook for components suppliers is generally bleak.

Looking. Some 1,300 exhibitors are expected to show their wares. Seen here are just some of the booths at the 1978 show.

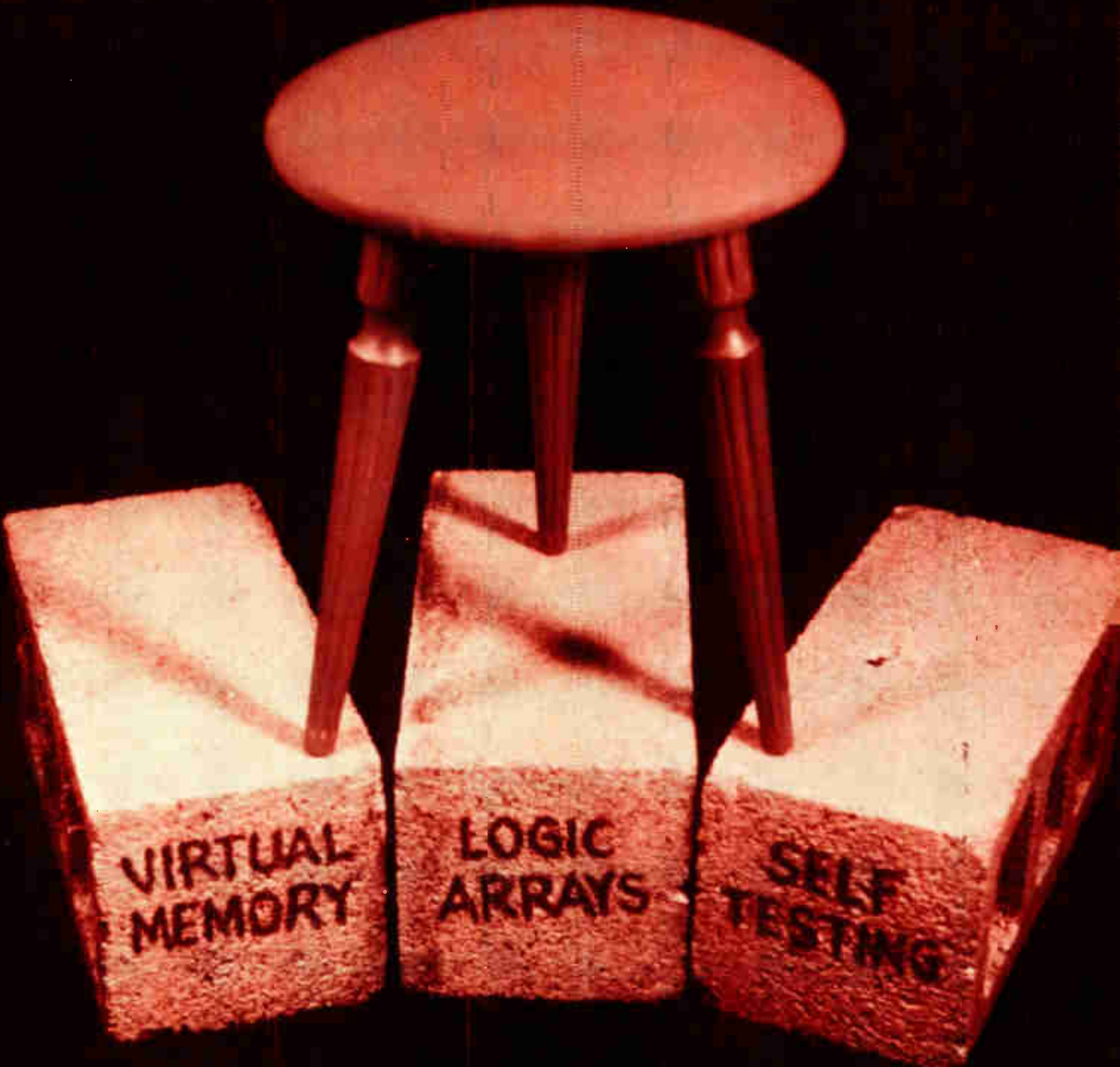
One pertinent reading of the climate in the marketplace is that of the Association of Franchised Distributors of Electronic Components (AFDC). It is predicting 8.6% growth this year to $1.5 billion for components of all kinds, including fans and racks. Discounted for inflation, the growth disappears. What's worse, cautions John Walker, managing director of Comstock Electronics Ltd., "these figures were put together before the recent strikes."
The prevailing mood is reflected by the assessment of Albert Shipton, UK marketing manager of General Instrument Microelectronics Ltd. "It's tough," he says, "and a lot tougher than most people will admit."

Italian pasta. Viewed from afar, what goes on in Italy's economy always looks worse than it does from the inside. And at the moment on the inside there is a mood of quiet optimism. Set makers are counting on a gain of some 10% this year and there are signs of improvement in semiconductor ordering by producers of industrial equipment.

Not much is happening in the way of growth at telephone hardware makers. The government-controlled telephone company still has trouble getting lira to invest. As for computers, Olivetti CCC, the country's largest office equipment maker, has been hit by a round of strikes; if it drags on, Olivetti's components intake will obviously shrink.

Even so, semiconductor sales should rise between 12% to 14%. The Italian market now looks quite good, reports Enrico Villa, director of marketing for SGS-Ates, the semiconductor producer in the Government's telecommunications/electronics group STET.

But industry executives are unsure how long the good times will last. The continuing political crisis keeps the government from making some crucial decisions. Ottorino Beltrami, president of the Associazione Nazionale Industrie Elettrotechniche et Elettroniche, believes that general economic conditions in Italy and its major trading partner, West Germany, "will strongly determine in the coming months whether 1979–1980 will be good years or see a return to the doldrums of 1975." □



Supporting computer design amid evolving technology

Large virtual memory, built-in testing, personalized logic arrays form the underpinnings of IBM's System/38

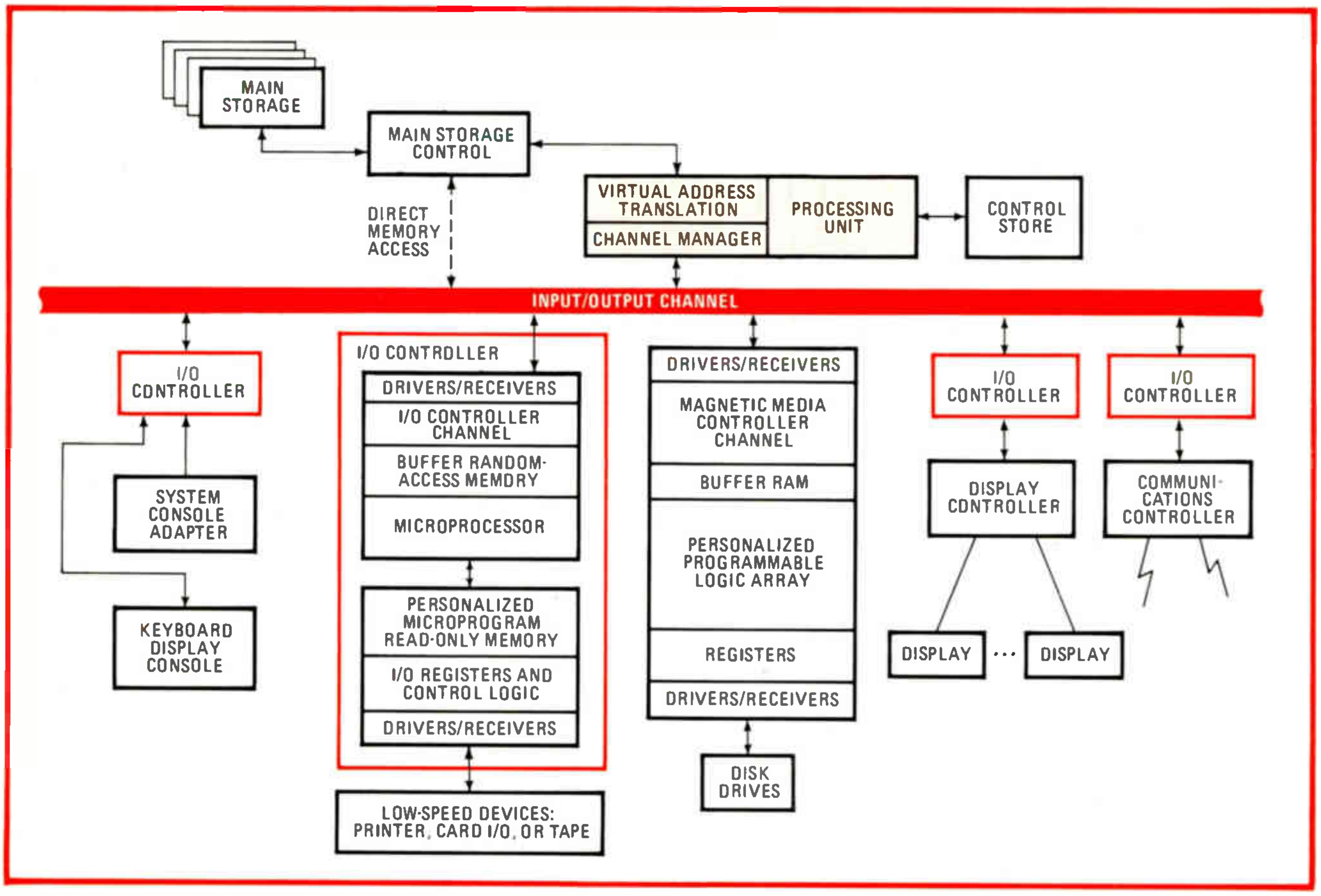
System/38 shows how IBM aims to keep up with the times

by Anthony Durniak,
Computers Editor

Computer architects are in much the same predicament as the sorcerer's apprentice. Having invoked semiconductor technology to solve their hardware problems, they find its forward momentum threatening to swamp their other requirements. The most obvious of these is the need to preserve the end user's considerable investment in software while at the same time giving him the benefit of ever faster circuitry. Just as important is the need to manufacture the ever more complex chips in volume and with guaranteed reliability, which means solving the problems the devices raise in the areas of power dissipation, packaging, logic flexibility, and above all testing.

The General Systems division of IBM faced many of these issues in the design of its System/38 [*Electronics*, Nov. 9, 1978, p. 81] (Fig. 1). In three key areas—logic chip design, chip and system testing, and virtual memory management—the division uses solutions that are unusual and in some cases unique. They may also furnish an insight into the directions in which the industry leader will go in fabricating and using large and very-large scale integrated circuits. For, although IBM will not say so, the techniques used in the System/38 are expected to provide a solid foundation for its future computer designs. Already its Data Processing division has announced a series of 4300 processers built around the same testing technique as the one used in the System/38

1. Most significant. In the System/38, General Systems division adopts solutions in the key areas of logic chip design, system testing, and virtual memory management that may show how IBM intends to fabricate and use large-scale and very large-scale ICs.



2. Central channel. System/38 hardware centers on an input/output channel that operates at speeds up to 5 megabytes per second. Attached to it are not only the central processing unit but also I/O controllers based on microprocessors or programmable logic arrays.

and even the same basic hardware element—an array of Schottky transistor-transistor-logic slices called a master slice [*Electronics*, Feb. 15, 1979, p. 85].

To make these master slices, IBM's East Fishkill, N. Y., facility builds identically laid-out substrates and then individualizes them with different layers of metalization. In this way it achieves both economy of scale in semiconductor fabrication and a wide range of options for its system designers.

"The whole topology of the design practice changes," explains the System/38 project manager, Brian G. Utley. Rather than being constrained to either a functional partitioning between the chips or a slice approach, he observes, "you can aggregate or split a function from chip to chip, because of the large number of both gates and input/output connections available."

Sophisticated tools

In Utley's experience, though, such an approach requires sophisticated design tools. The most important of these tools, as Jehoshua Pomeranz, Rolf Nijhuis, and Chet Vicary explain in their article on page 105, is a computer-aided design system that converts logic diagrams into layouts for the chip's metal layers.

A primary concern of both semiconductor manufacturers and computer designers is the invention of thorough enough tests for the increasingly dense circuitry of today's logic chips and boards. IBM gains access to the previously inaccessible internal chip signals so critical to troubleshooting by weaving a shift register through the logic on each chip and then loading it with test patterns. As Neil C. Berglund points out on page 108, this approach can then be extended to the board level.

A single eight-layer 10-by-15-inch board does in fact hold the System/38's entire central processing unit—all 29 of its gate arrays personalized into 22 different part types, plus five memory chips used for local registers. There are two versions of the CPU: model 3, which has a 400-nanosecond cycle time and can support between 0.5 and 1 megabyte of main memory, and the faster model 5, which has a cycle time of 200 ns and can handle up to 1.5 megabytes of main memory.

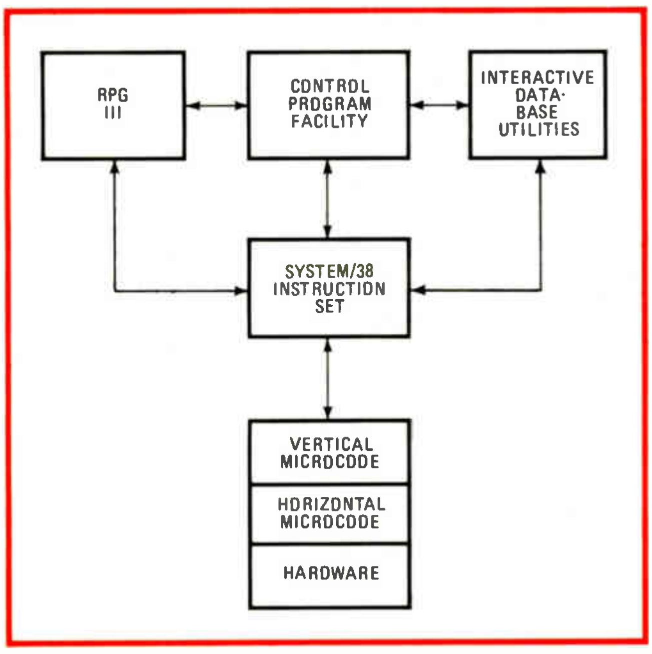
These storage capacities are due to another innovation—the use for the first time of IBM's new high-density memory chips [*Electronics*, Nov. 9, 1978, p. 39]. The slower model 3 employs a new 64-K part with a cycle time of 1,100 ns, while the faster model 5 uses a 32-K part with a 600-ns cycle time. Also, a new 18-K random-access memory is used in the model 3 for its 4,096 32-bit words of microinstruction control store, whereas the faster model uses an older 4,096-bit RAM for its 8,192 words of control store.

The central position in the System/38 hardware, however, belongs not to the CPU but to a bus called the input/output channel (Fig. 2). A dedicated portion of the CPU controls the channel, which operates at a transfer rate of up to 5 megabytes per second. Another dedicated portion of the CPU—the hardware for translating virtual memory addresses into physical locations in main memory—links the CPU's main memory to the input/output channel.

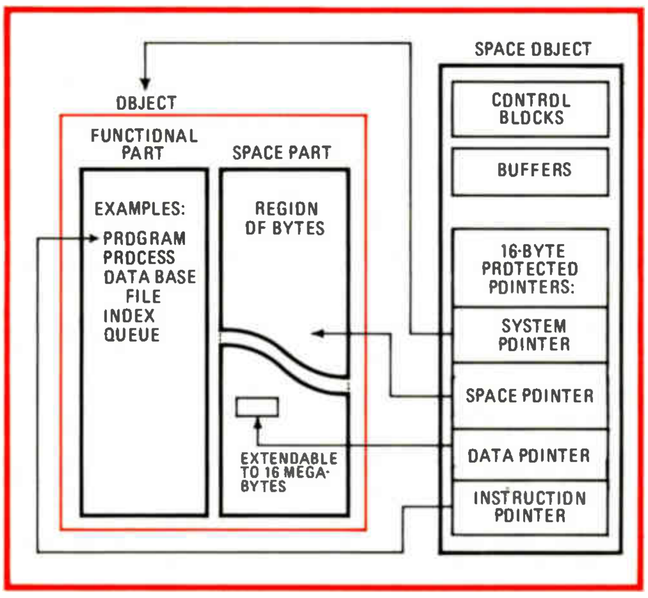
Also attached to the bus are a group of independently operating intelligent input/output controllers. For a low-speed I/O device like a cathode-ray-tube terminal, printer, or tape drive, an 8-bit microprocessor-based I/O controller is used. Higher-speed devices like disk drives employ IBM's Magnetic Media controllers, which are based on programmable logic arrays.

Each system also includes a System Control Adapter, a keyboard and display console that, as Berglund explains, handles the system's maintenance functions.

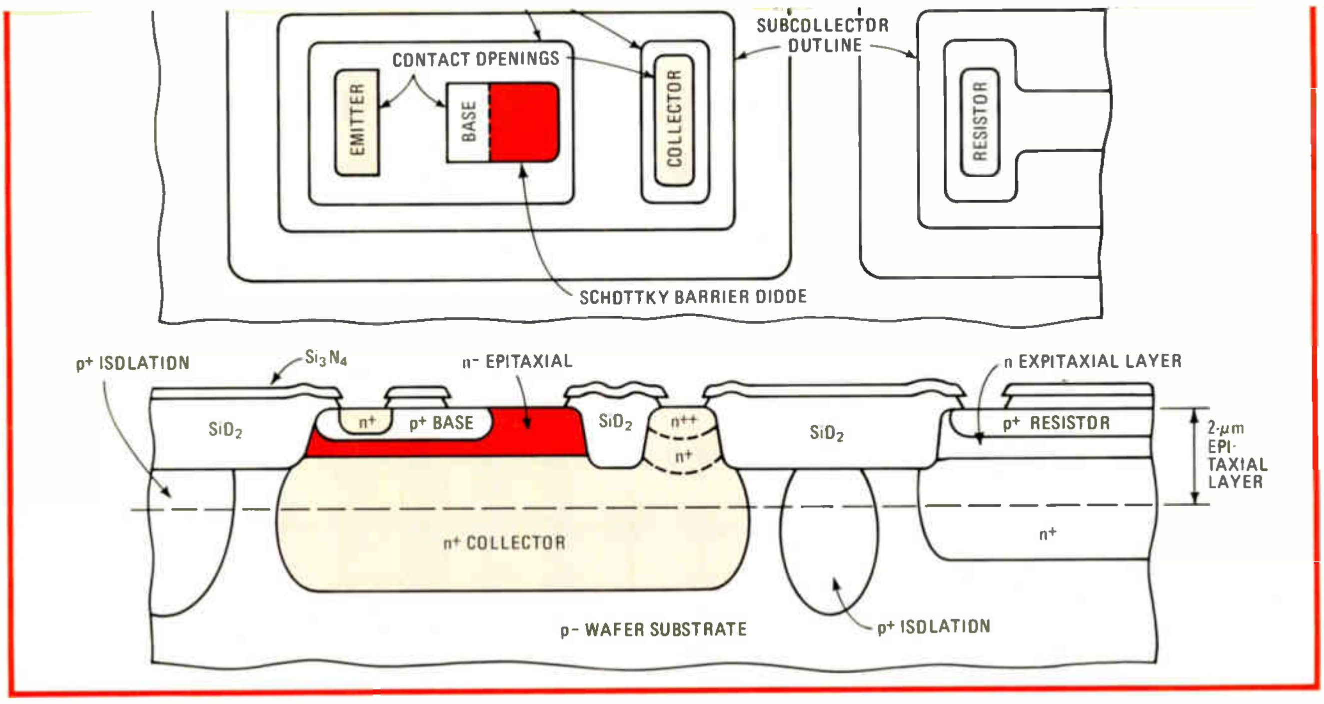
The virtual memory system of the System/38



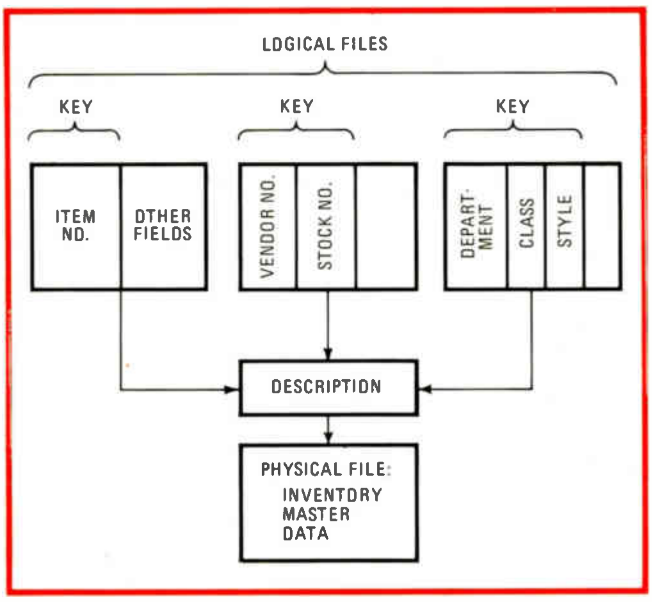
3. Insulation. Two layers of microcode insulate the computer user from the hardware. The Control Program Facility operating system, RPG-III high-level language, and Interactive Data Base Utilities use the System/38 instruction set, in turn translated by the microcode.



4. Objective memory. All information in memory is stored as an object whose functional part contains the information and whose associated space part provides a set of memory locations. A space object holds the pointers that indicate the location of the object.



1. Master slice. The master slice used in the System/38 contains an array of 704 gates made from transistors, Schottky clamping diodes, and resistors. To give an idea of scale, the devices are formed in an epitaxial layer typically 2 micrometers thick.



5. Multiple paths. Multiple logical files containing various reference keys can be used to access the information (in this case an inventory file) that is stored in a single physical data file. This allows users to share files simultaneously and eliminates duplication of information.

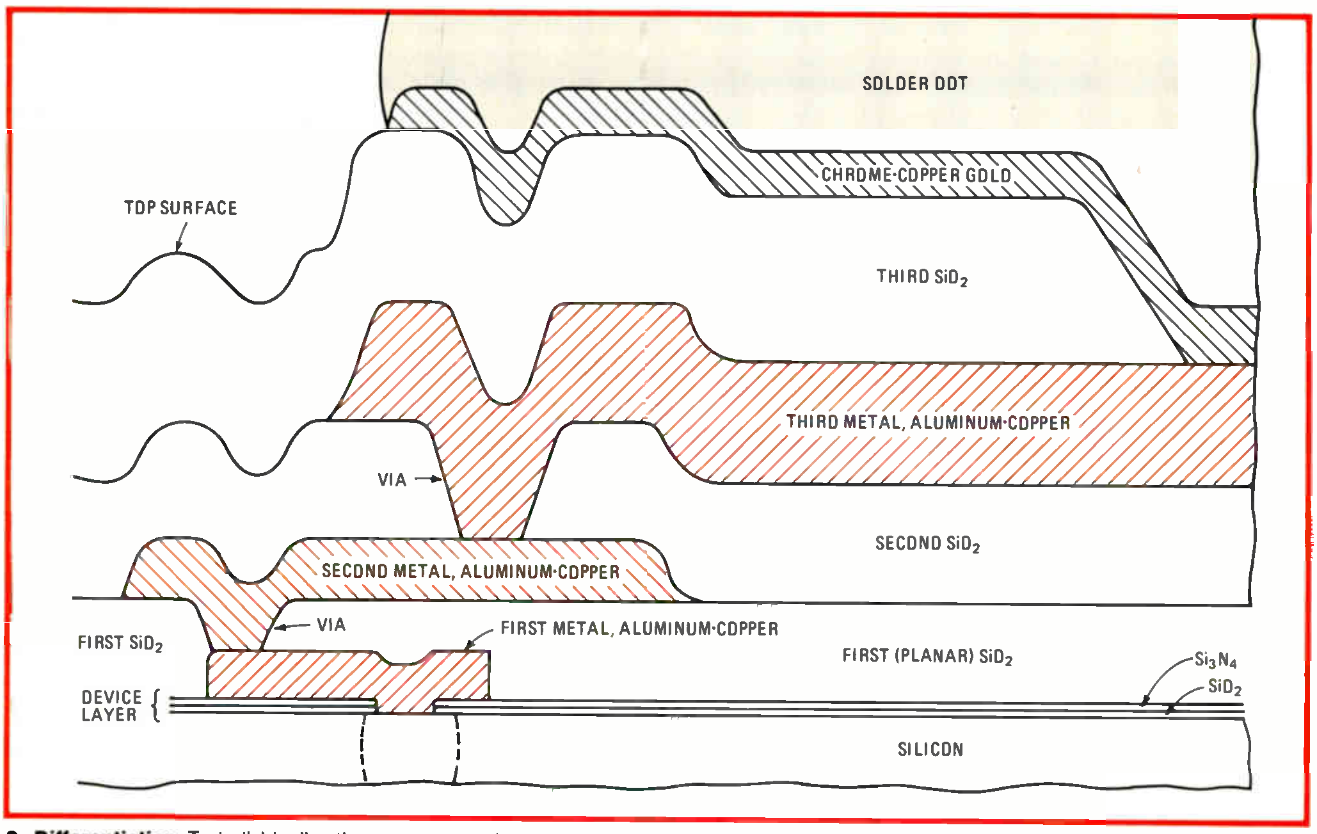
improves on the kind popular on most computers today. Those generally have one set of software for converting

seen by the user's programs (Fig. 3). The layer closest to the hardware is called horizontal microcode and is the bit-oriented microcode that resides in control store. This microcode handles a set of functions that have the appearance of systems software—examples are the management of the task queue and virtual memory previously discussed, as well as management of the storage hierarchy.

The second layer or vertical microcode is stored in main memory and is executed in an interpretive fashion against the horizontal microcode. The instruction set the user of the System/38 sees is translated into the horizontal microcode by the vertical microcode and so provides the user with a hardware-independent interface to the system—one that frees him from such concerns as main memory or auxiliary disk addressing, I/O interface details, and internal microprogramming details.

The System/38's equivalent of an operating system is executed in terms of this instruction set. A licensed program called the Control Program Facility, it supplies a single control language for use in all applications by all programmers, operators, or terminal users, plus a new data and file definition language.

Interacting with the Control Program Facility are the compiler for the high-level programming language RPG-III and the Interactive Data Base Utilities. These enter, display, and maintain data files as well as extract,



2. Differentiation. To individualize the gate arrays, the first two layers of metal and their interconnections, or vias, are customized. The third layer, used for power distribution and signal input/output, is fixed. Solder dots connect the chips to their ceramic carriers.

watt. The configuration of transistor, diode, and resistor diffusions is identical in every gate. These device regions are arranged in horizontal bands separated by spaces reserved for signal interconnection; these spaces amount to almost half the chip area in sum. Figure 1 shows the structure of a typical transistor and Schottky diode plus the contact with one end of a resistor: the entire surface area of the transistor emitter is 3 by 8 micrometers, while the Schottky diode measures 5 by 6 μm and the resistor 4.5 by 70 μm.

Above these devices lie three layers of metalization (Fig. 2), the lowest two of which may vary from chip to chip. The paths left for the wire channels on the lowest level run parallel to the straight rows of circuit elements, and the wire channels on the middle level run at right angles to the first. At every crossing it is possible to make a vertical connection, or via, between the two layers. The uppermost metal layer and the vias between it and the second layer are fixed for all chips and are primarily used for power distribution and as chip signal ports. The metal used for the layers is an aluminum-copper alloy; the insulation between is silicon dioxide.

The next-to-last fabrication step is to vacuum-deposit a protective layer of chromium-copper-gold over the 132 connection points, on which dots of lead-tin solder are then deposited. Finally the completed chip is inverted into the ceramic carrier, where the solder dots melt enough to bond the two together, forming electrical connections between the chip and a metal pattern on the ceramic (Fig. 3).

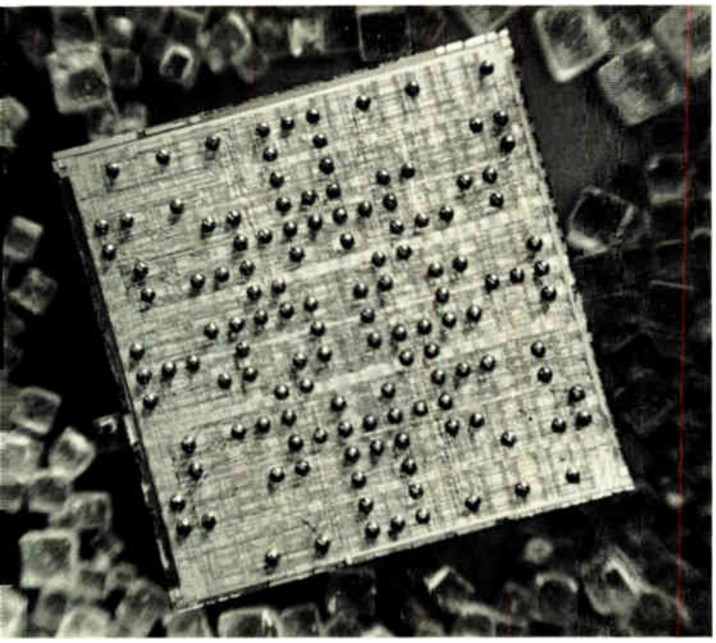
The metal shapes that define a particular logic gate are stored in the Engineering Design System in what is called a book. There are over 100 such books in the circuit library. The signal input/outputs of each book are defined as logic service terminals (LST). Since the EDS interconnects the LSTs of different books as specified by the logic requirements, it places them on the chip at via locations for easy access to both planes of the wiring channels. The 94 chip signal ports also have LSTs, but with fixed locations on the second level corresponding to the location of solder dots on the third level.

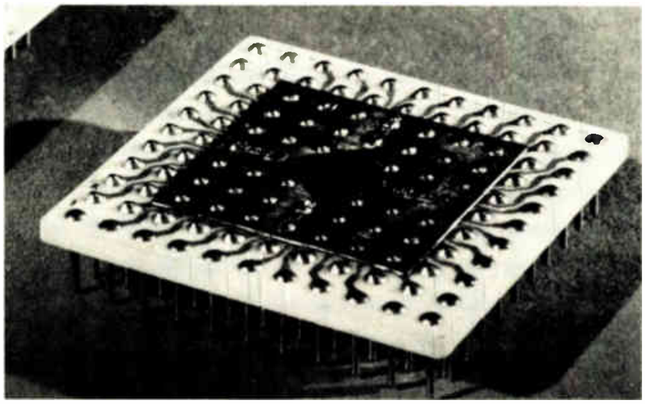
Gate in the majority

The predominant logic gate is configured with either a three- or four-emitter input transistor, one output transistor, the Schottky clamping diodes, and two to four resistors (Fig. 4). All of the multi-emitter transistors share a common collector and most have multiple bases as well. One resistor powers the bases of the multi-emitter input transistor and one the base of the output transistor. The two remaining resistors are not part of the circuit book definition; they are under the control of the wiring program rules, and their inclusion is dependent on the specific intercircuit net configurations and net performance requirement.

In addition, the voltage drop between each input and output on the net is calculated and, if too large, can be reduced by specifying a larger wire width for a particular net. (However, if the total net wire area increases too much, the network performance in general will suffer.)

For off-chip communications a simple emitter-follower transistor with a base resistor is provided. This





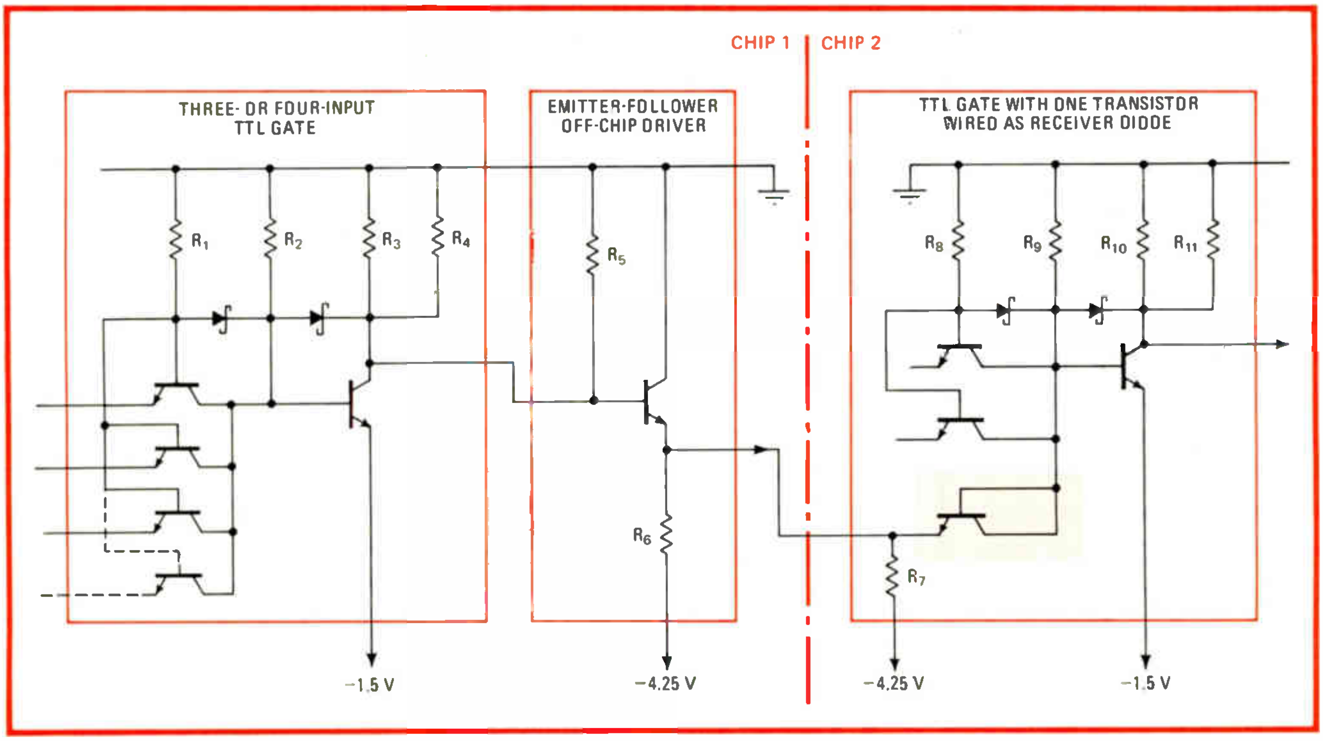
3. Bondage. There are 132 solder dots on the finished logic chip (left). The chip is inverted onto the 116-pin ceramic carrier (above) and the two are heated till the solder reflows and bonds them together, several chip solder connections being linked to the same pin.

current-amplifier circuit is used to drive the relatively long and high-capacitance off-chip networks. Resistors biased to −4.25 V are available for interchip connections on both driver and receiver circuits. These resistors are also excluded from the circuit books and are instead included in the definitions for chip-to-chip net connections. Additional off-chip terminator resistors are available for connections critical for performance.

To communicate off chip by means of an emitter follower, the on-chip voltage logic level is translated down by a base-emitter voltage potential. To restore this voltage level at the receiving chip, any input transistor of the receiving circuit is wired as a diode by having its base connected to the collector. Since almost all the transistors of the multi-emitter TTL circuits have separate base definitions, any input emitter can function independently as either an internal or an off-chip receiver.

Building blocks

To create the chip functional design, the system designer works with logical descriptive blocks. The automated EDS produces a logic diagram of the chip and employs a simulation scheme to verify the design. Once the logical description is approved, the EDS automatically matches the logical blocks to the physical books, chooses the chip locations at which to place these books,



4. Common gate. A typical gate in the array contains a three- or four-emitter input transistor with an output transistor, Schottky clamping diodes, and resistors R_1 and R_2. Resistors 3, 4, 6 and 7 are added as needed to balance interconnections.

and makes the required interbook and chip input/output connections. The program strives to achieve a design with the shortest possible interconnection lengths, in order to meet the electrical and performance restrictions included in the programs.

A designer is free to intervene manually to fix either book location or wire placement. Extensive checking programs assure correct circuit function, compatibility of various circuit shapes, and correct interwire spacing.

Determining delays

The description of the chip characteristics in the EDS include the delay equations of every circuit book. These equations contain delay terms that are a function of the circuit output load, so that at the completion of a particular chip design, all the output loads are known. The EDS can compute these, insert them into the circuit delay equation, and predict a logic path's performance.

One of the benefits to system performance of integrating many logic gates on a single chip is that the signal paths can track each other closely. But care must be taken to ensure this actually happens. The results of the automatic layout programs must be monitored to prevent logically identical paths from being given radically different physical path lengths.

Once the layout is complete, the EDS produces control information for an electron-beam tool that writes the pattern for the metalization layers directly onto wafers coated with photoresists. This is a very quick way to produce prototype chips. Moreover, once their design is finalized, the same system can be used to mass-produce the chips. If desired, however, the EDS can generate conventional photolithographic masks.

In the customization process, a selective lift-off process is used on the layers of metal instead of subtractive etching. This allows better coverage over device areas and permits a minimum line width of 4.4 μm with 2.5-μm spacing.

Another feature of the EDS is its ability to generate complete data for functional testing of the chips.

The authors would like to acknowledge the contribution of Huntington W. Curtis who provided some of the information on the chip's fabrication.

Level-Sensitive Scan Design tests chips, boards, system

by Neil C. Berglund
IBM Corp., General Systems Division, Rochester, Minn.

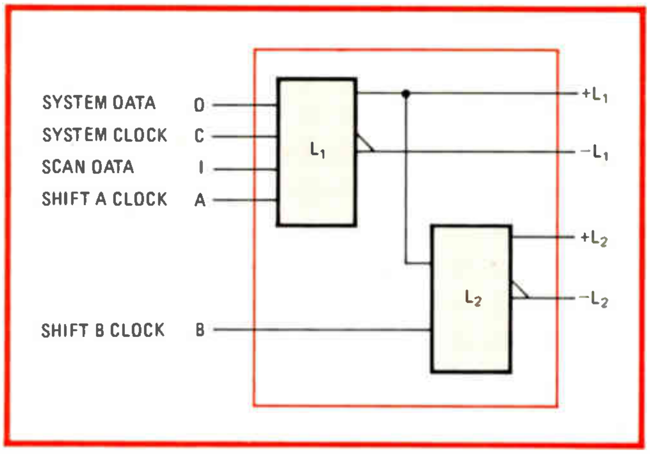
The denser the concentration of functions within a system, the more urgent the need to test them. And the System/38 is dense: it packs about 20,000 circuits on 29 logic chips together with five memory arrays on one 10-by-15-inch circuit board. It was therefore designed as much for testability from the chip level up as for economical manufacture.

The principal obstacle to testing large-scale integrated devices is the inaccessibility of internal signals. This must somehow be circumvented if problems are to be isolated initially during the debugging of engineering prototype hardware, later during manufacturing testing, and later still in field service at the customer's site. Past techniques tested the chips with complex sequential patterns that attempted to put all the internal circuits through all their paces and transferred the results to the output pins of the chip for observation. But given today's complex chips, this process takes far too long and makes inefficient use of computer-generated test data.

System/38 uses an approach called Level-Sensitive Scan Design (LSSD) to solve testing and test-data-generation problems at all levels of packaging—chips, boards, and systems. The LSSD technique enables every LSI chip to be completely tested for dc faults with the aid of computer-generated test data. When extended to the board level, this technique allows a system to test itself or be diagnosed by a field-service engineer.

With LSSD, the shift register latch (SRL) is the only type of storage element other than random-access-memory chips permitted in a logic design. An SRL is actually a linked pair of polarity-hold latches (type D) connected to form a single stage of a shift register (Fig. 1). The second latch of this pair, L_2, exists solely to enhance chip testability, though it can be used for other purposes as well. The first latch, L_1, is designed to serve both system design and testing requirements.

The L_2 latch has a single data input permanently connected to one output of its paired L_1, plus a single B clock input for loading it from L_1. The L_1 latch can be set from two sources by two different clock inputs and has two outputs, reflecting its dual role as part of the test system and as a storage element for the system designer. Its test input, called the scanned data input (SDI), is connected to the L_2 output of a different shift register latch, and its A clock input loads it with data from that source. Its other input comes under the control of one of the two system clocks.



1. Limited memory. Level-Sensitive Scan Design technique restricts the types of memory elements in a design to random-access memories and shift register stages made of paired latches. Latch 1 is both a test and a storage element, latch 2 primarily a testing element.

To convert all the shift register latches on the chip into a single long shift register, the first stage's L_2 output is connected to the next SRL's L_1 input, and so on through the last SRL (Fig. 2). The first stage's L_1 test input is connected to a chip input pin designated SDI, and the last stage's L_2 output is connected to a chip pin designated scan data out (SDO). The A and B clock inputs of each SRL are connected in common to a pair of chip input pins so designated.

Thus the designer has lost the use of four chip pins and the circuits required to implement the L_2 latches and associated clock drivers, but the connection of the SRLs into a shift register in no way interferes with the chip's performance of its normal functions. When the chip is tested, the four pins and the L_2 latches enable the test system to control and retrieve the contents of any latch on the chip by means of a simple shift technique.

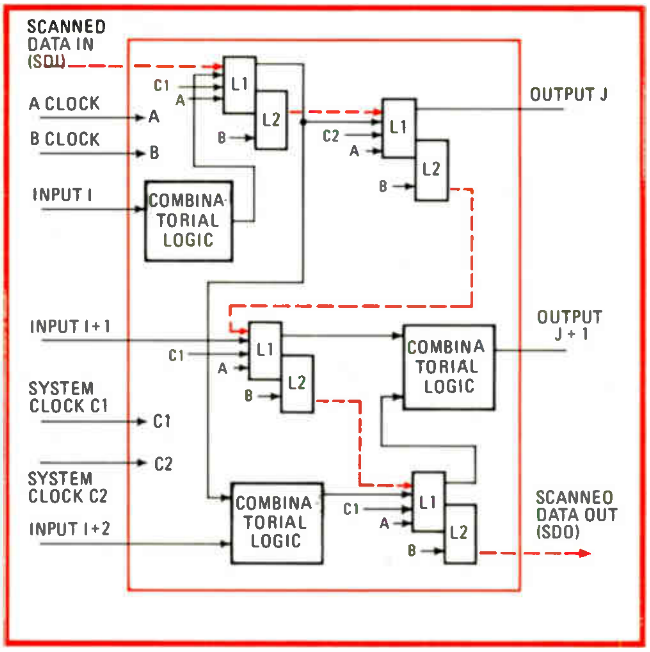
Testing, testing . . .

To test a chip, a test pattern—a serial string of binary data—is applied to the SDI pin of the chip. The A and B scan clocks are then pulsed, causing the test pattern to be shifted, or scanned, into the SRLs on the chip. All the latches on the chip having thus been initialized, stimuli applied to the input pins cause the combinatorial logic on the chip to assume some particular state. Some of the combinatorial logic is connected between the chip input pins and the SRL data inputs; the rest is connected between an SRL's L_1 output and the output pins. In the latter case, the output pins can be observed to determine if the combinatorial logic is functioning properly—but to test the logic connected to SRL data inputs, its state must be transferred into these stages' L_1 latches by pulsing the system clocks C_1 and C_2. Then the A and B scan clocks are pulsed once more, and the serial binary data coming out of this chip's SDO pin is observed.

These serial data output patterns represent the state of the SRLs after the system clocks were operated—in other words, the state of the combinatorial logic before the system clocks were applied. This data is compared with the expected state of the SRLs as determined by a computer simulation model. In this manner the logic on the chip is tested for typically 98% to 100% of all dc faults with program-generated test data.

Complex sequences of system clocks are not necessary to test all stages of counters, shift registers, and other logic elements buried in the logic of the chip. Instead, using the LSSD technique, patterns are loaded that test all stages of a counter, for instance, without stepping it through all its states. Each system clock is pulsed no more than once per test pattern, and this, in fact, is sufficient to test not only the combinatorial logic connected to the data input but also the clock driver of the SRL and the SRL itself.

But what of the cost of such a system? On first analysis, the LSSD system appears to carry a significant overhead in unusable circuits. The L_2 latch, the extra clock drivers, and the extra input to the L_1 latch do require circuits that are unavailable to the designer for his unrestricted use in implementing the processor function. These circuits represent the hardware cost of LSSD and can approach 20% of the available circuits.



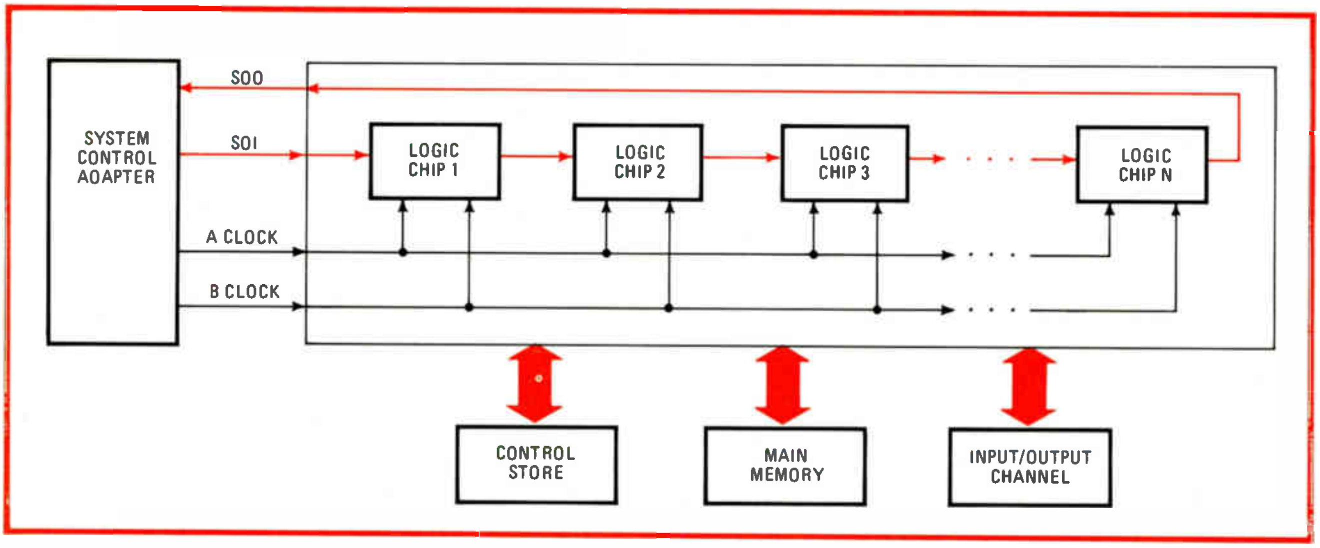
2. Chain gang. Chaining the latches together forms one large shift register that runs throughout the chip. Now only four pins are needed to test the entire internal workings of the chip: the scan data in and out pins (SDI and SDO), and the A and B clock pins.

In fact, though, these circuits do not have to remain strictly as overhead. They can be used to help realize the processor function and for several other features, in addition to their use in the LSSD system. At the chip level, for example, latch L_2 can be used to make functional shift registers, counters, and control latches. This is accomplished by logically OR-ing a system clock with the B clock input to L_2. (As the A and B clock inputs are used only when the chip is tested, no interference exists if L_2 is used functionally.) When combined with such a two-phase, nonoverlapping clock, the L_1 and L_2 latches act as a master-slave storage element that can implement any function that can be achieved with the more traditional storage elements—J-K flip-flops, for instance. Furthermore, the L_2 latches of a register are thus enabled to provide a double-buffer function with many uses—a backup register for retrying, for instance, or a double buffer for data storage.

Pros and cons of two-timing

Admittedly, a two-phase clock system does have disadvantages for counters, shift registers, and similar functions, since two clock pulses are required to advance them one position. On the other hand, it actually can be an advantage for the overlapped processing often employed in high-speed processors, which find it faster to start the next instruction before the current instruction cycle is completed. The SRL is unusually well suited to this mode of operation, since the L_2 can hold the information necessary for the current instruction cycle while L_1 is loaded to begin the next cycle.

For testing the entire processor, the LSSD shift register concept is extended to the board level (Fig. 3). When the SDO of one chip is connected to the SDI of the next, all the chips on the board form one long shift register. In



3. Self-testing. Connecting the logic chips' SDI and SDO pins together extends the shift register throughout the processor's board. Attaching these pins to the computer's system control adapter allows the computer to check the latches' state against a pattern in its memory.

practice, however, the chips are grouped into several shift registers of shorter length, then loaded in parallel to reduce test time.

Test patterns for the entire board are computer-generated in the same manner as for the chips. The board is inserted in a test fixture, test patterns are loaded into the SRLs of every chip, stimuli are applied to the board's input pins, and the system clocks are pulsed. The signals on the output pins are checked, the contents of the SRLs are scanned out, and both are compared with the expected results. Essentially no additional hardware is required to support board-level testing because the LSSD hardware in each chip is enough for the purpose.

Out in the field

After the entire processor board is installed in a system, the same LSSD technique is applied to it in the customer's environment, whether to have the system test itself each time the machine is turned on or to aid service personnel in diagnosing a problem. In the field, however, the testing problem is more complex, since the board is now mounted in a system rather than in a test fixture. Because of this, the board's pins are connected to channels, memories, and the like, so that the signals on them are not directly observable. But the processor's shift register latches can still be controlled, and since they are connected to 90% to 95% of the logic, an effective test can still be performed.

Historically, processors are tested in the field with diagnostic programs. With the LSSD techniques, test patterns can set up conditions to test for specific faults much more easily than can diagnostic programs, which are limited to the capabilities of the machine's basic instruction set. LSSD patterns provide only a dc test of machine operation, so that for full system verification they must be combined with diagnostic programs operating at machine speed to locate time-dependent or ac problems.

To handle the LSSD concept at the system level, the board's SDI, SDO, and A and B clock connections are attached to the system control adapter (SCA). Using its own microprocessor, the SCA performs several tasks related to system maintenance. For example, it can enter serial data on SDI and observe the serial data on SDO while pulsing the A and B clocks to the shift registers on the board, in this way controlling and checking the state of nearly every storage latch on the entire board.

A small quantity of maintenance interface logic on the processor board enables the SCA to cut off the C_1 and C_2 system clocks and pulse them, too, for test purposes. With this support, the SCA reads test patterns from a system file, loads them into the latches on the board, pulses the system clocks, retrieves the contents of the latches, and compares the results with the expected results also obtained from the file.

Since the shift registers used in LSSD provide a way of altering or displaying the state of every storage element in the processor, they also lend themselves to the support of manual console operations. As an aid for the diagnosis of hardware and program problems, computer systems generally have a console for displaying and altering the contents of registers, memory, and critical control latches, and System/38 is no exception.

The SCA makes use of the processor's on-board maintenance interface logic to bring the processor to a controlled stop while the SRLs are scanned, then restart it when the scan is complete. In addition, the SCA scans the data from the shift registers and formats it for display on the cathode-ray tube. If the displayed data is altered by a field service engineer, the SCA will take the altered value and replace it in the processor by scanning new contents into the machine latches. This technique, in addition to saving the extra hardware normally required to get into and out of the facilities to be displayed and altered, makes it possible to alter and display the state of every latch in the processor.

In System/38, IBM has found the LSSD technique to be an effective approach for designing processors using LSI circuits. LSSD, though originally conceived to solve LSI chip test problems, has been used to provide an integrated test and maintenance approach from the chip to the system level.

Hash index helps manage large virtual memory

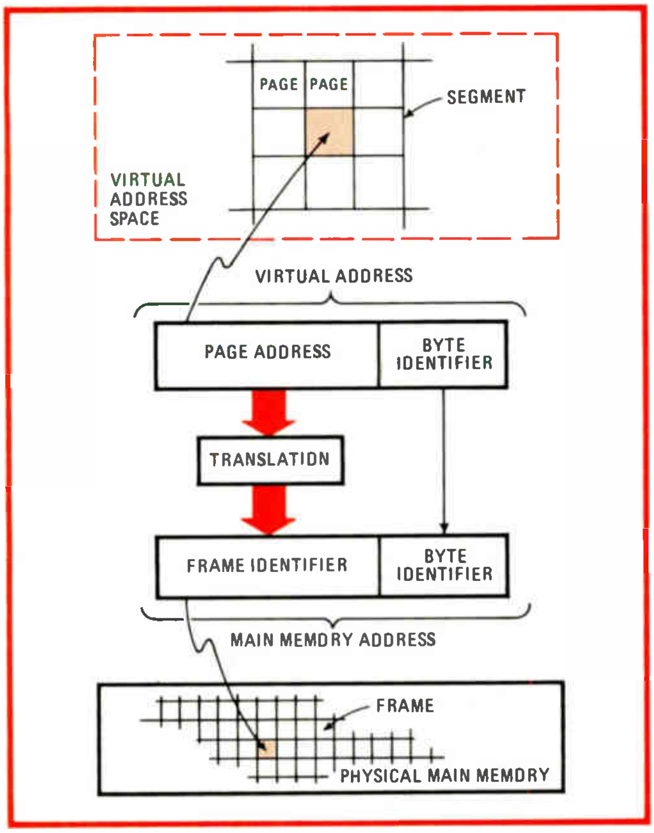
by Merle E. Houdek and Glen R. Mitchell,
IBM Corp., General Systems Division, Rochester, Minn.

A major design decision with the IBM System/38 was to employ an address structure with sufficient bits to reference all main and secondary memory without reusing an address. Such a structure provides improved data integrity, protection, and security.

Clearly, the 16-bit address used in many small computer systems was not enough. Even the 24-bit address often used on larger systems for access to 16 megabytes of storage lacked the desired flexibility. So it is that the System/38 uses a 48-bit address, providing a virtual address space of 281 trillion bytes—16 million times that of the System/370.

Managing virtual memory

Virtual memory is a scheme that permits the user to treat the main memory and auxiliary storage, such as disk drives, as a homogeneous unit. Essentially it is a management scheme that moves information from the disk drives to the main memory and back, as needed for processing a program.



1. Page frames. The 48-bit virtual memory address used in the System/38 indicates a page within a segment of the virtual memory space. This address is translated into the shorter main memory address, which points to a frame in the physical main memory.

These transfers are transparent to the user, who refers to the information with an unvarying address—the virtual address—with no need to know its location. However, the location of information does change, and the computer must keep track of the shifting internal addresses. Also, the addresses in the smaller main memory are shorter than those to be found in the user's virtual address.

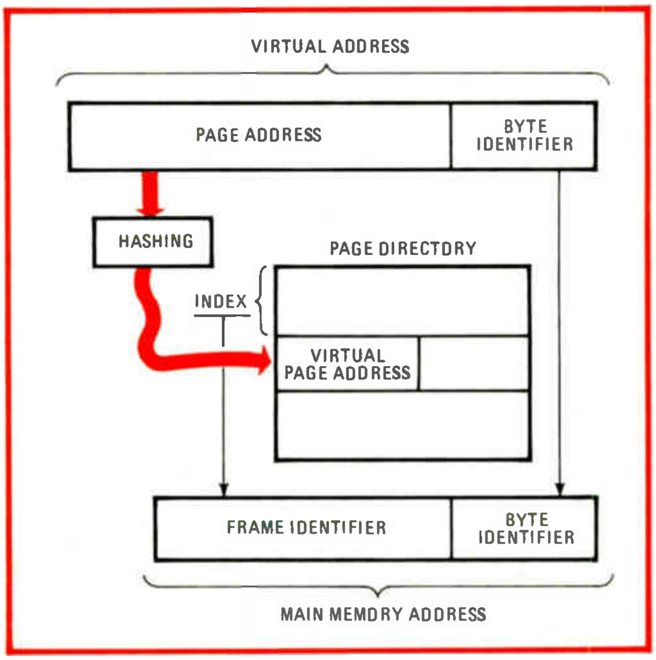
To keep track of information, the management scheme must translate between the unchanging virtual memory addresses of the user and the machine addresses. Yet conventional translation techniques would take more than a billion bytes of lookup tables to support the System/38's 281-trillion-byte address space.

Instead, the System/38 employs a two-tier translation scheme with an algorithm that uniformly distributes the virtual addresses throughout a significantly shorter directory used to specify the main memory address. In virtual addressing, the memory space is divided into segments that are further subdivided into 512-byte blocks called pages. When a page resides in the computer's main storage, all 512 bytes are assigned to what is called a frame. The translation task essentially is to turn the page address into the proper frame address.

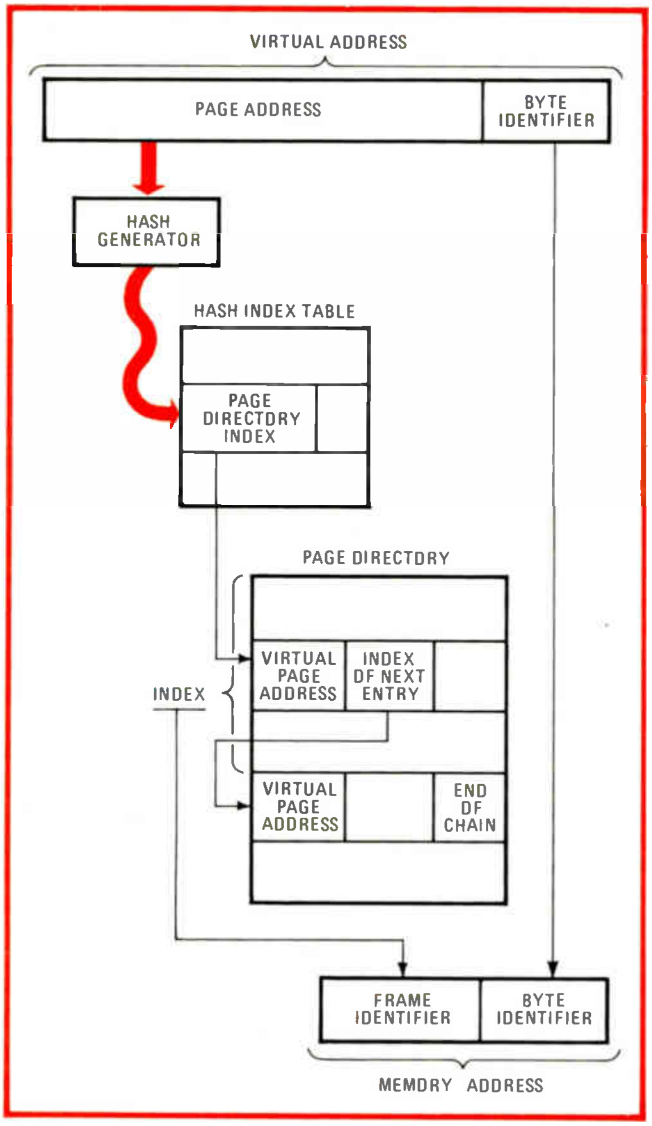
By page and byte

The virtual address has two parts—one identifying the page, called the page address, and one identifying a byte within the page, called the byte identifier (Fig. 1). Similarly, the first part of a main storage address identifies the frame and is called the frame identifier. The second part of the address identifying the byte within the frame is identical to the virtual address byte identifier. So no byte identifier translation is needed.

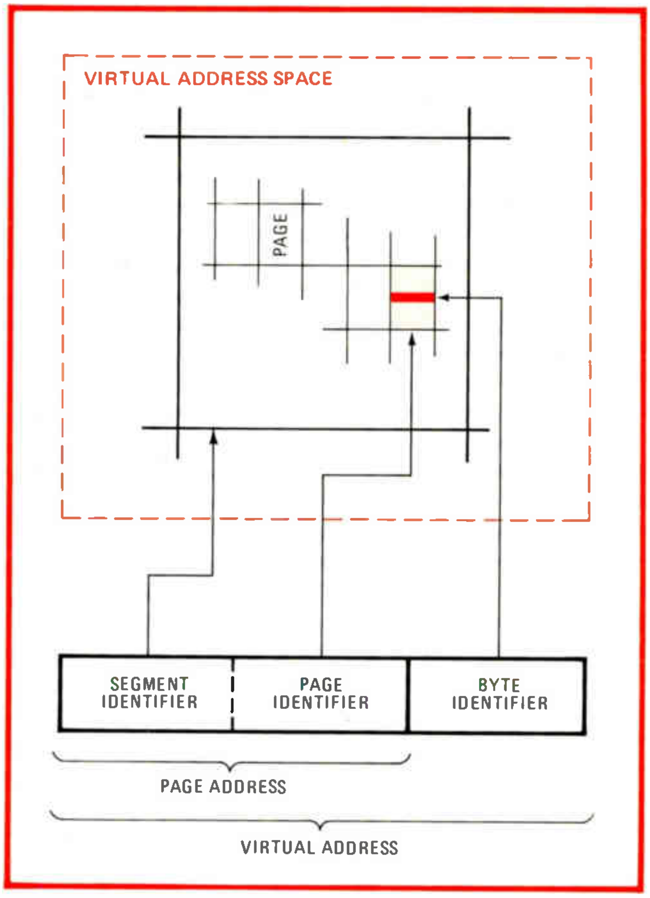
The page address, however, must be translated into



2. Directory. In looking for something in memory, the page address portion is hashed and compared with a directory of page addresses. The index of the matching entry then becomes the frame identifier, but the byte identifier is unchanged.



3. Scrambled hash. Rather than search the entire page directory, a hash generator produces a value that is looked up on an index table that points to the directory entry most likely to contain the matching page address, as several addresses have the same hash value.



4. Fine definition. To further the virtual address, the page address portion is divided into two portions: one points to a particular segment in the virtual address space, and another to a specific page. The byte identifier defines a single-byte within the page.

the frame identifier. This is accomplished with two tables. The first of these, the page directory, contains one entry for every frame in main storage (Fig. 2). The index value of the entry corresponds directly to the frame identifier.

Translating directory

Whenever a page moves into a frame in main storage, the corresponding entry in the directory has a field containing the page-address portion of the virtual address. To locate a page in main storage, the management hardware compares this field with the page-address portion of the virtual address. When the two of them match, the index of that page-directory entry becomes the frame identifier.

However, serially scanning the entire page directory every time a virtual address is translated would probably take too long. Consequently, an index of the directory is formed with the aid of the second table, the hash index table, and what is called a hash generator.

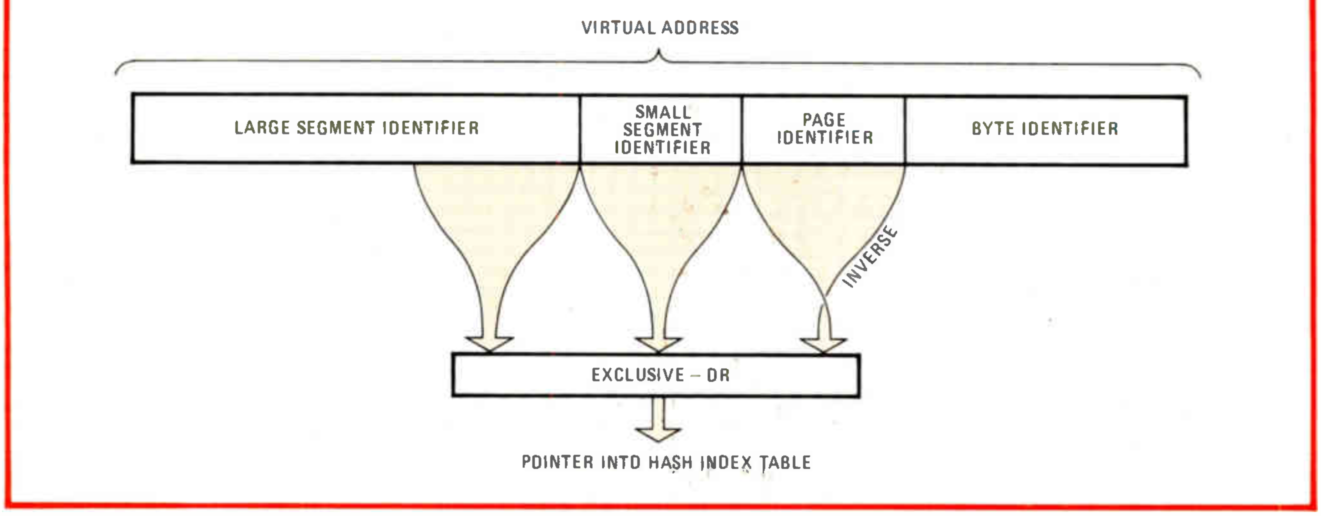
Actually the first step in the translation (Fig. 3), the hash generator is an algorithm that combines (hashes) specific bits from the virtual address to select an entry from the hash index table. This entry is a guide to the entries in the page directory.

The combining process of the hash generator could result in the same hash value for several addresses. Therefore, part of each page-directory entry is reserved as a pointer to the location of possible additional entries with the same hash. Thus entries with the same hash value are found on a linked list (or chain) in the page directory. An end-of-chain indicator distinguishes the last entry on each chain.

During the translation of the virtual address, the searching mechanisms need to find only the chain expected to contain the virtual page and then search its entries, looking for the match with the virtual page address. The index of that page directory entry becomes the frame identifier for that virtual page.

End of chain

An end-of-chain bit may be encountered before a match is found, which signals that the page is not in the main memory. A special routine then goes to the input/output channel and brings the page corresponding to that virtual address from secondary disk storage to



5. Generator. Since two types of segments are allowed in the System/38 there are two segment identifiers. An exclusive-OR combination of the large and small segment identifiers and the inverse of the page identifier produces the hash value.

main storage and updates the page directory. The I/O channel uses the full 48-bit virtual address and a similar translation technique to produce the physical address for the disk drive.

This two-tier indexing process will speed the translation, but only if the lengths of the page chains are kept short. Using a larger hash index table results in more page chains in the page directory and consequently fewer entries per chain. Thus the large hash index table enhances the translator performance since fewer page directory entries have to be inspected.

Uniform distribution

Equally important is a hashing algorithm that generates a uniform distribution of entries into the hash index table. Without uniform distribution of the entries in the hash index table, some entries would be favored over others, which would result in longer page chains for those entries and consequently a higher average number of entries probed.

Research into uniform distribution schemes has shown that the average number of page directory entries probed, N, is dependent on the ratio of the hash index table size to the page directory size, R, or:

$$N = 1 + 1/2R$$

For example, if the hash index table is twice the size of the page directory, the average number of probes will be 1.25 entries.

The hashing algorithm required for uniform distribution depends on how virtual addresses are assigned. In the case of the System/38, it must take into account the division of the virtual address space into the independent address spaces called segments. Within each segment are several pages, so the page-address portion of the virtual address is broken up into two identifiers (Fig. 4). One identifies the segment; the other identifies the page within the segment.

Since the segment of the virtual address space is reserved for one block of information regardless of the block size, the segment is generally larger than the block it contains. This situation leads to some unused virtual addresses and, in general, to a sparse usage of the virtual address space.

Also, System/38 has two types of segments—small ones of about 65,000 bytes and large ones of about 16 million bytes. Therefore, the segment identifier of the virtual memory is further divided into large segments and small segment identifiers. So efficient recall of data through this virtual memory scheme requires some technique to transform the resulting nonuniform distribution of virtual addresses to a uniform distribution of the hash index table entries.

The algorithm used in the hash generator must perform this transformation. It also should ensure that consecutive pages and consecutive small and large segments do not hash to the same location in the hash index table. After all, there is a relatively high probability that consecutive pages or segments being referenced together as information are sought.

The hash algorithm used on the System/38 meets these requirements (Fig. 5). It takes the exclusive-OR of the reverse order of the page identifier bits with the low-order bits of both the small segment identifiers and the large ones.

Accommodating variations

The effect of this hashing algorithm when the system is using a large number of small information blocks is that more bits from the segment identifiers and fewer bits from the page identifier affect the generation of the hash. At the other extreme, in a system using a few large blocks of information, fewer bits from the segment identifiers and more bits from the page identifiers are effective in generating the hash.

In this way, the hash generator compensates for variations in the size and number of information blocks contained in the system. Since virtual address bits are taken from both the small segment and the large identifiers, the ratio of the number of large to the number of small segments is not important to the effectiveness of the hashing algorithm. □

F • END • UNTIL • DO • WHILE • END • ELSE • FOR • NEXT

Forth's forte is tighter programming

Organized as a dictionary, language lets user add own definitions provides structured control, mixes easily with assembly code

by Stephen M. Hicks, *Forth Inc., Manhattan Beach, Calif.*

☐ When it comes to programming microcomputer systems, flexibility is more than a code word. It is an attribute that can spell the difference between success and failure. Fortunately, there is a high-level programming language where flexibility is the watchword: Forth.

Unlike other high-level languages that insulate the user from the machine, Forth allows easy movement between higher-level, machine-transportable programming and assembly modules for input/output control or time-critical routines. It exploits what is called indirect-threaded coding, which means that statements are built from a dictionary of definitions coming both in the

```
: QUADRATIC   DUP  3  *   12 - *  20 + ; OK
50 QUADRATIC .  6920 OK

: TABLE   10  0  DO   CR  I .   I QUADRATIC .   LOOP ; OK

TABLE
0  20
1  11
2  8
3  11
4  20
5  35
6  56
7  83
8  116
9  155 OK

: PLOT   CR  0  DO   42  ECHO   LOOP; OK
45 PLOT
********************************************* OK

: PICTURE   0  DO   I  QUADRATIC PLOT LOOP  ; OK
7 PICTURE
********************
***********
********
***********
********************
***********************************
******************************************************** OK
```

1. Ready to go. Four Forth operations are executed in this sample development session. QUADRATIC computes $3X^2 - 12X + 20$ with $X = 50$. In TABLE, QUADRATIC is used with 0 through 9 as arguments to form a list. Finally, PLOT and PICTURE draw lines of asterisks.

Byte	Contents	Remarks
1	9	Length of name
2	Q	First 3 characters of name
3	U	
4	A	
5	link	Link field; contains address of the previous entry in this dictionary chain.
6		
7	code	Code address field; contains address of the machine code starting the address interpreter
8		
9	a (DUP)	Address of the dictionary entry for DUP
10		
11	a (LIT)	Address of unnamed literal routine, which executed, will pick up the literal from the following byte and push it on the stack.
12		
13	3	
14	a (*)	Address of the entry for *
15		
16	a (LIT)	Another literal follows. Eight-bit processors may have 8-bit or 16-bit literals; 16-bit processors have only 16-bit literals.
17		
18	12	
19	a (−)	Address of the entry for −
20		
21	a (*)	Address of the entry for *
22		
23	a (LIT)	Another literal follows. Note that all numbers are stored in binary.
24		
25	20	
26	a (+)	Address of the entry for +
27		
28	a (;)	Address of the entry for ; This routine terminates compilation or execution.
29		

2. Definition. Forth operations are stored as definitions in a dictionary. Shown above is the QUADRATIC operation of Fig. 1 as it appears in memory. Using reverse-Polish notation, QUADRATIC executes from the top to the bottom, relying on a stack for intermediate results.

operating system and from the programmer. Moreover it permits structured programming, which is to say the programmer transfers control down a hierarchy from the most general to the most specific routines.

Forth is extensible: the user can fabricate his or her own operations, data types, etc., and these definitions are treated exactly like Forth's own. So they are immediately available when the system comes up, with no need for access to a software library or subroutine.

Supportive language

The language supports all number bases and permits at-will variation of the base, with no run-time penalty. Users have immediate feedback, because either Forth or assembly operations are ready for immediate execution as soon as they have been written. Most operations may be tested just by typing their names and arguments.

Also, Forth runs stand alone, avoiding the trouble and expense of obtaining other software for the operating system. Identical syntax is used throughout—in the language itself, in the assembler, in the editor, and in the keyboard-command interpreter.

Available on floppy disk from Forth Inc., the language now runs on the 8080, Z80, LSI-11, 6800, and 1802. Versions for the 8086 and 9900 should be available in the spring. It is also available for several minicomputers, including Digital Equipment Corp.'s PDP-11, Data General's Nova and Eclipse, the Honeywell Level 6, Computer Automation's LSI 4, and others.

Forth comes with a complete operating system: compiler, built-in assembler, text editor, I/O drivers, and a keyboard interpreter. The entire package is itself written in Forth and takes only 6 kilobytes in a read-only memory for a minimal implementation; this is a complete resident system with no need for memory swapping (paging from a disk). Adding features such as data-base management or double-precision arithmetic would push the memory requirement beyond the 6 kilobytes, however. A complete data-base management system requires about 10 kilobytes.

The language runs in a 16-kilobyte development system using a disk for source programs and data. It suits substantial projects like multiuser programming. For microprocessor systems, a utility program is available to prepare application programs to operate out of

This article is the third in a series on using high-level languages to program microcomputers. The first is an overview [Jan. 18, p. 105]; the second discusses optimization by assembly coding [Feb. 1, p. 121].

programmable ROM. It compresses the operating system into about 512 bytes.

This run-time support package is larger than that required by most assemblers. Thus, for very small programs, Forth offers little or no size advantage over assembly code, although there would still be substantial advantages over other high-level languages.

For systems larger than about 2 kilobytes, Forth produces a program smaller than an assembler. In fact, the bigger the program, the greater Forth's memory efficiency, due largely to its dictionary structure.

Dictionary structure

Forth is different from conventional languages, which translate a source program into an object program. Instead, it consists of a dictionary of operations, which may be combined as necessary to form a new command. An incremental compiler translates each new statement into a dictionary definition, ready for execution. When the Forth program is executed, the operations indicated in each definition are carried out. New operations are defined in terms of those defined previously.

The system is delivered with more than 100 operations in the dictionary. The user need not know them all, because many are for internal system use. The dictionary is homogeneous, meaning that the programmer need not worry about where the system definitions end and the user's applications begin.

Forth operation names can be as long as 64 characters and can contain nonblank characters, such as letters, numbers, mathematical symbols, and even nonprinting ASCII codes. Examples of some actual operation names are SWAP, */MOD, and VOCABULARY. While the names can be any length, only their first three letters and their length are used for identification; 1BUFFER and 2BUFFER are different, but BUFFER1 and BUFFER2 are the same.

Since the language is extensible, the user can define new operations, usually with a colon definition. The colon, itself a dictionary definition, signals a defining operation and creates a dictionary entry for the new command, whose name immediately follows the colon. A semicolon ends the definition. The words between the name and the semicolon are already defined and will be executed when the definition is invoked.

Before discussing colon definitions, it is necessary to look at the operation of the stack, which is used to pass parameters among routines at run time. During execution, almost all high-level languages use at least one of these last-in, first-out data structures. Most languages, though, hide the stack, insulating the user from the structures of the machine. However, the Forth programmer explicitly controls the stack with postfix syntax, also called reverse-Polish notation. Using a postfix calculator is good practice for learning the language.

Postfix formulas

The following examples illustrate postfix formula calculations. These formulas are executed directly; the Forth computer is being used as a calculator, not to write new programs. However, any formula can be used within a colon definition.

To find 783 – 9903, one would enter 783 9903 – . using postfix notation. Here, the minus sign is the name of the subtraction definition, and the period is a print order. When this formula is evaluated, the number 783 is pushed onto the top of the stack, followed by 9903. The subtraction operation then destroys the original numbers, and replaces them with their difference. Finally, the period prints this number, now on top of the stack, as –9120 OK. The OK means the task is finished and the program is ready to accept new input.

With Forth, the number base can be changed any time. For example, 783 9903 – OCTAL . will cause –21640 OK to be returned. The system will stay in octal until it is set to some other base, by using DECIMAL, HEX, or BINARY, either from the keyboard or in a program. Any number base from 2 through 36 may be used, but is apparent only in the entry of numbers and delivery of the results. All internal computations are done in binary, so there is no execution time penalty.

The stack also plays a role in using an existing definition in a new one. Suppose the task is to evaluate:

```
(2 * TIME – 14) * (TIME + 5)
```

where time is an integer. The solution uses several predefined Forth operations, including @, which fetches the one-word 16-bit value from the location of a variable.

One way to compute and print this formula is to type:

```
2 TIME @ * 14 – TIME @ 5 + * DUP .
```

First the number 2 is placed on the stack. Then the variable TIME places its address on top of the stack with the 2 below it. The @ replaces this address with the integer stored there. The asterisk multiplies the top two stack numbers, replacing them by their product, and 14 – subtracts 14 from that value.

Now the stack contains the result of the first part of the formula. TIME @ 5 + computes the second half of the formula. The * multiplies the two together and puts the result on top of the stack. DUP makes a copy of the result and the period prints it. The copy insures that the value is still on the stack in case the user wants to store it or to perform further computations.

Colon definitions

If such a formula must be used repeatedly, it could be stored as a colon definition, thus becoming a new Forth operation. The programmer can give this computation a name, say FORMULA:

```
: FORMULA     2 TIME @ * 14 – TIME @ 5 + *;
```

The colon begins a definition, and the word following the colon is the name given to the operation being defined. The semicolon ends the definition, and Forth will not print any value when this definition is entered, but will respond OK. Now the new definition will be available, either directly from the keyboard or in a later definition. For example, FORMULA will compute and print the value contained in that formula.

Suppose FORMULA must be able to accept an argument from anywhere: from any variable, from the keyboard, or from the result of a previous computation. In such cases, the operation takes its argument from the stack. The following definition will do this:

```
HEX OK
CODE START   A SUB   1E OUT   NEXT JMP OK
CODE STOP   1 A MVI   1E OUT   NEXT JMP OK
DECIMAL OK

: DELAY   0 DO   LOOP ; OK

5000 DELAY OK

: CYCLE   START DUP DELAY   STOP DELAY ; OK
: TEST   50 0 DO   I QUADRATIC CYCLE LOOP ; OK

START OK
STOP OK

10 CYCLE OK
TEST OK
```

3. Low-level control. Assembly language is mixed with Forth statements for demanding tasks like input/output control. HEX switches from decimal to base 16. CODE indicates that what follows will be in assembly language, in this case that of the 8080.

```
: FORMULA      DUP 2 * 14 - SWAP 5 + * ;
```

The term DUP 2 * 14 – computes the first part of the formula, first making an extra copy of the argument so that the original stays on the stack. SWAP reverses the top two numbers on the stack so that 5 + adds 5 to the original argument, and the asterisk completes the computation. Now TIME @ FORMULA will use the value in TIME, 5 FORMULA will use the number 5, etc.

In a typical development session, definitions are typed in directly from the terminal and some are executed to test them (Fig. 1). The computer's responses are underlined, except for the numbers in the table and the plots. First, an operation called QUADRATIC is defined. Then it is used to take an argument (50) from the stack, and compute $3X^2 - 12X + 20$, with $X = 50$.

The QUADRATIC operation appears in most of the following definitions in Fig. 1, showing how existing definitions can be reused in new ones. The TABLE definition, which prints a table of values, uses QUADRATIC to calculate its entries. PLOT takes one argument and plots a bar of that number of asterisks, and the operation PICTURE uses that number of values of QUADRATIC, from zero through one less than the argument.

Figure 2 shows a tabular representation of the dictionary entry, generated in memory, for the QUADRATIC definition developed in Fig. 1. The first 8 bytes are characteristic of all definitions. The code address is unique for each kind of definition, this one being a colon definition. Other kinds are VARIABLE, CONSTANT, and CODE definitions, in which the code address actually points to machine code following directly in the definition. Users may add their own kinds of definitions, as well as definitions of standard operations.

Structural control

Forth provides structured control, a major improvement in program writing that has come into substantial use over the last few years. Structured programming employs certain hierarchical forms of conditional branching and looping that prevent an arbitrary flow of control. This contrasts with earlier languages' GO TO statements; once one of these is executed, to backtrack in the program to find an error is complicated.

The simplest Forth control structure is IF ... THEN, for conditional branching. When the IF is encountered, the program interprets the next stack entry as a Boolean argument; a zero indicates false, any other value true. The code within IF and THEN can be any list of commands of any length and is executed if the Boolean value is true. Execution of the program continues after the THEN statement, whether the test is true or false.

If specific code must be executed in the event of a false test, IF ... ELSE ... THEN can be used. The false code is located between the ELSE and THEN statements. A bonus in Forth is that the expressions based on Boolean tests can contain other such tests. An IF ... THEN may appear inside the true portion of another IF ... THEN, for example. This nesting, as it is called, may be done to any depth.

For looping, Forth includes a BEGIN ... END expression. The code inside the loop is executed, leaving a value on the stack. END treats this as a Boolean value that terminates the loop if true. Otherwise, the looping continues. A similar operation BEGIN ... IF ... WHILE returns to BEGIN as long as the IF is true.

The structure DO ... LOOP takes two numbers from the stack; the first is an index, and the next is the terminating value plus 1. For example, the expression 100 0 DO ... LOOP goes through the loop a hundred times, with index values going from 0 through 99. Inside the loop, an operation named I retrieves the current value of the index and leaves it on the stack. This index advances by 1 for each iteration of the loop.

A related operation, +LOOP, takes the increment value off the stack. The increment can be a constant other than 1, or it can be computed inside the loop.

Looking up definitions does take a certain amount of

```
( QUADRATIC  OSCILLATOR)
: QUADRATIC   DUP  3  *  12  -  *  20  +  ;
: TABLE   10  0  DO   CR  I  .   I  QUADRATIC  .  LOOP ;

: PLOT   CR  0  DO   42  ECHO   LOOP  ;
: PICTURE   0  DO   I  QUADRATIC  PLOT  LOOP  ;

HEX
CODE START   A  SUB   1E  OUT   NEXT JMP
CODE STOP   1  A  MVI   1E  OUT   NEXT JMP
DECIMAL

: DELAY   0  DO   LOOP  ;
: CYCLE   START   DUP  DELAY  STOP  DELAY  ;
: TEST   50  0  DO   I  QUADRATIC  CYCLE   LOOP  ;

OK
```

4. Source screen. Forth stores code in 1,024-byte screens, which are displayed as 16 lines of 64 characters on a CRT. This screen contains the definitions depicted in Figs. 1 and 3. The Forth text editor is used to prepare and maintain such screens.

time. Sometimes speed is critical, or a program to interface a newly added I/O device must be written. In such cases, the Forth assembler comes into play to define machine language or primitive operations.

These routines can be used exactly as any other Forth definitions. The assembler, too, uses postfix syntax, so operands and addressing modes are written first, followed by the (mnemonic) operating codes. The operands and modes place data or addresses on the stack. The op code combines those arguments with the binary instruction code, and places the completed machine-language instruction into the dictionary where the definition of the new operation is being created.

The assembler *et al.*

The assembler takes one pass to translate source code and uses no symbol table. Instead, the stack is used for the operand memory addresses provided by Forth variables, constants, or computations.

The assembler has its own set of conditional instructions, including IF . . . THEN and BEGIN . . . END. These operations create conditional testing and branching instructions in the language of the machine being used. Higher-level and assembly versions of these control operations are kept separate because they reside at different addresses in the dictionary.

How can a one-pass assembler handle forward branches of unknown length, as with IF . . . THEN statements? The IF assembles a conditional branch instruction into the routine, leaving the unknown address blank. It also places the location of that blank address onto the stack (the same used to run Forth). When THEN is reached, the destination address of the branch is known, and the blank is replaced with its proper value.

The Forth assembler definitions START and STOP in Fig. 3 use 8080 machine language to turn on and off a device connected to an output port. DELAY is a timing loop, here written in Forth; it could have been written with the assembler instead. It accepts one argument, proportional to the length of the delay. Next CYCLE is defined. It accepts one argument, a delay, and turns the output port on and then off for that time. Finally, TEST uses QUADRATIC to compute a series of delay cycles to the I/O port.

Forth's organization goes beyond the dictionary structure and the structured control found in both high-level and assembly codings. It includes a block-oriented virtual memory scheme that contains the programmer's source code and any data he may wish to store.

Virtual memory scheme

In the random-access virtual-memory system, an operation called BLOCK takes a disk-block number from the stack and returns the address of a memory buffer containing that block's data. A buffer typically is 128 bytes in most microprocessors and 1,024 bytes in most minicomputers. BLOCK reads from the disk as necessary. If the data is already in a buffer from a previous call to BLOCK, no read operation takes place.

Two other operations are important in this virtual memory system. BUFFER gives the programmer the address of an empty buffer, and FLUSH writes all updated buffers to the disk, as at the end of a session.

Forth stores its source code in 1,024-byte units called screens. Each screen is displayed as 16 lines of 64 characters on a cathode-ray tube or a printing terminal. Because definitions are short, seldom over three lines, the entire code for an operation is displayed at once.

A command called LOAD takes a screen number off the stack, and reads that 1,024 bytes of data exactly as if it had been typed directly at the terminal. The screen can contain high-level or assembly definitions or an operation to be executed immediately.

Figure 4 shows a listing of a Forth source screen containing definitions developed in Figs. 1 and 3. Parentheses surround comments, which may appear anywhere. Forth's resident text editor is used to prepare and maintain such screens. □

Peak detector recovers narrow pulses accurately

by Jerome Leiner
Loral Electronic Systems, Yonkers, N. Y.

This peak detector can accurately process input data pulses as narrow as 50 nanoseconds and as high as 3 volts. The recovered voltage is always within 1% of the input signal's true value.

In the circuit shown, emitter-coupled logic generates a −0.2- to −3-volt signal for input into amplifier A_1. Assuming a pulse with a 50-nanosecond width and a rise and fall time of 5 ns, that leaves storage capacitor C_4 only 45 ns in which to charge. The LH0024 op amp used for A_1 has wide bandwidth and a high slew rate to accommodate the fast charging required.

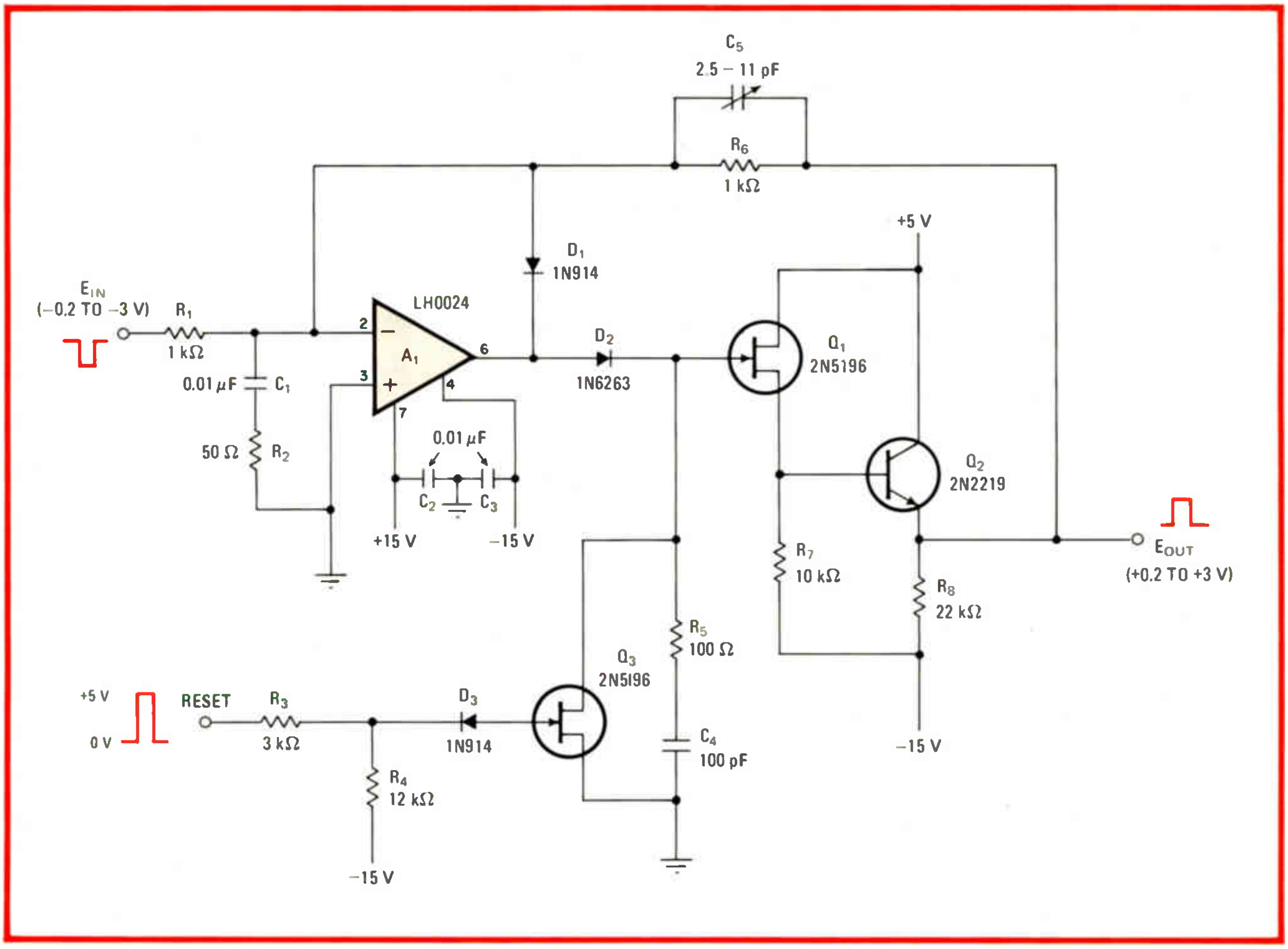
Q_1 acts as a buffer to prevent C_4 from discharging through R_7 between system reset pulses. The voltage at Q_1 appears at Q_2 and is fed back to A_1, to be compared with E_{in}. When E_{out} reaches E_{in}, D_2 becomes back-biased and the stored charge is held until C_4 is intentionally discharged by the reset signal. D_2 remains back-biased during discharge.

A_1 is normally used as an amplifer, and so it will be driven into negative saturation whenever the input signal drops below the output level. D_1 prevents this by clamping the amplifier output.

C_1 and R_2 provide A_1 with input- and feedback-signal stabilization. C_5 compensates for A_1's input capacitance. Note that if C_1R_2 were placed at the output of A_1, a larger charging current would be required for a given input signal. Because this current is usually limited, A_1's effective slew rate would be reduced.

The peak detector is optimized by shorting D_2 and then adjusting C_1, R_2, and C_5 for minimum overshoot and ringing on a series of fast data pulses. □

Fast and precise. Using one op amp, one transistor, and two field-effect transistors, peak detector recovers data pulses having amplitudes of up to 3 volts and widths as narrow as 50 nanoseconds. Output voltage is within 1% of the input data's true value under all signal conditions.



Optoisolator initializes signal-averaging circuit

by J. Ross Macdonald, *Department of Physics and Astronomy, University of North Carolina, Chapel Hill*

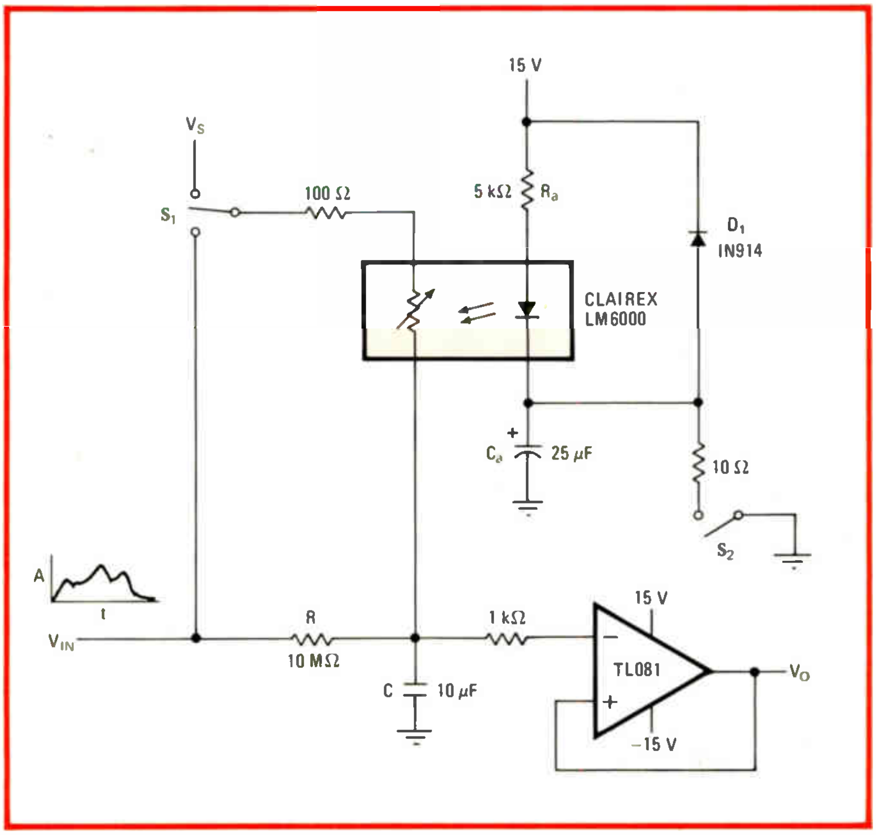
Long-term averaging circuits require an initializing voltage on their capacitive storage element in order to become almost immediately operational on power up. Here, an optoisolator is used to quickly charge the capacitor with a voltage derived either from the input signal itself or from any dc voltage, the two sources most widely used. The optoisolator circuit is superior to an initializer that uses a relay, which, besides having the disadvantage of being electromechanical, also draws power continuously.

In a circuit that averages a signal over a long period (see figure), the resistor-capacitor (RC) time constant may be on the order of a minute or more. Thus, the output of the averager (V_o) during the time $t = 0-1$ minute is considered to be the circuit's transient response to the input signal, where t is measured from the time that power is applied to the circuit. In most cases, especially when the circuit is part of a more complex system, it is not feasible to wait that long before the RC network starts generating a true average value.

The difficulty may be circumvented by using an optoisolator and a switch, S_1, to charge C on power up. Assume it is desired to charge C from a dc voltage, V_s. When power is applied, C_a, which may be 25 microfarads or more, is charged through R_a. Consequently, as current flows through the photodiode, the value of the photoresistance element in the LM 6000 optoisolator is reduced from more than 10^9 ohms to about 1 kilohm. Thus, in a few tens of milliseconds, C charges to V_s through the element, if S_1 is placed in the V_s position. As C_a becomes fully charged, the resistance of the element quickly increases to at least 10^9 ohms, and the circuit is ready to operate in its intended averaging mode.

When power is removed, C_a discharges through D_1, so that the on-off power cycle can be repeated fairly rapidly. C also discharges slowly through R. This action is of little consequence in circuit operation on a subsequent power up. Note that S_2, a momentary-contact switch, allows the resetting process to be repeated at any time, even while the circuit is active.

To initialize C from the input signal, it is only necessary to connect S_1 to V_{in} prior to power up (or at any time if S_2 is utilized). Otherwise the initializing operation is the same as before. □



Speedy average. Optoisolator enables long-term averager to operate almost immediately after power up by presenting an initializing voltage to circuit's sampling capacitor, C. Charge is introduced through isolator's low-resistance photoelement. Either a dc voltage or the input signal can be used as the initializing source.

Timer generates sawtooth with switchable symmetry

by Roberto Tovar-Medina
Institute of Applied Mathematics, University of Mexico

With some inexpensive components, a 555 timer operating in the astable mode forms a circuit that generates triangular waves of selectable symmetry. The cost of the unit is below $6.

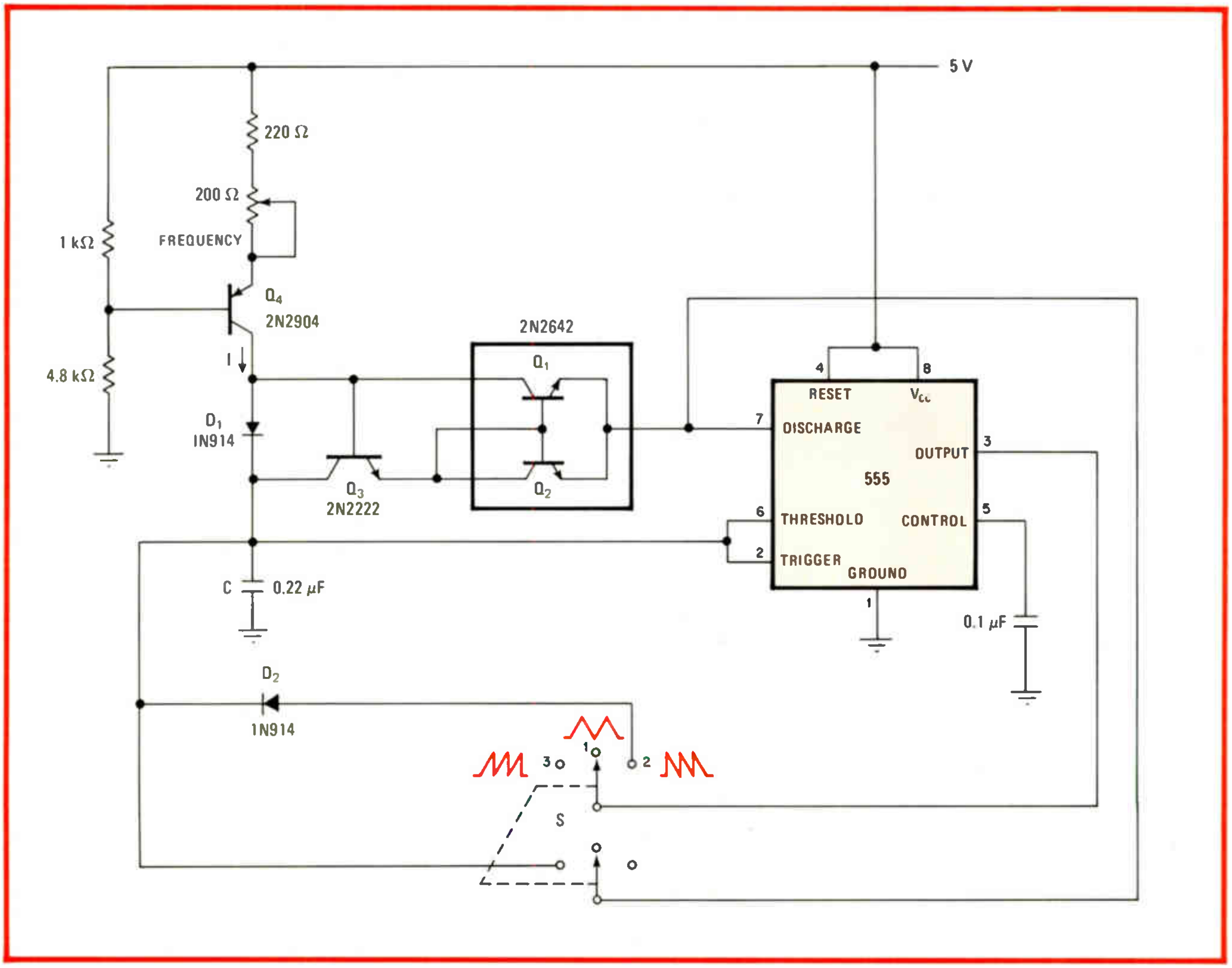
The triangular waves are generated by charging a capacitor with a constant current, I, and discharging the capacitor through a current mirror that sinks I. The symmetry is controlled by selecting the rate at which the capacitor is charged and discharged.

When capacitor C is virtually discharged and the switch, S, is at position 1 as shown, pin 7 of the 555 (the discharge port) is high, and Q_1 and Q_2 are off. Thus the capacitor is charged at a rate of It/C, where t is time, until the voltage at pin 6 (threshold port) of the 555 exceeds two thirds of the supply voltage, V_{cc}.

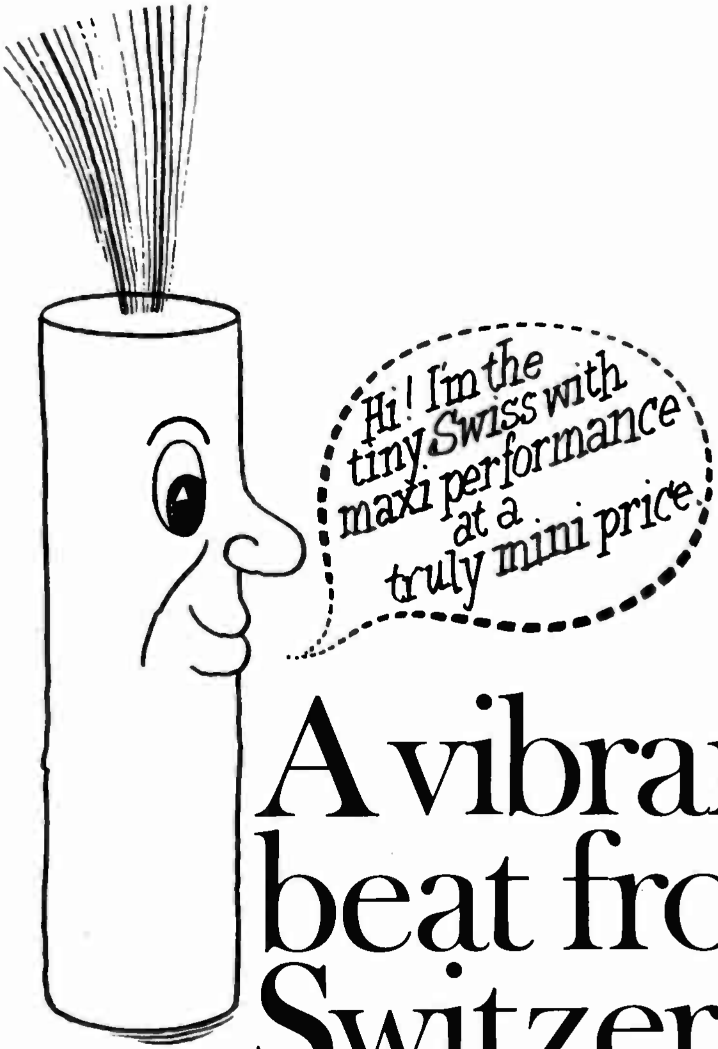
Pin 7 then moves low, Q_1 and Q_2 turn on, diode D_1 becomes back-biased, and C discharges through Q_1, Q_2, and Q_3 at a rate of It/C. When the voltage at pin 6 falls below a third of the supply voltage, pin 7 moves high again and the process repeats at a frequency given by $f = 3I/2CV_{cc}$. At low frequencies (below 1 kilohertz), D_1 may be omitted, because C can charge through the base-collector junction of Q_3. At high frequencies, D_1 must be included to avoid the discontinuities in the triangular waveform that are caused by switching.

A fast charge time is attained if the output of the 555 (pin 3) is connected to pin 6 through diode D_2. This connection is achieved by placing S in position 2. The discharge time is the same as before. Connecting the discharge port directly to the threshold pin yields a normal charge time and a fast discharge time. S must be placed in position 3 to achieve this symmetry. In either case, the operating frequency is exactly twice what it was previously, or $f = 3I/CV_{cc}$.

Given the component values shown, the circuit oscillates at about 1 kHz. It can be made to work at frequencies up to 30 kHz, however. □



Adjusting slope. Circuit built with 555, constant-current source, and current mirror generates triangle-type waves whose symmetry is selectable. Frequency is controlled by magnitude of I, which is adjusted with potentiometer. Three-position switch determines rate at which C is charged or discharged, so generator can produce standard or fast-rising sawtooth waves or waves that are truly triangular.



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Porcelain-on-steel boards can launch a thousand chips

Thermal and mechanical properties of popular appliance material cut processing steps in hybrid and pc-board manufacture

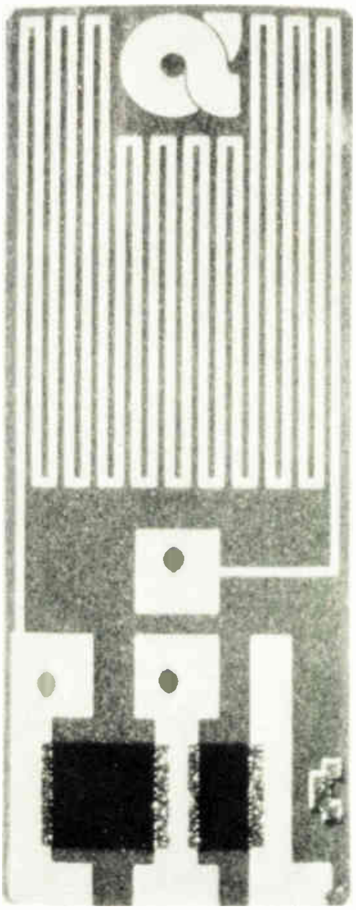
by Murray Spector, *Alpha Advanced Technology Inc., Newark, N. J.*

☐ Porcelain-coated steel, the material found in every kitchen, comes close to being the ideal substrate long sought by manufacturers of both thick-film hybrid circuits and printed-circuit boards. It has excellent mechanical and thermal properties and is low-cost in large volumes.

Its ruggedness will enable the hybrid makers to move from their present small, fragile alumina substrates to ones at least the size of pc boards, having built-in heat sinks and ground planes, and promising eventually to carry over a thousand chips. Its good thermal properties will enable the pc-board manufacturers to print and fire conductive and resistive inks directly onto it (Fig. 1), cutting their costs tremendously by eliminating all the plating and etching now needed, as well as much of the component assembly.

Still other benefits will be shared by both groups. For instance, the metallic substrate can be bent and shaped easily. After enameling, it survives environments inimical to both ceramics and plastics. Finally, it is possible either to wave-solder discrete components or wire-bond chips to the new steel boards.

A porcelain-coated steel substrate has a core of low-carbon steel and a coating of fired-on porcelain enamel. The porcelain enamel is a ceramic with a firing temperature high enough to allow hybrid components to be fired onto it subsequently at 650°C. Conductors may be of copper, silver, palladium-silver, platinum-silver nickel, gold, or any other metal available as a screenable ink. Resistors are ruthenium-oxide–based, and the smooth surface of the porcelain often makes their fabrication so uniform that trimming is unnecessary. When necessary, however, it may be done abrasively or by laser—and with the circuit energized. This kind of active trimming is possible because of the thermal mass of the steel, which is so great that it prevents the resistor from heating up much during the process.

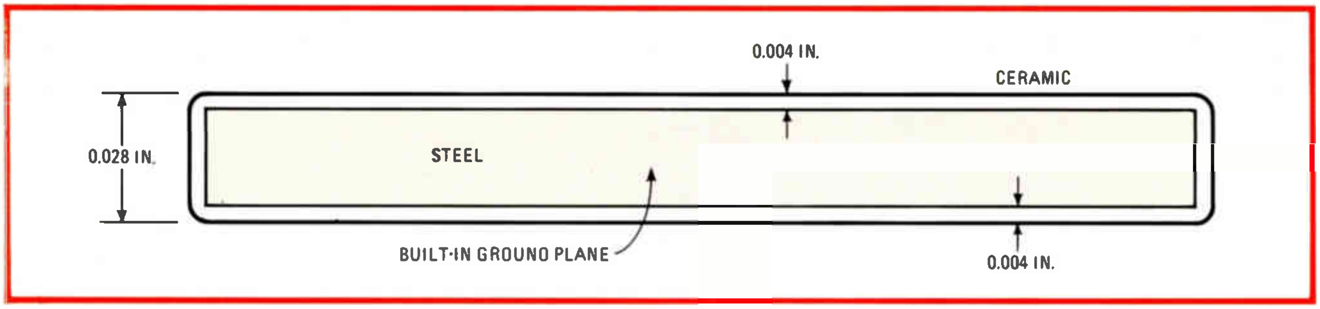


1. Porcelain on steel. The thermal and surface properties of porcelain-coated steel allow modified thick-film inks to be screened and fired onto its surface at a relatively low temperature. A sample, shown above, has screened-on resistors and conductors.

From heaters to circuits

Way back in the 1930s, heaters were being made of copper on porcelain-coated steel. So in the 1940s, when printed wiring boards were invented, there were immediate attempts to make boards with a metal core. But success came only in 1965, when steel boards were insulated with epoxy. Epoxy, though, cannot take the firing temperatures needed for hybrid circuits, so in 1967 the first serious attempts were made to use porcelain-coated steel in electronics. Some manufacturers of thick-film inks made inks that would fire at the right temperatures for it, but additional engineering problems with the inks and the coated steel held up the full emergence of the new substrate until about 1977.

Today porcelain-coated steel represents a new substrate technology. It has its limitations, which will be discussed later, but evaluations currently under way at several large potential users will probably result in its use



2. Big boards. After processing, a porcelain-on-steel substrate has a cross section as shown. The 28-mil-thick steel core can be used as a built-in ground plane. Boards of this composite material, aimed at large-scale circuitry, can be fabricated in sizes as large as 12 by 18 inches.

this year in both military and consumer electronics—automobiles, telephones, telephone switching circuits, television sets, and appliances. Still other possible areas of application are computers and medical electronics.

The metal-working step

The manufacturing process starts with the fabrication of the steel core by any of a number of common metal working techniques. For prototype runs, it is most economical to chemically mill the steel core. For larger quantities, a stamping process is best, being very inexpensive on a per-piece basis once the tooling is in place.

The tooling, however, can be very expensive, because it needs to be unusual. Simply drilling circular holes straight down through the steel substrate is not enough. Picture one such hole in cross section. It would have a square shoulder, and a square shoulder causes a porcelain coating to pull away from it and create a ridge encircling the hole. The result would be a point of minimum insulation and of extremely high electrical field density—in other words, an insulation breakdown hazard bad enough to defeat the use of this design in many electronic applications.

The solution to this problem is either to flare or to bevel the edge of the hole. This rounding of the sharp corners has the additional benefit of facilitating the automatic insertion of leaded components.

Once the steel is formed into its final shape, it starts through the processes leading to enameling. It is cleaned and then pickled in an acid solution, which roughens the surface and promotes the adhesion of the enamel. Pickling is followed by a rinsing operation and then by nickel-plating, which further promotes enamel adhesion. After additional rinsing the steel is ready to be dipped into the enamel.

Electronic-grade porcelain

The enamel used is a formulation designed for continued operation in an electric field at elevated temperature. It is applied in a water solution to the part, which then must be very carefully dried before firing; otherwise the water will vaporize explosively and pit the enamel surface. The firing yields the finished substrate—a 0.028-inch-thick core of enameling-grade steel coated on both sides with a black ceramic layer 0.004 inch thick (Fig. 2).

Metalization is next applied to the porcelain. This involves screening on a metal paste and firing it. The Electronic Materials division of E. I. du Pont de Nemours & Co., Niagara Falls, N. Y.; Cermalloy, Cermet division of Bala Electronics, West Conshohoken, Pa.; Electronic Materials Corp. of America (EMCA), Mamaroneck, N. Y.; Electro-Science Laboratories Inc., Pennsauken, N. J.; and Thick Film Systems, Santa Barbara, Calif., all manufacture precious-metal conductors, resistors, and dielectrics formulated for porcelain adhesion and having firing points between 600° and 650°C. These inks resemble those used on alumina substrates except for their lower firing temperatures. Additionally, DuPont and Cermalloy both have copper inks available. Where through-hole printing is required on double-sided boards or substrates, a special ink formulation is necessary to provide the requisite kind of plastic flow, or rheological properties.

Wave-soldering to copper

Copper inks are especially suited to printed-wiring-board applications since they allow the use of 60/40 tin-lead solder. Precious-metal inks, preferred by hybrid-circuit manufacturers, have the disadvantage of requiring a more expensive silver-bearing solder to inhibit the precious-metal ink from being leached off the board during soldering.

Wave-soldering a porcelainized steel board with copper conductors is not the same as wave-soldering a conventional epoxy-glass printed-circuit board. Preheating temperature and soldering speed must both be higher than those necessary with the epoxy board.

The first adjustment must be made because of the high heat capacity of the steel core. The core acts as a heat sink to the copper and prevents it from reaching soldering temperature unless the board has been sufficiently heated beforehand.

Conversely, at the time of application of the solder, when the board is over the solder wave, the core acts as a heat source and could encourage the solder to flow too far up the component leads. This can be prevented by speeding up the belt.

The steel core of the substrate may be used as a ground plane. First the bare steel must be exposed; then contact is made to it by conductive epoxy or by deposition of a thick film.

Comparing board materials

The biggest difference between steel and plastic boards lies in their thermal conductivity. None of the plastics used in standard printed wiring boards is good at conducting heat—a problem there have been many attempts to alleviate. One approach uses heavier copper laminates, but then the thickness of the copper demands that all lines and spaces be widened. Another approach is to back the board with aluminum or steel, but this is awkward and expensive and has gained relatively little favor with the industry.

A porcelain-coated steel board is far superior to a plastic type in thermal conductance, even when no direct contact is made to the steel core. By way of comparison a 2-watt precision resistor operating at rated power on an epoxy-glass board is 25.2°C hotter at its surface than an identical resistor mounted on an Alpha porcelainized steel substrate, trade-named Alphamet.

Even this performance can be enhanced by making ground contacts to the steel core and putting the core in metal-to-metal contact with a system's chassis. This is made possible by masking the steel so as to prevent porcelain from being deposited on any area to be directly contacted. The procedure often eliminates the need for heat-sinking components.

A second difference is that plastics all expand much more than steel with increased temperature. It is because of this characteristic that the pad areas around the holes on plastic boards have to be large, to compensate for any misalignment of the final etch pattern with holes. On porcelain-coated steel boards, the pad areas can be smaller because the much lower thermal expansion of steel allows more precise alignment.

Finally, standard printed-circuit board materials cannot be used reliably in high-temperature environments, as in an automobile engine, oil drilling apparatus, and thermal printing heads. These are all applications where porcelainized steel boards are found to be highly satisfactory substitutions.

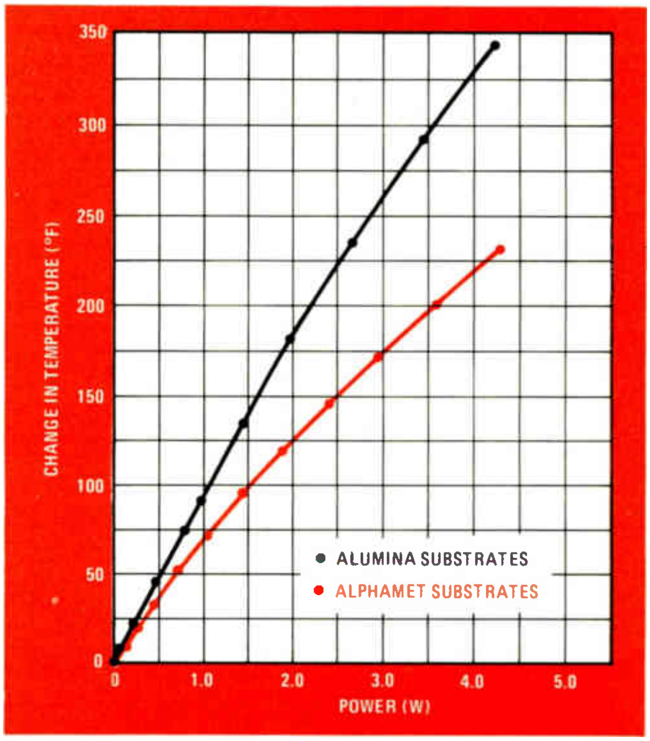
Steel vs alumina

All-ceramic substrates, in contrast, are inferior to steel not only thermally but in their electrical and above all their mechanical properties.

Indeed, mechanical fragility has historically been the greatest drawback of alumina and beryllia wafers. It precludes their use entirely in many harsh mechanical environments, or only if equipped with expensive steel backing plates. The same fragility keeps yields low in both substrate fabrication and finished circuit assembly and creates a cost structure that increases exponentially with substrate size. Porcelain-coated steel, on the other hand, is virtually indestructible, and its cost per square inch is unaffected by size.

To illustrate comparative thermal performance, identical resistors were printed on alumina and Alphamet substrates. Then the increase of temperature at the resistor surface was plotted as a function of power in the resistors. As can be seen in Fig. 3, alumina heats up faster and to a higher temperature than the Alphamet.

It is worth noting that a simple conductivity concept is not enough for a proper theoretical analysis of a composite material like porcelain-coated steel. Instead, the conductance of all five layers of the structure must be considered—the two outer porcelain layers, the innermost steel core, and the two transition layers between the porcelain and the steel. In addition, unlike other



3. Hot plates. A comparative plot of temperature change versus power shows porcelainized steel has a lower temperature rise per watt than similarly sized alumina substrates. The new substrate's steel core contributes to its excellent thermal conductance.

substrates, porcelainized steel radiates a significant amount of heat. The emissivity of its black porcelain is a measure of its efficiency at this form of thermal transfer. A mathematical model taking all these factors into account has been found to generate experimentally verifiable results.

As already noted, the thermal performance of porcelain-coated steel may be further enhanced by supplying metal-to-metal thermal paths away from the substrate. This is typically done by providing the substrate with unporcelainized mounting pads for bolting it to a chassis.

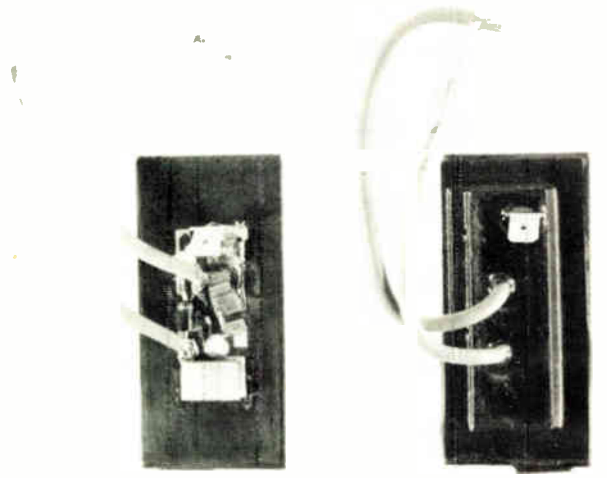
Finally, the steel core serves as an electrical plane, useful either as a ground plane or sometimes as a power distribution plane. Either use eliminates the need for one conductor and one dielectric layer.

Electrical performance may also be enhanced by the availability of two-sided construction. Conductor-filled holes can be provided as vias, or plated through-holes, connecting the two sides of the substrate.

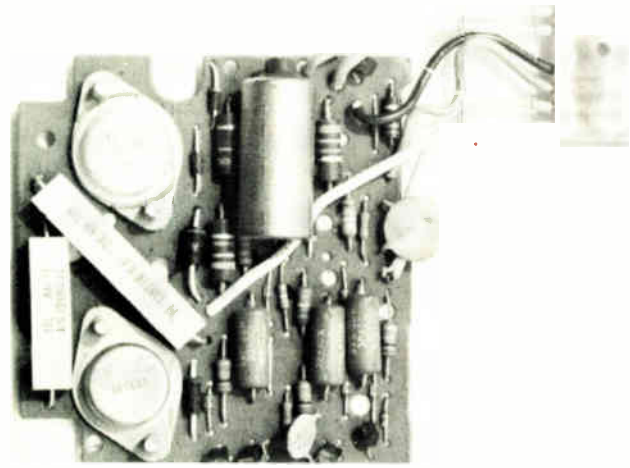
For multilayer circuits the number of firings is halved by using a cycle of print-dry-print-dry-fire. In applications where crosstalk is a factor, circuits can be separated and then shielded from each other by their common steel substrate.

Bending steel

The presence of the steel core creates two other useful properties that are not to be found in other rigid substrates. First, the steel can be worked in three dimensions; on a simple level, the edges of a board can be bent so that it becomes its own chassis. Second, the porcelain surface absorbs no water, and the ceramics used in



4. Potted power. Porcelain-coated steel replaces alumina in substrate for power-supply circuitry. The same material also replaces the aluminum heat sink. Hybrid thick-film techniques were used in both cases. An unpotted module is pictured to the left.



5. Printed wiring on steel. This porcelain-coated steel pc board has been substituted for a plastic type in an electronic ignition system designed at Motorola. Note the discrete components. Final version of this circuit will be a thick-film hybrid on a steel board.

hybrid substrates allow the porcelain-coated steel actually to be the outer wall of any package.

For all its advantages, porcelain-coated steel does present some problems, both technical and otherwise. The first is ion migration.

Porcelain enamel is a complex material. From an electrical point of view, it is generally considered to be simply an insulator. However, at a thickness of 4 mils, it is far from ideal in that role. The metallic oxides that comprise the porcelain ionize under the influence of heat and voltage. In a dc field, the ions move and constitute a leakage current to a working circuit. To minimize this problem, the current under an 0.080-in. pad (the size of a typical integrated circuit) should be less than 10^{-13} ampere. Also, the rate of ion generation should be so low that the adhesion of the metalization to the porcelain will not be affected by ion accumulation for 40 years.

The other technical problem is brown plague—the oxidation of silver alloy conductors at the edge where they accidentally come in contact with the steel core. The mechanism is not well understood, but can be avoided by using copper for ground contacts and keeping silver 0.060 in. away from the substrate edges.

The third problem is economics and concerns the cost-volume relationship. Tooling for steel substrate manufacture is so expensive that the process becomes cost-effective against epoxy-glass printed wiring boards only at a volume of over 100,000 substrates.

The last, and perhaps the largest, problem is psychological. The unavailability of all-ceramic substrates in large sizes at a reasonable cost has conditioned designers of hybrids to think in terms of circuit functions rather than systems. Designers now have to reorient themselves to today's reality in which 12-by-18-inch substrates are available, along with screen printers, drying ovens, and firing furnaces big enough to handle them.

Packaging power

Despite these obstacles, enameled steel substrates are being evaluated for many tasks. Figure 4, for instance, shows an application in a small power supply. The porcelainized steel substrate replaces an alumina substrate and an aluminum heat sink. Figure 5 shows a pc-board-like application—an automotive electronic ignition system—in which screened-on metallic conductors are combined with discrete components on porcelain-coated steel. It is a transitional version, meant to be followed by a completely hybridized version.

Steel substrates are eminently suited to the rough under-the-hood environment of cars and indeed in any high-shock environment. For example, ceramic hybrid boards are often backed with metal in such shock environments. This is an expensive procedure since both materials require extremely precise machining if they are to mate well enough to withstand the shock. A ceramic-on-steel substrate eliminates the need for a two-piece part as well as the high cost of machining surfaces in the first method.

Similarly, a circuit board, when it is required to act as a mechanical member of a mechanical assembly, often needs a metal backing. In one system a large plastic pc board had to be stiffened with a piece of aluminum before it was able to serve as a panel for rack-mounted equipment. A porcelain-coated steel board, on the other hand, could replace the aluminum plate and the epoxy-glass board.

A look to the future

Applications for porcelain-coated steel are moving in two major directions, toward combining existing functions and toward altogether new functions.

Its potential for serving as both circuit board and chassis or even package has already been mentioned. Another possibility is for the same substrate to support thin and thick films and discrete components.

As for the jobs that only porcelain-coated steel can do, thermal sensors have already been designed on such a substrate for direct insertion into a car's engine block. □

8085 program rapidly computes 8-by-16-bit product

by Gary A. Sitton
Baylor College of Medicine, Houston, Texas

More and more applications require finding the product of an 8-bit and a 16-bit word. Multiplication is easily done with this program using the versatile double-precision add (DAD) command in the instruction set of the 8085 microprocessor. The program thus uses less memory than other 8-by-16-bit multiplying algorithms, which require double-precision software geared to a 16-by-16-bit product.

One of the program's advantages is the time saved in multiplication. Defining the 8-bit word as the multiplier, n, the program needs no more than n shifts and double-precision additions.

The bits to be multiplied are introduced at register pair D-E and accumulator A. D-E and A are altered during execution but can be saved on the stack if so desired. Meanwhile, the DAD H instruction shifts the multiplicand left one position each time it is called by placing the 16-bit number in register pair H-L and adding it to the number already contained therein. The product is left in H-L upon program termination.

The execution time of the program will be directly proportional to the number of significant bits in the multiplier. If the total number of significant bits in register pair D-E and accumulator A exceeds 16, there will be no detectable error in the multiplication. ☐

8085 PROGRAM FOR 8-BY-16-BIT MULTIPLICATION

```
LOC   OBJ       SEQ          SOURCE STATEMENT

1000              1          ORG    1000H    ; ORIGIN = 1000 HEX
                  2
                  3  MULT:                   ; H, L = A * D, E (BOTH UNSIGNED)
                  4
1000  210000      5          LXI    H, 0000  ; CLEAR H, L
1003  B7          6  MLOOP:  ORA    A        ; CLEAR CARRY, GET STATUS
1004  C8          7          RZ              ; RETURN, MULTIPLY DONE
1005  1F          8          RAR             ; CARRY = MULTIPLIER LSB
1006  D20A10      9          JNC    SHFT     ; LSB = 0, SKIP ADD
1009  19         10          DAD    D        ; ADD IN MULTIPLICAND
100A  EB         11  SHFT    XCHG            ; SWAP D, E & H, L
100B  29         12          DAD    H        ; SHIFT MULTIPLICAND HERE
100C  EB         13          XCHG            ; SWAP D, E & H, L BACK
100D  C30310     14          JMP    MLOOP    ; CONTINUE
                 15
                 16          END
```

Fractional-binary program creates pseudorandom integers

by Robert L. Harding
Quaker Data Products, Middlebury Center, Pa.

Using the routine proposed by Tański,[1] this program generates a true pseudorandom sequence of integers over any range of numerical values from 0 to 255. The former program is used as a subroutine, called W times for a given word length W, so that 2^W fractions, each extending from 0 to a value approaching 1, are generated. Each fraction, which is pseudorandom, is then multiplied by the desired range (0–255) to produce pseudorandom integers.

Although Tański has shown that a 31-stage register with feedback is ideal for use in a pseudorandom sequence generator, his article implies that the register provides 31-bit random numbers each time the subroutine is called. In reality, the subroutine tends only to double the previous number generated, with the result that eventually the numbers can be predicted. Thus pseudorandom words are generated for only a relatively short period of time.

In order to produce random numbers over a long period in any word size up to W = 31, it is necessary to clock the registers (i.e., call the subroutine) at least W

FRACTIONAL-BINARY PROGRAM: PSEUDORANDOM INTEGERS

```
; 18-byte program translates a source of pseudorandom "binary fractions" into any desired RANGE
; (up to 255) of pseudorandom integers. Mapping operator is multiplication.
;
; Select fraction word size, W, for tolerable degree of distortion of original randomness.
;
          MVI     C,W        ; set loop counter
          XRA     A          ; clear RESULT register A

LOOP:     MOV     B,A        ; save partial product
          CALL    TANSKI     ; pseudorandom bit-source
                             ; sets S-flag (multiplier)
          MOV     A,B        ; B:  partial product
          JP      SHIFT      ; if random bit = 0, skip
          ADI     RANGE      ; if = 1, add multiplicand
SHIFT:    RAR                ; discard fraction bit
                             ; from result.  A:  new product (integer)
          DCR     C          ; count down W (word size)
          JNZ     LOOP       ; until finished
                             ; A:  final result = 0 thru RANGE -1
                             ; increment A to start values at 1 instead
RANGE     EQU     36         ; for roulette example
W         EQU     24         ; see text
                             ; W (maximum) = 31 to keep bit-source pseudorandom
TANSKI    EQU     PRBN       ; subroutine entry label
```

TANSKI: 8080A PSEUDORANDOM-BIT PROGRAM

```
PRBN:   DAD  H       ; shift lower part, clear LO
        MOV  A, E    ; shift higher bytes sequentially
        RAL          ;       8080A: use AC, CY
        MOV  E, A    ;       Z80   : RL E, RL D
        MOV  A, D
        RAL
        MOV  D, A
        XRA  L       ; calculate feedback
        RP
        INX  H       ; update LO if needed
        RET
```

times to generate W fresh bits. Here, the fractional-binary program is used to call the Tański program to generate a random word.

Each random word is considered one binary fraction of W bits (low-order bit first) in a total of 2^W fractions. The numerical range (RANGE in program) over which pseudorandomness is desired is then multiplied by the given fraction, and the integer portion of the product is retained. This operation will translate the fractional range into integer values extending from 0 to the value (RANGE − 1) with virtually equal probability. Note that the program multiplies with a conditional-add and shift algorithm. Whereas the Tański program delivers the multiplier bit by bit (via the S-flag), this program uses a single register to accumulate an 8-bit product. The integers generated are thus pseudorandom within the specified RANGE.

The only pitfall in using the program lies in selecting the length of W. It must be large enough to produce fractions with sufficient resolution to preserve the original randomness. For example, if RANGE is selected to be 36 so that numbers can be generated for roulette, then

W = 6 would be too small, because $2^6 = 64$; the 64 fractions produced would translate into each of 28 integers twice, but into each of the remaining 8 integers only once. That much bias on the roulette wheel could bring disaster to the house.

Selecting W = 24 would yield 2^{24} fractions to be mapped onto the desired RANGE. The resolution provided when that number is chosen would yield virtually no distortion of the source's randomness for a RANGE all the way up to 255. □

References

1. Tomasz R. Tański, "11-byte program generates 2 billion pseudorandom bits," *Electronics*, Oct. 12, 1978, p. 148.

Engineer's notebook is a regular feature in *Electronics*. We invite readers to submit original design shortcuts, calculation aids, measurement and test techniques, and other ideas for saving engineering time or cost. We'll pay $50 for each item published.

Five-state LED display monitors paging system

by D. F. Fleshren
Springfield, Va.

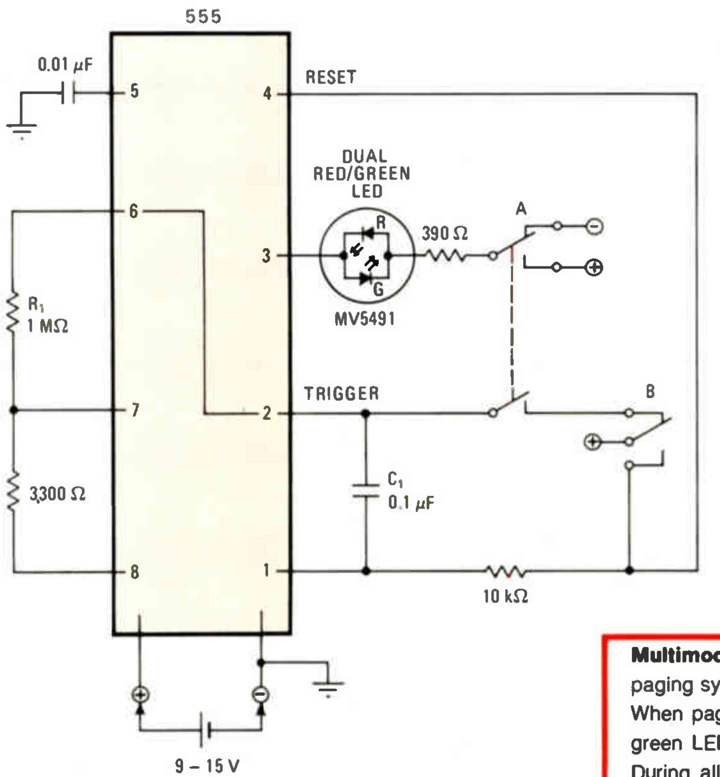
This paging station circuit uses a single red- or green-light-emitting diode to alert the user to any of five distinct paging conditions. It is a simple, extremely easy-to-build monitor designed to be part of a large paging system. Two relays and a 555 timer send a signal to the LED (a Monsanto MV5491 or Xciton XC5491) to produce the following signals:

- Off (no power) indicates that paging has been cut off to that station or the region in which it is located.
- Steady green signifies that the station is operational, but is not being paged.
- Steady red is the individual station's paging signal.
- Flashing green tells the user that all stations in the system are being alerted.
- Flashing red signals an emergency situation to all monitoring stations.

An external signal triggering relay A controls the color of the LED, changing it from its green (idle) condition to red. Relay B is excited when all stations are to be called. This second relay puts the 555 timer in the astable mode, changing the LED's usual dc state to an on-off oscillation of about 7.5 hertz at a duty cycle of 50%. The frequency of oscillation can be adjusted by suitably selecting R_1 and C_1. In the emergency red flashing mode, both relays must be tripped by external signals.

This circuit can readily be adapted to signal a single panel-mounted lamp. To derive the five operating modes, the relay contacts must be replaced by the contacts on a suitably wired rotary switch.

Supply voltage for the 555 may vary from 9 to 15 volts; with a 12-V supply, current drain is about 40 milliamperes. □



OPERATING MODES FOR 5-STATE MONITOR

Condition	Typical application	Relays operated	Lamp display
1	power off	none	off
2	power on, circuit idle	none	steady green
3	paging	"A" only	steady red
4	all zone paging	"B" only	flashing green
5	emergency announcement	A and B	flashing red

Multimode monitor. Module indicates the state of a multizone paging system using red/green LED, 555 timer, and relay contacts. When pager is off, both LEDs are extinguished. When pager is idle, green LED turns full on. If monitor is paged, red LED turns full on. During all-zone paging and emergency announcements, relays are energized for timer so that red or green LED flashes.

Engineer's newsletter

What to do before the board tester comes

As the amount of in-service digital equipment expands apace, maintenance and testing concerns loom ever larger. Designing testability into digital circuit boards is a big timesaver. Dave Schneider of Giordano Associates, Sparta, N. J., and Bill Muller of Datapoint Corp., San Antonio, Texas, addressed this problem at a seminar on automatic test equipment sponsored by Benwill Publishing Co., Boston, and held in Los Angeles on Jan. 23–25, 1979. They listed some simple, practical (but often overlooked) production guidelines to aid testing:

- Keep all components off the solder side of the board, to allow in-circuit testers to be used for bare or loaded board testing.
- Don't overpack a pc board. The defect rate per board appears to increase linearly as chips per square inch rise from 0 to 0.7.
- In laying out a board (especially a microprocessor type), major bus lines should be laid out first with an eye towards quick isolation of shorts and other pc manufacturing defects.
- **A good general rule of thumb: do not build any components into a system that take longer than five minutes to replace.**

Al says Al limits a transformer's leakage flux

In sensitive equipment containing cathode-ray-tube displays, line-powered transformers can be an annoying source of electromagnetic interference even after you've wrapped a Mumetal shield around their cores. This solution doesn't attenuate the higher harmonics of the leakage flux enough, though it works well for the low frequencies. Al Schamel of Tektronix Inc., Beaverton, Ore., improves on the idea: he sandwiches a layer of aluminum between the transformer core and the usual Mumetal shield. **Not only does this hold down both 60-Hz and high-frequency leakage, but it lets you use a thinner layer of the costly Mumetal.**

Picking resistors resistant to pulses

It is by no means obvious from a resistor's steady-state power-handling specifications whether it will survive under pulsed conditions. "Pulsed Handling Capability of Wirewound Resistors" is a booklet from TRW/IRC which tells how to select these devices for a wide range of pulsed circuits. The first section of the **booklet explains how to calculate the maximum energy that can be safely applied to a resistor in pulses** ½ to 5 seconds long. Examples illustrate how to use this energy value to calculate the maximum allowable pulse voltage or current for a resistor. The booklet's second section goes into calculations necessary for pulses shorter than ½ second. Sample designs given are for square and exponential pulses. The booklet is available free from W. C. Robbins, TRW/IRC Resistors, P. O. Box 1860, Boone, N. C. 28607.

Wet your feet in a half inch of liquid-crystal display

If you're thinking of dabbling in large-area liquid-crystal displays, it might be worth your while to look into a new designer's kit from Beckman Instruments. **This $11.95 kit includes a half-inch-high four-digit LCD, a connector/bezel assembly, a printed-circuit board, plus complete specifications and application information.** A list of IC manufacturers that supply chips for interfacing to LCD's is also included. Contact the Display Systems division, Beckman Instruments Inc., 2500 Harbor Blvd., Fullerton, Calif. 92634.

Jerry Lyman

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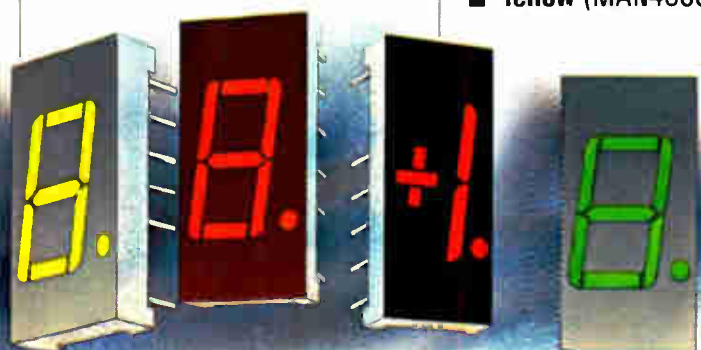

They're available in common anode or common cathode and overflow models.
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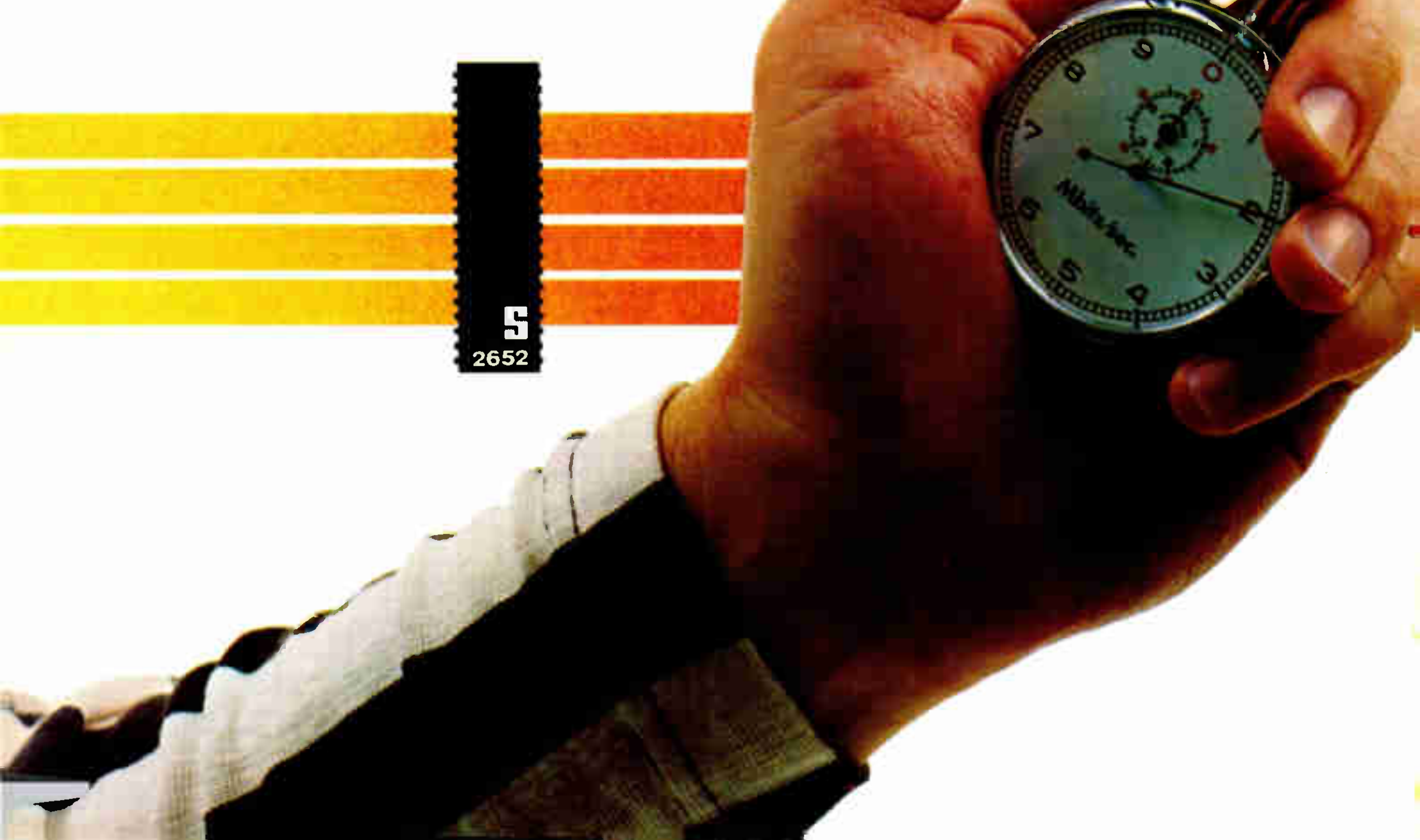

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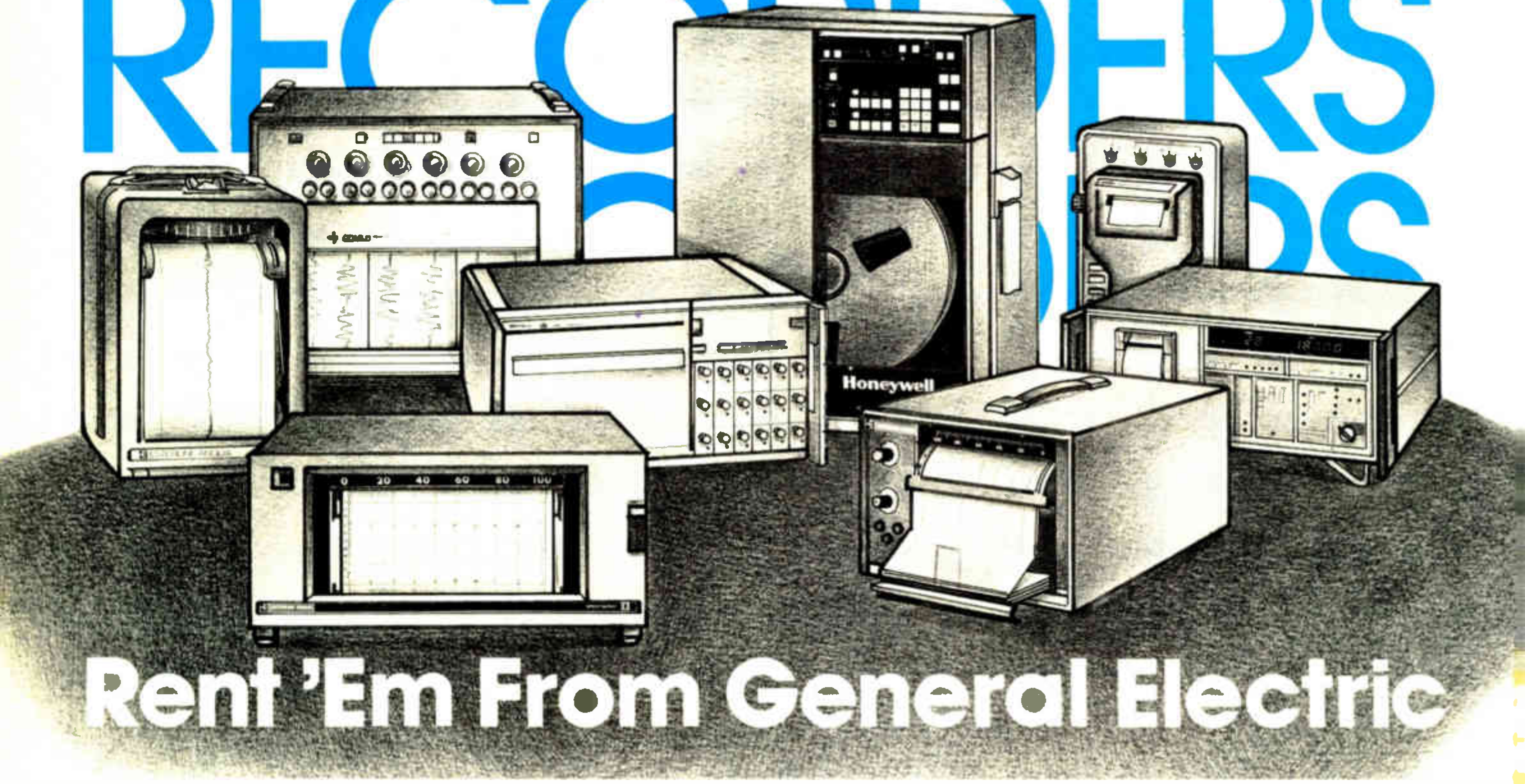

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GENERAL ELECTRIC

Desktop computer sells for $2,850

Highly modular versatile system, built around the 8085A, can act as a stand-alone computer or as a terminal in a large system

by Pamela Hamilton, Boston bureau

Smaller is better, at least in the electronics industry, and Solid State Technology Inc. is driving the point home with its Athena Dt/C 8200 desktop computer [*Electronics*, Feb. 1, 1979, p. 35]. The neatly packaged unit, which can act as a stand-alone terminal or as part of a large system, was designed for easy adaptability. "Our aim was to develop a product that isn't limited to a specific marketplace and won't dead-end quickly," says Harry J. Grossman, vice president for research and engineering. "The Dt/C 8200 can be redefined and reconfigured at the customer level; all the software implementations are contained in the operating system."

The strength of the system is its modularity, according to Grossman. The basic hardware includes a processor module, a video controller and display modules, a keyboard module, a motherboard module, a power supply, and a printer module. The processor board is based on a 3-MHz 8085A microcomputer (the 5-MHz version is available as an option) and also contains 2 kilobytes of read/write random-access memory (RAM), 12 kilobytes of read-only memory (ROM), and 256 by 4 bits of RAM with battery backup configured as 128 8-bit registers. The processor board provides 12 levels of vectored interrupts, a programmable real-time clock, programmable baud-rate generators, a keyboard interface, and an asynchronous communications interface. "The system organization is similar to Intel's Multibus," explains Grossman.

At the heart of the videocontroller module is a Motorola 6845 video controller chip, which provides programmable display features, the capability of generating custom fonts, and light-pen support for a 12-inch cathode-ray-tube display. The 25-line-by-80-character screen format displays up to 160 different characters: 32 control symbols and 32 graphics symbols in addition to 96 ASCII characters. A buffer allows one page to be displayed while another is waiting. The keyboard module has a full ASCII typewriter keyboard as well as a 15-key numerical keypad, a 12-key editing pad, and 14 special-function keys—four of which are programmable to eight levels of nesting.

The motherboard has nine nondedicated slots for logic modules. A triple-output unit, the power supply delivers +5 V and ±12 V. Finally, the five-by-seven-dot matrix printer has an 80-column format and will print 150 characters per second.

Decentralized. "We've totally off-loaded any input/output handling," says Grossman, "providing the ability to reconfigure the system at will without burden to the user." Key to this is the use of microprocessor-based controller boards, housed within the Dt/C 8200 shell, for all the peripherals. The printer, CRT display, keyboard, minicassettes, and minifloppies can be built into a single unit.

Much of the flexibility of the system comes from the automatic system generation software (Auto-SysGen), which allows automatic adaptation to any hardware configuration when the user simply shuts down the system, adds the needed controller board and peripheral, and turns the power back on. All the software needed to support the

added peripherals is already included in the operating system, according to Grossman.

In addition to the multitasking operating system and Auto-SysGen, the system's standard software includes a text editor. Basic, Cobol, Pascal, APL, and Fortran are offered as options.

A basic Dt/C 8200 system includes a processor, a keyboard, a display with its controller, 64 kilobytes of RAM, a power supply, the operating system, text editing, and Auto-SysGen as well as a diagnostic package and sells for $2,850. Full-scale production is scheduled to begin in late May or early June, at which time the company expects to ship about 350 units a month.

Solid State Technology, 17 Wheeling Ave., Woburn, Mass. 01801. Phone Roger Trudeau at (617) 935-3910 [339]

Video system unburdens host

Graphic display unit uses dual processors with dual buses to format data, do number crunching, and set up memory

by Robert Brownstein, San Francisco regional bureau

Visualizing complex data has been so critical to scientists and engineers that for years their computers have borne the overhead of condensing reams of alphanumeric-riddled printouts into a few charts or graphs. Now, however, the market in the graphic processing of nontechnical data is showing a 26% annual compound growth rate. Some analysts predict commercial computer graphics may bring in nearly $2 billion by 1983.

Past obstacles included the computational drain on the central processing unit, as well as need for extra memory and special programming and software. To slash the work-load placed on a host computer, Ramtek Corp. has placed dual parallel processors on separate buses inside their modular RM-9400 graphics display system. Furthermore, they have designed a system whose speed and resolution allow designers better use of the 1,000-line, wideband color monitors that are currently available, according to Jon Fowler, director of 9400 systems marketing for the company.

Placed between a computer and a cathode-ray-tube monitor, the RM-9400 accepts graphics data and instructions from the host, converts the generalized graphics coordinates (called "world coordinates") into screen-specific coordinates, maps them into refresh memory, and scans the memory to form analog signals for the CRT monitor. Even where images are moved or rotated, or the screen's picture is shifted left, right, up, or down, the intensive computations required to maintain coordinate integrity are performed by the RM-9400 instead of the host.

Data flows back and forth between host computer and graphics system via the display processor's bus and a hardware computer interface subsystem. The 8-bit (Z80) microprocessor-based display processor (DP) interprets the host's instructions, performs coordinate transformations, and passes processed data on to a memory control processor (MCP) based on a 16-bit bipolar microprocessor. The MCP performs high speed mathematical routines when needed and writes the image data into the refresh modules, which are composed of 16-K dynamic metal-oxide-semiconductor random-access memory chips.

The MCP then directs a video generator's scan sequence and initiates conversion of the digital codes into analog color monitor signals. Some monitors can handle picture element signal times of 17 ns, Fowler says, and to squeeze maximum performance out of them takes digital-to-analog converters that can perform a conversion in 6 to 7 ns. The 8-bit d-a modules in the 9400 are rated 10 ns, which means they keep the monitor busy but allow room for future improvement.

Flexible. The system's modular design lets it be tailored to specific applications. In a command and control system, for example, flicker-free appearance is important and requires refresh rates of 60 Hz. At that rate, a RM-9400 system with a resolution of 1,280 picture elements (pixels) per line by 512 lines can be configured. For computer-aided design systems, flicker is secondary to the need for higher resolution, Fowler explains. For these applications, Ramtek offers system setups with resolution of up to 1,280 pixels per line by 1,024 lines, but with refresh rates of 30 Hz.

"A typical system like the RM-9400/80 costs between $50,000 and $60,000 depending on the number of refresh memory planes and monitors serviced and on the computer interface," Fowler says. The hardware computer interface is between $1,500 to $2,500 for most minicomputers, but an IBM-compatible module costs $5,000. A single refresh memory plane for the RM-9400/80 (for black and white) sells for $2,970, and a full 16-plane assemblage (1-K by 1-K by 16 bits) shoots the price up to $37,520.

Ramtek offers three versions of the video generator system module. One, the RM-9400-V1, drives up to four color monitors, provides hardware "blink" (selective blinking of screen images), and mixes up to four cursors with any of its 12 output channels. Fowler sees this version as best suited for general-purpose color graphics.

The V2 version drives only one color monitor but has a 2,048-by-13-bit video lookup table programmable for 4,096 colors at any of 2,048 input intensities. This version is tailored to image processing. A third generator, the V8 version, drives up to two color monitors and has a pair of 256-by-8-bit video lookup tables. This one is geared to command and control applications such as pilot flight simulation systems, according to Fowler. The RM-9400 is now in production and first units are being shipped.

Ramtek Corp., 585 North Mary Ave., Sunnyvale, Calif. 94086. Phone (408) 735-8400 [338]

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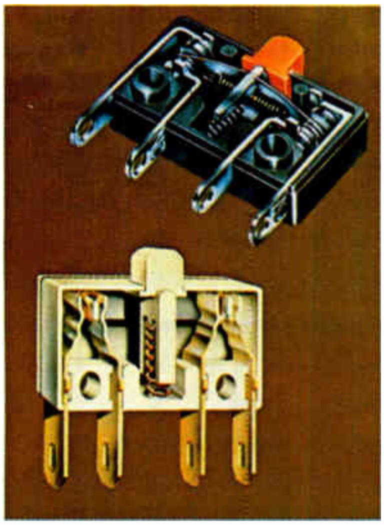

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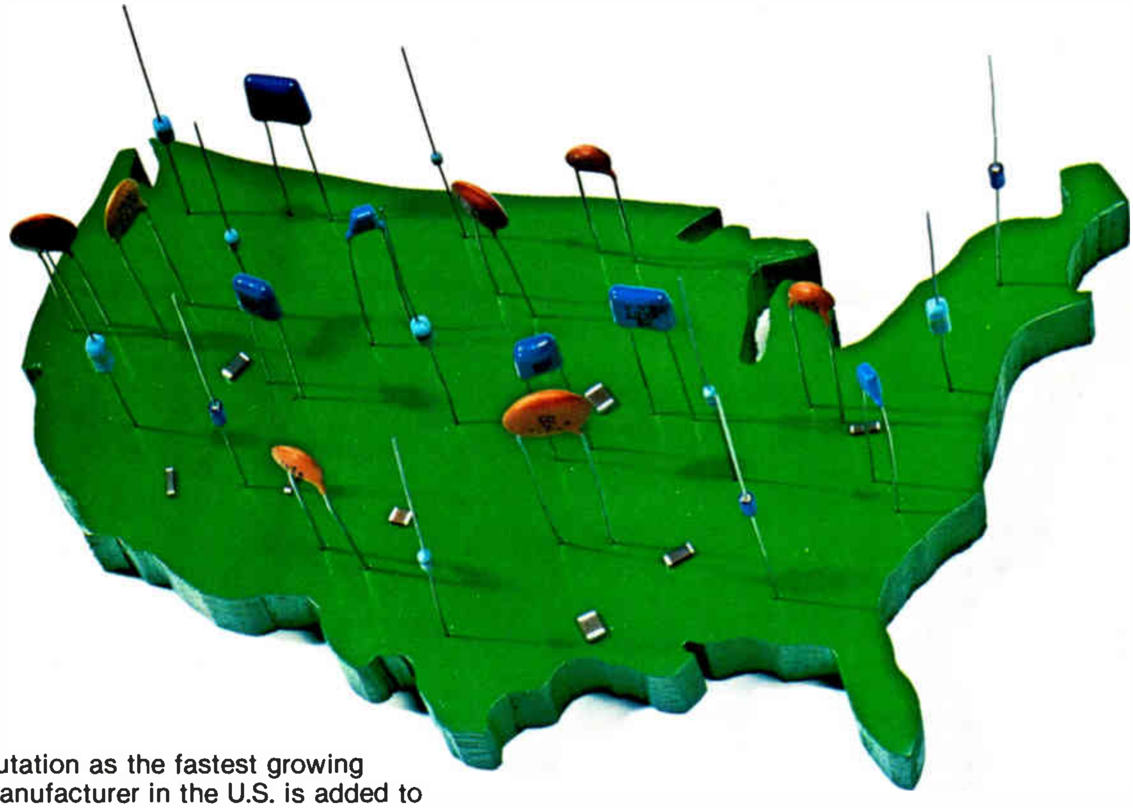

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Bit-slice mini boasts lower price

Computer serves multiple users with floating-point processing and allows them to alter microcoding by plugging in their own PROMs

by William F. Arnold, San Francisco regional bureau manager

Although speedy bit-slice parts have been designed into some minicomputers, enabling them to emulate mainframes, the bit-slice approach to higher performance has not yet become popular for lower-priced systems. But the debut later this month of a multiuser 16-bit minicomputer—one built with bit-slice power and priced with microcomputer savvy—should change all that.

Called the HEX-29, the bipolar minicomputer takes full advantage of microcoded bit-slice technology, according to Michael Simmons, head of Hex, a small Carmel Valley, Calif., design group. Consequently, the computer comes packed with a host of features, including floating-point processing and multiuser time-sharing, at a reasonable price.

The systems will actually be manufactured and marketed by Digital Microsystems Inc. John Torode, president of the company, says that the basic minicomputer will come with cathode-ray display, 96 kilobytes of random-access memory, two floppy-disk drives, four serial input/output ports, and power supply. Housed in a 14-by-17½-by-20-in. cabinet, it will sell for a price just under $15,000.

The HEX-29 has a basic machine cycle time of 160 ns and a register-to-register cycle time of 320 ns, Simmons says. Pipeline instruction fetching also aids fast processing. Moreover, many instructions can be executed in as few as two machine cycles, he says.

Simmons and his team wanted to optimize HEX-29 for the complex numeric and string processing encountered by high-level language compilers and interpreters. To do so, they could "not emulate, not build yesterday's architecture," Simmons says. Rather, they had to design "a real new architecture from the bottom up."

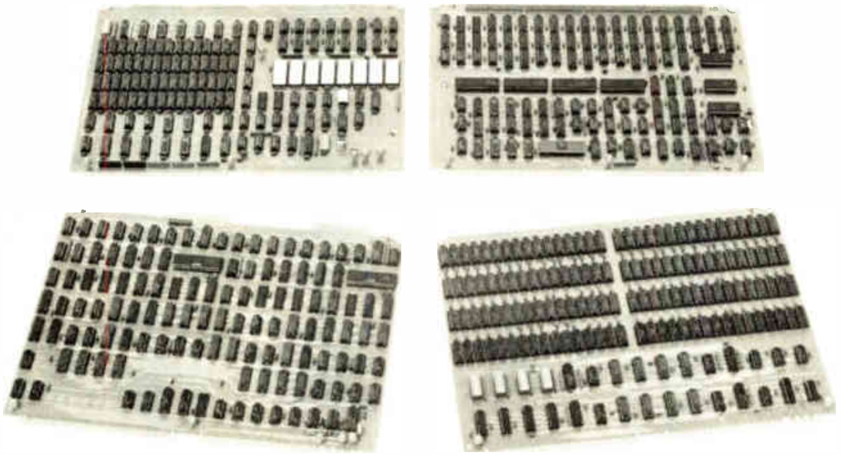
Based on Advanced Micro Devices' 2901 bit-slice parts, the HEX-29's 64-bit-wide microinstructions are stored in programmable read-only memory, so a user can easily incorporate new machine-level instructions and complex routines by adding PROMs.

The architecture uses an extensive register set of 16 definable general-purpose registers, 16 memory management registers, and numerous special-purpose registers, including an extended-function condition register and an interrupt status and control register. The HEX-29 can handle a complete set of data formats from bit operations up to quad word and variable field operations. It also boasts a sophisticated interrupt structure with up to 256 interrupt levels under program control.

Hex and Digital Microsystems are eyeing potential sales to manufacturers of small business computers, educational systems, research laboratory and medical instrumentation—almost any system that can take advantage of the HEX-29's speed and features. Simmons points out that HEX comes with a great deal of system support. On the software side, its Timeshare operating system and macro-assembler will be followed by Super Basic, Fortran 77, and a Pascal compiler. In hardware, the programmable channel controllers for floppy disks and video graphics will be followed by ones for hard disks, magnetic tapes, and serial communications. And although the basic system has four I/O ports, it can handle up to 16 users and can plug into 1 megabyte of memory.

Digital Microsystems Inc., 4448 Piedmont Ave., Oakland, Calif. 94611 [340]

Key boards. Clockwise from top right: CPU, memory, disk controller, and program store.



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For more information, write to our head office or to the office nearest you.

H2516

SPECIFICATIONS

Model No.	H2515	H2516	H2518	H2519
Characters x Line	40 x 1	40 x 2	16 x 2	16 x 1
Module Dimensions (w x h x d (max.) mm)	240 x 53 x 23	240 x 53 x 23	160 x 38 x 23	160 x 75 x 12
Power Supply (V)	$(V_{dd}-V_{ss})$ $+5\pm0.25$ $(V_{ee}-V_{ss})$ -5 ± 0.5	$(V_{dd}-V_{ss})$ $+5\pm0.25$ $(V_{ee}-V_{ss})$ -7 ± 0.7	$(V_{dd}-V_{ss})$ $+5\pm0.25$ $(V_{ee}-V_{ss})$ -5 ± 0.5	$(V_{dd}-V_{ss})$ $+5\pm0.25$ $(V_{ee}-V_{ss})$ -5 ± 0.5
Power Consumption (mW max.)	100	100	60	60

FEATURES

- Excellent readability and high contrast ratio of twisted nematic display
- Alphanumeric display with 5 x 7 dot-matrix characters (with cursor in models H2515, H2516 and H2519) Character dimensions: 3.1 w x 4.4 h mm
- Easy to interface — only 8 connector pins
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Circle 143 on reader service card

New products

Power supplies

Power-One gets into switchers

Linear-supply maker's first switcher is a 5-V/40-A unit that sells for $250

To break into the highly competitive switching power-supply market, a manufacturer has to offer something special. In the case of Power-One Inc., a leading maker of linear supplies, the something special is a combination of the best of the various special features offered by its competitors.

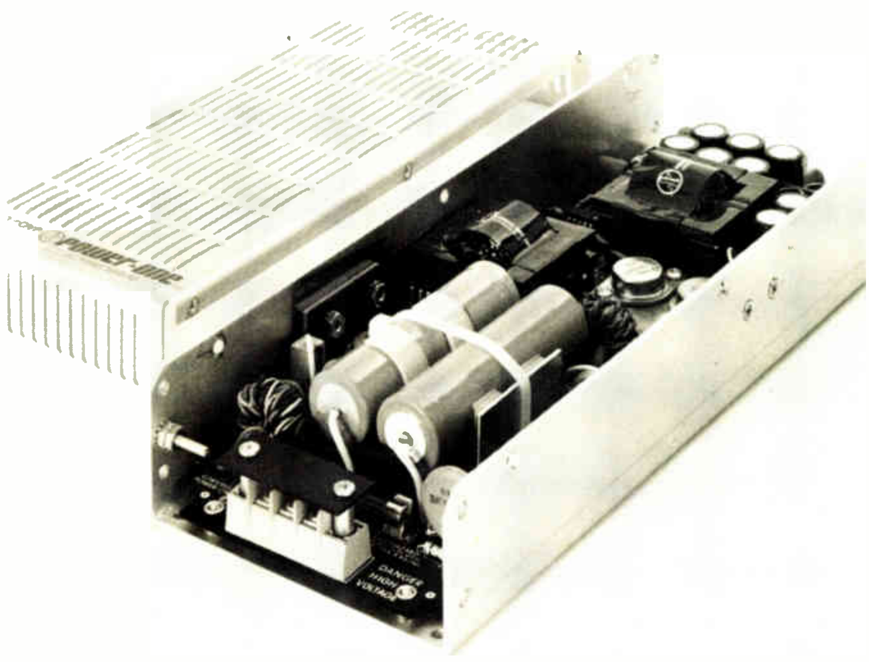
"We looked at literally all our competitors and picked out what works," says Steven Cole, vice president for marketing at the privately held firm. Individually, the features to which he refers are not uncommon, but taken together, he believes, they are indeed special.

The company's first switcher is a 200-W single-output unit, the model SK5-40/OVP. Its payoff specification, as with any other switcher, is its efficiency. The basis upon which this is quoted is intentionally different from the ones used by competitors, states Cole.

"Efficiency is 70% minimum at full load over the entire ac input-voltage range," he states. "This is a more realistic specification for a user," he asserts, adding, "we can achieve efficiency numbers up in the 80s just like anybody else." The ac input-voltage range is 90 to 130 V ac or 180 to 260 V ac at 47 to 63Hz.

One truly unusual aspect of the new supply is its switching frequency—28 kHz. Most other supplies operate between 18 and 22 kHz, which Power-One engineers felt was less than optimum. They believe that they have maximized efficiency and eliminated the possibility of acoustical noise by going to 28 kHz. A major manufacturer of switchers, however, believes that the increased frequency is merely the result of the "usual design tradeoffs, and neither better nor worse than what we and others do."

Among the more common features and specifications that Cole mentions is the SK5-40/OVP's regulation to within 0.1% both over the full input-voltage range and for loads from no load to full load. He also



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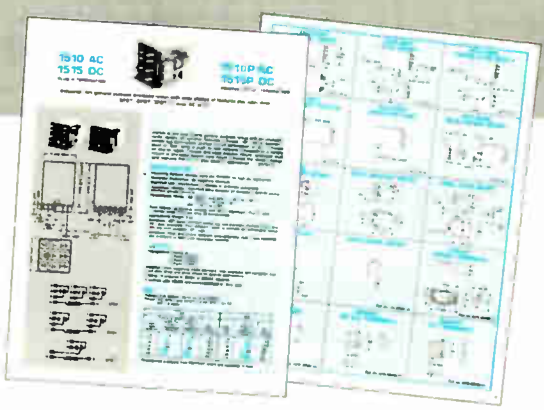

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Circle 145 on reader service card

notes its maximum transient deviation of 5% due to a sudden load change and its transient recovery time of 150 μs to within 1% of the nominal output voltage.

Cole singles out the supply's direct-drive circuitry, which eliminates the base-drive transformers found in many other switchers, for special mention. Not only does the circuitry provide more positive control of the switching power transistors, he says, but it also improves line-noise rejection. According to Cole, it effectively regulates the volt-second product applied to the power transformer, providing a form of preregulation. As a result, he says, "you can even plug in a soldering iron next to the supply and nothing will show up on the scope attached to the supply output."

Other key specifications include 2,500-V-rms input-to-output isolation, input-to-chassis isolation of 1,500 V rms, and output-to-chassis isolation of 500 V dc. The unit has isolated terminals for remote on-off control of the dc output, with 5 mA required to cause shutdown. For further protection, the supply has a power-failure signal flag and current limiting to 105% to 125% of rated current. If a short occurs, the current is automatically reduced to 25% of rated current after 1 second.

The supply will deliver its full output from 0° to 50°C and can be derated for operation up to 70°C. It measures 4.88 in. high by 2 in. wide by 13 in. long for a total of 127 in.^{3} In quantities of one to nine, the unit sells for $250; a 20% discount applies for lots of 100 or more. High-volume deliveries are planned to begin in early summer.

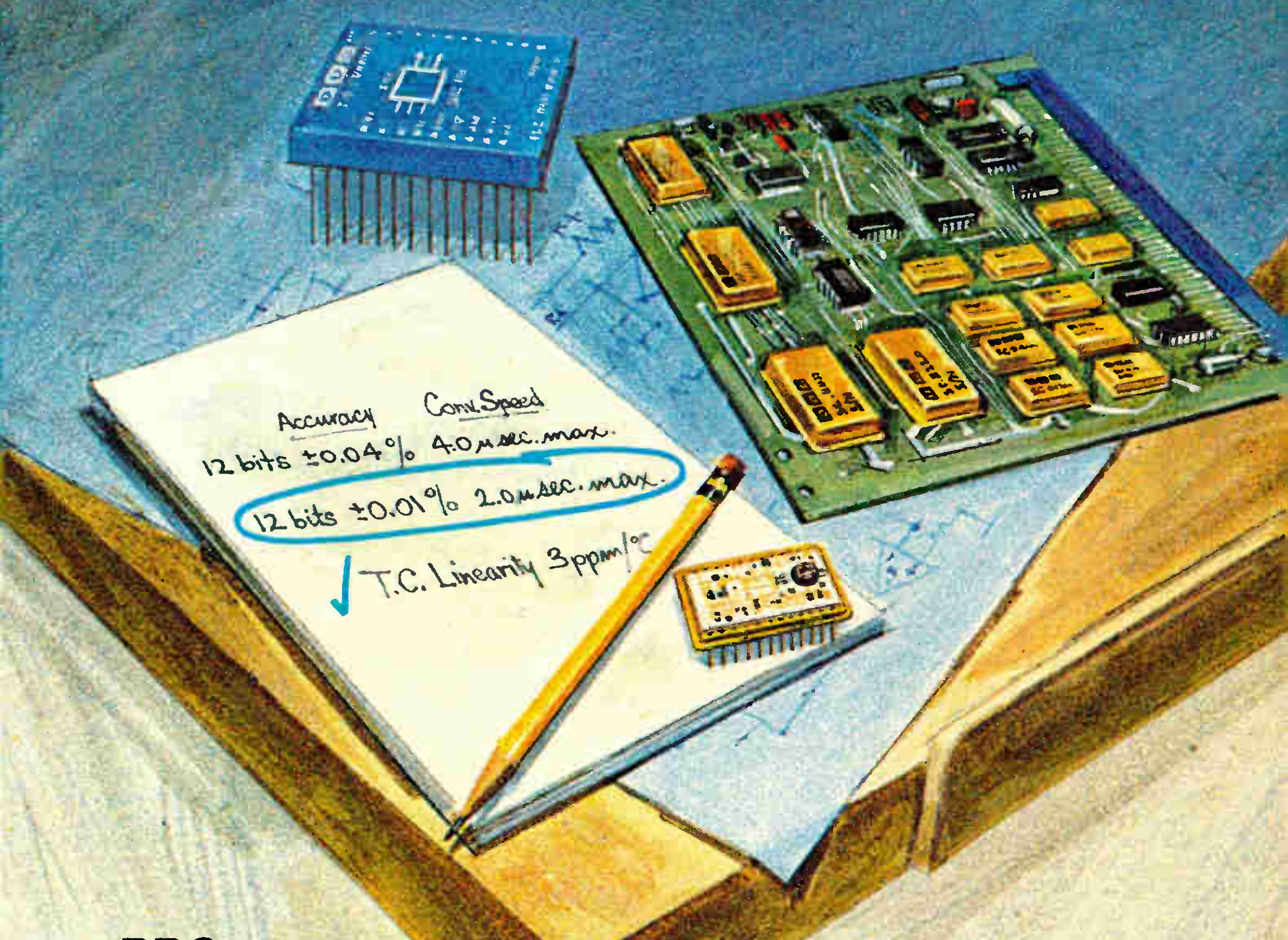
Power-One Inc., Power One Drive, Camarillo, Calif. 93010. Phone (805) 484-2806 [381]

DIP-packaged batteries last longer at 50°C

Designed as a power source for such applications as memory backup and single-chip microcomputers, the Goldtop DataSentry is a rechargeable nickel-cadmium battery that comes in a dual in-line package for direct wiring to a board. Unlike other such batteries with 50°C ratings, the Goldtop DataSentry is rated for up to 70°C. At 50°C, it will have an application life three times that of comparable units, according to the manufacturer.

The batteries have a capacity

Before you choose a converter, be sure you get the facts you need



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of any supply can be equipped with over-voltage protection. All models are currently available from the manufacturer's stock.

Gould Inc., Electronic Components Division, P. O. Box 6050, El Monte, Calif., 91731. Phone (213) 575-4777 [386]

High-voltage modules power photomultiplier tubes

The series PMT-10A and -20A, for powering photomultiplier tubes, provide outputs of 0 to 1,000 V dc at 4 mA and 0 to 2,000 V dc at 2 mA, respectively. Locally adjustable as well as remotely programmable, the output exhibits ripple of less than 2 mV peak to peak and is stable for the short term to within 0.005% of full scale.

The modules can operate from a

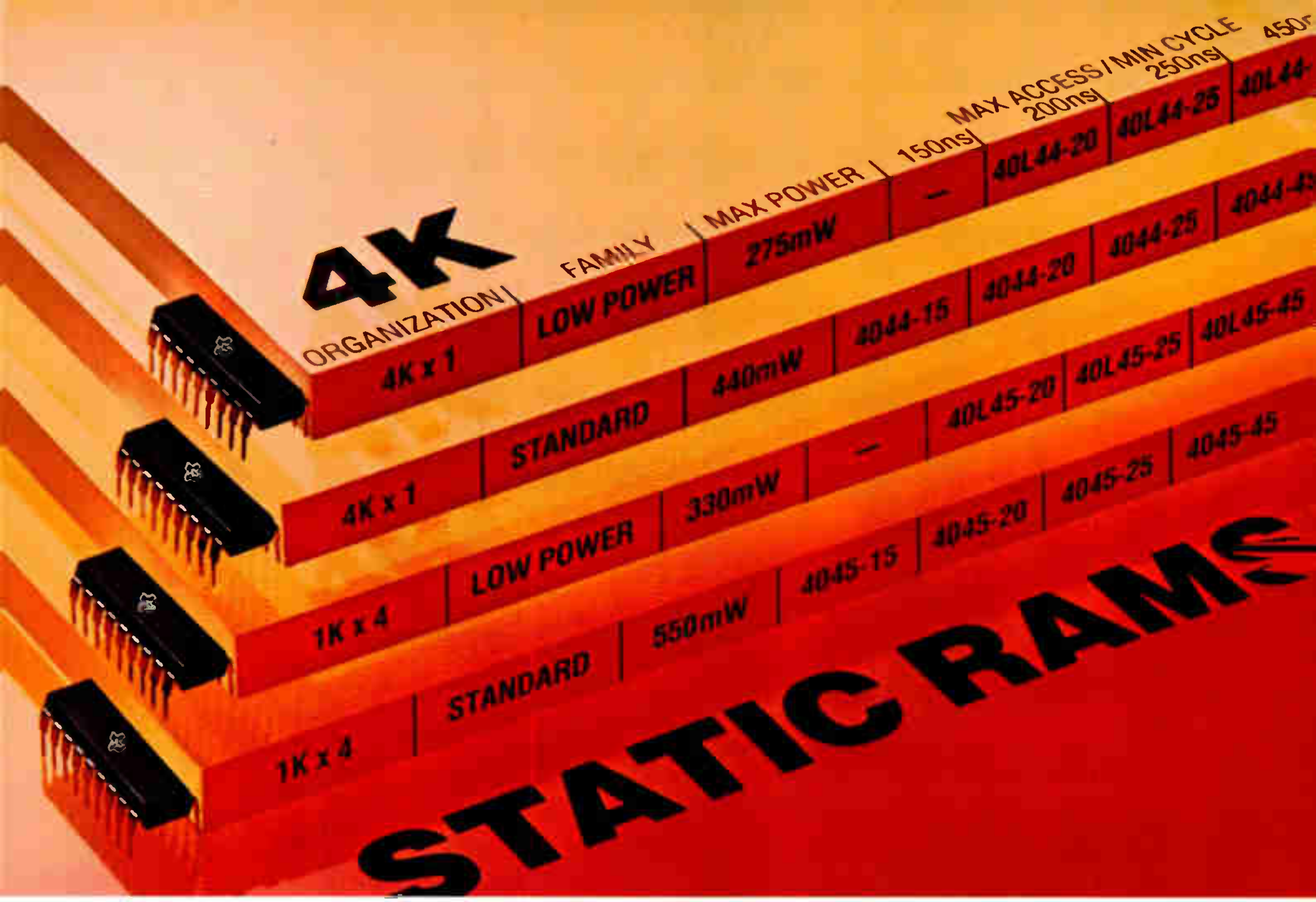
variety of dc input voltages and may be ordered in versions that provide positive or negative voltages. They are protected against short circuits and arcing.

Available from stock, the units are priced at $185 in single quantities.

Bertan Associates Inc., 3 Aerial Way, Syosset, N. Y. 11791. Phone (516) 433-3110 [384]

Stable voltage reference comes in single-cell version

A low-end addition to a series of voltage reference standards introduced last fall [*Electronics*, Oct. 26, 1978, p. 236], the model VTS 101-SC is a single-cell source. Like its



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200 ns	TMS40L44-20 TMS4044-20	275/96 mW 440/156 mW	TMS40L45-20 TMS4045-20	330/110 mW 550/170 mW
250 ns	TMS40L44-25 TMS4044-25	275/96 mW 440/156 mW	TMS40L45-25 TMS4045-25	330/110 mW 550/170 mW
450 ns	TMS40L44-45 TMS4044-45	275/96 mW 440/156 mW	TMS40L45-45 TMS4045-45	330/110 mW 550/170 mW

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- Improved address hold time: 0 ns minimum.

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Circle 151 on reader service card

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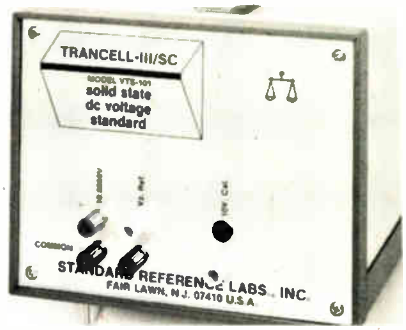
New products



multiple-cell relatives, the solid-state unit uses a 6.3-V zener diode that is stable to within 2 parts per million per year and has a typical short-term drift of 0.2 ppm/hr. The zener diode's voltage drop is accessible through terminals on the front panel, as is a 10.0-V output derived from it. The latter is stable to within better than 10 ppm/yr, with a typical drift of 0.5 ppm/hr.

The VTS 101-SC is priced at $1,695. Delivery takes 16 weeks.

Standard Reference Labs Inc., Pollitt Drive South, Fair Lawn, N. J. 07410. Phone John Halgren at (201) 797-3907 [385]

Triple-output supplies work at 50 Hz without derating

Providing full-rated output over the ambient range from 0° to 65°C, the MP series of triple-output supplies consists of six models. Users can choose outputs of ±12 or ±15 V and 5-V outputs at 3, 6, or 12 A, and all models operate from 115 or 230 V ac at 50 to 60 Hz with no derating for 50-Hz operation.

The units have a maximum output ripple of 1 mV rms, line and load regulation of 0.05% and 0.1% of nominal output, respectively, and efficiencies of 45%. Dual outputs track to within 0.05% of absolute value and all outputs are adjustable over a ±5% range by externally accessible potentiometers. In single quantities, prices range from $128 to $244 depending on output needed, and the delivery time is from one to four weeks.

Datel Systems Inc., 1020 Turnpike St., Canton, Mass. 02021. Phone Gene Murphy at (617) 828-8000 [388]

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If your prefer an isolated banana jack input with full floating capability, specify the 8921A (also only $995).

*U.S. Price

For more information, contact one of the more than 100 Fluke offices or representatives, worldwide. In the U.S., CALL (800) 426-0361*, TOLL FREE. Residents of the U.S. and all countries outside of Europe, contact: John Fluke Mfg. Co., Inc., P.O. Box 43210, Mountlake Terrace, WA 98043, U.S.A. Telex: 32-0013.

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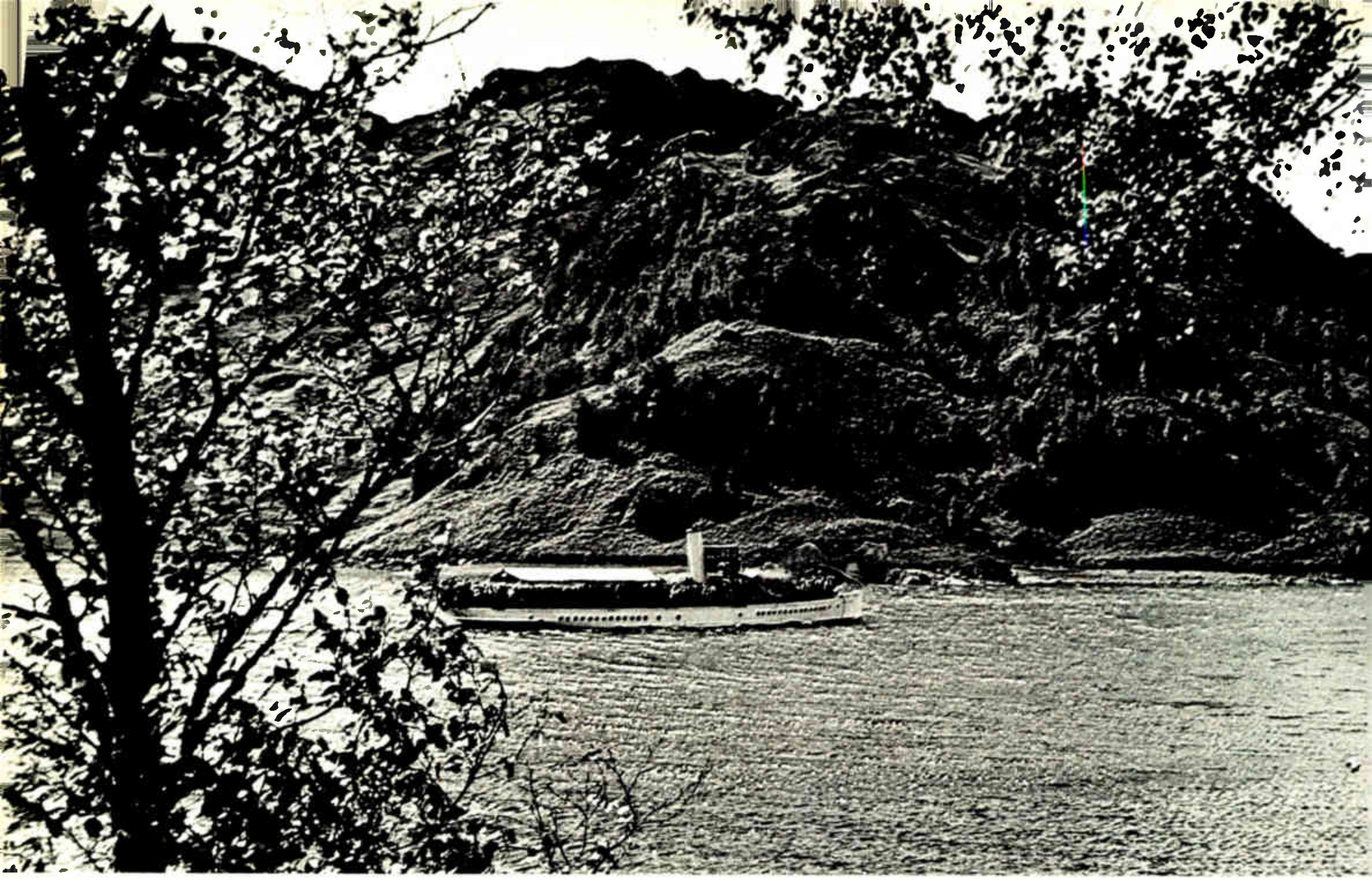

Loch Katrine in the Trossachs — where Glasgow draws much of its exceptionally pure water

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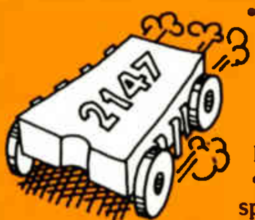
The Industry's First 25-MHz Memory Test System

From the company that was first to introduce 10-MHz LSI test systems comes the industry's first all-new 25-MHz memory tester – the Macrodata M-1.

With the advent of high-speed MOS Static RAM's and 16K/64K Dynamic RAM's with complex timing requirements, the need for a new high-speed memory tester is obvious and urgent. Looking ahead, Macrodata foresaw that need and developed its new 25-MHz M-1 Memory Test System.

But there's more to the new M-1 than just speed. Here is a brief run-down of some of the outstanding features:

True 25-MHz Device Testing Speed



- tests 4K (and larger) fast Static MOS RAM's up to 25-MHz (40 nanosecond period) speeds
- tests 16K and 64K Dynamic MOS RAM's up to 20-MHz (50 nanosecond period) speeds with full split-cycle timing
- tests both bipolar and ECL RAM's at speeds up to 25-MHz

Unique Device Interface

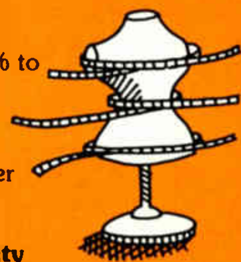
- special hybrid comparator packaging allows measurement and error processing at end of cable
- small lightweight test head provides easy interface to commercial probers and handlers

Full Computer Control

- full stand-alone software capability based upon DEC LSI-11 system, providing program generation, datalog, shmoo plot, edit, bin summaries, etc.
- standard video terminal plus hard-copy print-out

System Timing Accuracy

- skew specification guaranteed over 20% to 80% of waveforms, not restricted to a single midpoint measurement
- fully automatic software calibration without the use of pots – many times faster than any other system



Designed for Reliability

- efficiently designed with advanced IC technology to reduce hardware complexity and parts count
- design rule of 10 watts per double board maximum allowable power dissipation to eliminate heat problems
- maintenance by card replacement with guaranteed interchangeability to eliminate pots and minimize downtime

Cost Advantages

- provides the highest performance per dollar investment, resulting in the "lowest-cost-per-hertz" in the industry
- single rack console minimizes floor space
- simplicity of design maximizes system utilization

Get the Facts

The new Macrodata M-1 is not only the industry's fastest memory tester, but it is the precursor of a whole new generation of test systems. For more information on this advanced new system, send for a copy of the M-1 brochure or call us directly. Also ask about Macrodata's complete family of memory board and other LSI device testers.

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Macrodata Corporation, P.O. Box 1900, Woodland Hills, California 91365, Phone: (213) 887-5550, Telex: 69-8489

Computers & peripherals

4-pen plotter sells for $16-k

Three microprocessors allow intelligent unit to plot at 15 inches per second

I Corp.'s chief designer, Victor Kley, did not set out to design a plotter when he went looking for one to hook up with his company's line of low-cost computer-aided design systems [*Electronics*, Nov. 23, 1978, p. 196]. He found, however, that available plotters were either too slow or too costly. So he solved the problem by taking a bare-bones plotter and designing a three-microprocessor front end to make it fast, flexible, and very competitive on a price/performance basis.

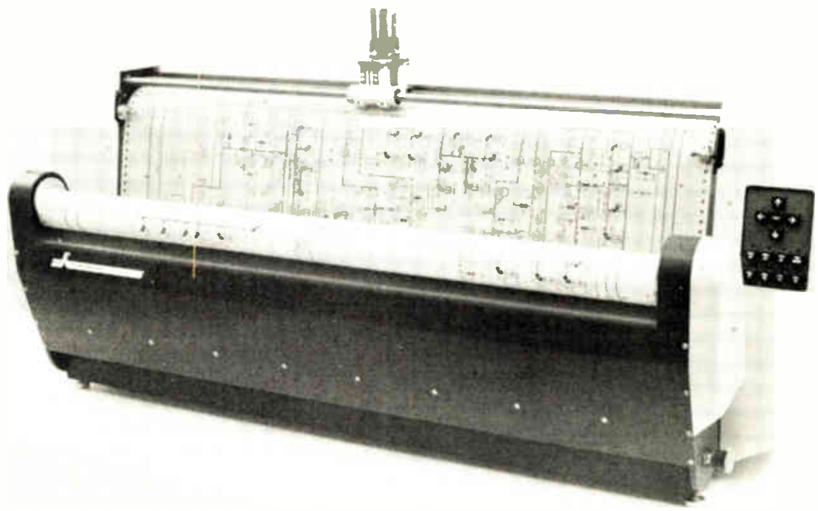
Compared with a competitor's one-pen 2-inch-per-second plotter that sells for $12,500, Kley feels I Corp.'s four-pen 15-in./s model 3700 at $16,000 is a real breakthrough. Made to complement I Corp.'s equipment, it nevertheless interfaces easily with any IEEE-488– or RS-232-C–compatible terminal or computer. "It will hook up to Tektronix' 4051, HP's 9835 and 9845, and DEC's LSI/11 and PDP/11 and makes these systems faster than with any other plotter now available," he claims.

Inside the 3700 are three 3870 8-bit microprocessors: one is a master chip that orchestrates the 3700's hardware arithmetic section, another processes X-axis data, and the third handles Y-axis information. With intelligence built in, the plotter relieves its attached system's processor of data-intensive arithmetic tasks each time a drawing is zoomed (scaled up or down), for example.

"That is what really slows a system down," states Kley. "A line-intercept equation needs to be solved for all the points every time a drawing is partitioned, causing throughput to sag. Now a user can load the plotter with raw data and let the machine do the calculations."

Instead of using vector approximations for curved sections as do many plotter systems, the 3700 has an integral curve-generation routine that produces smooth curves with much less data than the vector-approximation technique requires, according to Kley. Users have, in addition to the built-in printing character set, provisions for creating virtually any other symbols by downloading patterns to the plotter and configuring the 225 (15-by-15 stroke character points, he adds.

When manipulating a variety of pens and drawing media, users need dynamic control of pen velocity, and the 3700 provides for such control via software. Page sizes can be



varied up to a maximum of 34 by 150 inches, with folding wings provided for working on sheet material. Users can continuously vary pen pressure and the plotter's carriage has an ink reservoir for use with technical pens on Mylar, Kley points out. Delivery time for the new plotter is 30 days.

I Corp., 735 Addison St., Berkeley, Calif. 94710. Phone (415) 848-6600 [361]

Microcomputer opens door to minicomputer systems

Most computer manufacturers add to the low end of their lines so that potential users can gain entry to the family at less cost, but Texas Instruments has done so with added flair. Additions to the DS990 series of minicomputers, models 1 and 2 let users enter the minicomputer world through a microcomputer portal.

A multiuser system, the model 2 is based on a new single-board microcomputer, the 990/5, that contains the central processing unit, 64 kilobytes of random-access memory, and input/output ports. Available in either a desktop housing or a 30-in.-high cabinet, the model 2 offers such choices as a video display or printer terminal as a work station and two to four double-sided double-density diskette drives.

The model 2's system software includes the 990 assembly language as well as TX Basic, an enhanced version of ANSI-standard Basic for business applications. TX Basic runs under the TX5 operating system, which is completely file-compatible with the TX10 system used on larger DS990 systems.

Software for the model 1, a single-user desktop system based on the TMS 9900 16-bit microprocessor, also includes TX Basic operating under the TX5 system, as well as Terminal Programming Language, or TPL. The latter runs under the TPL operating system used on 700 series distributed-processing systems, and thus the model 1 forms a bridge between those systems and the DS990 series. The model 1's main

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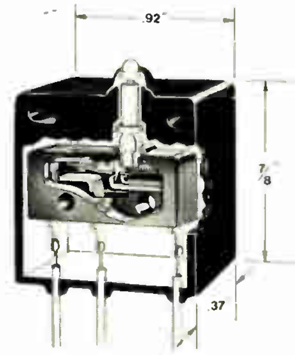

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housing includes 64 kilobytes of random-access memory, two communications ports, a 1,920-character video display, and a keyboard. Two to four drives are housed in a separate unit.

A multiuser model 2 with two diskette drives and two video display terminals is priced at $13,200, with deliveries slated for early June. A basic single-user model 1 with two drives sells for $9,450; with a Silent 700 thermal printer built in, it costs $10,550. Model 1 deliveries are scheduled to begin in April.

Texas Instruments Inc., Digital Systems Division, P. O. Box 1444, M/S 7784, Houston, Texas 77001. Phone (512) 250-7305 [363]

Software enhances use of Naked Mini 4, SyFA systems

In the ever more aggressive computer market, more manufacturers are looking to the provision of greater software support to foster hard sales. Computer Automation, for example, is now offering an extended Fortran IV compiler for its Naked Mini 4 family of computers, as well as a programming aid called SyMPLE for its SyFA network processing systems.

Naked Mini 4 (NM4) Fortran IV operates on all NM4 computers that have 32 kilowords or more of memory, a keyboard entry device and associated intelligent cable, an input/output distributor, and a disk-storage subsystem. Compatible with ANSI X3.9-1966 standards, it includes advanced functions such as Boolean operators and can generate compact object code.

Fortran IV applications programs compiled under the OS4 operating system can be executed under either OS4 or RTX real-time operating system. Distributed in object-code format on a floppy diskette, the compiler is priced at $1,500 and is supplied complete with language and operations manuals.

The SyFA multiprogramming language extender, SyMPLE, is free to all users of SyFA systems. It interactively generates code for programs used in data entry, data inquiry,

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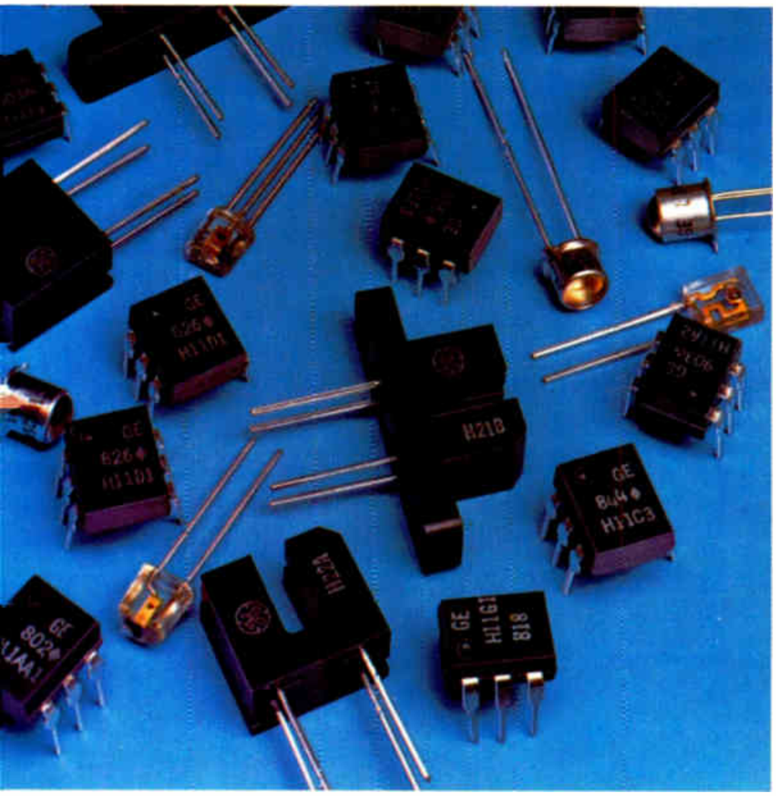

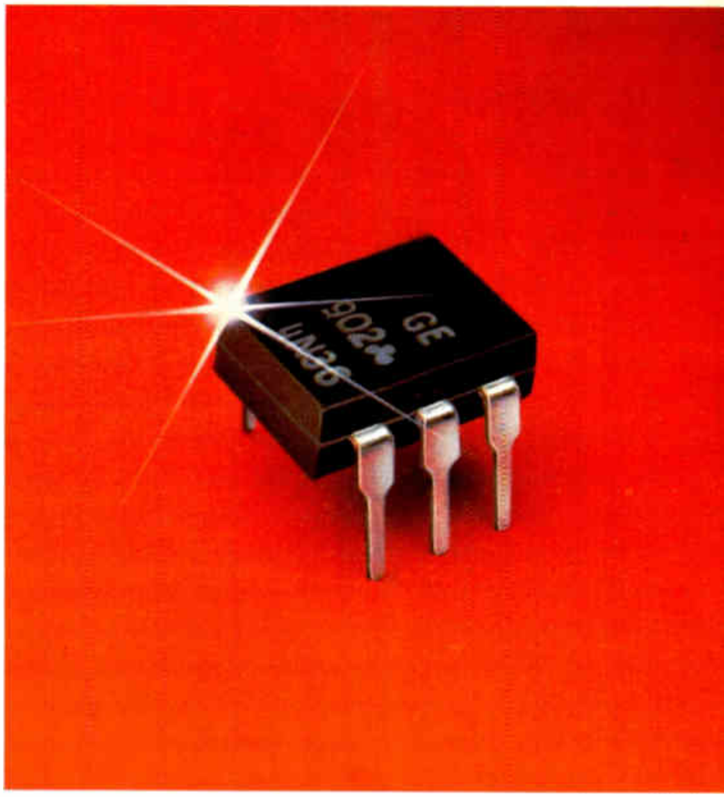

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In Europe, contact International General Electric of New York, Dundalk, Ireland, (042) 32371, telex: 33816.

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There's more to GE semiconductors than meets the eye

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record deletion and modification, screen formatting, and menu selection. With SyMPLE, source code has a standard internal format that eases integration and maintenance of programs by making them appear as though they were all coded by the same programmer.

For NM4 Fortran IV compiler: Naked Mini Division, Computer Automation Inc., 18651 Von Karman, Irvine, Calif. 92713 [368]

For SyMPLE: Commercial Systems Division, Computer Automation Inc., 17982 Skypark Circle, Suite N, Irvine, Calif. 92714 [369]

Network family interfaces with variety of hosts

Another contender has entered the networking arena: Raytheon Data Systems Co., Norwood, Mass., is now offering a five-member family of upgradable single and multiple processor configurations—Raynet—which can interface with a variety of major host machines. As David B. Levi, executive vice president points out, "our computers live in networks and we want networks that are easier to use."

The family consists of line concentrators (Raynet I, II, and III), message switchers (Raynet IV), and network nodes (Raynet V). Raynet I is an RDS-500 minicomputer-based network that allows 60 terminal lines to be added without adding host hardware. The Raynet I also allows mixed line speeds of up to 9,600 bits

per second and an application-dependent throughput rate of 50 to 60 messages per second.

Raynet II is also an RDS-500 based system with all the features of the Raynet I, but also offers a choice of line disciplines and allows communications with up to eight different hosts from a single terminal, using automatic protocol conversion for "host transparency" in mixed-protocol environments. Raynet III, RDS-500 based as well, differs from the II system in that it will support multiple protocols. This will allow the user to integrate systems with multiple communications line disciplines. Raynet currently supports Binary Synchronous, Synchronous Data Link Control, Univac U-100, and Pars airline industry protocols.

The next upgrade step in the family is Raynet IV, which has up to one billion bytes of local disk storage for store-and-forward message switching. Raynet V, as the largest configuration in the group, functions as a network processor, with the capabilities of Raynet III and IV, plus data switching between nodes for distantly distributed mainframes and virtual terminals. Up to five Raynet Vs can be strung together within a single network.

Immediate applications for Raynet I include airline reservation/ticker services or for users with IBM 3270s. These applications would hold for the Raynet II systems, which also include users with remote-job-entry functions. Raynet III users would have multihost access requirements, while Raynet IV users would also have teletype networks. Raynet V would be used for large corporations in need of switching networks. All Raynet systems can be expanded with additional peripherals. Raytheon Data Systems' communications operating system is standard for all configurations.

A single Raynet I with CRT display/keyboard and software will sell for about $60,000. Deliveries will begin in March.

[Raytheon Data Systems Co., 1415 Boston-Providence Turnpike, Norwood, Mass. 02062. Phone (617) 762-6000 [362]

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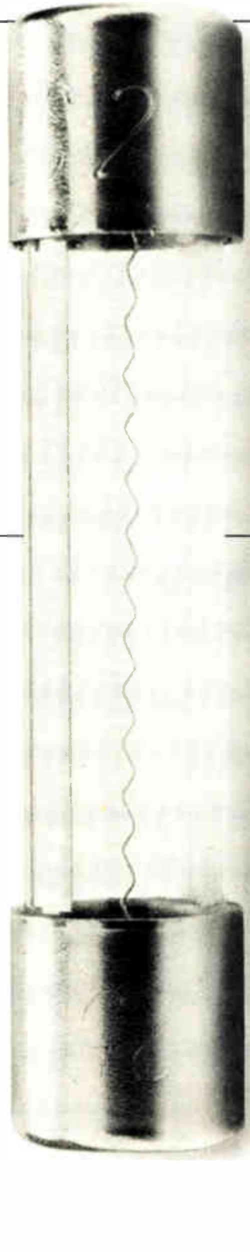

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New products

Instruments

Hand-held meter reads true rms

One of a 3½-digit series, it, too, measures to 10 A, checks continuity

Beckman Instruments has entered the 3½-digit, hand-held multimeter market with a series of three meters that offer several features never before found in instruments of their type. Further, the top-of-the-line unit, the RMS 3030, earns its letters by being the only true rms meter of this type available today.

The $130 model 3010, the $170 model 3020, and the $190 RMS 3030 all can measure ac and dc current up to 10 A. All three feature a continuity test indicator and a semiconductor test function. Powered by a 9-V battery of the type used in portable radios, each unit can operate for up to 2,000 hr. Should it fail to operate properly, even because of mistreatment, it can be returned to the factory for free repair or replacement under a one-year "no-fault" warranty.

All models measure across the same ranges: five dc voltage ranges, from 200 mV to 1,500 V full scale; five ac voltage ranges spanning 200 mV to 1,000 V full scale; five ac and dc current ranges, 200 μA to 2 A full scale (a separate input extends the range to 10 A); and six resistance ranges with full-scale values from 200 Ω to 2 MΩ.

The low-power resistance ranges permit users to make in-circuit resistance measurements without turning on semiconductors, which would affect those measurements. To verify the operation of a semiconductor junction, the units provide a 5-mA test-current range. In all resistance ranges, the instruments provide a quick continuity check by flashing the Greek letter omega in the upper left portion of the display.

Both the model 3010 and the 3020 provide ac voltage measurements of signals with frequencies of up to 10 kHz, and they have input impedances of 22 MΩ. The 3010 is accurate to within 0.25% of reading +1 digit on all dc voltage ranges and the 3020 is accurate to within 0.1% +1 digit.

The RMS 3030, which has the same dc voltage accuracy as the 3020, makes true-rms measurements of both ac voltage and current for accurate measurement of nonsinusoidal waveforms. All ac voltage ranges have guaranteed accuracy specified out to 20 kHz for signals with crest factors (peak value

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Compare the features of our 64K with other ROMs on the market. You'll see why it should be your first choice for design-ins.

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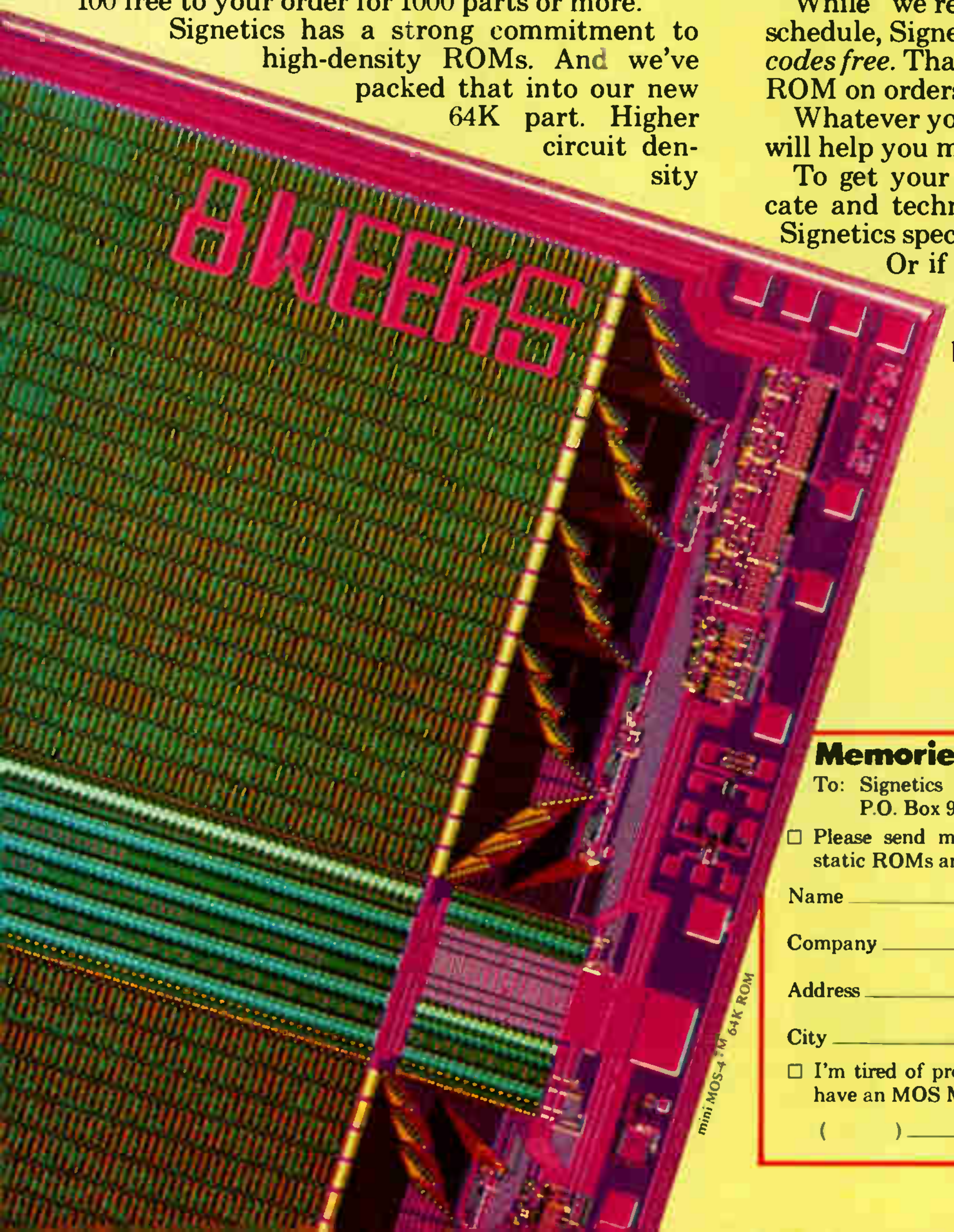

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divided by rms value) of up to 3:1 at full scale.

The three instruments' inputs are protected against overload conditions that result from the measurement of unknown signals or from operator error. Voltage ranges are protected from inputs in excess of 1,500 V dc or 1,000 V rms ac. Resistance ranges are protected to 300 V dc or rms ac. The current inputs are protected with a 2-A fuse. (A replacement fuse is included inside each instrument case.) The 10-A range is rated for 20 A for 30 s.

The multimeters' liquid-crystal display and complementary-metal-oxide-semiconductor custom-designed integrated circuitry minimize battery drain. A single 9-V battery provides up to 2,000 hours of continuous instrument usage. During the final 200 hours of battery life, a decimal point blinks on the display to warn the user to change the battery.

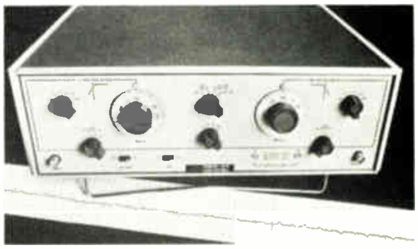
Calibration of the instruments requires only one adjustment on the 3010 and 3020—four on the RMS 3030—and is guaranteed for a full year. Each instrument is shipped with a battery, a spare fuse, test leads, and an operator's manual.

Accessories for the multimeters include two carrying cases, a radio-frequency probe for voltage measurements up to frequencies of 200 MHz, a current clamp for measurements up to 200 A, and a deluxe test-lead kit with test leads and 10 screw-in probe tips.

Advanced Electro-Products Division, Beckman Instruments Inc., 2500 Harbor Blvd., Fullerton, Calif. 92634 [401]

Variable filter offers choice of four attenuation slopes

An extremely versatile filter, the model 3750 not only offers low-pass, high-pass, band-pass, and band-reject modes, it also offers a choice of four attenuation slopes: 6, 12, 18, and 24 dB per octave. The filter, which is tunable over the range from 0.02 Hz to 20 kHz, has a Butterworth response and a switch-selecta-



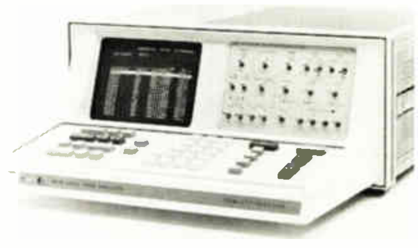
ble gain of 0 or 20 dB. In addition to the Butterworth response, the 3750 provides a low-Q transfer function with a more nearly linear phase characteristic for pulse-type signals.

The filter is particularly well suited for applications in medicine, seismology, and vibration and geophysical studies. It sells for $1,100 in its standard line-operated form and $1,300 in a battery-operated version for use in situations requiring complete isolation from the ac line. Delivery is from stock.

Krohn-Hite Corp., Bodwell Street, Avon Industrial Park, Avon, Mass. 02322. Phone Ernie Lutfy at (617) 580-1660 [403]

Module lets HP1611A analyze almost any microprocessor

Hewlett-Packard's model 1611A logic-state analyzer for microprocessor-based systems is a plug-in system that requires different personality modules for different microprocessors. The company's latest such module, the 10264A, differs from its predecessors in that it is flexible enough to monitor activity on virtually any microprocessor, albeit with certain limitations. For example, the general-purpose module can display code lists in octal or hexadecimal, but not in mnemonic code, because the mnemonic code is different for each microprocessor. When the 10264A is plugged into the



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The Harris HA-5190 wideband, fast-settling Op Amps provide the high-speed performance of costly hybrids—with the economy of monolithic bipolar construction.

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Now you have an economical, true Op Amp to match the performance of high-speed DACs. The natural choice for data acquisition, pulse and wideband video amplifiers, avionic and military equipment, and a variety of graphic displays.

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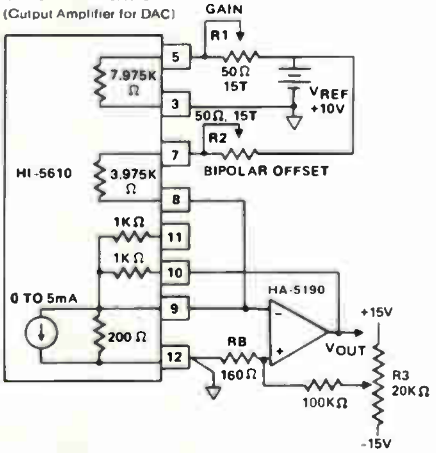
PERFORMANCE PARAMETERS

INPUT OFFSET VOLTAGE	5	mV
BIAS CURRENT	5	μA
FULL POWER BANDWIDTH	6.5	MHz
RISE TIME	11	ns
SLEW RATE	±200	V/μs
SETTLING TIME		
5 V to 0.1%	70	ns
5 V to 0.01%	100	ns
POWER DISSIPATION	600	mW

TYPICAL APPLICATION
(Output Amplifier for DAC)



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1611A, therefore, the latter's mnemonic key is disabled.

With a display up to 36 bits wide, the user can watch activity on several buses simultaneously, for both 8- and 16-bit microprocessors. Seven clocks allow multiplexed data on common bus structures to be latched into the 1611A as necessary for proper display. Each half of a multiplexed 16-bit address bus and a 16-bit data bus can be clocked into the 1611A separately, allowing an additional 4-bit bus to be interrogated by a different clock at a different time.

A model 1611A analyzer with the general-purpose module installed sells for $6,000; the model 10264A plug-in is priced at $2,000. Deliveries are beginning this month.

Hewlett-Packard Co., 1507 Page Mill Rd., Palo Alto, Calif. 94304 [404]

20-MHz portable scope is priced at $950

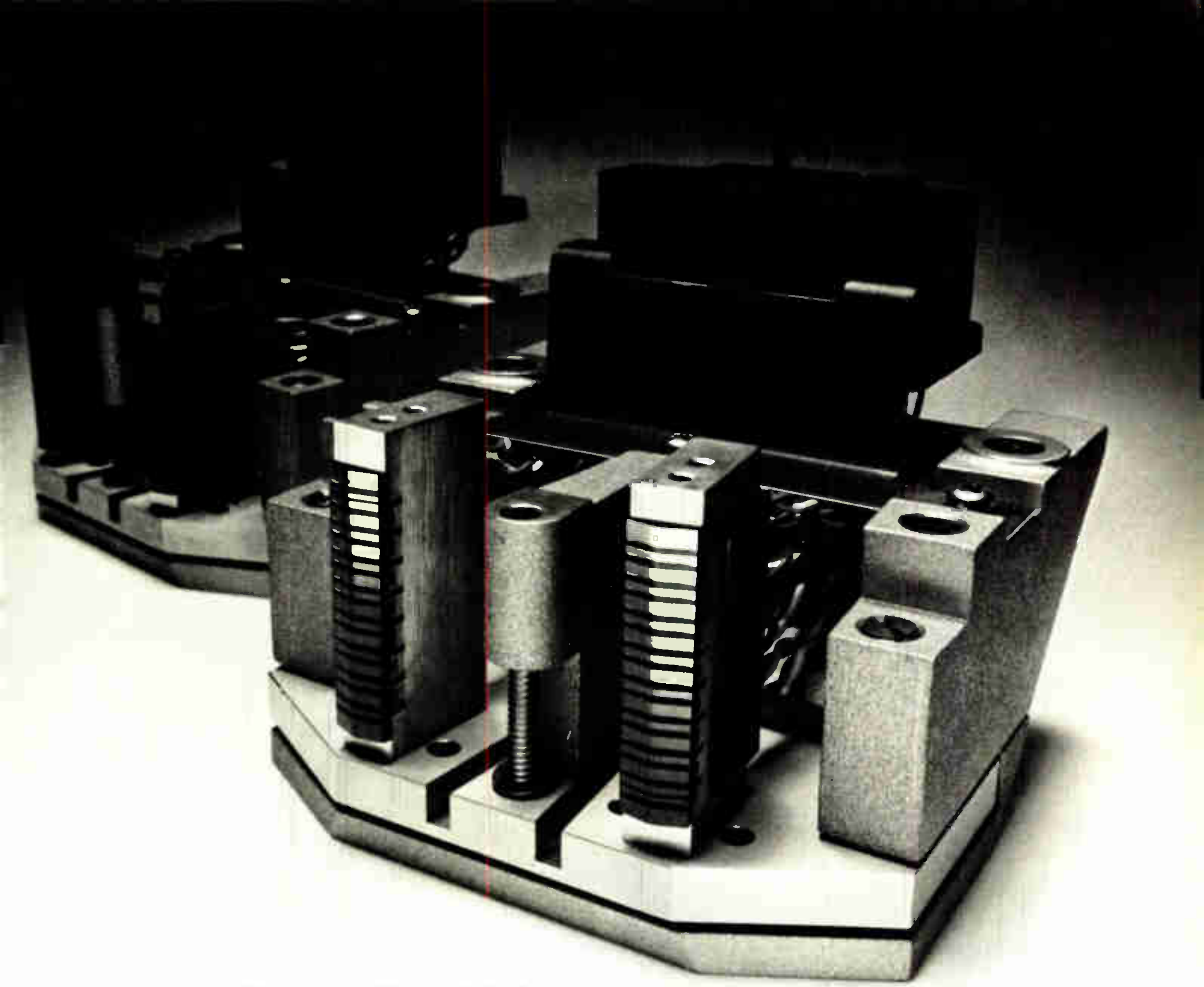
The model LBO-308 dual-trace oscilloscope is a portable instrument with a bandwidth of 20 MHz, a sensitivity of 2 mV per division, and a price tag of $950. Designed for field and laboratory applications, the scope may be powered by the ac line, by a dc power supply, or by an optional rechargeable battery pack. Its 3-inch screen is divided into an 8-by-10-division grid. Two probes with switches for direct or 10× operation are included with the scope. A carrying case is optional.

Leader Instrument Corp., 151 Dupont St., Plainview, N. Y. 11803. Phone George W. Zachmann at (516) 822-9300 [406]

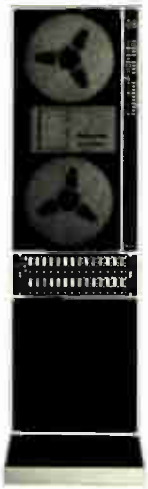
Substitution box provides resistance and capacitance

The model RCS-500 digital resistance-capacitance substitution box uses one set of side-by-side thumbwheel switches for setting the desired resistance value and another, similar set of switches for selecting the desired capacitance. This permits

← Circle 174 on reader service card



THE SUCCESS OF OUR MODEL NINETY-SIX GOES TO OUR HEADS.



Quite frankly, a tape system's performance depends on the quality of its heads. And that's why Honeywell developed the advanced technology needed to produce the heads for the Model Ninety-Six.

They are made of solid ferrite, a material so long-wearing that we warrant the heads for 3000 hours of operation. These heads also have such uniform gap azimuth, and such minimal gap scatter, that they can be counted on to produce stable, solid data whatever your record or reproduce application.

But the Model Ninety-Six offers more than the long-lasting ferrite heads. Its adjustment-free tape path features a highly efficient combination of vacuum-column isolation, dynamic inertial damping and high-performance capstan servo that keeps skew, flutter, and TBE to absolute minimums.

So if you need a system that offers consistent, gentle tape handling; up to 28 data channels; and a variety of tape widths and recording formats, call Ed Haines at (303) 771-4700. He will be happy to give you a no-nonsense explanation of the features and options of the Model Ninety-Six.

Or write for technical data sheets on the Model Ninety-Six and a free illustrated brochure that describes all of Honeywell's magnetic tape systems, oscillographic recorders and signal conditioning modules. Honeywell Test Instruments Division, Box 5227, Denver, CO 80217.

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Honeywell

New products

the user to choose any resistance from 1 to 9,999,999 Ω in 1-Ω increments and a capacitance value between 100 pF and 99.9999 μF in 100-pF increments.

The selected resistance and capacitance may be used independently, in series, or in parallel. All of the resistors are 1% devices with a power rating of 0.5 W. The capacitors are 100-V units with tolerances of 4%.

The 14.5-oz box measures 4.72 by 3.16 by 2.17 inches and sells for $185.95. Delivery is from stock.

IET Labs Inc., 761 Old Country Rd., Westbury, N. Y. 11590. Phone S. Sheena at (516) 334-5959 [405]

Portable gauss/fluxmeter takes wide range of probes

A portable 3½-digit gaussmeter and fluxmeter, the model 906 measures flux density in two ranges, 1 and 10 kilogauss full scale, using any of nine different Hall-effect probes. It also has two magnetic-flux ranges, 10^5 and 10^7 Maxwell turns, over which inputs from four standard search coils or custom probes are integrated and displayed.

The instrument has an internal reference magnet of 600 G ±2%. When used as a gaussmeter, its readings are accurate to within ±(0.4% of full scale + error of reference magnet) ±1 digit for static fields and to within ±3% for dynamic fields to 10 kHz. Used as fluxmeters, they are accurate to within ±(0.4% of full scale + 0.5% of reading) ±1 digit.

The 906 provides a maximum analog control output of 0.5 V dc and costs $665 without probe.

RFL Industries Inc., Instrumentation Division, Boonton, N. J. 07005 [407]

MILLIONS OF LAMPS.

Litronix is turning out LED lamps by the millions in four different colors. Six different sizes. Nine different arrays. And we're continuing to develop innovative products like our flashing lamps and lamps that maintain a constant brightness over a 4.5 to 16 volt range.

Our super brights include a powerful green lamp which puts out a dazzling 20 millicandellas.

And our broad product line comes in all popular sizes, from general purpose T1¾ down to lamps of one millimeter. See the sampling below.

Whether you need 100 lamps or 100,000, we're the high volume producer who can get you product fast. Our huge distributor network is everywhere.

Write for samples on your letterhead. And light up with Litronix, 19000 Homestead Road, Cupertino, CA 95014. (415) 257-7910.

Part Number (Series)	Color	Package Size & Description		Minimum Light Output MCD	mA
LD52	Red	T1¾	High Brightness	1.2 to 15	10
FRL4403	Red	T1¾	Flashing	.5	20
RL4403	Red	T1¾	Wide Angle	.8	20
RL5054	Red	T1¾	Narrow Angle	.5 to 1.0	10
RLC200	Red	T1¾	Constant Current	0.4 to 0.8	10 to 20
LD32	Red	T1	High Brightness	1.2 to 2.0	10
RL209	Red	T1	75 mil lead spacing	.3 to 2.0	20
RL4480	Red	T1	100 mil lead spacing	.3 to 2.0	20
RLC210	Red	T1	Constant Current	0.1	10
RL50	Red	Sub Min	Radial Lead	.3 to 2.0	20

Part Number (Series)	Color	Package Size & Description		Minimum Light Output MCD	mA
LD56	Yellow	T1¾	High Brightness	1.6 to 10	10
YL4550	Yellow	T1¾	General Purpose	1.0	10
LD36	Yellow	T1	High Brightness	1.6 to 2.0	10
YL212	Yellow	T1	General Purpose	1.0	10
YL56	Yellow	Sub Min	Radial Lead	2.0 (typical)	20
LD57	Green	T1¾	High Brightness	2.5 to 20	10 and 20
GL4950	Green	T1¾	General Purpose	1.0	20
LD37	Green	T1	High Brightness	2.0 to 4.0	20
GL211	Green	T1	General Purpose	.8	20
GL56	Green	Sub Min	Radial Lead	1.0 (typical)	20

litronix

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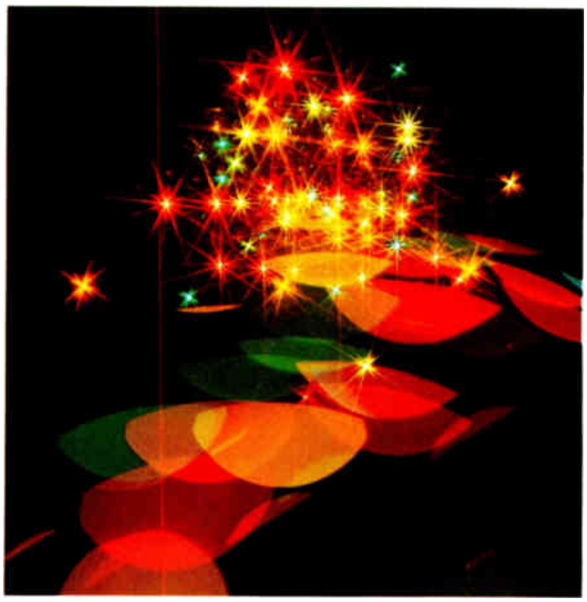
THE LIGHTS FANTASTIC



Circle 177 on reader service card

16 bits and then some... and Datawest packs it all together

DATAWEST will cut your data acquisition system and digital signal processing system cost by applying time proven techniques to your application. Putting together a successful analog-to-digital data acquisition system requires more than just a good **A/D converter.** Expertise is needed in signal conditioning, front end multiplexing and digital techniques. DATAWEST has been designing and manufacturing systems for sophisticated applications for over a decade. DATAWEST-designed systems, installed all over the world, are being used in a wide variety of applications including geophysical studies, vibration analysis, nuclear system monitoring and bio-medical research. DATAWEST supplies complete analog-to-digital data acquisition systems from **input amplifier** to **computer interface,** including the DATAWEST line of **array processors.** Field proven standard modules (plus custom interface circuits if needed) can be assembled to provide reliable, cost-effective systems to meet specific needs.

The 390 system offers high resolution and high speed utilizing the DATAWEST 16-bit, 150 kHz **A/D converter.**

Other DATAWEST products:

- **Array Processors**
- **Channel Simulators for IBM 360/370**
- **Digital Audio Delay Systems**
- **12, 15 and 16 bit A/D Converters**
- **12, 15 and 16 bit D/A Converters**
- **Complete Scientific Signal Processing Systems**

DATAWEST CORPORATION™

For information regarding DATAWEST products, contact David Long, Director of Technical Marketing

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The worldwide switch is at hand.
Manufacturers of computers and computer peripherals throughout the world use C&K switches. Producers and designers of test instrumentation, panel boards, word processing, and telecommunication equipment are switching our way too.
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Circle 179 on reader service card

Components

V-I converters are accurate

Modules convert voltages between 0 and + 10 V into currents from 4 to 20 mA

Voltage-to-current converter modules that can maintain tight accuracy specifications over a broad temperature range are hardly common. They're a little easier to come by now, however, with the introduction of two new ones by Analog Devices Inc. The converters—the nonisolated model 2B20 and the isolated model 2B22—are expected to find wide application in a variety of industrial areas.

"The 2B20 is completely self-contained," notes Janusz S. Kobel, marketing manager for signal conditioner components. "No external components are needed for this non-isolated model." Voltage inputs for the 2B20 may range from 0 to +10 V and will produce outputs between 4 and 20 mA. Nonlinearity, as a percentage of the full 16-mA span, is a maximum of ±0.025% for the A model and ±0.005% for the B. Settling time to within 0.1% of full scale, for a 10-V step, is 25 μs for both and input impedance is 10 kΩ.

Both converters operate from −25° to +85°C. At 25°C the maximum offset error (total output error with 0 V at the input) is 0.4% of span for the A model and 0.1% for the B. Over the temperature range, the offset error temperature coefficient is 0.01%/°C (2B20A) and 0.005%/°C (2B20B).

The 2B20 comes in a module with dimensions of 1.1 by 1.1 by 0.4 in. It requires a nominal supply voltage of +15 V, but the actual value may range from +10 to +32 V. The 2B20A sells for $26 each in lots of 100 or more, whereas the 2B20B is priced at $33.

Isolated. The isolated 2B22 uses a single resistor to program its 10-kΩ input's voltage range. This may vary from 0 to +1 V up to 0 to +10 V, while the output current range remains fixed at 4 to 20 mA. The 2B22 has an input-to-output common-mode voltage rating of 2,500 V rms (at 60 Hz for 1 minute) and ±2,500 V peak (continuous ac or dc). The input-to-output common-mode rejection ratio is 90 dB at 60 Hz with a 1-kΩ source imbalance.

Nonlinearity, as a percentage of span, is ±0.2% for the model 2B22J, ±0.1% for the 2B22K, and 0.05% for the L. Settling time to within 0.1% of full scale for a 10-V step is 300 μs for all three devices. Nominal supply voltage is +15 V, although the units will work off voltages between +14 and +32 V.

The 2B22 will meet its specifications from 0° to 70°C, but it can be used with reduced accuracy from −25° to +75°C. The maximum offset error at 25°C is ±0.25% of span for the J and K versions and 0.1% of span for the L. The offset temperature coefficients for the three versions are: ±0.01%, 0.005%, and 0.0025% per °C for the J, K, and L, respectively.

The isolated units are housed in modules that measure 2.2 by 3 by 0.6 in. In hundreds, the prices are $59 (J), $74 (K), and $92 (L).

Applications for both models include industrial instrumentation and process control, principally digital-to-analog conversion and data monitoring and logging. "The live zero (non-zero output for zero input) is especially useful to the process-control industry," says Kobel. The

Now you can get your favorite programs in color.

Heeeeeeeerrrresssss Xerox!

With the new 6500 Color Graphics Printer. The first printer that can put full-color reproductions of computer generated graphics in your hands in seconds.

So now, for the first time, you can quickly get a permanent record in full color.

A permanent record to hand out after presentations, or as part of a report on an ongoing project.

Process industries, for example, can use the 6500 CGP for prints of process variables such as temperature, pressure, flow, valve settings and to record alarm conditions for analysis. It can help railroads keep track of their train routes. Graphics data processing centers can now print graphic data in color.

And when the 6500 CGP isn't working off a computer, it becomes a great way to make full-color copies from regular hard-copy originals. Or even 35mm slides.

So ask about the 6500 Color Graphics Printer.

It'll not only make your programs look better.

It'll do wonders for your ratings.

XEROX

Circle 181 on reader service card

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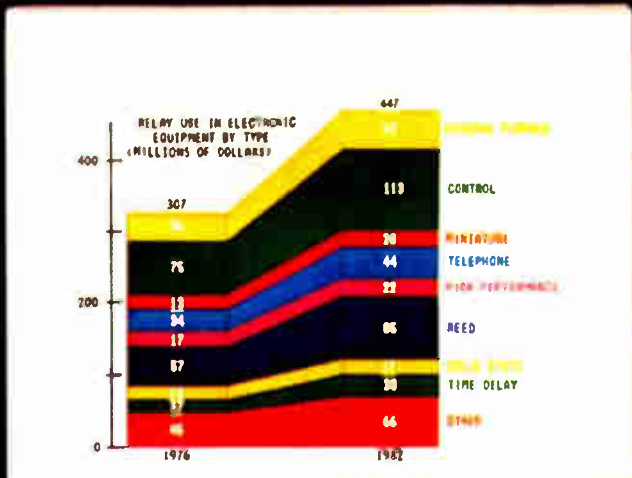
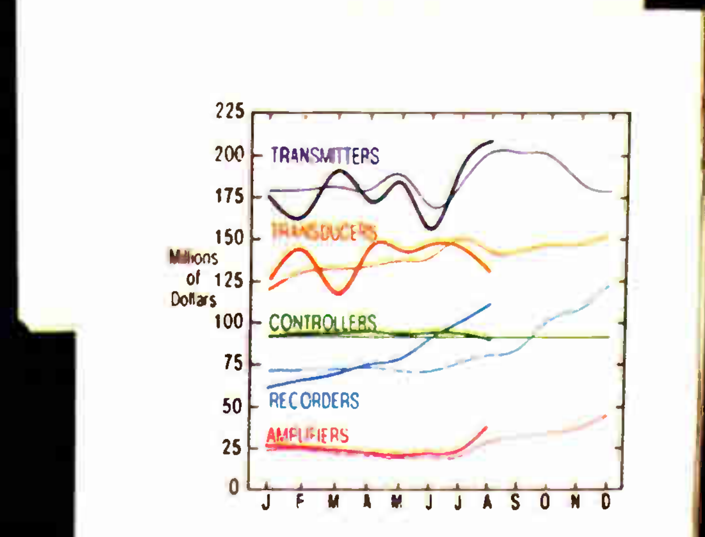
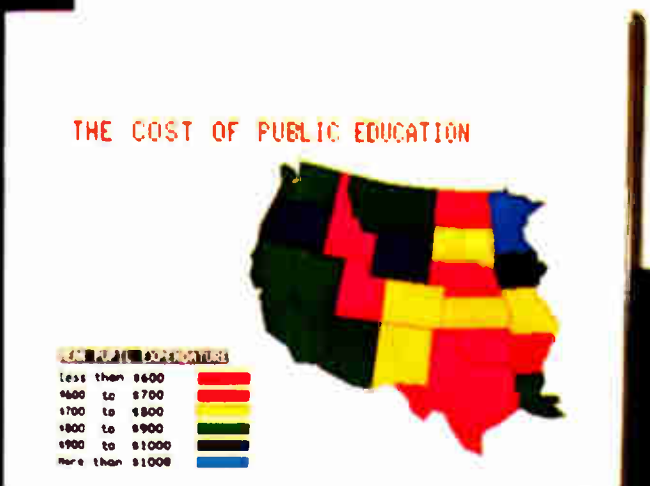






These prints were made on a 6500 CGP.

isolated 2B22 can be used in current-to-current isolators, "where isolation from one loop to another is needed," he adds.

Both products are available from stock.

Analog Devices Inc., Route 1 Industrial Park, Norwood, Mass. 02062. Phone Janusz Kobel at (617) 329-4700 [341]

400-V/800-mA triac is controlled by less than 10 mA

A small, sensitive-gate triac, designed to be compatible with integrated logic circuits, requires less than 10 mA of input current to control its 800-mA rms output. The SC92 withstands 400 v, allowing it to control small motors, solenoids, lamps, and similar devices directly.

The triac is protected against nonrepetitive voltage transients by a breakover-triggered mechanism, which guarantees that if the triac is hit with a high-voltage transient, it will turn on and protect itself. Furthermore, its glass-passivated pellet enhances its blocking life while its gold eutectic mountdown provides virtual immunity to thermal fatigue.

The SC92 is priced in the vicinity of 30 cents. For detailed specifications, along with a free sample kit, write to George Sawchuck at the following address.

General Electric Co., West Genesee St., Auburn, N. Y. 13021 [342]

Keyboards withstand high-pressure selling

A series of sealed keyboards designed for severe environments, Thinswitches can withstand not only the rigors of military aircraft and industrial control applications but even the punishment inflicted on them in vending machines.

The high-reliability keypads come in three-by-four and four-by-four arrays as well as in custom configurations. They have been designed to meet the requirements of MIL-E-16400 and −5400, and can be

purchased with or without plastic bubbles that provide tactile feedback. Each key has a rated life at load of 10^6 operations.

The switches are constructed with gold-plated beryllium copper contacts. A high-temperature transparent polyester laminate allows lights at the edge of the panel to illuminate the switch legends, which can be produced to the purchaser's specifications by photographic means. The units work without springs, buttons, or other mechanical linkage and are only 0.13 in. thick.

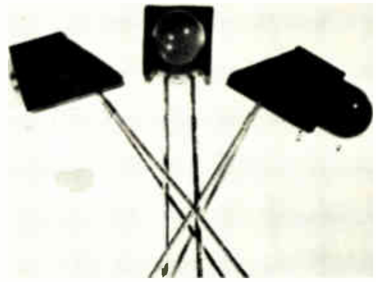
Within an array, each single-pole, single-throw key provides momentary contact between a row and a column element when pushed. At 25°C, it has a contact rating of 50 mA at 28 V dc and maximum contact bounce duration is 5 ms.

A standard four-by-four array Thinswitch with tactile feedback costs $95 in lots of 100. Delivery of standard models takes four to six weeks.

Industrial Electronic Engineers Inc., 7740 Lemona Ave., Van Nuys, Calif. 91405. [343]

Light-emitting diodes shine brightly from pc boards

Available in red, green, or yellow, the 5300 series of light-emitting diodes have a high-intensity output.



Depending on color, the LEDs have a luminous intensity of 6 to 7.5 millicandelas with a current of 20 mA.

The units can be mounted on circuit boards where they can act as pilot lights or illuminate back panels. A channel on the bottom of the housing permits flux cleaning solutions to circulate beneath them.

In quantities of 1,000, each unit costs 45¢. Delivery is from stock.

Industrial Devices Inc., 7 Hudson Ave., Edgewater, N. J. 07020. Phone (201) 224-4700 [344]

Digital delay line withstands harsh production processes

Designed to withstand manufacturing processes such as wave soldering and freon degreasing, the HY-5001 digital delay lines are housed in hermetically sealed, 14-pin, dual in-line packages. Delay times can be selected in 20% increments by five taps, maximum values being 25 ns to 250 ns. Accuracy is to within ±5% of maximum delay time or ±2 ns, whichever is larger. In quantity, the HY-5001 sells for $14.80 and is available from stock.

Hytek Microsystems Inc., 16780 Lark Ave., Los Gatos, Calif. 95030. Phone Dick Fryoff at (408) 358-1991 [348]

Gas-discharge display looks bright 50 ft away

A seven-segment, six-digit gas-discharge display, the SP-491 has a brightness of 210 foot-lamberts. The neon-orange display is 0.7 in. high, can be read at distances up to 50 ft, and is visible at an angle of up to

Today's management techniques are not new to him.

Kieran Fitzpatrick has learned to work with cost control, quality control, flexible production schedules, and increased employee responsibility. Many international companies have shown that innovative management can be very successful in Northern Ireland. It works for Du Pont, Goodyear, ITT, for Grundig, Michelin, Telefunken—for firms of all sizes in a range of industries.

The Northern Ireland work force fits new methods into a manufacturing tradition as old as the industrial revolution. We combine innovation with positive attitudes toward company loyalty, productivity, and labor relations. We apply to the task skills from the basic to the sophisticated.

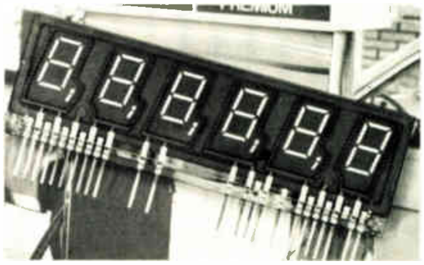
And to help put all this to work for you, we offer the best overall package of economic incentives in the EEC.

Find out how well we fit your business style. Get the facts from Reg Browne or George McLaren at the Northern Ireland Industrial Development Office in New York. They will quickly tailor an offer of assistance to suit your plans. Call (212) 593-2258. Or write: NIIDO, British Consulate-General, 150 E. 58th Street, New York, NY 10022.

Kieran Fitzpatrick works. He's building a career in electronics at Grundig.

Northern Ireland works.

New products



130° even at that distance.

Designed for multiplexed operation, it is well suited for use in point-of-sale terminals. The SP-491 is priced at $13.80 in quantities of 1,000 and is deliverable from stock.

Display Systems Division, Beckman Instruments Inc., 350 N. Hayden Rd., Scottsdale, Ariz. 85257. Phone (602) 947-8371 [347]

Photoelectric reader lamp beams with higher power

For photoelectric card and tape readers that require a higher-wattage light source, a T-2-½ model incandescent lamp has been added to the CM8 Thin-Line series. The 5/16-in. diameter lamp contains a 4-in.-long filament that radiates 5.16 W at 12 V.

Like other members of the CM8 series, the 10,000-hr lamp is constructed with a spring that supports the filament by tension. The usual filament supports are thus eliminated, together with the cold spots on the filament they typically create.

The units are priced at $11.60 in quantities of 1,000. Delivery is from stock to eight weeks.

Chicago Miniature Lamp Works, 4433 North Ravenswood Ave., Chicago, Ill. 60640. Phone Tom Knopp at (312) 784-1020 [346]

GROWTH SPURS HIRING

Rockwell Plans For Continued Avionics Growth In 1979.

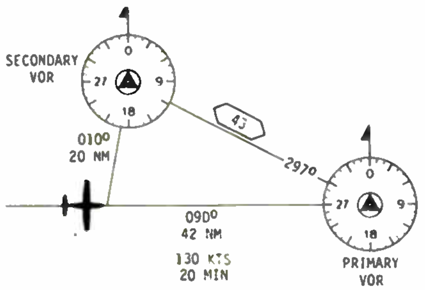
CEDAR RAPIDS — Rockwell International is anticipating another year of growth and new developments for its avionics and telecommunications businesses, according to sources in Cedar Rapids where Rockwell's Avionics and Missiles Group is headquartered. Rockwell's Collins Divisions have helped place the company among the largest electronic firms in the world. The company is now gearing up for development of the next generation of electronics products. Among the systems produced in Cedar Rapids are the Rockwell-Collins Pro Line and Micro Line avionics for general aviation aircraft, and a complete line of air transport avionics. Government avionics products and systems include the U.S. Air Force standard tactical air navigation system, and the complete avionics system for the new U.S. Coast Guard Medium Range Search Aircraft.

Rockwell-Collins digital flight control systems to guide new generation of commercial aircraft through the turn of the century.

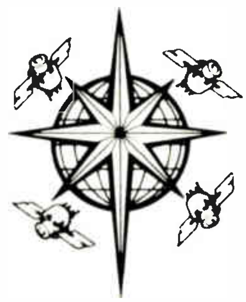
CEDAR RAPIDS — A new multimillion-dollar contract awarded to Rockwell International's Collins Air Transport Division is expected to provide a baseline business for the Division through the turn of the century. The contract is for digital flight control systems to guide a new generation of commercial aircraft. It's the firm's largest single avionics project ever, surpassing even their work on the U.S. space program. The Division has immediate openings for additional engineers to help handle the increased work load.

General Aviations' new product introductions help provide continued market leadership.

CEDAR RAPIDS — The availability of exciting new technology, combined with healthy sales projections for general aviation aircraft, has helped stimulate a wave of new product introductions by Rockwell International's Collins General Aviation Division. Typical of the energetic product development efforts of the Division was the introduction this year of six new general avionics products. Among them: the first Rockwell-Collins Pro Line color weather radar and a Pro Line navigation processor which displays checklist and map information of the radar indicator; and the new Micro Line DCE-400 distance computing equipment which uses the bearing information



from two VOR stations to compute distance and groundspeed. (The engineer who developed the latter product was named Engineer of the Year for the Division.) The thrust of the new product development work for both product lines will be to further increase the momentum that has propelled the Division to market leadership.



New products and systems under intensive development at Rockwell's Collins Government Avionics Division.

CEDAR RAPIDS — The GPS generalized development model user equipment being developed by Rockwell's Collins Government Avionics Division continues to perform well beyond expectations in USAF Avionics Lab tests. Meanwhile, the Division continues work on the USAF standard TACAN, standard AM/FM comm transceiver, the avionics system for the USCG HU-25A and an entire new family of cockpit control and display systems. The Division is also engaged in a series of major new product and system development programs for the government avionics market, creating a requirement for engineering and technical personnel to help the Division expand its share of this growing market.

Professional Rockwell employees enjoy a wide range of benefits, including life, medical, dental and accident insurance; income protection; paid vacations/holidays; liberal reimbursement for relocation; and generous savings and retirement plans.

For full details, write Loren Wells, Mgr., Professional Employment, Avionics and Missiles Group, 400 Collins Road NE, M/S 120-145, Cedar Rapids, IA 52406.

Rockwell International

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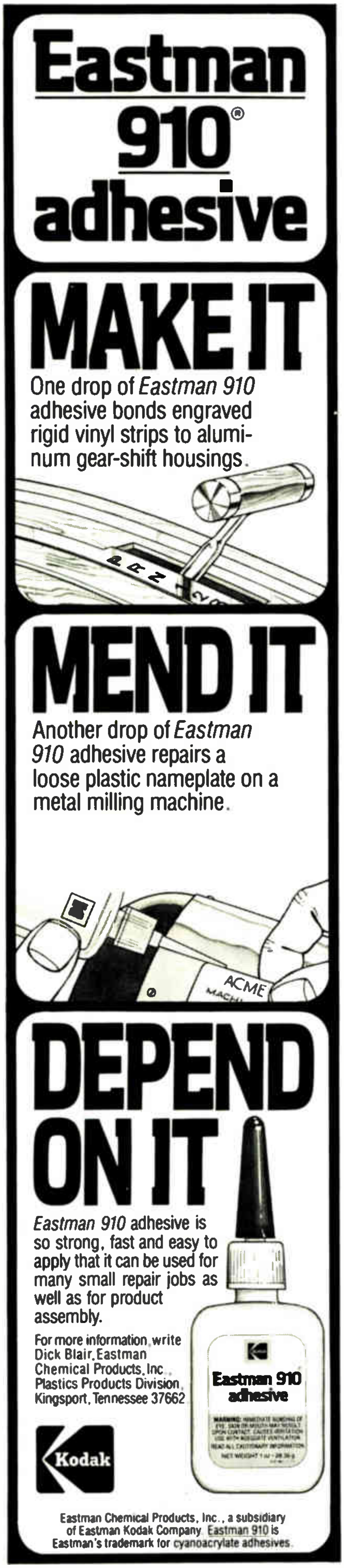


Microcomputers & systems

System develops C-MOS computers

CRT instrument supports 8080A and Z80 and also accepts 1802 overtures

Playing second fiddle does not give second sources much of the limelight. So, to demonstrate its own virtuosity, Hughes Solid State Products division, which manufactures 1800-family devices under license from RCA, has decided to introduce a noteworthy product itself. Called HMDS, it is a microprocessor development system that supports the complementary-metal-oxide-semiconductor 1802, as well as n-MOS processors like the 8080A and the Z80.

"It shows that Hughes is more than a second source, that we bring something more to the 1802," notes Gary DesRochers, manager of microprocessor applications for the division. In his view, RCA's use of a teletypewriter (rather than the cathode-ray tube found in most n-MOS support systems) presented an opportunity in the C-MOS MDS field. "Our customers are used to CRT systems for real-time visual feedback," DesRochers underscores.

The system, which uses personality modules to orchestrate the various types of processors, is being offered in two configurations: one with floppy-disk storage for loading and maintaining programs and data files, and a lower-priced cassette version.

The disk-storage HMDS sells for under $11,000, the exact price varying according to whether 630 or 1,018 kilobytes of storage are required. It includes a 40-by-24-character display, an ASCII keyboard, 16 kilobytes of static random-access memory, an in-circuit debugger board for the 1802, power supplies, and a chassis. Also provided are editor, assembler, and monitor-debugger software. Similarly equipped, the cassette-storage MDS sells for under $7,000. In the disk-based version, programs and data files are loaded by programmable read-only memories. The PROM programs include commands for reading object code and for comparing and changing data.

The HMDS assembly language is compatible with RCA's Cosmac, says DesRochers. At present, the system uses Basic as its high-level language, and Hughes is considering offering Pascal as an option.

In addition to its monitoring and debugging capabilities, the in-circuit debugger board can select either the internal or an external clock. It can also enable or disable direct memory access or interrupts.

Optional hardware and software

PLUG ALL YOUR MEASUREMENT NEEDS INTO ONE RECORDER.

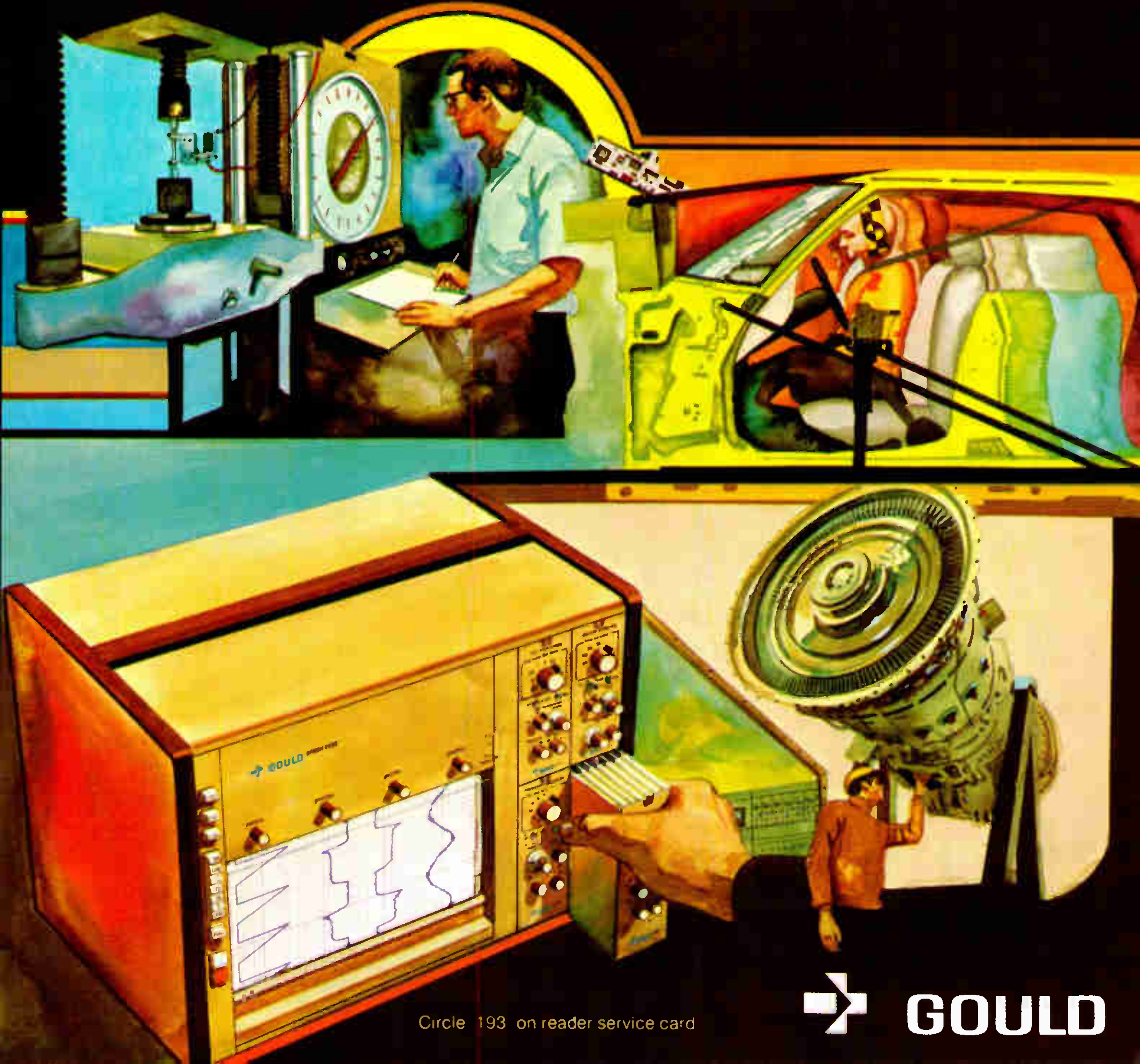
Gould plug-in signal conditioners give you all the versatility you need so you don't have to buy new recorders as your measurement needs change.

This modular approach allows you complete latitude of measurement capabilities. Measure microvolts to kilovolts; microstrain to 10,000 microstrains; temperature from −250° to 2500°C; frequencies from 10 Hz to 50KHz. Simply plug in the appropriate signal conditioner.

And you get all this versatility without sacrificing any of the features you expect from your Gould instrument — calibrated zero suppression, low pass filtering to eliminate high frequency interference, full floating inputs for operation up to 500 volts off ground at any sensitivity setting.

Find out how one recorder can satisfy all your measurement needs. Contact Gould Inc., Instruments Division, 3631 Perkins Ave., Cleveland, OH 44114. Or Gould Alco S.A., 57 rue St. Sauveur, 91160 Ballainvilliers, France.

For brochure call toll-free: 800-325-6400, ext 77. In Missouri: 800-342-6600.



Circle 193 on reader service card

GOULD

at present offered include additional static RAM boards priced at $550 for 8-K, $1,000 for 16-K, and $1,750 for 32-K. Personality modules for n-MOS processors and the associated software are priced at $500 and $50, respectively. Also offered is a PROM programmer. Delivery of prototypes began in February and Hughes expects delivery times of 8 to 12 weeks for all subsequent system orders.

Hughes Aircraft Co., Solid State Products Division, 500 Superior Ave., Newport Beach, Calif. 92660. Phone (714) 759-2907 or 2678 [371]

System supports development of 12-bit processors, too

Original-equipment manufacturers working with a number of different microprocessors or anticipating future change can now purchase a single system to handle all development needs. The UDS, or Universal Development System, unites a 5-in. cathode-ray-tube display, keyboard, and open card cage in a portable (shown) or bench-top package.

According to their needs, system developers can purchase boards tailored to specific processors, as well as support and memory modules. All popular 8-, 12-, and 16-bit central processing units, like the Z80, 8085, 8080A, IM6100, 6800, 9900, Z8000, and 68000, are supported by boards and software, and bipolar processors can be accommodated on special order.

With power supplies, a boardless portable unit sells for $3,195. An 8-bit CPU board, a 4-kilobyte memory module, an erasable program-

New products

mable read-only memory module, and an E-PROM programmer are priced at $599, $350, $140, and $350, respectively. Source tape or floppy disk for the Editor costs $500, as do those for the Universal Assembler. Compatible floppy disk and line printer systems are also offered.

Micro Specialists Inc., 1431 E. St. Andrews Pl., Santa Ana, Calif. 92705. Phone (714) 549-0391 [397]

Fast worker hires on for $7,700 or less

Intended for tasks best handled in Basic, the SDS 420 microcomputer system sits neatly atop a desk and goes to work for only $7,700. The 6502A-based system has a maximum instruction time of only 3.5 μs.

The unit's 32-kilobyte memory, expandable to 56 kilobytes, fits on a single board, and mass storage of from 1½ to 10 megabytes is provided by up to four single- or double-density floppy-disk drives. A 71-character detachable keyboard and a 12-in. cathode-ray tube that can display up to 25 lines of 80 characters allow transactions under the guidance of the operating system and 12-K Basic interpreter.

Delivery time for the SDS 420 is 90 days and substantial discounts are available for large orders.

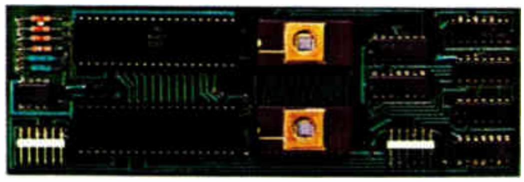
Scientific Data Systems Inc., 12640 Beatrice St., Los Angeles, Calif. 90066. Phone (213) 390-8673 [398]

Computer processes English and data

Blending a high-speed, Z80-based microcomputer, a video terminal, dual floppy-disk drives, and a printer, the Memorite 2 meets the computing needs of many small businesses or departments within larger companies. In building the computer, Vector Graphic Inc. used its own MZ microcomputer and Mindless Terminal as well as Qume Corp.'s Sprint 5 printer and dual Micropolis

Once you compare our new 191 digital multimeter to ordinary 5½-digit DMMs, we think you'll readily agree that it outclasses its class. For good reason.

The 191 is a ±200,000-count DMM capable of 0.004% accuracy and 1μV/1mΩ sensitivity. It delivers unsurpassed accuracy, faster, because firmware in the 6802-based μcomputer has replaced slower, less precise analog circuitry.



Displayed data is updated at the fastest rate of digit change readable by the human eye—4 conversions per second. Settling time of 0.5 seconds is easily half that of the 191's nearest competitor.

The μP combines both charge-balance and single-slope conversion techniques. Every displayed reading is automatically corrected for zero and gain drift.

If you've ever had to contend with the frustration of potentiometer zeroing, you'll appreciate the 191's null function. Automatic arithmetical correction of residual error is standard. With a touch of the button you can buck out any in-range signal, large or small.

A year from now you'll own one or wish you did.

You don't need low-level noise either. So the 191 automatically suppresses it. The 191's non-linear digital filter is entirely free of dielectric absorption and leakage problems associated with analog techniques. On the 200mV and 200Ω ranges, the filter effectively attenuates noise by displaying a running average of the 8 previous readings. Yet it instantly displays input changes of 10 digits or more.

Another exclusive of the 191 is 2 and 4-terminal measurement from 1mΩ to 20MΩ across six ranges. Simply adding two more sense leads automatically enables Kelvin measurements. No changing input terminal links or even pushbutton settings.

And, finally, since μP design reduces component count, the 191 requires less servicing and calibration, increasing reliability and stability.

At $499 without plug-in ACV, the 191 is today's performance/value leader in 5½-digit DMMs. A year from now most people will agree.

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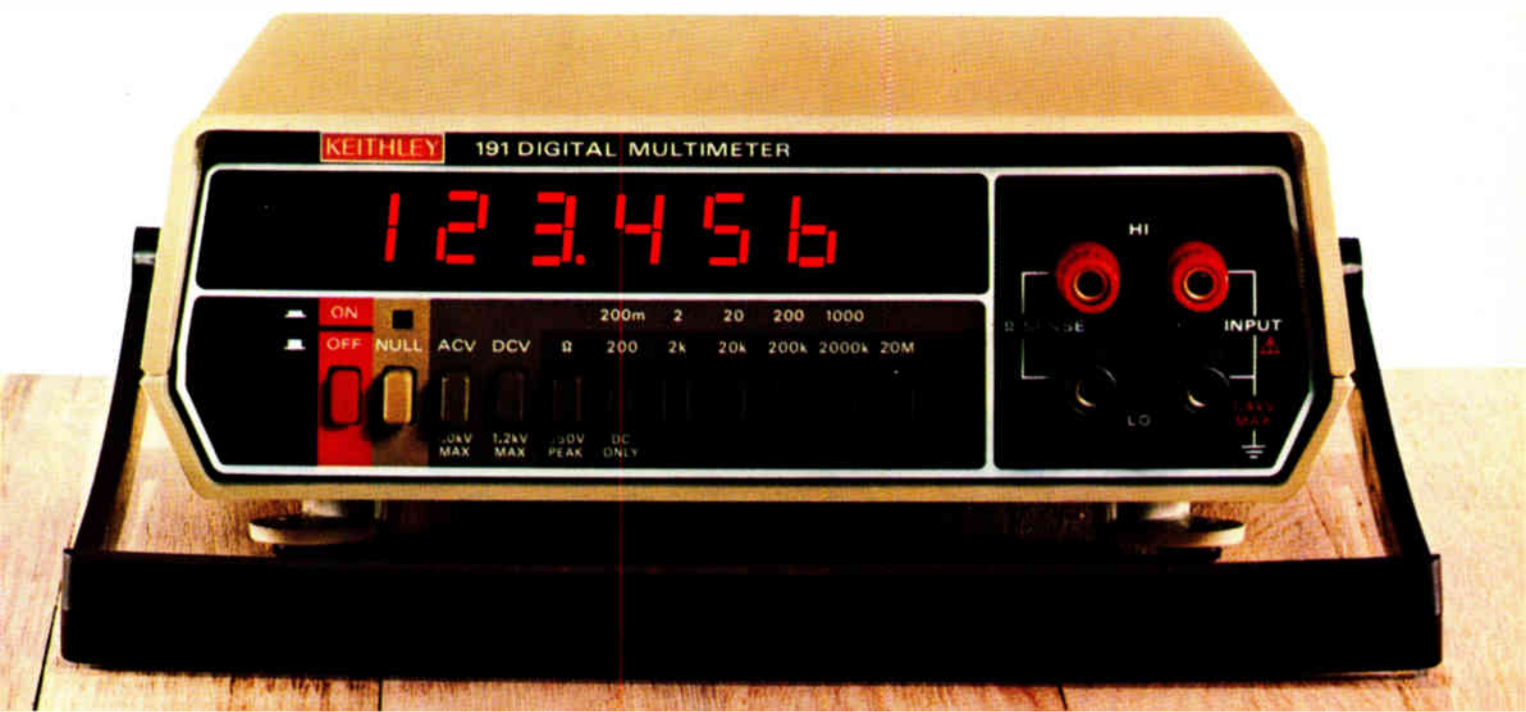
But you probably don't need that much time to make up your mind. And we're ready to help you with a demonstration or additional information. Call 800-321-0560. In Ohio, 216-248-0400.

Next year you'll be glad you did.

Circle #261 for literature

Circle #197 for demonstration



floppy-disk drives. The MZ can manage up to 630 kilobytes of disk memory and the printer can operate at speeds up to 55 characters per second.

For word processing, Memorite 2 has edit and delete capabilities for advanced text preparation. The system will automatically type letters from memory with underlining, indentation, automatic margins, and variable line and character spacing. Moreover, letters and address lists may be merged for mass mailings.

As a data processor, Memorite 2 can perform not only accounting tasks amd custom calculations using the Business Basic language, but also scientific calculations. Price of the Memorite 2 system is $8,950.

Vector Graphic Inc., 31364 Via Colinas, Westlake Village, Calif. 91361. Phone (213) 991-2302 [394]

Disk operating system executes faster than most

Index, which stands for interrupt-driven executive, is a disk operating system for the 6800 microprocessor. It is faster than most disk operating systems because the keyboard console and other input/output devices are serviced by interrupts rather than polling. Also, because the I/O devices are treated as disk files, new devices can be added without altering the operating system.

A user can expand Index by adding utility commands and driver routines, which reside on diskette and are loaded into memory only when needed. Thus software can be enhanced without changing the entire program or adding memory.

Index handles both ASCII and binary files, and these disk files are

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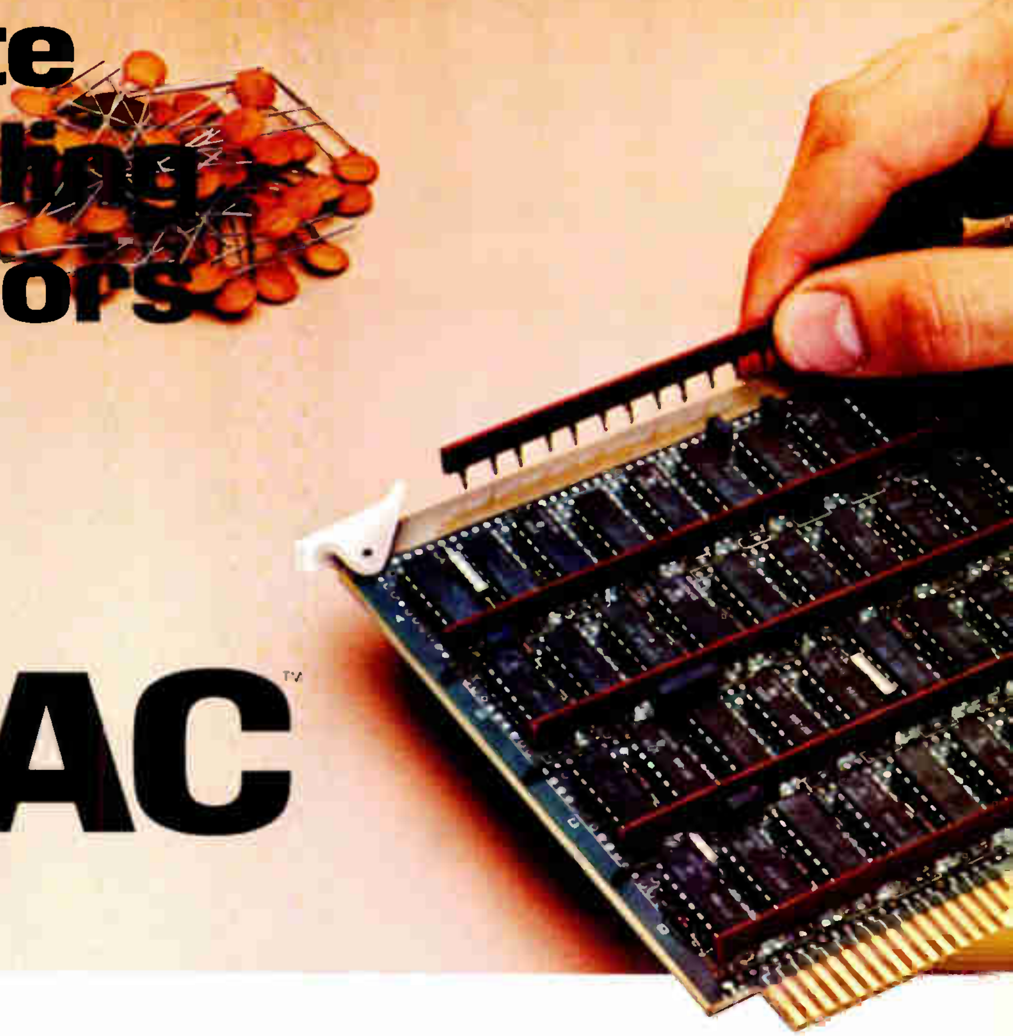

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Circle 228 on reader service card

automatically created, allocated, and de-allocated storage. Files are given names up to eight characters long to which parameters are appended to indicate drive number, directory level, protection status, and activity value. With the activity value, the user may list or display only the file entries at or above this level.

Versions of Index are available for the PerCom LFD-400, Southwest Technical Products' MF-68, Smoke Signal Broadcasting Co.'s BFD-68, and Motorola's EXORciser development system. Index is supplied on two minidiskettes for $99.95

Percom Data Co., 318 Barnes, Garland, Texas 75042. Phone (214) 272-3421 [395]

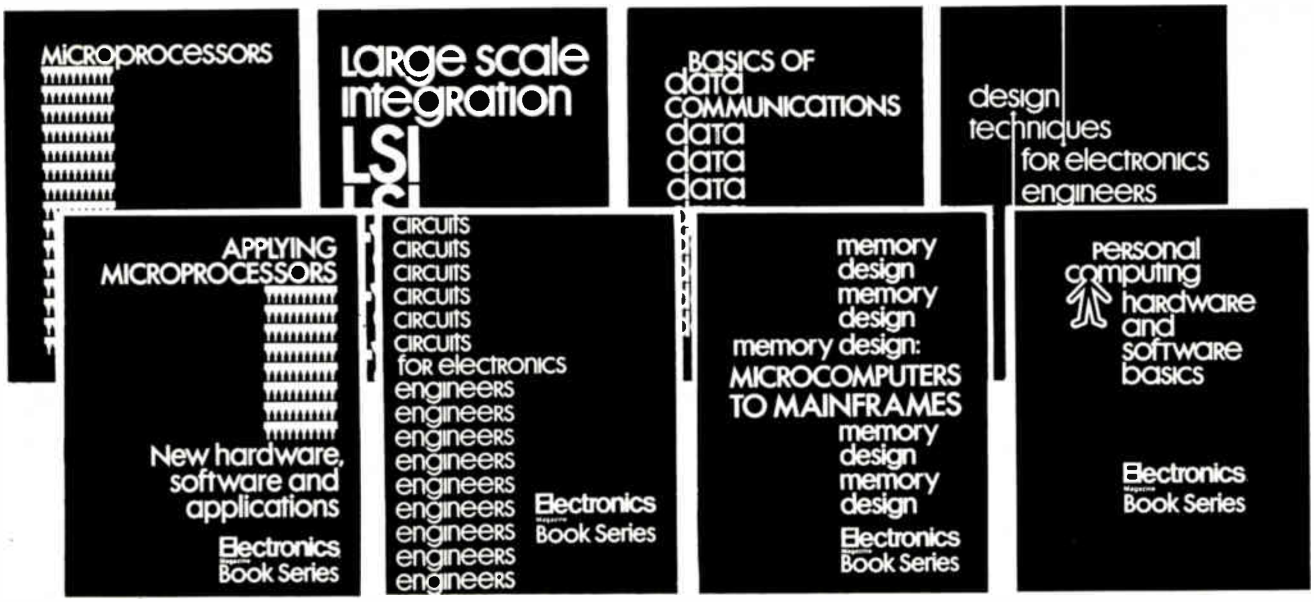
Simulator takes place of RAMs or ROMs

The ED-6000 simulator is used in place of read-only or read/write random-access memories while code is being developed for them. This allows a user to design and test machine-code software for microprocessors, as well as bit-slice and minicomputer systems. Because of the unit's short access time (65 ns), user programs can be executed and diagnosed at full speed without wasting programmable ROMs.

The simulator will support words up to 128 bits in length. Its memory is contained on cards holding 16 kilobits each. Data can be entered into the high-speed simulator through an optional terminal, through the use of a paper-tape reader, or by a computer.

The basic ED-6000, with 16 kilobits of memory, sells for $4,500.

Eldyne Inc., 7364 Convoy Court, San Diego, Calif. 92111. Phone (714) 277-2471 [396]



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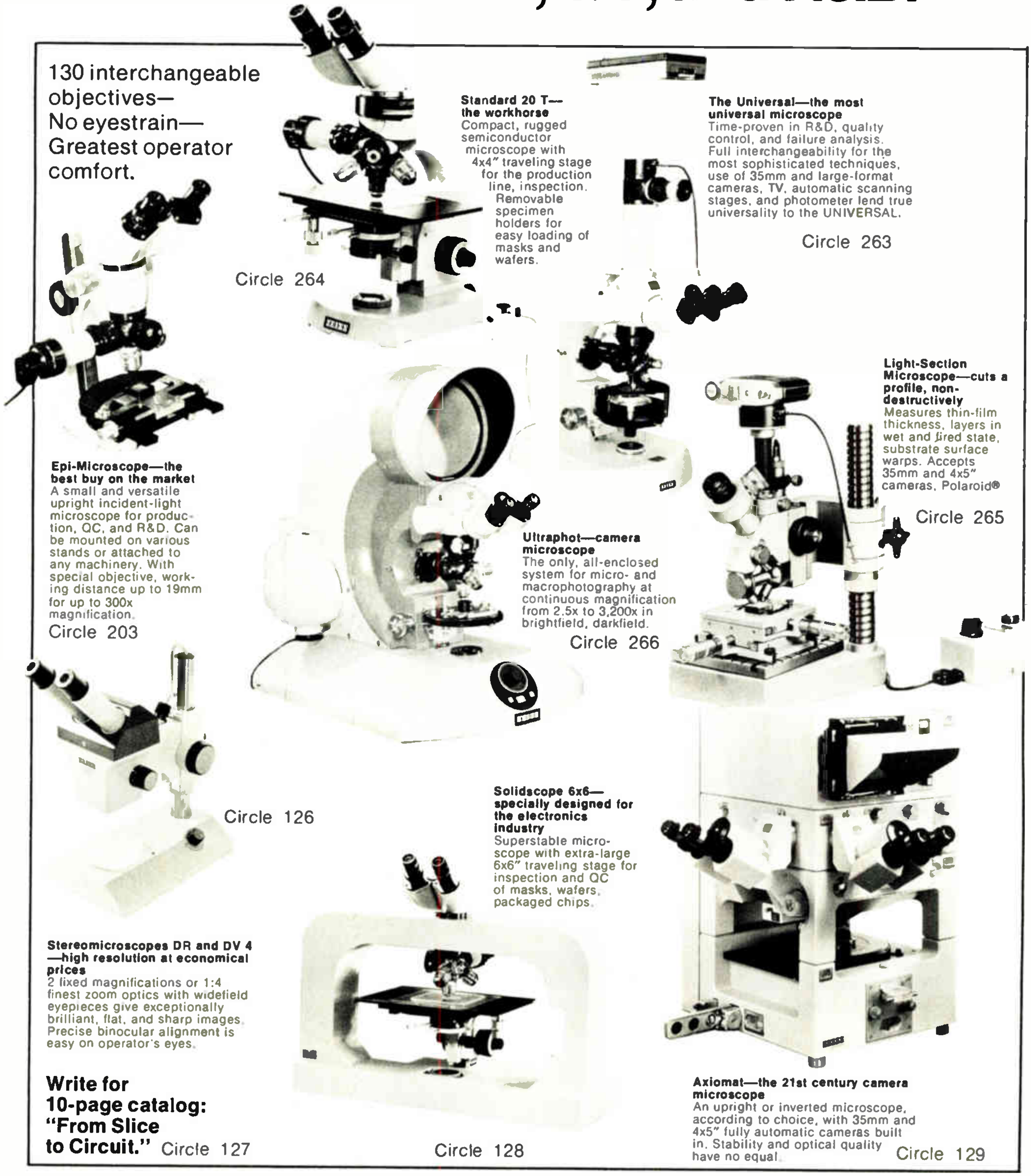

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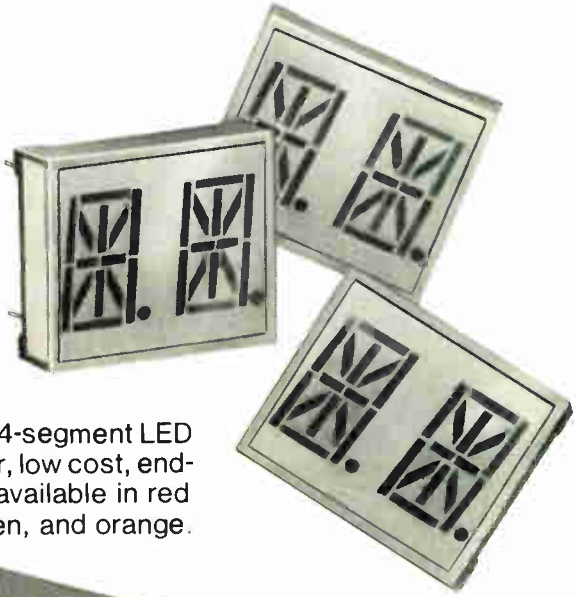
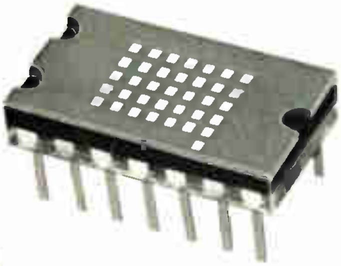
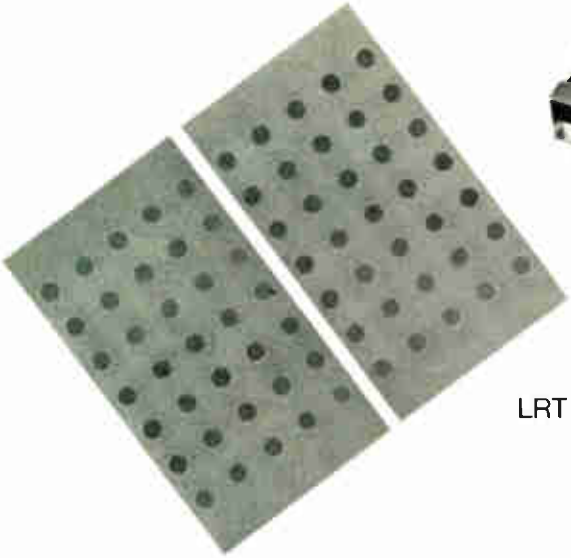


LRT1784/85 is a dual .54" 14-segment LED display; it is low power, low cost, end-stackable and available in red green, and orange.



LRT1704 is a .3" 5x7 LED array available in the high brightness colors of red, yellow and orange.



LRT1057 is a 1.16" 5x7 dot matrix, side-stackable LED capable of creating a "marqueeing" type of display effect; available in red, green, yellow and orange.

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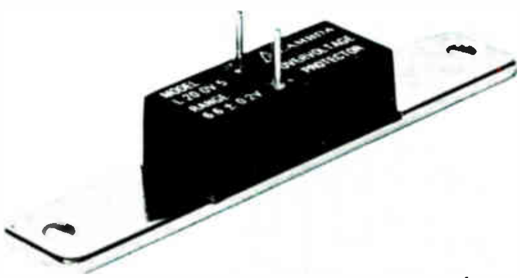

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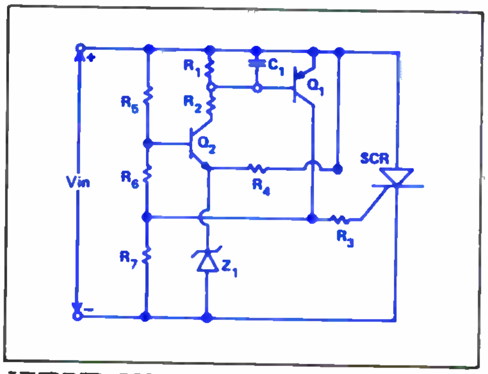
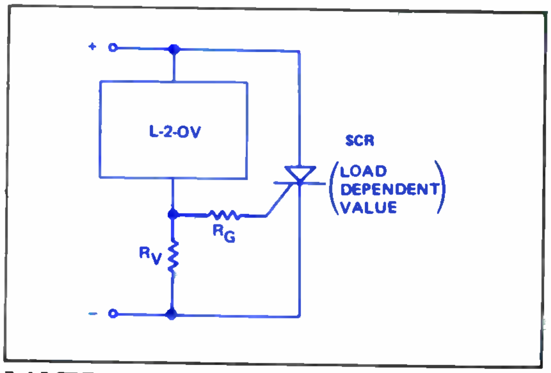


HYBRID OVERVOLTAGE PROTECTOR
SCHEMATIC DIAGRAM



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5	8.6 ± .2	L-2-OV-5	$2.50	$2.00	$1.90	$1.70	L-6-OV-5	$5	$4	$3.75	$3.40
6	7.3 ± .2	L-2-OV-6	2.50	2.00	1.90	1.70	L-6-OV-6	5	4	3.75	3.40
9	10.5 ± .4	L-2-OV-9	2.50	2.00	1.90	1.70	L-6-OV-9	5	4	3.75	3.40
10	11.0 ± .5	L-2-OV-10	2.50	2.00	1.90	1.70	L-6-OV-10	5	4	3.75	3.40
12	13.7 ± .4	L-2-OV-12	2.50	2.00	1.90	1.70	L-6-OV-12	5	4	3.75	3.40
14	16.0 ± .5	L-2-OV-14	2.50	2.00	1.90	1.70					
15	17.0 ± .5	L-2-OV-15	2.50	2.00	1.90	1.70	L-6-OV-15	5	4	3.75	3.40
18	20.5 ± 1.0	L-2-OV-18	2.50	2.00	1.90	1.70	L-6-OV-18	5	4	3.75	3.40
20	22.8 ± .7	L-2-OV-20	2.50	2.00	1.90	1.70	L-6-OV-20	5	4	3.75	3.40
24	27.3 ± .8	L-2-OV-24	2.50	2.00	1.90	1.70	L-6-OV-24	5	4	3.75	3.40
28	31.9 ± 1.0	L-2-OV-28	2.50	2.00	1.90	1.70	L-6-OV-28	5	4	3.75	3.40

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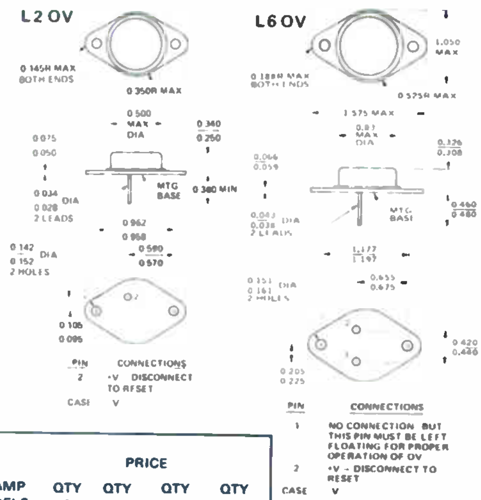

NOM SUPPLY VOLTAGE (VOLTS)	TRIP POINT VOLTAGE[A] (VOLTS)	12 AMP MODELS	PRICE QTY 1	QTY 100	QTY 250	QTY 1000	20 AMP MODELS	PRICE QTY 1	QTY 100	QTY 250	QTY 1000	35 AMP MODELS	PRICE QTY 1	QTY 100	QTY 250	QTY 1000
5	6.5 ± 0.2	L-12-OV-5	$11	$8	$7.50	$6.80	L-20-OV-5	$16	$11.20	$10.50	$9.50	L-35-OV-5	$20	$14.40	$13.60	$12.30
6	7.4 ± 0.2	L-12-OV-6	11	8	7.50	8.80	L-20-OV-6	18	11.20	10.50	9.50	L-35-OV-8	20	14.40	13.60	12.30
9	10.5 ± 0.5	L-12-OV-9	11	8	7.50	6.80										
12	13.8 ± 0.5	L-12-OV-12	11	8	7.50	8.80	L-20-OV-12	16	11.20	10.50	9.50	L-35-OV-12	20	14.40	13.60	12.30
15	17.0 ± .5	L-12-OV-15	11	8	7.50	6.80	L-20-OV-15	18	11.20	10.50	9.50					
20	22.8 ± .7	L-12-OV-20	11	8	7.50	8.80	L-20-OV-20	16	11.20	10.50	9.50					
24	27.3 ± .8	L-12-OV-24	11	8	7.50	6.80	L-20-OV-24	16	11.20	10.50	9.50					
28	31.9 ± 1.0	L-12-OV-28	11	8	7.50	6.80	L-20-OV-28	16	11.20	10.50	9.50					
30	33.5 ± 1.0	L-12-OV-30	11	8	7.50	8.80	L-20-OV-30	16	11.20	10.50	9.50					

[A] VOLTAGE TOLERANCE MAINTAINED OVER 0-71°C DUE TO POWER DESIGN

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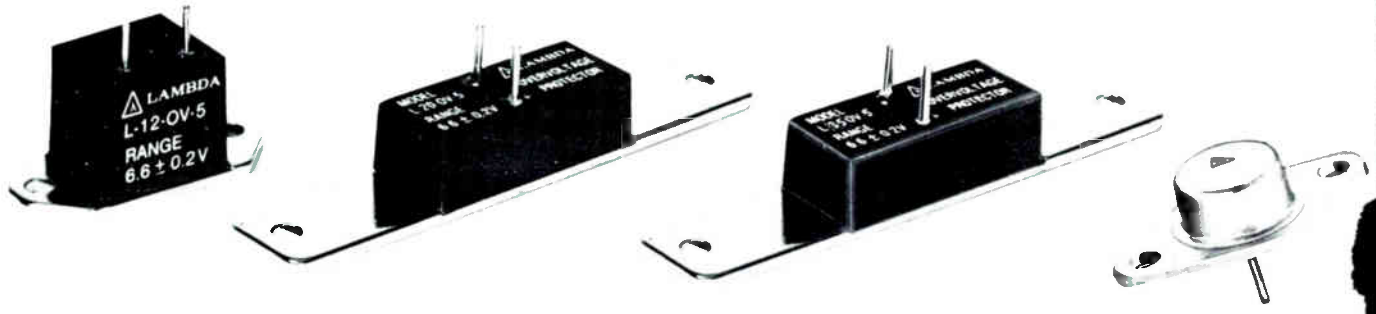

HYBRID
L-12-OV

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L-35-OV

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L-2-OV

TRUE TEMPERATURE-COMPENS
2A, 6A, 12

GENERAL DESCRIPTION

The Lambda overvoltage protector prevents damage to the load caused by excessive power supply output voltage due to improper adjustment, improper connection, a disconnected sense lead, or failure of the power supply Load protection is accomplished by effectively short circuiting the output terminals of the power supply when a preset limit voltage has been exceeded. The trip-point limit voltage cannot be adjusted To reset overvoltage protector, remove AC input to power supply, allow overvoltage protector to cool, and reapply power

OVERVOLTAGE PROTECTOR ABSOLUTE MAXIMUM RATING

PARAMETER	SYMBOL	L-2-OV SERIES		L-6-OV SERIES		L-12-OV SERIES		L-20-OV SERIES		L-35-OV SERIES	
		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
On State Current	I_{DC}	–	2A	–	6A	–	12A	–	20A	–	35A
On State Voltage	V_{DC}	–	2 6V	–	2 6V	–	1 3V	–	1 4V	–	1 6V
Non Repetitive Peak Surge Current*	I_P	–	20A	–	70A	–	200A	–	260A	–	350A
Standby Current	I_S	–	35mA	–	25mA	–	30mA	–	30mA	–	30mA
Operating Temperature (Blocking)**	T_{CB}	−40°C	+100°C	−40°C	+100°C	−40°C	+100°C	−40°C	+100°C	−40°C	+100°C
Operating Temperature (Conducting)***	T_{CC}	−40°C	+150°C	−40°C	+150°C	−40°C	+140°C	−40°C	+140°C	−40°C	+140°C
Storage Temperature	T_S	−40°C	+150°C	−40°C	+150°C	−40°C	+125°C	−40°C	+125°C	−40°C	+125°C
Power Dissipation @T_C=25°C Derate above 50°C	P_O	30 Watts @0 6°C/W		150 Watts @1 5°C/W							
Thermal Resistance	$R_{\theta JC}$	5 0 C/W		1 0°C/W							

*For sinusoidal current duration of 8 3 milliseconds max

**Case temperature for overvoltage protector in non-conducting or "OFF" state

***Case temperature for overvoltage protector in conducting or "ON" state Power must be removed and case temperature allowed to drop to 71°C before application of output voltage

The overvoltage protector requires an external heat sink to maintain case temperature below rated limit When the overvoltage protector is used with a Lambda power supply the power supply chassis acts as the heat sink The L 12-OV L-20-OV L 35-OV overvoltage protector is supplied with mating connectors for pins on overvoltage protector (+V and − V engraved on unit)

L-129

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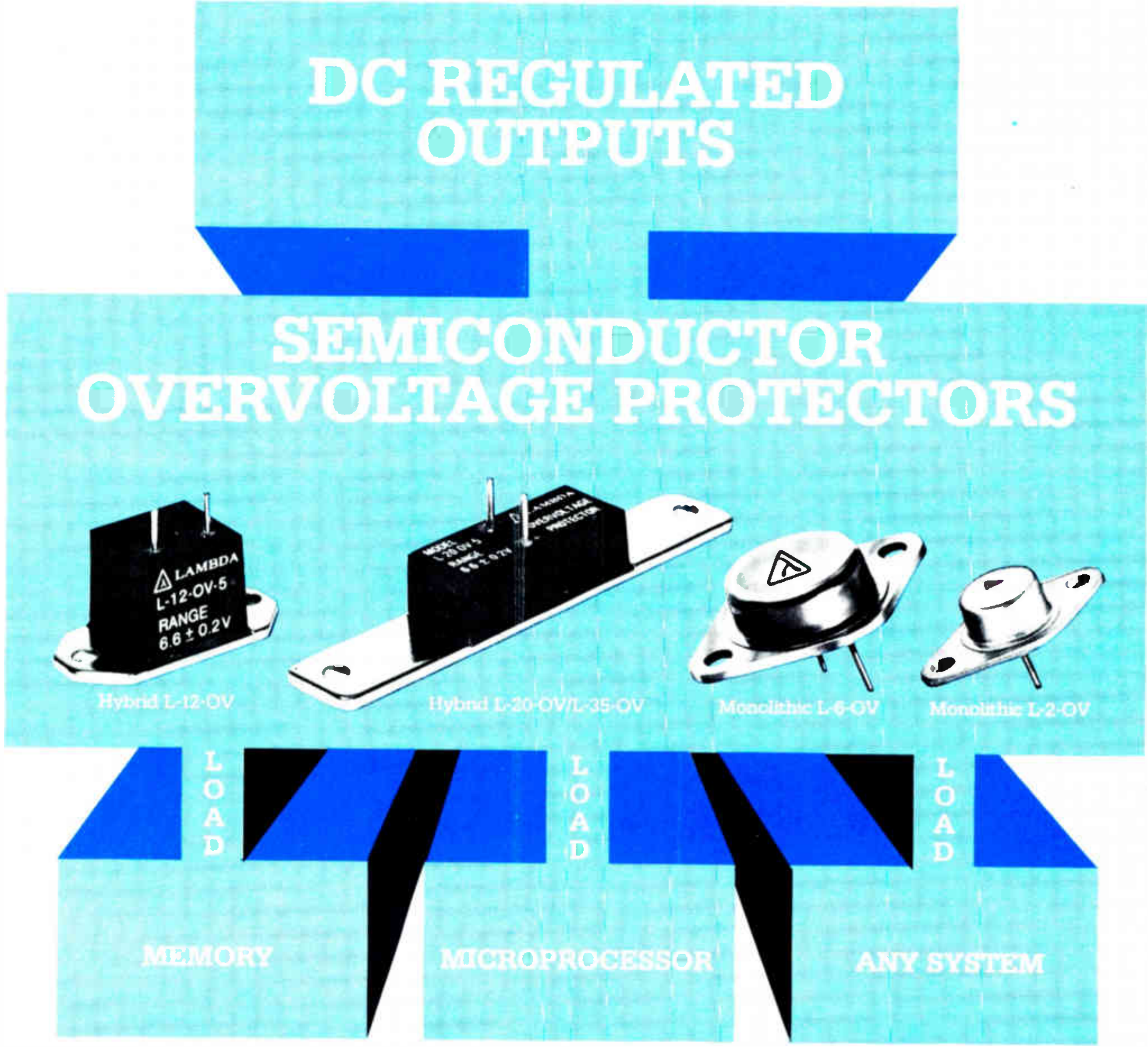

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Products newsletter

4-bit quantizer has 10-ns conversion time, $45 price

Watch for Advanced Micro Devices Inc., Sunnyvale, Calif., to speed up the analog-to-digital conversion market with a 100-MHz 4-bit quantizer that performs a complete conversion in 10 ns. Available as samples, **the Am6688 is a parallel converter that obtains its high speed by operating 16 emitter-coupled-logic comparators in parallel,** instead of using a series technique like successive approximation. Although it only resolves four bits, the device has 8-bit accuracy, so 16 of them can be stacked to make an 8-bit converter. The part will sell for $45 each in hundreds. A 6-bit version is expected by the end of the year.

Probe enhances logic analyzer

Users of E-H International Inc.'s model LA 1850 logic analyzer should be glad to hear that the Oakland, Calif., firm is enhancing the instrument's capability with a new data-probe accessory, the model DP11. **The probe, which sells for $525, features 11 channels—8 regular data bits plus 3 qualifier lines**—according to product manager Richard L. Newsome. Units may be connected to provide more bits for complex combinational triggering, Newsome says.

Monolithic 8-bit a-d converter sells for $14.50

Analog Devices Inc.'s Semiconductor division in Wilmington, Mass., has applied integrated injection logic to an 8-bit analog-to-digital converter with a conversion time of 25 μs. **The single chip contains a clock, a comparator, a successive-approximation register, a buried zener reference, a d-a converter, and three-state output circuitry.** It requires no external components to operate at full accuracy (±½ least significant bit uncertainty) and is priced at $14.50 in hundreds.

Floppy-disk systems offered for PDP-8 users

There are still plenty of PDP-8 computer systems around and Xebec Systems Inc. of Santa Clara, Calif., hopes to supply many of them with its two new flexible-disk systems. The first is the model 1252A, **a double-density system capable of storing 1.56 million 12-bit words.** The second, the 1252AS, is compatible with DEC media and can store 788,000 12-bit words. Both units sell for $3,950 and come complete with computer interface, formatter, two drives, cables, and manuals.

Price reductions

Mupro Inc., Sunnyvale, Calif., has reduced prices on its line of 16-kilobyte Multibus-compatible memory boards. The basic MBC-016 has been reduced by $190 from $985 to $795, while the cost of top-of-the-line MBC-016C with its error checking and correction capability has been lowered $220 from $1,395 to $1,175.

General Electric Co.'s Electronic Components Business division, Auburn, N. Y., has cut the prices of 27 of its optocouplers. The reduction averages 16% on the 4N types and 22% on the H11A and B devices.

Analog Devices Inc., Norwood, Mass., has slashed prices across its entire line of synchro-to-digital converters. Prices for the SDC1702511 (10-bit), 1700511 (12-bit), and 1704511 (14-bit) converters, in single quantities, are now $215 (down from $325), $255 (from $345), and $385 (from $440), respectively. "Other resolutions and reference frequencies have similar price reductions," says Edward H. Friedman, product line manager for synchro converters.

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Rogers Corp., Circuit Systems Division, P. O. Box 700, Chandler, Ariz. [476]

Thick-film thermistor pastes may be used to replace conventional discrete thermistor chips. Four different pastes are available in the NTC 100 series, with resistivities ranging from 500 Ω per square to 10 kΩ per square, and maximum betas from −1,500 to −2,350 (comparable to a −7,000 to −8,500 temperature coefficient of resistance). These materials can be blended prior to use to achieve intermediate resistivities, or they can be custom-blended to customer specification. In evaluation quantities they sell for $4 per gram, and in production lots for about $2.50 per gram.

Cermalloy, Cermet Division of Bala Electronics Corp., Union Hill Industrial Park, West Conshohocken, Penn. 19428 [477]

A ceramic coating insulates electrical and electronic components at temperatures up to 3,200°F. Cerama-Dip 538, a single-component material, comes in paste form with a liquid thinner that gives the thixotropic coating a souplike consistency. The material can then be brushed onto a component, or the component can be dipped in the mixture. After air-drying for one hour, followed by baking at 180°F for 3 to 4 hours, the coating hardens into a dense ceramic surface. Cerma-Dip 538 has a dielectric strength of 150 v/mil at

New products/materials

room temperature, a dielectric constant of 4.0, and a volume resistivity of 10^9 Ω-cm at room temperature. It resists oils, solvents, and all acids except hydrofluoric. The paste sells for $40 a quart, and the 538-T thinner sells for $20 a quart. Delivery of both is from stock.

Aremco Products Inc., P. O. Box 429, Ossining, N. Y. 10562 [478]

Foam microwave absorbers are backed with an electrically conductive coating, allowing application to both nonconductive and conductive surfaces. The three types of Eccosorb absorbers, ANP-ML-73, -74, and -75, display a maximum power reflectivity of −17 dB. Depending on the type of material, the frequency range is 2.5 GHz to 12 GHz, weight is from 0.16 lb/ft² to 0.50 lb/ft², and thickness is from 7/16 to 1 3/16 in. Standard sheets of the material are 2 ft².

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Emerson & Cuming Inc., Microwave Products Division, 59 Walpole St., Canton, Mass. 02021 [480]

A cyanoacrylate adhesive fuses to almost any combination of materials in 10 to 12 seconds, forming a permanent bond. Developed for industrial use, AR-1776 is useful for production assembly, prototype assembly, and field repairs. The one-component transparent material does not require any surface preparation and is resistant to most chemicals, weather, and temperature. Shelf life is six months.

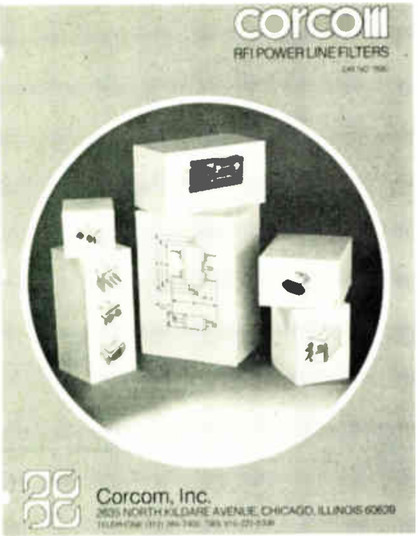
AR-1776 has a viscosity of 75 centipoises, a specific gravity of 1.06 at 25°C, and a melting point of 350°F. Tensile strength depends strongly on the substrate to which the material is bonded.

In quantities of 1 to 24, the material sells for $6.40 in 1-oz bottles and $63 in 1-lb bottles. For 25 bottles or more, the price is $5.80 per 1-oz bottle and $59.50 per 1-lb bottle.

Formulated Resins Inc., P. O. Box 508, Greenville, R. I. 02828 [475]

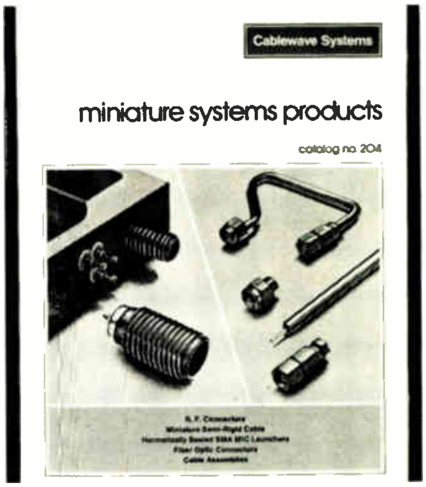
New literature

Rfi filters. "Corcom RFI Power Line Filters," a 24-page catalog, provides a flow chart that shows how to choose the correct filter for an application. Several series of filters are



presented in the catalog, each with complete electrical and mechanical specifications. Six pages discuss such subjects as what radio-frequency interference is, choosing an effective filter, and testing for rfi susceptibility, rf emissions, and insertion loss. International specifications are also provided. Corcom Inc., 2635 North Kildare Ave., Chicago, Ill. 60639. Circle reader service number 421.

Miniature systems. A 112-page booklet gives information on SMA, SMB, SMC, radio-frequency coaxial connectors, miniature semirigid cable, coaxial-cable assemblies, and hermetically sealed SMA MIC launchers, plus a line of fiber-optic connectors and assemblies. Two additional sections contain instructions for assembling connectors and engineering data that include detailed line drawings. The devices are indexed by



product type. Cablewave Systems Inc., 60 Dodge Ave., North Haven, Conn. 06473 [422]

Winchester disk drives. "Who's Selling Rifles to the Indians?" describes the evolution of the Winchester disk drive. Subtitled "A Winchester Disk Drive Technology Primer," the booklet also explains the differences between Winchester disk-drive technology and the earlier disk-drive technologies from which Winchester evolved. A brief history traces the development from IBM's Ramac 305 with 50 disks and 5 megabytes of data storage. Improvements in track and bit density and in disk-drive reliability are discussed. Priam Corp., 20730 Valley Green Dr., Cupertino, Calif. 95014 [423]

Microcomputer products. The series 80 family of microcomputer products is discussed in a Databook from National Semiconductor. It includes descriptions, photographs, and diagrams for six board-level computers, three rack-mounted computer systems, and three prototyping systems, all based on the 8080A microprocessor. More than 30 support products are also described, including boards with random-access memory, read-only memory or programmable ROM, input/output expansion boards, combination memory and I/O boards, analog I/O boards, peripheral controllers, and system chassis and power supplies. National Semiconductor Corp., C.P.G. Marketing Services, MS/10A190, 2900 Semiconductor Dr., Santa Clara, Calif. 95051 [424]

Telecommunication statistics. The sixth edition of "The Yearbook of Common Carrier Telecommunication Statistics" is a compilation of telecommunications information gathered from 163 countries. Covering the years 1968 to 1977, this 351-page yearbook includes such information as the number of automatic main telephone stations, number of Telex connections, annual investments in telecommunication facilities, the gross domestic product, and the ratio of investment to gross domestic product. It sells for 42 Swiss francs and is available from Sales Service, International Telecommunication Union, CH-1211 Geneva 20, Switzerland.

Ceramic capacitors. A 32-page catalog covers a wide range of monolithic ceramic capacitors, including radio-frequency ceramic-chip capacitors, multilayer ceramic capacitors, glass-sealed multilayer ceramic capacitors, and special products. Technical information and test and performance specifications are also given, as are detailed drawings with dimensions in both English and metric units. The catalog can be obtained from Centre Engineering Inc., 2820 East College Ave., State College, Pa. 16801 [426]

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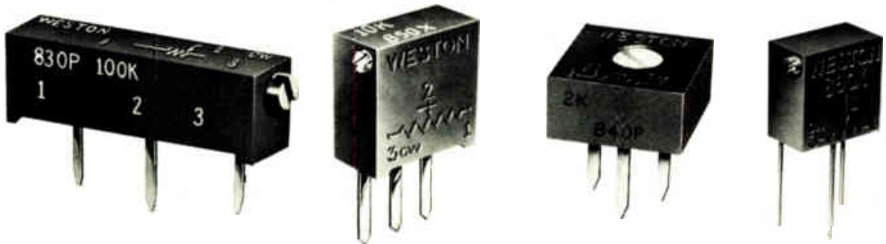

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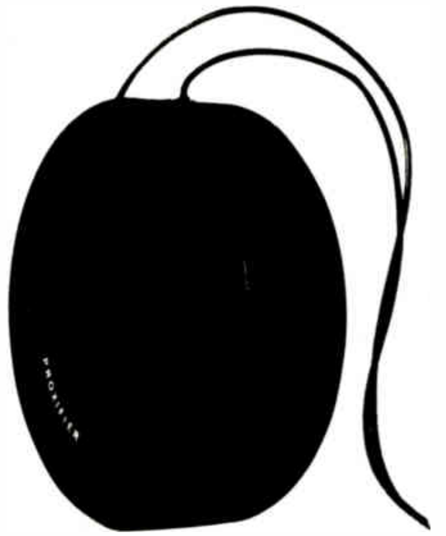

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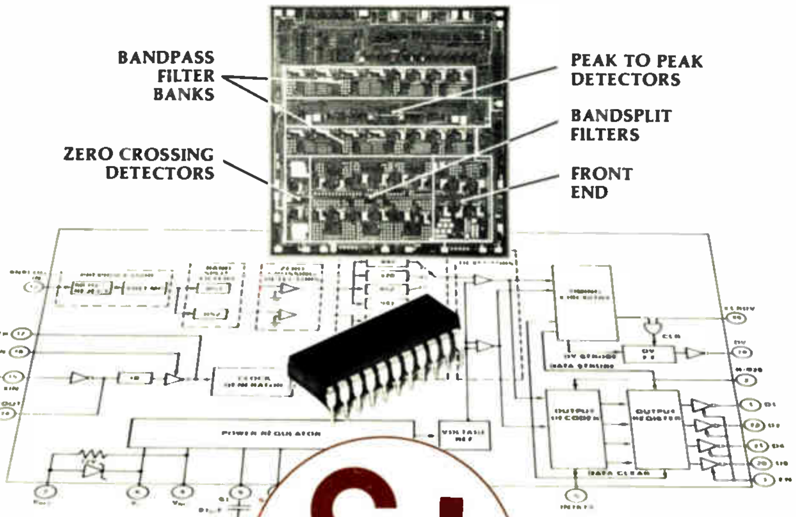

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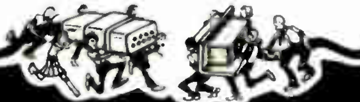

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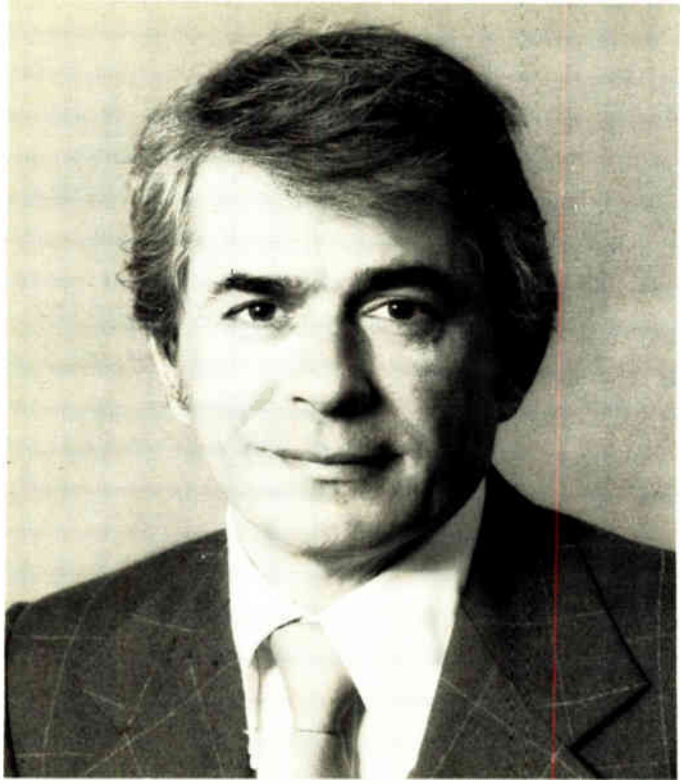

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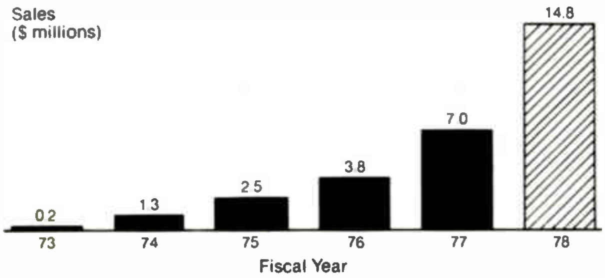

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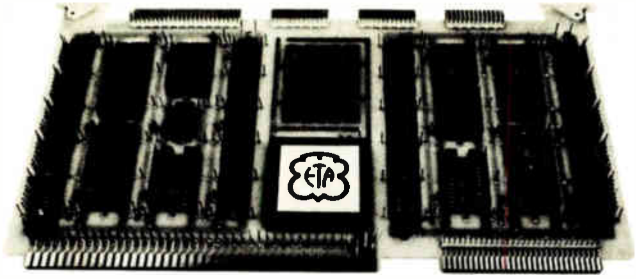
Electronics Buyers' Guide

H.T. Howland, General Manager
[212] 997-6642
Regina Hera, Directory Manager
[212] 997-2544
Thomas Kazich, Production Manager
[212] 997-2044
Marieanne Meissner, Production Assistant
[212] 997-2843
Frances Vallone, Reader Service Manager
[212] 997-6057

Classified and Employment Advertising

Frank Eberle, Manager
[212] 997-2557



PROTOTYPING BOARDS
ETA MV 80
SBC COMPATIBLE

SBC compatible Board MV 80 has six double-sided edge connectors for busoriented parallel or serial input/ output.

The board MV 80 holds up to 40 16 pin Robinson Nugent U-type wire-wrap sockets or a combination of 16, 24, 28 and 40 pin wire-wrap sockets. It has a 32 cm 2 free area for component and an area for an on board 5 V/± 15 V, ± 150 mA DC/DC converter.

There are 10 independent heavy duty power and ground buses on the back of the board. The connections for the by-pass condensors are also provided on board.

The main advantage of this board is its low profile, the wrapping is done on the component side.

The board is delivered as a kit including board with insert bushes, wire-wrap pins and a set of screws for the fastening of the sockets. DC/DC converter and sockets are options.

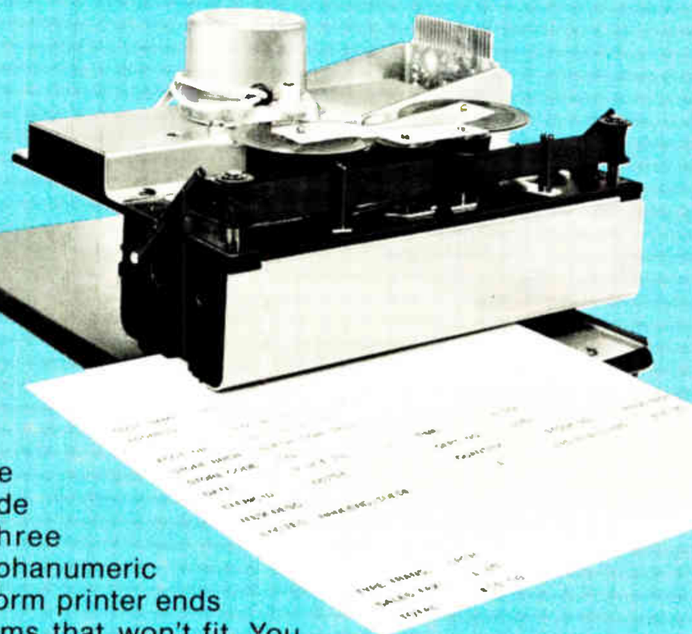
There is also a set of Europecards using the same principle available.

For further informations and price quotations, please contact:

ETA SA FABRIQUES D'EBAUCHES · Division Diversification
2540 **Grenchen**/Switzerland · Tel. 065/51 11 21 · Tlx. 34284 assa ch

Circle 234 on reader service card

Feed all your forms to our wide-open printer



The OEM impact printer wide open on 3 sides

With an edge guide sensor on one side and the other three sides open, our alphanumeric DMTP-8 impact form printer ends worries about forms that won't fit. You can easily insert from bank checks to out-size pages, single sets to multipart reports... any forms where you need to print up to 50 characters per 4" line.

Consider the advantages! Programmable character pitch, heavy-duty construction and an extra long-life dot matrix printing head means real durability. Its exceptionally long needle stroke turns out crisp multiple-copy printings on thicknesses from .003" to .015" —without adjustment.

Its easily replaceable ink rollers and self-reversing ribbon gives you a 10 million character life.

ALL THAT, YET STILL ECONOMICAL— ONLY $269 IN 100's.

P A **PRACTICAL AUTOMATION, INC.**
Trap Falls Road
Shelton, Conn. 06484
Tel: (203) 929-5381

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Electronics

Reader Service

For additional information on products advertised, new products or new literature, use these business reply cards.

Complete entire card.

Please print or type.

Circle the number on the Reader Service postcard that corresponds to the number at the bottom of the advertisement, new product item, or new literature in which you are interested.

To aid the manufacturer in filling your request, please answer the three questions.

All inquiries from outside the U.S. that cannot reach Electronics before the expiration date noted on the Reader Service postcard must be mailed directly to the manufacturer. The manufacturer assumes all responsibilities for responding to inquiries.

Subscriptions & Renewals

Fill in the subscription card adjoining this card. Electronics will bill you at the address indicated on the card.

Electronics **March 15, 1979** This reader service card expires June 15, 1979

NAME ____________________ TITLE ____________________

PHONE (______) ____________ COMPANY ____________________

STREET ADDRESS (Company ☐ or home ☐ check one) ____________________

CITY ____________ STATE ____________ ZIP ________

Was This Magazine Personally Addressed to You? ☐ Yes ☐ No

Industry classification (check one):

a ☐ Computer & Related Equipment
b ☐ Communications Equipment & Systems
c ☐ Navigation, Guidance or Control Systems
d ☐ Aerospace, Underseas Ground Support
e ☐ Test & Measuring Equipment
f ☐ Consumer Products
g ☐ Industrial Controls & Equipment
h ☐ Components & Subassemblies
j ☐ Independent R&D Organizations
k ☐ Government

Your design function (check each letter that applies):

x ☐ I do electronic design or development engineering work.
y ☐ I supervise electronic design or development engineering work.
z ☐ I set standards for, or evaluate electronic components, systems and materials.

Your principal job responsibility (check one)

t ☐ Management
v ☐ Engineering

Estimate number of employees (at this location): 1. ☐ under 20 2. ☐ 20-99 3. ☐ 100-999 4. ☐ over 1000

1 16 31 46	61 76 91 106	121 136 151 166	181 196 211 226	241 256 271 348	363 378 393 408	423 438 453 468	483 498 703 718
2 17 32 47	62 77 92 107	122 137 152 167	182 197 212 227	242 257 272 349	364 379 394 409	424 439 454 469	484 499 704 719
3 18 33 48	63 78 93 108	123 138 153 168	183 198 213 228	243 258 273 350	365 380 395 410	425 440 455 470	485 500 705 720
4 19 34 49	64 79 94 109	124 139 154 169	184 199 214 229	244 259 274 351	366 381 396 411	426 441 456 471	486 501 706 900
5 20 35 50	65 80 95 110	125 140 155 170	185 200 215 230	245 260 275 352	367 382 397 412	427 442 457 472	487 502 707 901
6 21 36 51	66 81 96 111	126 141 156 171	186 201 216 231	246 261 338 353	368 383 398 413	428 443 458 473	488 503 708 902
7 22 37 52	67 82 97 112	127 142 157 172	187 202 217 232	247 262 339 354	369 384 399 414	429 444 459 474	489 504 709 951
8 23 38 53	68 83 98 113	128 143 158 173	188 203 218 233	248 263 340 355	370 385 400 415	430 445 460 475	490 505 710 952
9 24 39 54	69 84 99 114	129 144 159 174	189 204 219 234	249 264 341 356	371 386 401 416	431 446 461 476	491 506 711 953
10 25 40 55	70 85 100 115	130 145 160 175	190 205 220 235	250 265 342 357	372 387 402 417	432 447 462 477	492 507 712 954
11 26 41 56	71 86 101 116	131 146 161 176	191 206 221 236	251 266 343 358	373 388 403 418	433 448 463 478	493 508 713 956
12 27 42 57	72 87 102 117	132 147 162 177	192 207 222 237	252 267 344 359	374 389 404 419	434 449 464 479	494 509 714 957
13 28 43 58	73 88 103 118	133 148 163 178	193 208 223 238	253 268 345 360	375 390 405 420	435 450 465 480	495 510 715 958
14 29 44 59	74 89 104 119	134 149 164 179	194 209 224 239	254 269 346 361	376 391 406 421	436 451 466 481	496 701 716 959
15 30 45 60	75 90 105 120	135 150 165 180	195 210 225 240	255 270 347 362	377 392 407 422	437 452 467 482	497 702 717 960

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f ☐ Consumer Products
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h ☐ Components & Subassemblies
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15 30 45 60	75 90 105 120	135 150 165 180	195 210 225 240	255 270 347 362	377 392 407 422	437 452 467 482	497 702 717 960

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Reader Service

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you may obtain the needed information
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