APRIL 7, 1982

ROBOTS INHERIT VISION FROM INSPECTION SYSTEMS/89

Plasma panels at last rival CRTs for text display/125

Plastic carriers chip away at board costs/141

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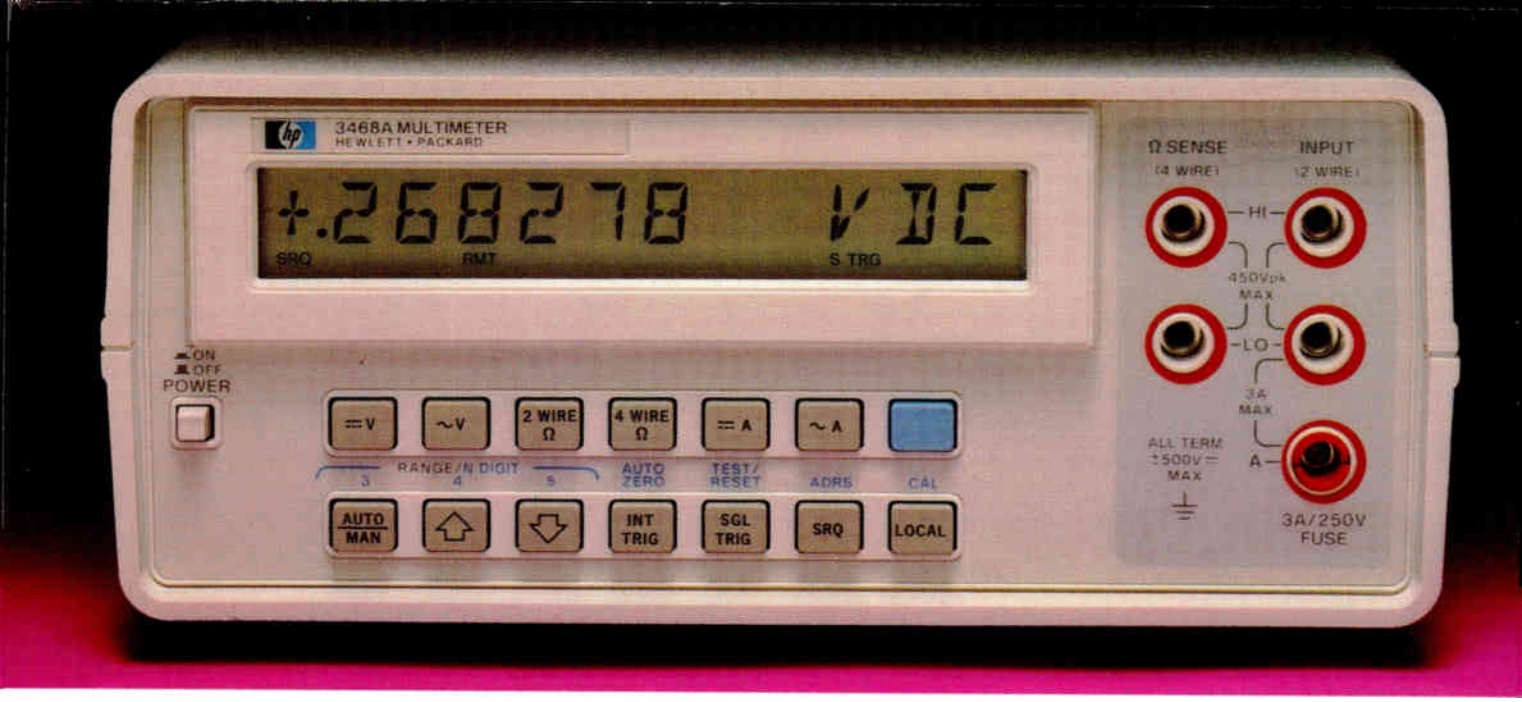

More than a low-cost DMM... It's the arrival of low-cost bench automation.

HP's new 3468A is not just another high-performance 5½ digit DMM. It's the first instrument with HP-IL (Hewlett-Packard Interface Loop)... a low-cost interface that lets you program the 3468A with the popular HP 41 hand-held calculator. Now, you can make voltage, current or resistance measurements automatically. And the HP 41 can process results for statistical analysis or direct readout in engineering units. For extra capability, you can add a printer for hard copy output and a tape drive for fast program loading or data storage.

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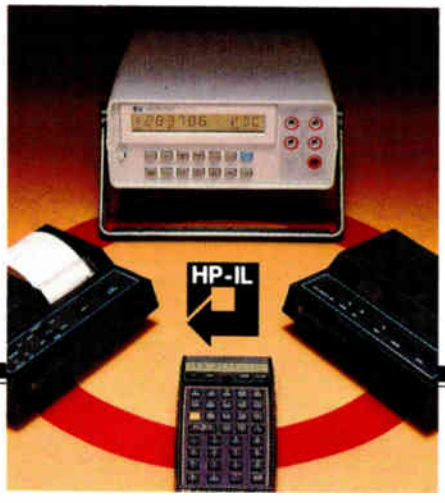

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HP-IL, the Hewlett-Packard Interface Loop, is a flexible, expandable serial interface for small, low-cost, battery-operable systems. Its simple closed-loop structure makes system setup fast and easy, while Auto Address Assignment and Device Identification speed programming. A new dimension in HP instrumentation is possible with HP-IL, which brings the convenience of automation to lab and field at low cost.

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* Domestic U.S.A. price.

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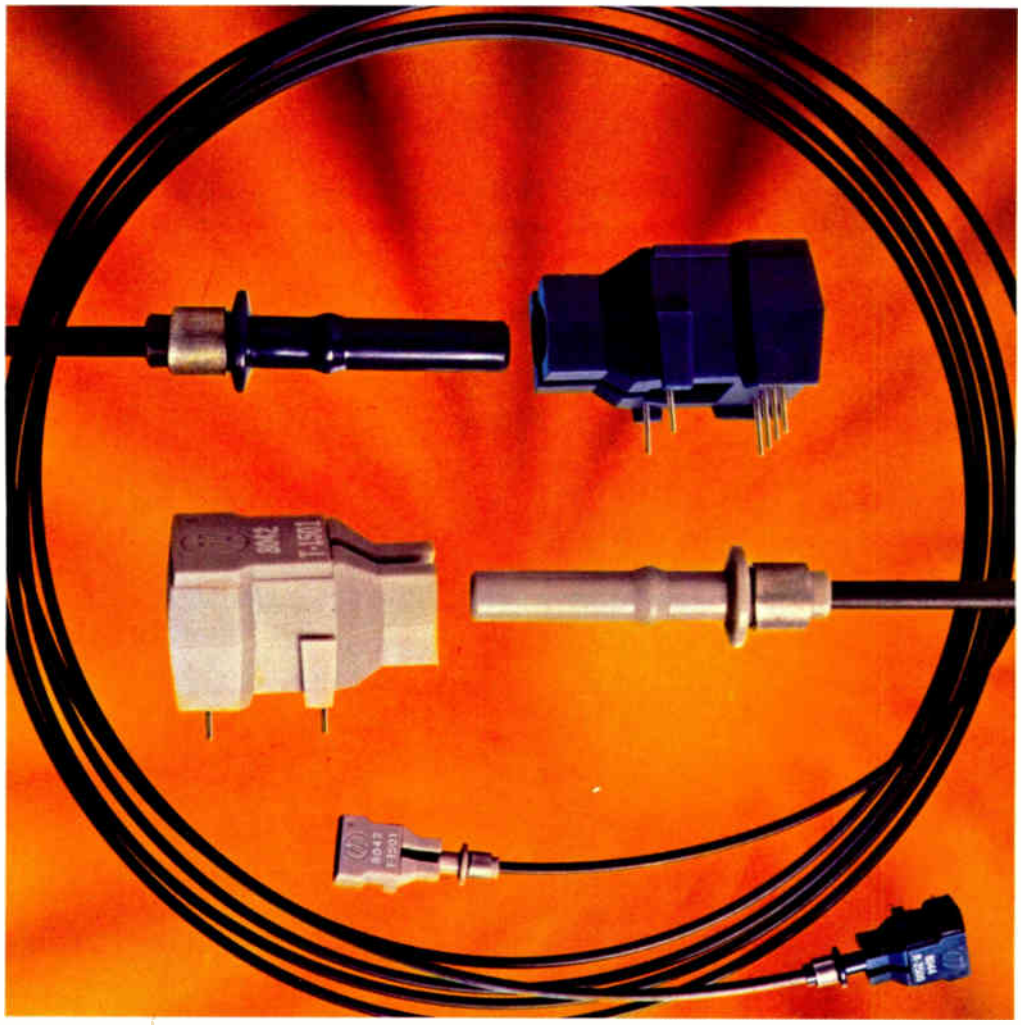

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Electronics
The International Magazine of Electronic Technology and Business

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Equipment courtesy of U.S. Instrument Rentals.

The Cover Story

Special report: Field-service automation takes burden off the technician, 110

Intelligent computer-based tools with self- and remote-diagnosis, along with decentralized repair depots and new techniques, increase the service technician's productivity.

Major New Developments

Robotics

A new generation of sophisticated computerized vision systems for robots can go beyond simple inspection tasks to perform more complex jobs such as materials handling, 89

Local networks

IBM provides guidelines to IEEE 802 standards committee, positioning that giant amidst throngs of contenders, 37
A microcomputer-based local network adapts a military standard for a rugged, noise-immune physical link with collision protection, 147

Packaging

The leaded plastic chip-carrier is the latest weapon in the battle for more efficient use of printed-circuit–board space, 141

New products

A stand-alone data-acquisition system supports a throughput of 50,000 samples per second at up to 15-bit resolution, 163

Electronics Review

Electronics International

Probing the News

Technical Articles

New Products

Electronics

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Highlights

Cover: Field-service woes are succumbing to automation, 110

Complex new systems, a wider range of applications, and a shortage of technicians are producing a nearly unmanageable burden for field-service organizations. However, help is on the way, as this special report makes clear, taking such forms as systems and chips designed for self-testing and for remote diagnosis and automated troubleshooting gear.

Robots' eyes are seeing more clearly, 89

More capable vision systems for robots are forthcoming from a number of companies, many of them start-ups. A major trend is integration of the systems with the robots; a developing tendency is for greater visual discrimination through such advances as gray-scale processing.

Plasma-display technology slims down for commercialization, 125

The knotty problem of addressing the many-element matrix in a plasma panel display is unraveling, as this pair of articles demonstrates. One approach (p. 126) is to reduce the number of drivers by designing the panel to combine dc scanning and addressing with ac display cells that have memories. Another tactic (p. 130) is to integrate the drive electronics, made possible by a process that combines bipolar, complementary-MOS, and diffused-MOS field-effect transistors on a single chip.

Power-delay product drops in bipolar technology, 133

Low-voltage–inverter logic unites the best attributes of its bipolar predecessors, achieving the density of TTL and speeds even faster than emitter-coupled logic. What's more, LVI logic's power-delay product is half that of TTL and a tenth of ECL's, thanks to parallel transistors that merge level sensing and output driving into one stage.

Plastic packaging arrives for chip-carriers, 141

Plastic leaded chip-carriers save as much board space as do their ceramic leadless counterparts, and they overcome two major disadvantages of the ceramic versions: high cost and susceptibility to thermal shock.

Local net adapts military ruggedness to industry needs, 147

To meet the demands of industrial environments, a new local network bases its physical link and interface configuration on the U. S. military standard for aircraft internal data buses.

. . . in the next issue

A special report on high-density data-storage techniques . . . a preview of the Electronic Components Conference . . . silicon software: a real-time operating-system kernel on a chip.

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Publisher's letter

Today's industrial robots bear a much closer resemblance to factory machine tools than to the adorable R2-D2 and C-3P0 robots of *Star Wars* movie fame. However, given technology's relentless advances, those Hollywood fantasies could come closer to reality in this decade than many of us think.

For example, our lead story in the Probing the news section (p. 89) reports on the emergence of robot vision systems for factory use. The story's author, Wes Iversen of the Chicago bureau, says that intelligent factory robots that can see and feel objects may eventually spawn successors for the nonindustrial world.

"Joe Engelberger, the president of robot-maker Unimation, is already talking about sensor-equipped robot arms for jobs ranging from loading garbage trucks to operating fast-food restaurants," Wes says. With the addition of mobility—which is already being tested by Unimation—plus voice recognition and synthesis, who knows? The "household robot" may not be far behind. "It may sound far out," says Wes, "but Engelberger, for one, believes it will happen before 1990."

Wes, too, manages to stay abreast of the relentless advance of technology. He was a contributor to a story on biotechnology that was nominated for this year's Deadline Club prize for science writing from Sigma Delta Chi, the national journalism honor society.

The performance of hardware that is on the leading edge of technology is impressive—indeed, sometimes it is truly spectacular. As a result, there's a tendency to forget that the true test of a design doesn't start until the buyer of the hardware puts it to work.

However, designs that seem superb in the factory sometimes lose their luster fast. "In the U. S. and Europe," says Richard W. Comerford, who covers the sector of test, measurement, and control for us, "systems users on the average have to spend about 15% of the original cost every year for field service." The comparable figure in Japan is only 6%, he adds.

The task of keeping equipment running is further exacerbated by a shortage of service engineers and technicians. "Designers tend to think of field-service people as 'gorillas'; actually they're the first line of contact with the customers," he says.

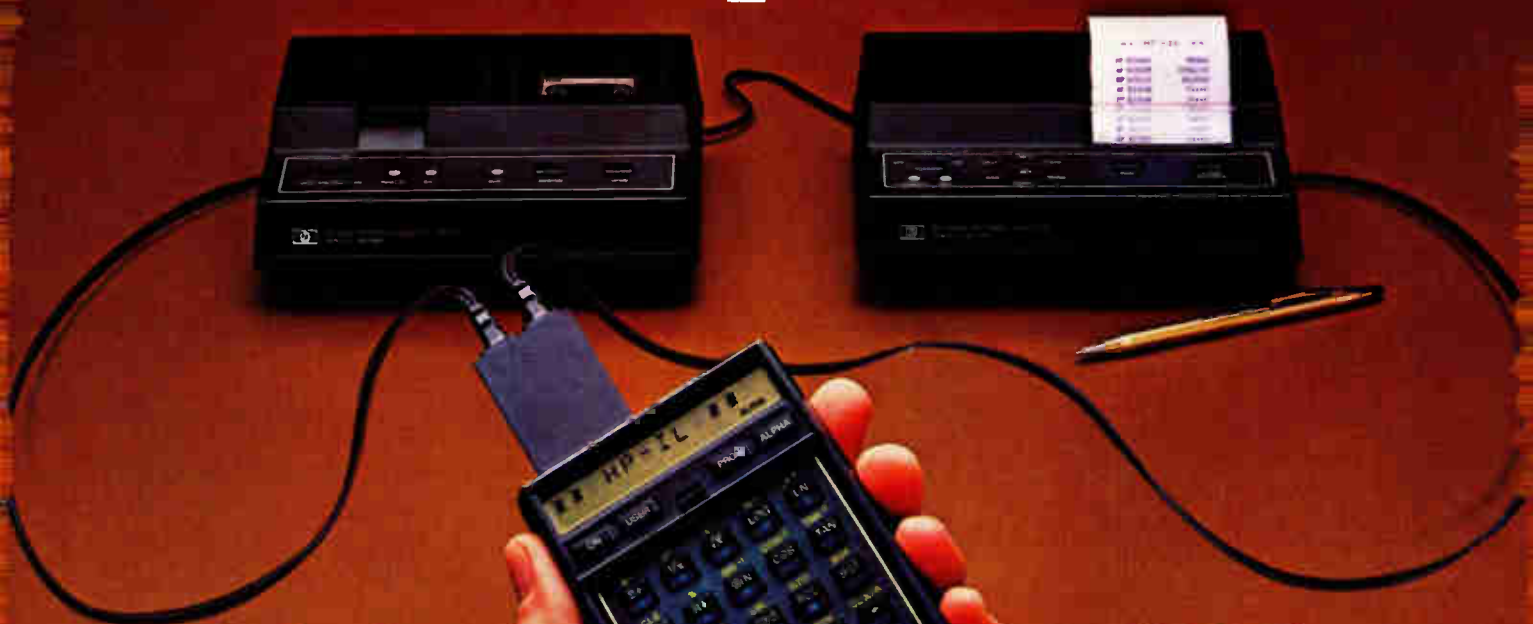
"Field testing is not the jumble many people think it is," Rick insists. "Patterns are emerging." He first spotted their evolving shapes last October at the Institute of Electrical and Electronics Engineers' Cherry Hill International Test Conference (held in Philadelphia). "For the first time at Cherry Hill, there was a whole session devoted to field testing," Rick explains. That consecration of field testing touched off a series of interviews with test-equipment makers throughout the U. S. (additional reporting was done by Charlie Cohen in Tokyo and John Gosch in Frankfurt).

For an in-depth view of the new field service and the hardware they are creating, read our special report, "Automation promises to lighten the field service load" (p. 110). "Sharp design isn't the only thing that sells equipment," says Rick.

Time to order your *Electronics* editorial index

The index of all editorial material that ran in 1981 (Vol. 54) is now available. To get your copy, simply circle No. 370 on the reader service card inside the back cover. If the card is missing, order by letter from Kathleen Morgan, *Electronics*, 1221 Ave. of the Americas, New York, N. Y. 10020. The 1981 index is free; indexes for previous years can be purchased from our reprint department for $4.00 each.

How to turn your HP-41 into a handheld computer.



Introducing the Hewlett-Packard Interface Loop.

Starting today, your HP-41C or HP-41CV can be more than just a great little calculator. It's a great little computer, capable of controlling a quickly-expanding family of peripherals.

The new Hewlett-Packard Interface Loop (HP-IL) makes it all possible. HP-IL is an easy-to-use, low-cost interfacing system, specifically designed for battery-operable devices.

The Interface Module and Peripherals.

At the heart of the system is the Interface Module, which plugs into any one of four HP-41 ports. You can control up to 30 peripherals, using only one port in your HP-41 calculator.

One of the key HP-IL peripherals is the new Digital Cassette Drive. This battery-operable device provides an incredible 131,000 bytes of mass memory.

Another work-saving HP-IL peripheral is the new, battery-operable Thermal Printer/Plotter with enhanced formating options and graphics.

This is just the beginning.

There are many more HP-IL products on the way. And they're all designed to provide the versatility and adaptability you expect from HP. You see, Hewlett-Packard is committed to a very big idea: small devices talking to each other, giving you big system capabilities – at small system prices!

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392/04

When performance must be measured by results.

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Readers' comments

On speaking with authority

To the Editor: I agree with the essence of your editorial in the Jan. 13 issue ["The social responsibility of technologists," p. 12]: that there exists a responsibility toward the American worker displaced by automation and technology. An enlightened and affluent society represented by labor, management, and academia can and will make the transition to a post-industrial America as free of distress as possible. I must, however, take exception to two of your statements.

You stated that "an automated industrial base will create even fewer jobs than there are now." This statement is patently wrong. Today, it is not a case of comparing an automated with a nonautomated industrial base to see which creates most new jobs, but of finding the means in a competitive market system to stem the tide of lost jobs. Automation, by making insufficiently productive industries like the auto industry more productive and thereby more competitive, will ultimately create expanding markets and new jobs in the economy in general. In addition, the change will result in a new, vibrant growth industry that will spawn the many benefits to society that previous technologically innovative industries have done.

Your statement is disconcerting in that it comes from the editorial pages of a magazine whose name is synonymous with innovation, technology, rapid growth, competitiveness, and job creation. The danger here, coming from a representative of one of this nation's most productive and innovative industries, is that those with no long-term vision will use such fallacious pronouncements as proof that technological advancement must be hindered.

Secondly, government, by its past record, has shown itself to be the epitome of inefficiency and poor results. Government intervention cannot possibly accomplish anything but further aggravation of the problem. It is only now being realized to any great extent just how ineffective government can be, and it seems inadvisable to request government assistance at a time when that power is being returned to local levels.

Let us demonstrate effective concern for all who experience misfortune. Let us not, however, unwittingly impede one of the most potent forces for progress with ill-advised assumptions and suggestions.

James E. Quinn, Jr.
(address omitted)

PALs and PROMs

To the Editor: I disagree with Sorin Zarnescu's substitution of programmable read-only memory for comparators in decoding input/output port addresses, as suggested in the Engineer's Newsletter of Feb. 24 ("Port select is PROM's job," p. 146). At Cycon, we use programmable logic arrays such as Monolithic Memories' PAL 14L4 or PAL 10L8, instead of PROMs. This lets us decode more addresses and select more I/O ports.

David Tolub
Cycon Ltd.
Tel Aviv, Israel

Separation of powers

To the Editor: Regarding your editorial on the antitrust settlements for International Business Machines Corp. and American Telephone & Telegraph Co. ("Antitrust settlements are a boost for innovation," Jan. 27, p. 12), I fully concur with your observations. Nonetheless, it included one incorrect statement. You said that Japan's fifth-generation computer project will address issues with a blend of hardware, software, and communications. The scope of the project, as currently defined by the Ministry for International Trade and Industry, however, does not include communications issues—those are left in the hands of Nippon Telegraph & Telephone Co.

Fumio Taku
Digital Equipment Corp.
Marlboro, Mass.

Correction

In "Digital filter flattens hi-fi audio response" (Feb. 24, p. 45), the unit flattens the response within 2 decibels up to 14,000 hertz.

Interested in higher performance software?

The Mark Williams Company announces **COHERENT**,™ a state of the art, third generation operating system. **COHERENT** is a totally independent development of The Mark Williams Company. **COHERENT** contains a number of software innovations not available elsewhere, while maintaining compatibility with UNIX*. The primary goal of **COHERENT** is to provide a friendly environment for program development. The intent is to provide the user with a wide range of software building blocks from which he can select programs and utilities to solve his problems in the most straightforward manner.

COHERENT and all of its associated software are written totally in the high-level programming language **C**. Using **C** as the primary implementation language yields a high degree of reliability, portability, and ease of modification with no noticeable performance penalty.

Features

COHERENT provides **C** language source compatibility with programs written to run under Seventh Edition UNIX, enabling the large base of software written to run under UNIX (from numerous sources) to be available to the **COHERENT** user. The system design is based on a number of fundamental concepts. Central to this design is the unified structure of i/o with respect to ordinary files, external devices, and interprocess communication (pipes). At the same time, a great deal of attention has been paid to system performance so that the machine's resources are used in the most efficient way. The major features of **COHERENT** include:

- multiuser and multi-tasking facilities,
- running processes in foreground and background,
- compatible mechanisms for file, device, and interprocess i/o facilities,
- the shell command interpreter—modifiable for particular applications,
- distributed file system with tree-structured, hierarchical design,
- pipes and multiplexed channels for interprocess communication,
- asynchronous software interrupts,
- generalized segmentation (shared data, writeable instruction spaces),
- ability to lock processes in memory for real-time applications,
- fast swapping with swap storage cache,
- minimal interrupt lockout time for real-time applications,
- reliable power failure recovery facilities,
- fast disc accesses through disc buffer cache,
- loadable device drivers,
- process timing, profiling and debugging trace features.

*UNIX is a trademark of Bell Labs

Software Tools

In addition to the standard commands for manipulating processes, files, and the like, in its initial release **COHERENT** will include the following major software components: **SHELL**, the command interpreter; **STDIO**, a portable, standard i/o library plus run-time support routines; **AS**, an assembler for the host machine; **CROSS**, a number of cross-assemblers for other machines with compatible object format with '**AS**' above; **DB**, a symbolic debugger for **C**, Pascal, Fortran, and assembler; **ED**, a context-oriented text editor with regular expression patterns; **SED**, a stream editor (used in filters) fashioned after '**ED**'; **GREP**, a pattern matching filter; **AWK**, a pattern scanning and processing language; **LEX**, a lexical analyzer generator; **YACC**, an advanced parser generator language; **NROFF**, an Nroff-compatible text formatter; **LEARN**, computer-aided instruction about computers; **DC**, a desk calculator; **QUOTA**, a package of accounting programs to control filespace and processor use; and **MAIL**, an electronic personal message system.

Of course, **COHERENT** will have an ever-expanding number of programming and language tools and basic commands in future releases.

Language Support

The realm of language support is one of the major strengths of **COHERENT**. The following language processors will be supported initially:

- **C** a portable compiler for the language **C**, including stricter type enforcement in the manner of **LINT**.
- **FORTRAN** portable compiler supporting the full ANS Fortran 77 standard.
- **PASCAL** portable implementation of the complete ISO standard Pascal.
- **XYBASIC**™ a state of the art Basic compiler with the interactive features of an interpreter.

The unified design philosophy underlying the implementation of these languages has contributed significantly to the ease of their portability. In particular, the existence of a generalized code generator is such that with a minimal effort (about one man-month) all of the above language processors can be made to run on a new machine. The net result is that the compilers running under **COHERENT** produce extremely tight code very closely rivaling that produced by an *experienced* assembler programmer. Finally, the unified coder and conformable calling sequences permit the intermixture of these languages in a single program.

Operating System

In part because of the language portability discussed above, and in part because of a substantial effort in achieving a greater degree of machine-independence in the design and implementation of the **COHERENT** operating system, only a small effort need be invested to port the whole system to a new machine. Because of this, an investment in **COHERENT** software is not tied to a single processor. Applications can move with the entire system to a new processor with about two man months of effort.

The initial version of **COHERENT** is available for the Digital Equipment Corporation PDP-11 computers with memory-mapping, such as the PDP 11/34. Machines which will be supported in the coming months are the Intel 8086, Zilog Z8000, and Motorola 68000. Machines for which ports are being considered are the DEC VAX 11/780 and the IBM 370, among others.

Because **COHERENT** has been developed independently, the pricing is exceptionally attractive. Of course **COHERENT** is completely supported by its developer. To get more information about **COHERENT** contact us today.

Mark Williams Company

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News update

■ Plans to pick up a malfunctioning satellite, coupled with an attempt to repair it while still in orbit, were announced shortly before the latest space shuttle was launched on March 22. But it will not be until sometime in 1983—on the 11th shuttle flight—that this dual space first can be fitted into the busy schedule of shuttle chores.

The sick bird is the 2½-ton Solar Maximum Mission spacecraft, now orbiting at some 270 kilometers over the earth. It was launched in 1980 to watch for radio-interference–producing solar flares during the peak years of a sunspot cycle [Oct. 23, 1980, p. 210] and six months after its launch developed an in-place wobble.

The satellite is still transmitting data and, in fact, ground controllers can exercise some control over its positioning. However, they do not have as much control as they would like over where its gamma-ray, ultraviolet, and X-ray spectrometer sensors are pointing.

With some tenderness, it is hoped, the ailing craft will be retrieved by the space shuttle's remote manipulator arm and tucked into the shuttle's cargo bay. According to the man who was in charge of the solar spacecraft's development, Peter Townsend Burr, the entire attitude-control module will be replaced by the resident astronaut-doctors. Once this operation is completed, the craft will be put back into orbit, perhaps at a higher altitude than before so that its orbit will decay more slowly.

The satellite was originally meant to be recovered in 1984 and reused; there is a handle on its outside for the shuttle's arm to grab. Also, the spacecraft's major subsystems, like power and command, control, and data handling, as well as attitude control, are contained in separate modules. But if the in-orbit fix does not work, the National Aeronautics and Space Administration is also considering carrying the craft back to earth.

Perhaps more important than getting this ill bird going again is showing just how useful the shuttle can be. **-Harvey J. Hindin**

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Legislation cannot substitute for policy

Californians have long prided themselves on their ability to innovate in almost any imaginable area, from surfing to semiconductors. Now the Golden State's delegation of Democrats in the House has come up with a novel package of legislative proposals that aims merely to save the semiconductor industry in its own state and in the rest of the nation from the Japanese threat; exclude multicorporate research and development ventures from the threat of civil antitrust actions; provide Federal funds to states for training technicians in the electronics and computer sciences; extend tax breaks on R&D to new small businesses; broaden tax write-offs on corporate gifts of equipment to schools; and save the jobs of the staffs of Pasadena's Jet Propulsion Laboratory and Berkeley's Lawrence Berkeley Lab, who are threatened by the Reagan fiscal 1983 budget cuts.

That makes for a lot of threats to eliminate in the few months the Congress has left to pass some kind of Federal budget in both chambers and then adjourn early enough to hit the campaign trail in this election year. With the Congress and the White House bogged down in trench warfare over the budget, it seems clear that all this other legislation will have a tough time wending its way through the maze of hearing, debate, and passage in the House, then the Republican-controlled Senate, to final resolution in a joint conference committee before being signed into law by the President—if he so chooses.

Support for the bills is hardly unanimous. The affected industries as represented by the Semiconductor Industry Association and the Electronic Industries Association understandably like the legislation—they helped write some of it [*Electronics*, March 10, p. 66]. Some of the other bills are being promoted by the universities, secondary schools, and federally supported laboratories that would gain from those proposals.

However, the opposition is at least as purposeful, consisting of importers and other corporations—multinationals among them—anxious to maintain the image of free trade. Then there are the fiscal conservatives who see backbreaking Federal deficits growing even bigger if special electronics interests get a few more tax breaks. There is other opposition, too, and none of these groups can be expected to roll over for the California Democratic delegation. Some cynics even suspect that some of the bills were designed less for quick and easy passage than for campaign cannon fodder for use by the sponsors in November's congressional race.

This analysis is not to argue whether the glass is half empty or half full; such arguments can be pointless and unending. It says, in sum, that the California Democratic delegation's goal of preventing the unraveling of the fabric of U. S. leadership in electronics is both desirable and needed.

Still, it is regrettable, to say the least, that this latest collection of bills has come so late in the game. In some cases, they seem hastily drafted and directed at serving a narrow interest. The U. S., it seems, responds only to issues after they have become crises, and the response is seldom well thought out.

In view of the absence of a coordinated national policy for science and technology—an absence not of recent origin—action in the face of catastrophe may be the only response possible. Nevertheless, the people of this country deserve better.

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16 character display system for the OEM

The Cherry W416-1050 16 alphanumeric gas discharge display system is a lot more than "bare bones" even though it's priced at just $96 in lots of 5,000. It is equipped with microprocessor controlled circuitry including drivers, character generator, refresh memory and provides 19 control functions at a price so low it's ideal for OEM product applications.

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People

Agin is a household word in world of vision systems

At the Robots VI show last month in Detroit, a software company official at one booth was explaining his robot vision system to several visitors when a smallish, full-mustachioed man strolled up. Spotting the man's nametag, the exhibitor paused, did a double take, then cut off in midsentence to enthusiastically introduce himself and pump the hand of the new visitor.

Gerald J. Agin no doubt still needs his American Express card to be known at most places. But at this exhibitor's booth, his name alone was enough. The 40-year-old Carnegie-Mellon University researcher is credited with perfecting the binary image-processing algorithms that are the basis for algorithms employed in new commercial vision systems shown by at least a half-dozen Robots VI exhibitors (see p. 89).

The work was done while Agin was with SRI International in Menlo Park, Calif., from 1973 until 1979. He was part of the team headed by Charles Rosen that many credit with being the first to demonstrate a capable yet cost-effective vision module for factory robots. Though many contributors had a hand in the much-emulated module, "the most important work was done by Gerry Agin," Rosen confirms.

With a bachelor's degree in electrical engineering from Lehigh University, a master's degree in the same field from Syracuse University, and a doctorate from Stanford University, Agin today is tackling more complex three-dimensional vision problems in Pittsburgh at Carnegie-Mellon's Robotics Institute. As for the wide commercial application of his earlier work, Agin says it was "partly a matter of being in the right place at the right time."

Since the SRI work was Government-funded, Agin says he has not profited financially from it. However, he does own a stake in Machine Intelligence Corp., the Sunnyvale, Calif., firm formed by Rosen to exploit the SRI technology. Moreover, seeing the fruits of his efforts applied throughout the commercial world "does help tide me through when I feel I'm hitting a dry spell," he allows.

IXO's Rochlis sees link from games to telecomputing

At first glance, knowing that the founders of IXO Inc. had cut their management teeth on electronic games, the onlooker might raise an eyebrow at their new market. But Jeffrey A. Rochlis, president and chief executive officer of the new Culver City, Calif., maker of portable telecomputing equipment, soon dispels the surprise.

The link between the businesses is human engineering, or the way people interface with machines. Explains Rochlis, "No better proving ground exists than electronic games, where complex technology products not only get the toughest kind of workout, but must be both easy to use and reliable."

IXO's kick-off product is a portable, self-contained communications terminal that can remotely access and talk to host computers via plain English prompts and responses—

Input from everywhere. Jeffrey Rochlis hopes to have businessmen communicating with a host computer by telephone from anywhere using this terminal.

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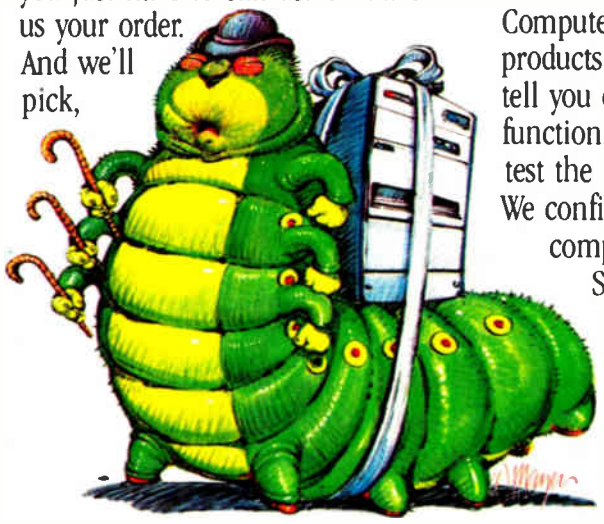

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People

"which is exactly the same thing we used in the electronic-game arena," says Rochlis.

Rochlis was founding president of Mattel Inc.'s Electronics division before leaving to organize IXO along with Robert O. and Holly Thomis Doyle. A husband and wife team with doctoral degrees in astrophysics from Harvard University, in Cambridge, Mass., they invented all Parker Brothers' electronic games between 1977 and 1978. Rochlis himself, who has a bachelor's degree from Bard College in Annandale-on-Hudson, N. Y., has also been an executive at two New York advertising agencies.

For purposes of addressing new markets, the game business also offers sound background in designing the hardware, continues Rochlis. "You have to find out what the consumer wants and needs, build upward, and put the burden on technology for the solution," points out Rochlis.

Keep goal in sight. The boneyard is full of products that went the other direction from companies that were mesmerized by their own brilliance and pushed technology as an end in itself, not a means. Rochlis cites as examples the $200 language translator and some personal computers that require 125 pages of instruction.

At IXO, the emphasis is on showing the prime businessman customer the benefits of communicating with a host computer from anywhere. The terminal is "as easy to use as a telephone," Rochlis claims. The $300 volume price, about the same as a modem, also is a come-on.

IXO raised its investment stake from venture capitalists, who ask two fundamental questions these days, according to the founder: "Where's your patent, and what about the Japanese?" In IXO's case, the answers were easy, but took 10 meetings to explain. Patents are pending, and the telecomputer is really just a front-end box. Says Rochlis, "The trick is in extensive software for access and security that would present a tough problem for the Japanese to copy." □

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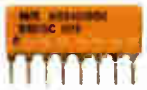

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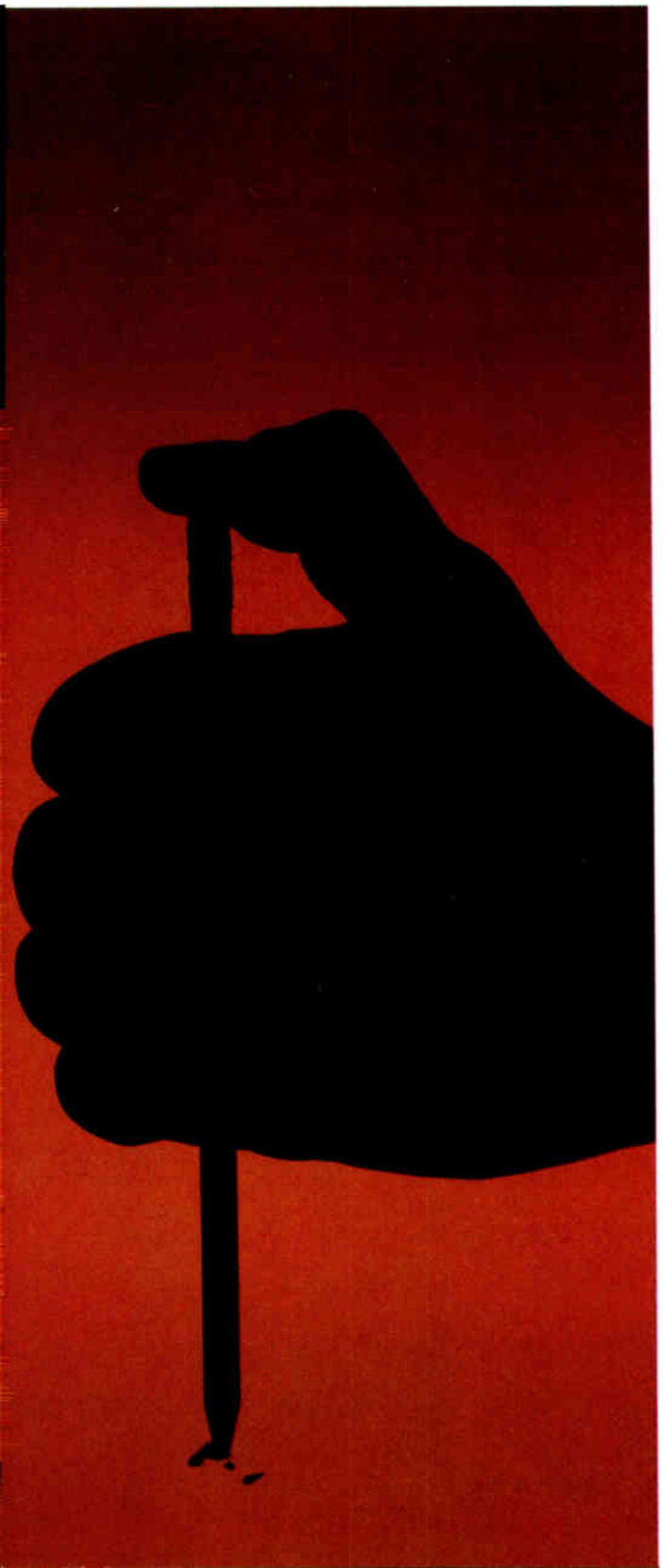

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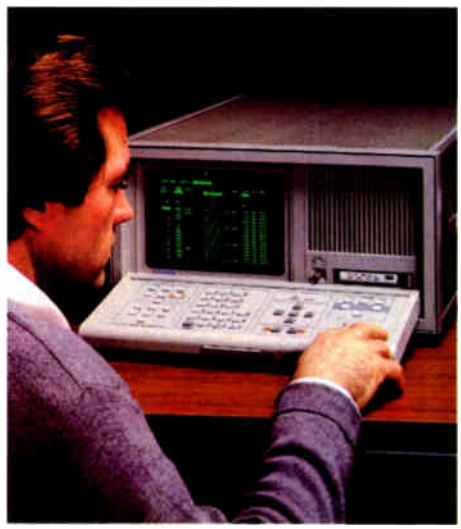

unambiguous glitch detection and our unique, new "arms mode" allows timing correlation between synchronous and asynchronous data.

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The DAS 9100 lets you start debugging hardware even before your software is available. Pattern generation makes it all possible.

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Circle 23 on reader service card

Who owns employees' inventions?

by Marc E. Brown, *patent attorney practicing in Los Angeles*

A company generally has no rights in an invention merely because it was created by an employee. This general rule, however, is subject to the following three exceptions:

Use of company time, facilities, or funds. When an invention has been developed on company time or with the use of its facilities or funds, a "shop right" usually can be asserted over it by the company. This right allows the company to make use of the invention without the inventor's consent and without having to pay any compensation. However, this right to free use cannot be sold by the company to another company or individual. Moreover, it does not include the right to prohibit others (including the inventor) from using the invention. That right is preserved for the inventor, who may still patent his invention. In law, the interest conveyed by the shop right is referred to as a "nonexclusive" and "nonassignable" license.

Although a shop right cannot be asserted unless company time, facilities, or funds were used, the mere use of one or more of these company assets will not always guarantee the creation of a shop right. Other factors often considered are: whether the invention is closely related to the company's business, whether the company knowingly assisted in its development or protection (for example, paid for a patent on it), and whether the inventor permitted the company to use it without charge or objection. No single factor is decisive. In each case, the court will examine whether the company's connection with the invention is sufficient to justify its assertion of a shop right.

Employees in special positions. If the inventor was employed specifically for the purpose of creating the invention, for example, a consultant hired to develop a flip-flop circuit with a very high input impedance, the company can claim all the assertable rights in the invention. This claim can include the right to sell it or to preclude all others from making use of it—even the inventor. (However, as suggested in previous columns, these rights will not generally be enforceable unless the invention is patented or maintained in secrecy.) Moreover, unlike the shop right, these full ownership rights will exist even if the invention has been created at home without company equipment or funds.

A few older cases have held that inventions of engineers are not normally subject to full ownership rights because engineers are merely employed to "design," which is different from to "invent." It is uncertain whether these cases would be followed today. Of course, the possibility that a shop right can be successfully asserted is not precluded, as long as the necessary connections with the company, as discussed above, are present.

Full ownership rights may also be obtained over inventions made by high-ranking company officials (like directors, officers, and partners), regardless of their assigned duties, if a shop right would otherwise have existed. The differential treatment often afforded to high-ranking company officials is a consequence of the higher degree of loyalty required of them by law.

Rights by contract. The results discussed above can be altered by written agreement between the company and the employee (oral agreements are also usually effective, but difficult to prove). However, if the agreement is grossly unfair to the employee, the courts may refuse to enforce it.

For example, an agreement granting a company all rights over all inventions made by its employees following termination of employment probably would be held void. However, if limited in time and to only those inventions closely related to the company's business, the agreement might be upheld.

Employee suggestion plans are another source from which companies can obtain invention rights by agreement. Moreover, rights may be obtained through such plans, although the plan does not give the employee a fair share of the profits made from the company's use of the invention. Some compensation to the employee is usually required before the court will enforce the plan.

One final point: claims of ownership over employee inventions should be made promptly. If the company or employee remains silent until after the invention becames a commercial success, all rights may be lost.

This column sets forth basic principles of law and is not intended as a substitute for personal legal advice. Questions and comments are invited and should be sent to Mr. Brown in care of Electronics.

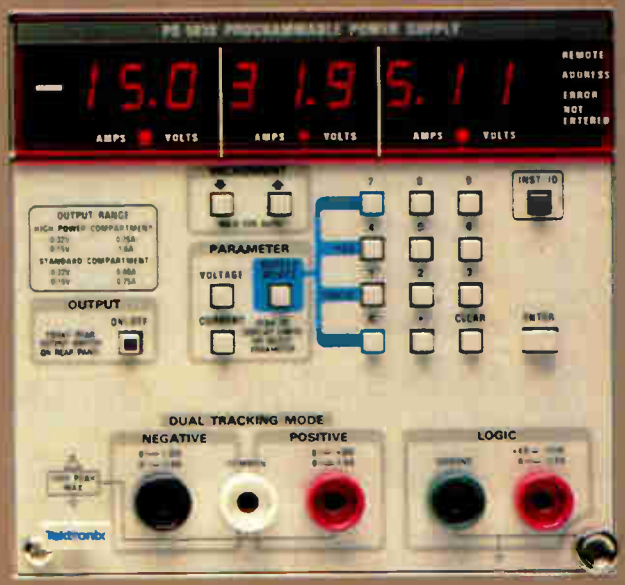
Three programmable power supplies in a compact package. Price plus performance in a DMM.

Tektronix brings you the world's first and only triple programmable power supply. The PS5010, $2500,* offers exceptional accuracy and programming ease, in systems or stand-alone applications.

You get the most commonly used voltages: 0 to ±32 V dual floating supply, to 1.6 A (0.75 A above 15 V) and +4.5 V to +5.5 V logic supply, to 3 A.

Each supply can be programmed independently for voltage and current limits with auto crossover. Digital displays indicate regulated values automatically. Total voltage accuracy of 0.5% eliminates the need for monitoring devices.

Unlike listener-only power supplies, used in most IEEE-488 systems, the PS5010 constantly monitors itself and communicates changes in status, over the bus and front panel. Other features include source on/off and powerful GPIB status reporting commands.



The DM5010 has all the right answers, at just the right price. This highly versatile fully Programmable Digital Multimeter, $1995,* gives you calculating power, priced-right performance, plus programming ease and measurement speed.

The DM5010 measures DC volts, resistance and true RMS (AC and AC + DC volts). Built-in math functions include averaging, nulling, offset, scaling, db and comparison to limits activated with either front panel controls or the IEEE-488 bus.

You get 4½ digits of readout resolution, accurate to within 0.015% dc. Or up to 26 readings per second with 3½ digit resolution, accurate to within 0.1%.

Part of the family: TM5000 Programmables. The PS 5010 and DM5010 share the configurability of TM500, plus Common Codes and Formats that fit all Tek GPIB instruments. The Tek GPIB approach is the simplest, most comprehensive implementation of the IEEE-488 standard ever developed.

For additional information or the address and phone number of the Tektronix Sales Office nearest you, contact:

U.S.A., Asia, Australia, Central & South America, Japan.
Tektronix, Inc.
P.O. Box 4828
Portland, OR 97208
Phone: 800/547-1512
Oregon only: 800/452-1877
Telex: 910-467-8708
Cable: TEKTRONIX

Europe, Africa, Middle East
Tektronix Europe B.V.
Postbox 827
1180 AV Amstelveen
The Netherlands
Telex: 18312

Canada
Tektronix Canada, Inc.
P.O. Box 6500
Barrie, Ontario L4M4V3
Phone: 705/737-2700

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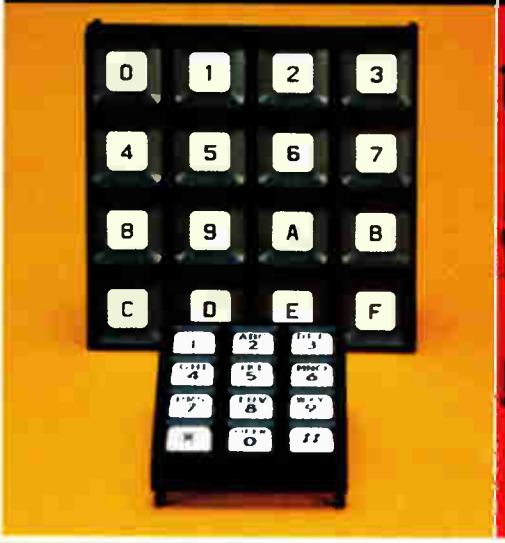
GRAYHILL KEYBOARDS: DIFFERENT STROKES FOR DIFFERENT FOLKS

SERIES 88 A short stroke *sealed* keyboard with excellent audible and tactile feedback. Colorful standard or custom-made graphics integrates this keyboard into your front panel. Coded outputs and low bounce characteristics easily mate with logic circuitry.

SERIES 82 Long stroke high profile, wiping contacts. 1, 2, 3 and 6 button modules can be arranged for your specific needs. SPST to 4PST circuitry under each button; also available with coded outputs.

SERIES 83-84-86 Short stroke standard 3x4 and 4x4 keyboard configurations. Choice of ½ inch or ¾ inch button centers and post or flange mounting. Standard coded outputs—easily interfaces with logic circuitry. Excellent audible and tactile feedback.



SYSTEM 87 Short stroke low profile, snap dome contact system provides tactile and audible feedback. Modular units—1 thru 6 buttons and 3x4 and 4x4 pads can provide any conceivable button arrangement.

Your product is distinctive, and thus your keyboard needs are also likely to be unique. That's why Grayhill offers you four different keyboard families, with a host of options in each. We'll help you arrive at the keyboard solution that's most practical, attractive, and cost effective. Two of our four families—Series 83-84-86 and Series 88—are built around the popular 3 x 4 and 4 x 4 keyboard configuration; the other two—Series 82 and System 87—are modular, allowing you to create any unique keyboard arrangements.

Other features and options include:

- up to 3,000,000 operations per button
- standard or special coded outputs
- sealed or unsealed
- high or low profile
- short stroke or long stroke—dome or wiping contacts
- excellent audible and tactile feedback in dome contacts
- post, flange or PC mount
- ½", 11/16" or ¾" button centers
- wide choice of legending modes
- color choices

For detailed information on Grayhill Keyboards, consult EEM, ask your local distributor, send for a copy of the Grayhill Keyboard Catalog or call us with your questions at (312) 354-1040.

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Meetings

Technical Symposium East '82, The International Society for Optical Engineering (P. O. Box 10, Bellingham, Wash. 98227), Hyatt Regency Crystal City Hotel, Arlington, Va., May 3–7.

Electronic Components Conference, IEEE (D. J. Gendz, IBM Corp., Department 649/014-4, 1701 North St., Endicott, N. Y. 13760), Sheraton Harbor Island Hotel, San Diego, May 10–12.

Carnahan Conference on Security Technology, IEEE (Sue McWain, Office of Continuing Education, 533 South Limestone St., University of Kentucky, Lexington, Ky. 40506), Carnahan House, University of Kentucky, May 12–14.

Custom Integrated-Circuits Conference, IEEE (David Lewis, Research Laboratories, B-81, Eastman Kodak Co., Rochester, N. Y. 14650), Americana Hotel, Rochester, N. Y., May 17–19.

Appliance Technical Conference, IEEE (Jim Stevens, 1000 Jorie Blvd., CS 5030, Oak Brook, Ill. 60521), University of Wisconsin, Madison, May 18–19.

Control Engineering Conference and Exposition, Control Engineering magazine (Tower Conference Management Co., 143 North Hale St., Wheaton, Ill. 60187), O'Hare Exposition Center, Rosemont, Ill., May 18–20.

National Aerospace and Electronics Conference, IEEE (Naecon, 140 East Monument Ave., Dayton, Ohio 45402), Dayton Convention Center, May 18–20.

Northcon/82 Show and Convention, Electronic Conventions Inc. (999 North Sepulveda Blvd., El Segundo, Calif. 90245), Seattle Center Coliseum, May 18–20.

International Defense Electronics Expo '82, Kiver Communications (Information Center, P. O. Box 338, Whitehouse, N. J. 08888), Hanover Fairgrounds, Hanover, West Germany, May 18–25.

Vehicular Technology Society Conference, IEEE (Eddie Simon, 1970 B St., San Diego, Calif. 92102), Town and Country Hotel, San Diego, Calif., May 23–26.

International Semiconductor Power Converter Conference, IEEE (E. E. Von Zastrow, General Electric Co., Building 37-478, P. O. Box 43, Schenectady, N. Y. 12301), Hyatt Orlando Hotel, Orlando, Fla., May 24–27.

Electro '82, IEEE (Dale Litherland, Electronic Conventions Inc., 999 North Sepulveda Blvd., El Segundo, Calif., 90245), Boston Sheraton Hotel, May 25–27.

Semicon/West '82, Semiconductor Equipment and Materials Institute (625 Ellis St., Suite 212, Mountain View, Calif. 94043), Fairgrounds, San Mateo, Calif., May 25–27.

Microcomputer Show '82, Japan Electric Industrial Development Association (3-5-8 Shiba Koen, Minato-ku, Tokyo 105), Tokyo Ryutsu Center, May 26–29.

Seminars

A series of 31 all-morning seminars on digital signal processing is being presented in 25 cities around the U. S. and in eastern Canada by TRW LSI Products, P. O. Box 2472, La Jolla, Calif. 92038. The meetings began late last month and will finish in June. Call (714) 578-4385.

Integrated-Circuit Fabrication, Howard Johnson's Motor Lodge, Boston, May 11–12, and at Hyatt Rickeys Hotel, Palo Alto, Calif., June 3–9. Also **LSI [Large-Scale Integration] Design Alternatives,** Howard Johnson's Motor Lodge, Boston, May 13–14, and at Hyatt Rickeys Hotel, Palo Alto, June 10–11. Each seminar costs $395 and is sponsored by Integrated Circuit Engineering Corp., 15022 North 75th St., Scottsdale, Ariz. 85260.

Now. IEEE-488 plus Common Codes and Formats: Modular. Consistent. And easier than ever before.

From Tektronix comes the simplest, most comprehensive implementation of the IEEE-488 standard ever developed. Tek GPIB equipment meets all IEEE-488 requirements and enhances productivity with Common Codes and Formats. More than practical, it makes automating measurement systems easy.

Our Common Codes and Formats ensure compatible data transfer between instruments—which IEEE-488, by itself, does not.

And basic to the Tek GPIB concept is a commitment to design instruments that are eminently compatible, not just with controllers, but with people who use them.

No other system can say so much.

Common Codes and Formats keep commands clear and consistent. Their English-like programming language makes bus control exceptionally simple, even for the non-technical programmer. Writing systems software is easier, programs more efficient and self-documenting.

```
4100 REM       SET UP PS5010
4110 PRINT @22:"INIT;VPOS 11.7;IPOS 0.5;OUT ON"
4120 REM       SET UP DC5010
4130 PRINT @20:"INIT;TER LO;AUTO A;PER;SEND"
4140 INPUT @20:P
4150 PRINT @20:"MAX?;MIN?"
4160 INPUT @20:M1,M2
4170 A=M1-M2
4180 PRINT @20:"RISE;SEND"
4190 INPUT @20:R
4200 PRINT @20:"FALL;SEND"
4210 INPUT @20:F
```

The command set is in "standard engineering English" matching the abbreviations on instrument front panels. As is shown above, readable mnemonics in the command string set up the PS 5010 Programmable Power Supply and the DC 5010 Programmable Universal Counter. In line 4110 we set the PS 5010 positive supply for 11.7 volts with an 0.5 amp current limit, and turn the supply output on. In lines 4130 through 4210 we measure the period, amplitude, risetime, and falltime of a signal and set them equal to P, A, R, and F, respectively.

Operating conventions which are user-oriented make Tek GPIB devices even more convenient. Resistant to operator errors.

It's easy to set up your system now. And get back inside of it later. Our GPIB line includes instrument controllers, scopes, digitizers, plus programmable test and measurement instruments such as counters, digital multimeters, power supplies and more.

System integration comes easily. Common Codes and Formats help minimize the software modifications required when systems are changed or expanded.

The Tek GPIB approach frees you from dependence on outside systems developers, while assuring assistance from our own applications engineers.

You'll enjoy a direct connection to a long future of reliable, state-of-the-art Tektronix instrumentation. We provide what you need to integrate Tek GPIB instruments into your system. And you can be sure that the equipment you buy today will be compatible with our future GPIB products.

For further information, contact:

U.S.A., Asia, Australia, Central & South America, Japan
Tektronix, Inc.
P.O. Box 4828
Portland, OR 97208
For additional literature, or the address and phone number of the Tektronix Sales Office nearest you, contact:
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Oregon only 800/452-1877
Telex: 910-467-8708
TLX: 15-1754
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Tektronix Europe B.V.
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1180 AV Amstelveen
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Phone: (20) 471146
Telex: 18312 - 18328

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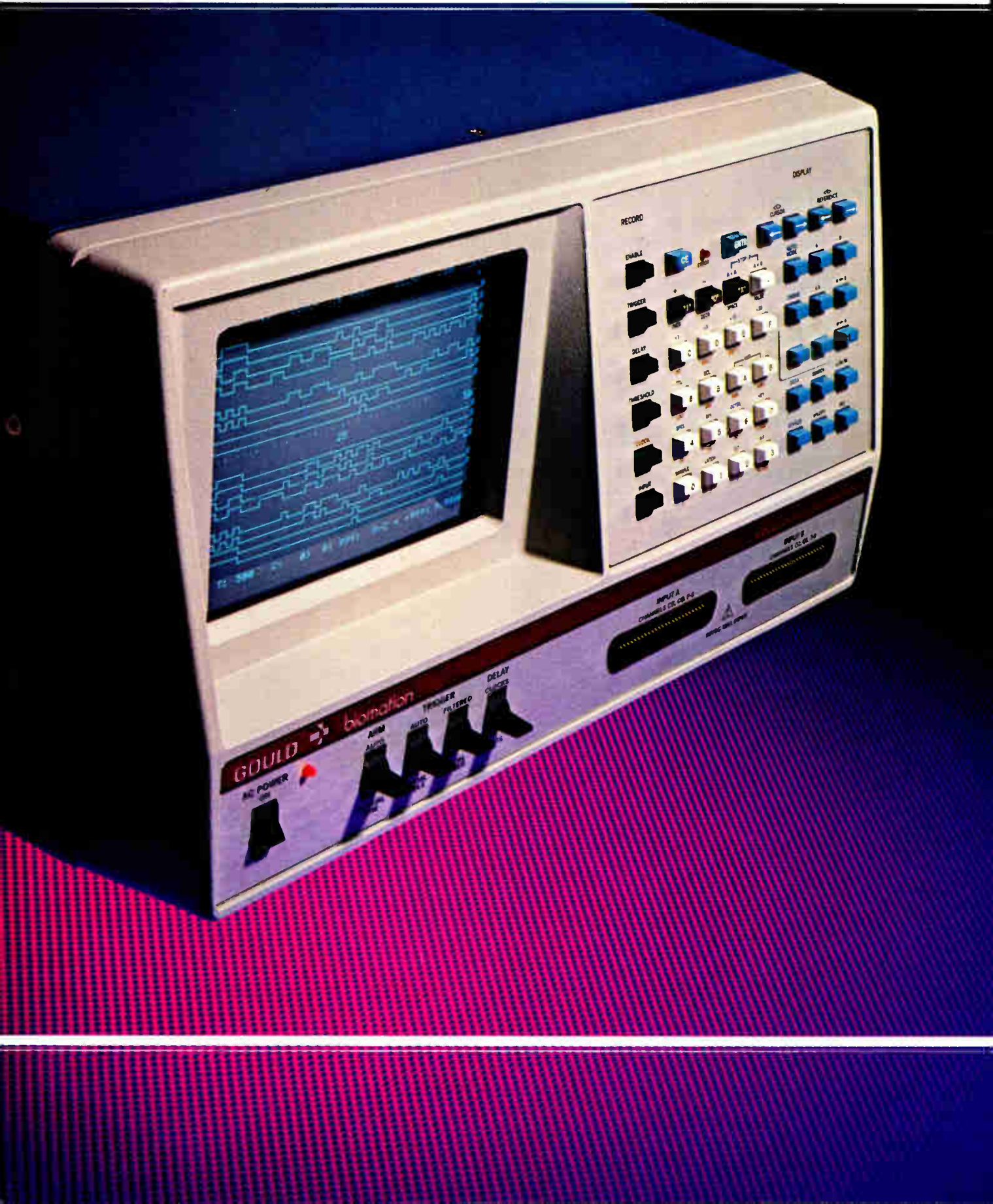
GOULD BIOMATION K100-D



7 reasons why the K100-D is now the world's best-selling logic analyzer.

How the general-purpose K100-D beat out H-P to become #1.

Not so long ago, Hewlett-Packard logic analyzers were the industry standard. We asked digital designers to compare the K100-D with H-P's popular 1610B and 1615A logic analyzers before making any buying decision.

In head-to-head comparison, the K100-D came out looking so good, it's now the best-selling logic analyzer in the world. Here's why:

1. It's easy to systematize.

For automated troubleshooting and production ATE, the K100-D features a fully-programmable GPIB interface.

To help you support a wide variety of bus-oriented systems, there are standard high-performance probes, specialized probing accessories and detailed application notes available on all the popular microprocessor systems currently in use.

2. It's concise.

The K100-D monitors 16 channels in time domain, 32 in data domain, so you can probe enough points to pin down problems at their source.

3. It's fast.

A 100 MHz clock rate resolves signals to 10 nanoseconds. The front end is also sensitive enough to capture glitches as narrow as 4 ns.

4. It's deep.

1024 words deep in memory—for faster, more accurate debugging. The K100-D extends the length of data you can trap from your system at any one time.

5. It's clear.

The K100-D has a large keyboard and interactive video display, a comprehensive status menu, highly useful time domain display, and data domain readout in user-specifiable hexadecimal, octal, binary or ASCII.

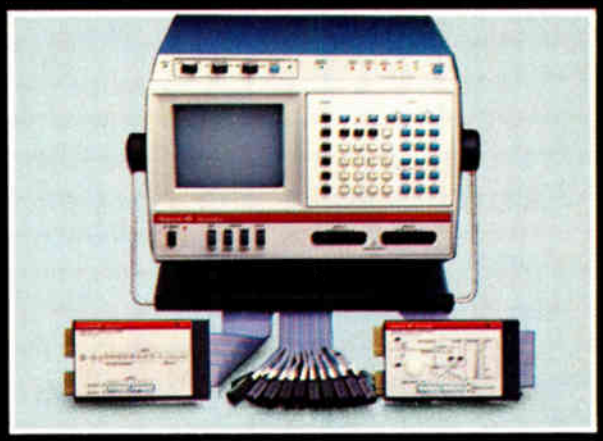
6. It has remote diagnostics.

A new T-12 communications interface option lets your field troubleshooters share their system observations with the best engineers back at headquarters. Remote diagnostics provide faster debugging and save a lot of time and travel for your most valuable people.

7. It's well supported.

You get full applications support from the experts in logic analysis.

For a free copy of our "Logic Analyzer Comparison Guide," request card for microprocessor system application notes, and T-12 Communicator information, just circle the appropriate reader service numbers. Or contact Gould, Inc., Instruments Division, Santa Clara Operation, 4600 Old Ironsides Drive, Santa Clara, CA 95050, phone (408) 988-6800.



The T-12 "top hat" for the K100-D provides logic analyzer remote diagnostic capability. Other options include the GPIB Analyzer and RS232 Serial Data Analyzer.

GOULD

Electronics & Electrical Products

Circle 30 for Comparison Guide
Circle 272 for APP Note request form
Circle 273 for T-12 communicator data

Intermittent Problems?

Blowing a Fuse?

Whether they blow fuses or not, transients can cause disruption in all modern electronic equipment. Their sources may be found in power line disturbances or in the internal circuitry itself.

Find Out Why

For many years, power line monitors have given us data on the number and amplitude of line transients, but not on their causes. Today improvements in instrumentation make it possible to capture whole waveshapes, revealing information on the nature of a transient. A recent Navy report has made progress in categorizing types and suggesting typical signals resulting from events such as abruptly energized transformers and switch contact arcing. Figures 1 and 2 show transients from a 60Hz, 120V shipboard power network. They are similar in amplitude and duration, but distinctly different in type. The Nicolet Digital Oscilloscope's pre-trigger viewing and large memory size capture the entire wave signature. Amplitude and duration can be read from the screen's numerics.

Erratic Unexplained Errors?

Intermittent errors located within electronic circuitry are illustrated in Figure 3. This bothersome transient was detected during development of a complex daisy wheel printer. Although a logic analyzer indicated an error condition, the nature of the error remained a mystery. By triggering the Nicolet scope on the error, a fault in the daisy wheel displacement was isolated and corrected.

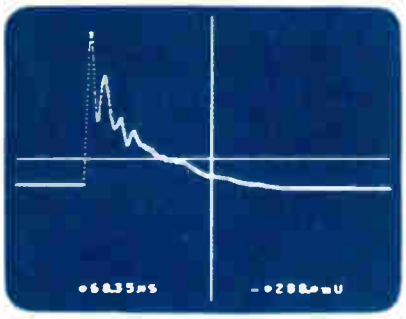


Fig. 1: One type of power line transient

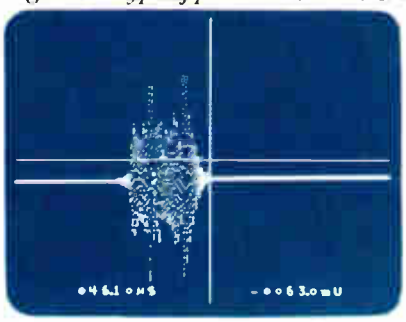


Fig 2: Second type of transient from same network.

• Waveforms courtesy of Naval Electronic Systems Engineering Activity and Diablo Systems Inc., Div. of Xerox.

Let a Nicolet Scope Capture the Cause

In both these examples, transients were captured and recorded on floppy disk automatically, freeing engineers and technicians for more important tasks. Later the signals with all their original data were recalled for detailed examination and comparison.

The data could then be manipulated, plotted or transferred directly to a computer for more complex calculations, for example, of the energy content of the transients.

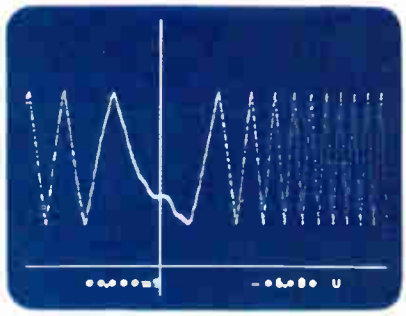


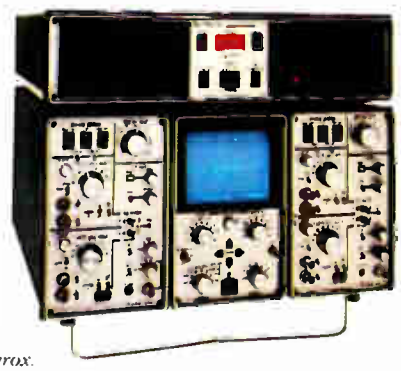
Fig. 3: Print wheel movement. Glitch caused by noise in control circuitry

The Nicolet digital oscilloscope is using new technology to solve long-standing problems. With its help, even hard to find intermittent problems are being isolated and eliminated.

If you would like to try out a Nicolet digital oscilloscope in your own laboratory call 608/271-3333 or write Nicolet Instrument Corporation, Oscilloscope Division, 5225 Verona Road, Madison, WI 53711.

In Canada: call 416/625-8302.

NICOLET INSTRUMENT CORPORATION
OSCILLOSCOPE DIVISION



Circle #32 for immediate need

Circle #38 for literature only

Electronics newsletter

Bell widens wavelength range of optical fiber

A team of researchers from Western Electric Co. and Bell Laboratories has designed and experimentally verified the widest wavelength range (1.45 to 1.73 μm) for a single-mode, low-loss, low-dispersion optical fiber. **The fused silica fiber has two claddings in order to tailor the refractive index to the desired combination of wide bandwidth, low loss, and low dispersion.** It is ideal for wavelength-division multiplexing, where a number of lasers beam different frequencies into the same fiber simultaneously.

Array microphone compensates for speaker's distance

An array microphone that compensates for variations in a speaker's position while minimizing noise pickup and needing no attachment to the person will be introduced by American Telephone & Telegraph Co. Designed for teleconferencing by Bell Laboratories, Murray Hill, N. J., **the Quorum system does its job by means of an array of 28 electret microphones mounted on one side of a 30-in. stalk** that sits on a table. Up to four of the arrays can be ganged for larger rooms.

Steering unit explores goals for R&D co-op

A task force scheduled to meet in Denver on April 1 aims at hammering out areas of agreement among participants in the proposed semiconductor and computer research cooperative, MCE Inc. William C. Norris, chairman of Control Data Corp. and prime mover behind MCE [*Electronics*, March 10, p. 97], also says that **three more companies have joined the group,** although he declines to name them.

Rolm PBX wins NTT approval

Rolm Corp. of Santa Clara, Calif., a top U. S. maker of digital private-branch exchanges, became the first company of any nation to win full and formal approval from Nippon Telegraph & Telephone Public Corp. for Japan's digital switching market. **Thus, Rolm becomes only the third foreign firm to win any kind of NTT approval.** With virtually no such PBX systems in place yet in Japan, Rolm foresees an annual total market there of $600 million to $1 billion within four to five years.

Another standard pushed for local nets

The quest for a local-network standard is getting harder: a new contender from Cromemco Inc. (see p. 147) is on the scene, and IBM is staking out its own position (see p. 37). So far, the 802 committee of the Institute of Electrical and Electronics Engineers **has endorsed two major approaches, collision detection and token passing.** Now, Cromemco of Mountain View, Calif., has asked the IEEE Computer Society's standards board—yet another review group—to approve its network scheme as a standard. C-Net, as it is known, employs both virtual circuits and collision detection along a twin-axial cable with balanced differential drives.

National unveiling midrange mainframe

What is probably the first U. S. non-IBM mainframe in a while to use state-of-the-art semiconductor technology is coming from National Advanced Systems, Mountain View, Calif. The AS 6100 includes high-speed emitter-coupled-logic gate arrays, 4-K bipolar random-access memories for writeable control storage, and 64-K MOS RAMs for main memory. The IBM-compatible computer is a midrange machine **with a performance figure of about 2 million instructions per second** and is intended to compete with IBM's 4341 group II systems.

Electronics newsletter

Honeywell poised to sell ICs

Don't be surprised if Honeywell Inc.'s captive chip operation jumps into the merchant semiconductor business by midyear. Its Solid State Electronics division in Plymouth, Minn., has set up what it terms **a solid-state venture department that is currently settling on which niches look most profitable to attack.** It has expertise in both MOS and bipolar circuits as well as sensor and advanced packaging technologies.

Package downloads CP/M programs to HP-41

Developers of software for Hewlett-Packard Co.'s HP-41 hand-held computer no longer need be limited to programming with its calculator-style keyboard. F. M. Weaver Associates Inc.'s Hand-Held Products division will demonstrate a CP/M-compatible software development package for the 41 at an HP-41 users' conference to be held April 17 in Philadelphia. **Software developed using the HHP-410UCC (user-code compiler) can be downloaded** from a host computer to the 41 through the HP-IL and a parallel-port converter supplied by Weaver, of Charlotte, N. C.

Personal computer coming from DEC

Digital Equipment Corp. will dive into the personal-computer market in May with a family of machines elegantly packaged with tilting, lightweight screens and detached, low-profile keyboards. One computer will be a repackaging of the DECmate Work Processor, the PDP-8–based small computer announced last year by the Maynard, Mass., company; another will be based on the 16-bit PDP-11 architecture (probably using the new T-11 microcomputer chip) and will contain floppy and hard disks. **The third newcomer will run a widely used outside operating system** (most likely CP/M). Also, late this month at the Hanover Fair in West Germany, DEC will introduce a new baby member of its 32-bit VAX family, the VAX-11/730. Meanwhile, Italy's Olivetti has announced its entry into the personal-computer market (see p. 64).

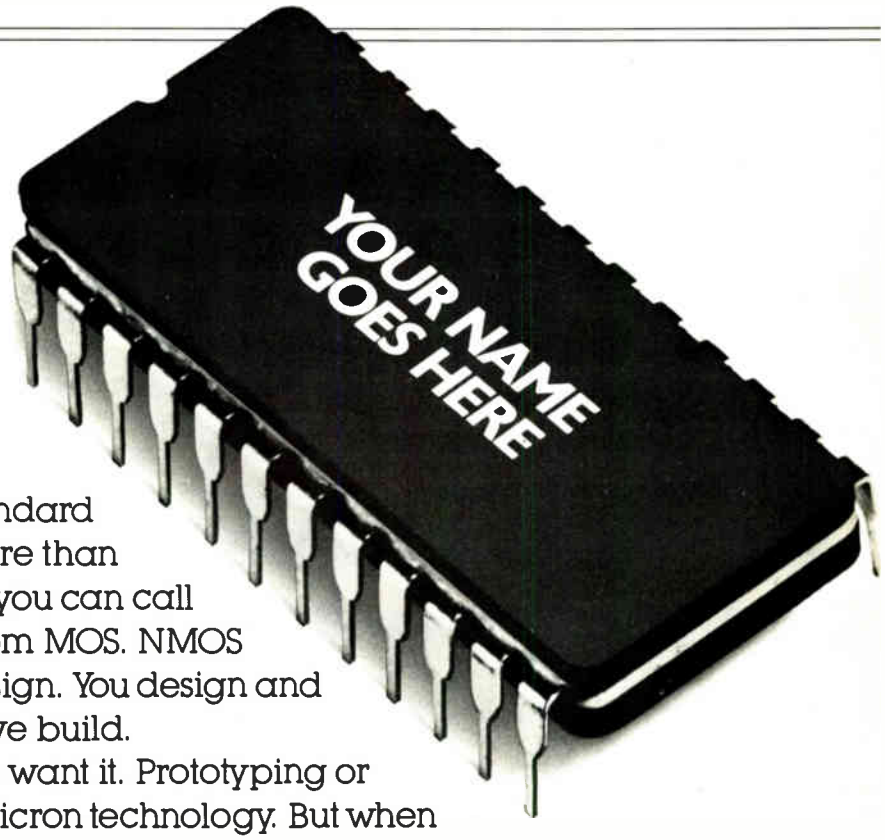
Jedec proposes H-C-MOS standard

Order may soon arise from the confusion in high-speed complementary-MOS logic. Motorola, National Semiconductor, Philips, RCA, and Signetics met with the Joint Electron Device Engineering Council to come up with a standard set of specifications for the high-performance C-MOS, or H-C-MOS, logic families they produce. **The standard will be for silicon-gate logic circuits operating with a supply voltage of 2 to 6 V.** The proposed specifications will be presented at another meeting in June, and if agreement is reached, the standard will be published by mid-1983.

Addenda

Leading-edge microelectronics has come to photocopiers with the introduction by Eastman Kodak Co., Rochester, N. Y., of a model that has two 8085 microprocessors for sophisticated user interfacing and extensive self-diagnostics. Capable of 5,500 images an hour, **the Ektaprint 250 Duplicator uses 122 K-bytes of a possible 128 K-bytes of memory;** the two microprocessors communicate over an IEEE-488 bus that permits expansion of internal memory as well as external communication capabilities. . . . International Business Machines Corp. has added three large computers **to fill the performance gap between its midrange 4300 series and the top-performance 3081 series.** The new 3083 series has three model groups—E, B, and J.

WHY BUY THEIR CIRCUITS WHEN WE'LL BUILD YOURS?



Since you have some ideas about systems, you probably also have some ideas about IC's. And maybe your ideas include a wish list. Because nobody makes exactly the IC you need to optimize your system.

You can make do with standard parts, maybe three or four more than you think you really need. Or, you can call I.M.P. We're specialists in custom MOS. NMOS or CMOS. You design or we design. You design and we build. Or, we design and we build.

Custom MOS any way you want it. Prototyping or production quantities. 5 or 3 micron technology. But when we're finished, you own it. We don't. And neither does anybody else. Which means you can hold your jump on the market.

But why I.M.P.? One reason: A management team with experience. 91 years of it in all five critical areas of custom IC manufacture. Design. Production. Operations. Quality control. Customer liaison. And that's just our management team.

And we started with CAD. It isn't pasted on. It's built into our design and manufacturing operations. Which means we can deliver your designs or circuits on a schedule that fits your schedule.

And here's the clincher. In the long run, it is always cheaper and more efficient to build your own circuits than it is to buy theirs.

Planning a system? Call us. We'd like to work with you from initial concept through final production. And we can join you at any stage in between. With complete custom MOS facilities. Any way you want them.

EX4-27

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2830 North First Street
San Jose, CA 95134 (408) 262-9100

You build our circuits?
Tell me about your capabilities.

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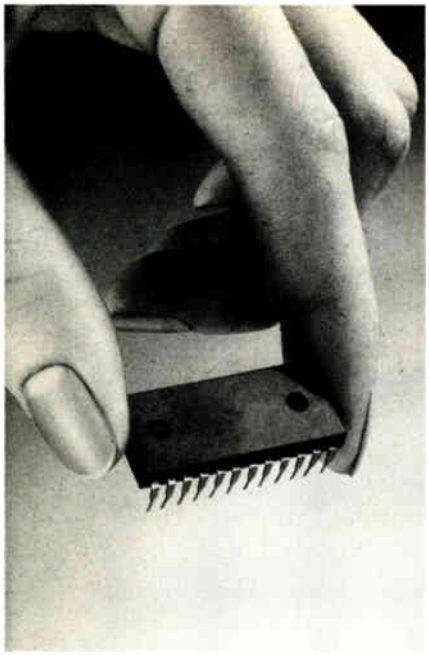
Company_____

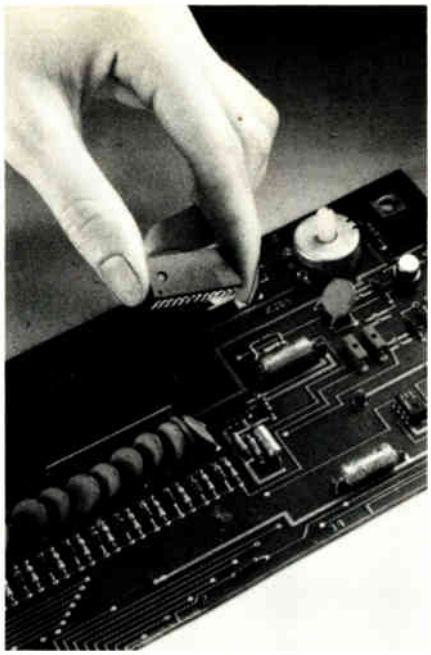
Address_____

City_____ State_____ Zip_____

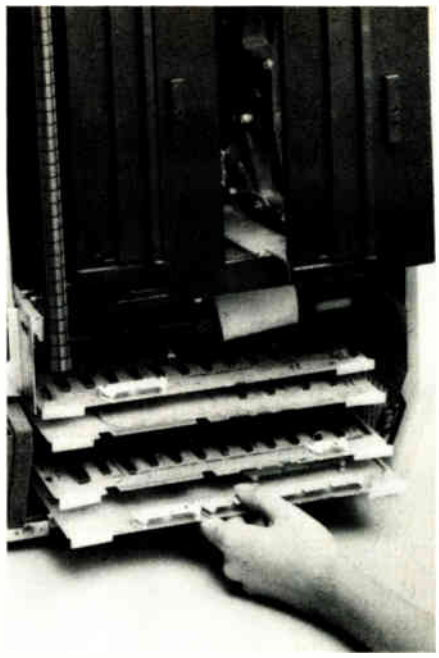
I'm a prospect, call me at ( )_____



One device out of 200...



One board out of 10...



Two systems out of 5

How a respectable 0.5% device failure rate can turn into a 40% disaster

Even if only one static-damaged device out of every 200 escapes your notice, the result can be a disaster.

Figuring that each PC board has 20 devices, a 0.5% device failure rate means one out of 10 boards will fail.

Put 5 boards into a system and the rate compounds to 40%.

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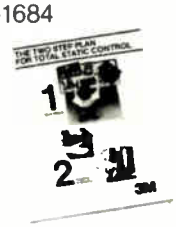

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Circle 36 on reader service card

IBM sees baseband, token-passing ring for local networks

by Harvey J. Hindin, Communications & Microwave Editor

Studies for IEEE standards committee shed light on the future office but presage no product plans, says company

Results of local networking studies conducted within International Business Machines Corp. have for the first time been made available to the committee of the Institute of Electrical and Electronics Engineers that has been working to develop standards for the networks. In four technical papers, IBM engineers outline a scheme for the office of the future that relies on a ring network with token-passing access control and baseband transmission.

It remains to be seen, of course, whether IBM, whose market clout can establish *de facto* standards, introduces its own local network, as has been rumored [*Electronics*, Feb. 24, p. 33]. IBM will not say, and it emphasizes in the papers that its submission "is not an IBM product offering nor an implied commitment to any future product offerings."

The IBM conception contains elements already present in the myriad other nets introduced in the last few years, such as Ethernet, spearheaded by Xerox Corp. and employing baseband transmission, and Arcnet from Datapoint Corp., using token passing. The ring net itself is being used extensively in the UK.

As for speed, contend the IBM authors, who are staff members of the Communication Products division, Research Triangle Park, N. C., 4 megabits "is a good design point" and a "tradeoff between network drive distance and data rate." It is around the midrange of data rates that have been proposed.

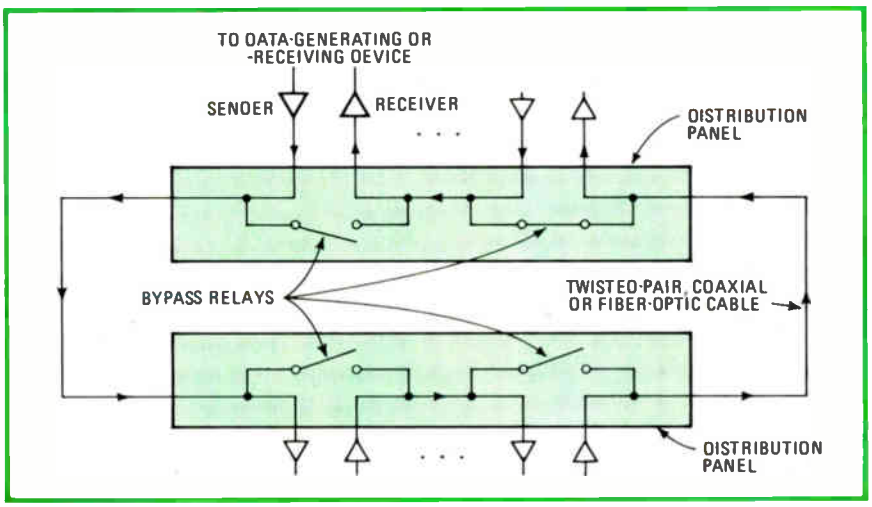
For example, C-Net by Cromemco Inc. operates at 880 kilobits per second (see p. 147), and Ethernet is up at 10 megabits/s. However, any IBM network that results is not likely to be limited to this figure. At the National Telecommunications Conference in New Orleans last December, researchers at IBM's Zurich (Switzerland) laboratories described their work with ring nets at 8 and 16 Mb/s, as well as 4 Mb/s.

For IBM, "the token-ring architecture is [for] an evolutionary system and today represents the best response to the known [office] environment," says D. W. Andrews. "In the future it can adapt to new requirements and technologies."

As described in the documents, IBM's lines of work processors, computers, printers, terminals, and the like can be linked with either twisted-pair copper wire, coaxial cable, or fiber-optic cable. The company's J. D. Markov points out that "data-grade twisted pair is suitable for a 4-Mb/s data rate at distances up to 1 kilometer."

The key to IBM's use of token passing to regulate access to its network is a software-controlled "monitor." This program not only supervises the token's operation but takes care of efficient recovery of the local network in the case of token-related errors. (The token passed is actually a digital word sent to each terminal in turn that allows it to communicate with the net.)

Equally important is that the token-passing design allows all existing terminals to interface with the local network. In fact, according to Andrews, the terminals will need no modification to their present data-link–control protocols. This feat is



Around the loop. Receiving and transmitting amplifiers and bypass relays connect each piece of data-generating and -receiving gear to the distribution panels in IBM's local network. The relays bypass unused stations and protect the ring by locking out faulty gear.

accomplished by incorporating the terminal's data and protocol bits in the data field of the local network's transmission frame.

The ring involves distribution panels to which work stations are connected; the panels connect to the ring (see diagram, p. 37).

Relays and switches in the panel act to bypass inactive or malfunctioning stations. Data-generating and -receiving devices are connected to the ring through adapters, which contain the analog and digital circuitry to receive and retransmit the data as well as the ring-access protocols. For now, these protocols are restricted, like Ethernet's, to the physical- and data-link–level layers of the International Standards Organization's standard architecture.

Signal jitter and distortion in the repeaters in general limit the number of stations a local network handles. So, IBM has opted to connect multiple-ring networks through "bridges," or software-controlled high-speed digital switches. These bridges, says R. C. Dixon, one of the IBM authors, could use fiber optics when the aggregate data rate is 10 Mb/s or higher.

The bridges can handle either asynchronous or synchronous data traffic. This means the token-access protocol will allow priority network access for synchronous transmission from selected stations on the ring.

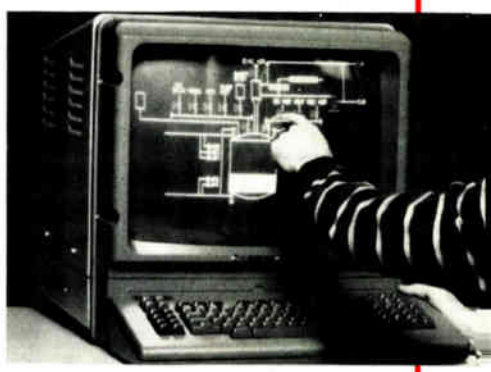
One important application of this priority access is for synchronous operation of a 64-kb/s voice channel based on pulse-code modulation. This requires a guaranteed bandwidth and time delay, provided by a control station on the network that sets access priorities and handles the token monitor.

Responsive console brings up controller status at a touch

To make its industrial-communications networks more accessible to human operators, Gould Inc.'s Modicon division in Andover, Mass., has introduced a real-time, color-graphics monitoring and control terminal activated by a touch-sensitive screen. Users can either load the 8086-based Modvue from a library of disk-stored standard displays or create their own custom graphics to represent the internal states of programmable controllers or the status of processes and equipment.

By touching a transparent resistive grid laminated on Modvue's screen, the user can call up new displays, change the status of a controller or of equipment managed by the controller, or set conditions for alarms.

The initial Modvue offering, the $25,000 CR-900 programmable touch control center, supports links with up to 64 Modicon controllers operating on the company's three-year-old Modbus communications range of equipment that includes



robots, machine tools, and microprocessors as well as programmable controllers.

Modvue's capabilities include the ability to display in color the real-time activities of transfer lines, batch reactors, valves, motors, and so on, in images like pie charts, line drawings, or text. **-Linda Lowe**

Industrial

Factories net still more networks

Increasing numbers of programmable-controller makers are backing their own communications schemes in hopes of taking a dominant position in "the factories of the future."

Texas Instruments Inc. and General Electric Co. independently joined the factory network competition with announcements on March 30 of TIway II and GEnet. TI is developing integrated circuits to provide access to its planned industrial system, while GE is gearing up for its first factory-office network deliveries this summer.

Installations. Meanwhile, programmable-controller leaders Allen-Bradley Co. and the Modicon division of Gould Inc. are both concentrating on the installation of earlier announced nets. Andover, Mass.–based Modicon, which introduced Modway last year [*Electronics*, March 10, 1981, p. 33], is currently installing its first system at an automotive plant in Michigan. At Allen-Bradley, Odo J. Struger, director of engineering of the Programmable Controller Systems division near Cleveland in Highland Heights, Ohio, declines to give an exact number, but says his firm has "a substantial number" of Data Highway networks up and running.

Partly at stake in the dash for factory network supremacy is a programmable-controller market that most estimate will reach $1 billion in four years. Programmable controllers, as well as equipment like robots, will be connected to these high-speed digital highways, allowing them to work in harmony with each other. The current slumps in automotive and other industrial sectors have delayed some programmable-controller installations, admits Struger, who places total U. S. sales in 1981 at slightly less than $300 million. "Most auto firms pushed back installations by a half year or so," he says.

To come. At the programmable-controller show in late March in Chicago, TI unveiled plans to make available late next year interface

modules to Tiway II, a peer-to-peer broadband industrial-communications system designed to use cable-television lines. (Tiway I, also unveiled at the show, is an extension of the company's present hierarchical controller system that has a network controller to supervise data traffic.) TI's Industrial Controls division in Johnson City, Tenn., also intends eventually to make Tiway II compatible with other transmission media, such as fiber optics, twisted pairs, phone lines, microwave radio, and satellite communications.

Tiway II will have a data rate greater than 1 megabit per second and will be able to handle video and voice communications over its broadband lines. TI says the network scheme, which will be detailed later this year, "is to be generally compatible with the leading proposed network standard" of the Institute of Electrical and Electronics Engineers. The company plans to sell its Tiway chips to other industrial-controls manufacturers in an effort to further promote the use of its factory communications scheme.

Dual purpose. Meanwhile, GE's programmable-control operation in Charlottesville, Va., is planning to deliver a broadband, turnkey network system for use in both the office and the factory. GEnet, which has a transfer speed of 5 megabits per second, is designed to accommodate interactive graphics units, numerical-control equipment, robots, and programmable controllers, as well as office data terminals. It was developed by GE subsidiary Intersil Systems division in Sunnyvale, Calif.

A Bus Interface Unit will be available in both 4-port and 16-port versions for between $500 and $1,000 per port. To handle translation between GEnet and other protocols, GE will provide a Versatile Communications Controller containing eight Z80s at $800 to $1,200 per line. Software is already on the market to bring Digital Equipment Corp. computers onto the network, with packages for IBM, Hewlett-Packard, and other computer manufacturers planned, according to a GE spokesman. **-J. Robert Lineback**

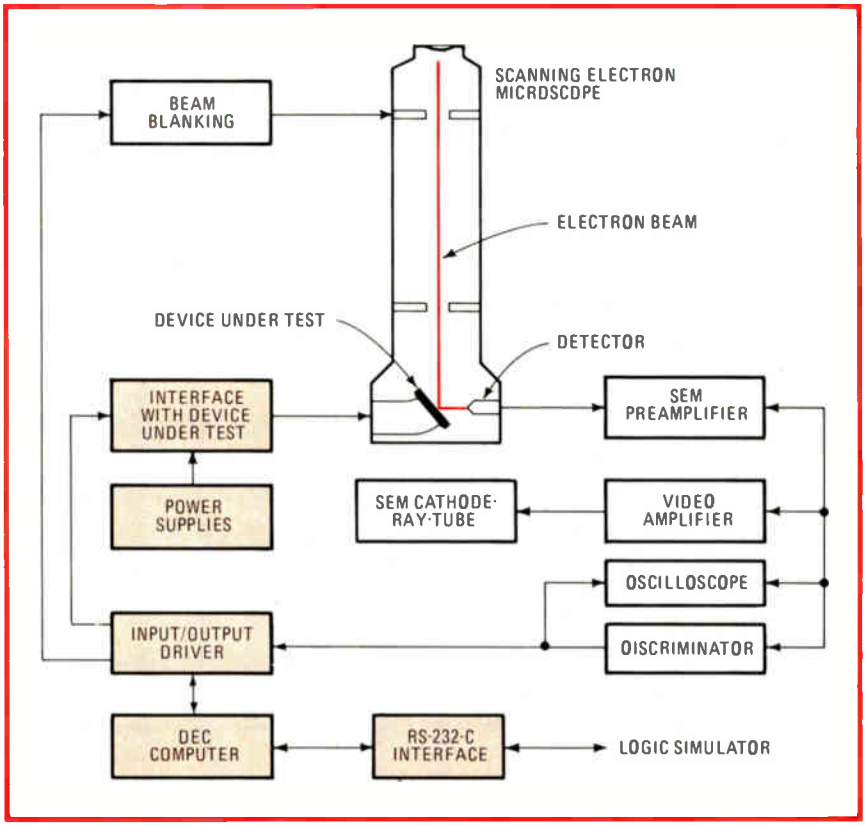
Testing

Electron beams focus on testing of VLSI

Electron-beam probing of an integrated circuit's internal interconnections (or nodes) to test their logic states promises to replace mechanical probes. The electron beam's ability to focus narrowly on tiny interconnecting areas of very large-scale ICs without the need for special test pads, and its advantages as a loadless, noninvasive probe, are giving impetus to development efforts by a number of IC makers [*Electronics*, July 14, 1981, p. 105].

In what may be the first step toward automating the probe's testing capability, International Telephone & Telegraph Corp.'s LSI Technology Center in Shelton, Conn., reports it has demonstrated a system able to make pass/fail decisions about the dynamic logical response of IC nodes without requiring human analysis. Designed for both design verification and failure analysis, the ITT system uses the same principle, called voltage contrast, as do other electron-beam probes. It depends on the fact that secondary electrons, induced when an electron beam is applied to an interconnection, become trapped by a retarding electrostatic field if the interconnection is kept at +5 volts, but can speed away unimpeded from a grounded one.

Flags rejects. A system equipped with a collector of these secondary electrons thus sees measurably greater energy emitting from a ground value (0) than from a +5-v value (1). But while existing systems convert energy readings into visual "logic maps" for manual analysis, ITT's system analyzes the nodes' logic responses internally, generating a printout that flags bad responses, according to Swamy Thangamuthu,



Probe system. The tinted blocks indicate the elements that ITT had to add to a standard scanning electron microscope so as to automate a contractless electron-beam system for probing ICs. A DEC PDP-11/30 minicomputer directs the testing.

manager of product evaluation and product assurance at the ITT center.

With the manual approach, an operator must be involved to judge node response by studying voltage-contrast photographs or representations on an oscilloscope or other display equipment. "But when you need to check many nodes, extensive test patterns, or whole device cycles," he says, "the number of logic displays and the time it takes to analyze them becomes impractical."

The ITT system employs standard functional blocks including a commercially available scanning electron microscope (SEM) and a Digital Equipment Corp. PDP-11/03 minicomputer configured as a functional tester (see diagram). The computer uses a logic-simulation program generated at the time the IC was designed; this is nothing more than a truth table describing the expected logical response of each internal circuit node for an applied electrical stimulus.

Collector. In addition to dictating the electrical stimulus delivered through a specially designed interface to the device under test, the ITT system's computer synchronizes the SEM's delivery of an electron-beam pulse with a given node's response. It does this in a so-called spot mode, focusing on a single node rather than scanning across the chip.

The system's detection system collects any secondary electrons emitted at the node and converts them into photons, which are amplified by a photomultiplier and passed on to the SEM's preamplifier. From there, the signal passes to an ITT-designed discriminator circuit, where it is filtered and amplified for delivery back to the system minicomputer. The preamplifier can in addition send the signal through a video amplifier for display.

After analyzing each node's response, the system's computer generates a test printout detailing sequence numbers from the stored logic-simulation file, each truth-table input, the identity and response of each node, and the nature of any untoward response. Instead of wading through many voltage-contrast images to reach a complete characterization of a circuit, the test operator need only scan a single printout [*Electronics*, Feb. 24, p. 34].

ITT has no plans at present to market its system, notes Thangamuthu, who, along with colleagues Michael Macari and Seymour H. Cohen, reported on the system at last week's International Reliability Physics Symposium in San Diego, Calif. He adds that continuing development efforts will focus on automating the beam-positioning process, which is now done manually, and on integrating an improved electron-beam source and more sensitive detection equipment. **-Linda Lowe**

Memory

Revised process yields 15-ns RAM

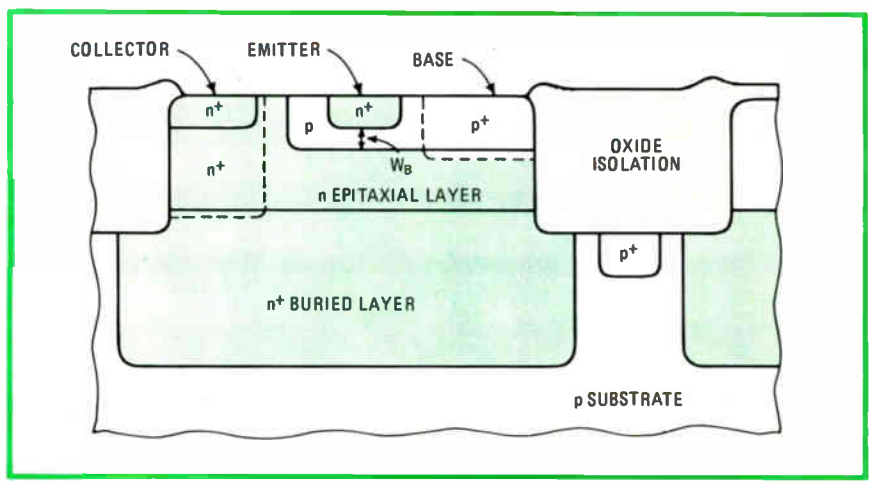
Big-computer designers will have at their disposal this month a superfast high-speed random-access memory: a 4-K design sporting a blazing 15-nanosecond access time. Sample quantities are being made available by Motorola Semiconductor, which fabricates the device with a new version of an oxide-isolated bipolar process it has been using for high-speed emitter-coupled logic arrays. Heretofore, access time for the fastest RAMs, which have also relied on ECL circuitry, topped out at 25 ns.

The MCM10470A, which Motorola refers to as a Mosaic device (for Motorola oxide self-aligned implanted circuit), is only the opening shot in a campaign by the company to apply Mosaic to all its ECL RAM and TTL parts. The firm is also providing samples of its first TTL part this month. It is a low-power, 256-by-4-bit device that uses only 400 milliwatts. Other Mosaic-based products are set to roll out steadily from the Bipolar Integrated Circuits division in Mesa, Ariz., says James Miele, manager of bipolar-memory product marketing.

Mosaic makes sense for faster and smaller bipolar memories, says Miele. It allows the larger packing densities that are achieved with Motorola's Macrocell ECL arrays, for which Mosaic was initially developed in the late 1970s. These arrays crowd 1,200 gate-equivalents onto a single chip.

This density cannot be achieved with established junction-isolated devices because of the isolating junction's diffusion during subsequent processing steps. Also, the larger the diffusion, the greater the parasitic capacitance. With Mosaic, an implanted oxide barrier (see figure) cleanly isolates devices from themselves and from resistor areas.

A transistor that is fabricated with Mosaic I, Motorola's first version, measures 1,169 square micrometers



Implanted oxide. The isolation oxide in Motorola's Mosaic process is implanted to form a well-defined steep-walled barrier. It takes up less room than the usual diffused junction isolation and has less parasitic capacitance. Base width, W_B, is only 1,000 Å.

AN OPEN LETTER TO: **DATA GENERAL, PRIME COMPUTER AND ROLM**

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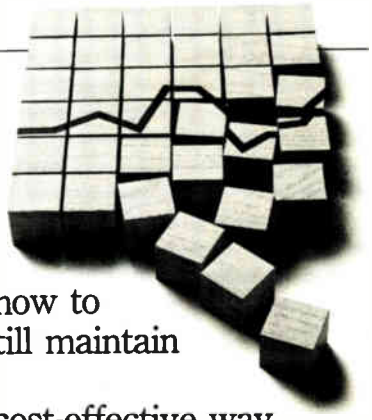

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compared with 2,040 μm^2 for the earlier junction-isolated approach. The ECL RAM parts are seeing a smaller version of Mosaic I, in which device area is reduced to 424 μm^2. Small size is critical, says Miele, since the chip must be small enough to fit the 300-mil-wide "skinny" dual in-line package fast coming on the scene.

Room to improve. Miele sees plenty of room for product improvements with Mosaic I. He cites as an example a 256-by-4-bit RAM with 10-ns performance. Still bigger gains will come, he says.

Mosaic II halves device size by changing to a walled emitter, reports Sal Mastroiani, the engineer responsible for developing the original process and now in charge of bipolar digital-process development. "We eliminated the ring around the emitter, so now the same size emitter fits in a smaller space and goes all the way to the isolation-oxide wall," he explains.

As a result, a factor-of-two reduction in speed-power product, with 250-picosecond gate speeds, is possible. The walled emitters will first appear in Motorola's upgraded Macrocell arrays, designated MCA II. Memories built with Mosaic II are at least several years away.

However, Mosaic III will come on the scene next year, notes Mastroiani. In Mosaic III, n^+ polysilicon emitters will be self-aligned to the p^+ polysilicon base contacts to cut device size in half again—to 222 μm^2—and reduce parasitic capacitance even further. **-Larry Waller**

Production

X-ray lithography gets new source

Researchers at almost all of the major semiconductor companies agree that when the limits of optical-lithography systems are reached—down around 0.75 micrometer—X rays and not electron beams will be the exposure system of choice. And though gas-plasma X-ray tubes and synchrotrons [*Electronics*, Jan. 27, p. 40] look promising for production systems five years from now, what is needed today is a reliable X-ray source.

Kevex Corp. of Scotts Valley, Calif., may have the answer. At a meeting of the Society of Photo-Optical Instrumentation Engineers in Santa Clara, Calif., last week, Kevex unveiled a new fixed-target X-ray tube designed for semiconductor wafer-exposure systems.

The source is the first one with a fixed target to be commercially available. Similar devices have been built by other companies but were designed for specific customers, says Brian Skillicorn, manager of Kevex's X-ray tube division.

Most X-ray tubes employ a rotating target to keep temperatures down—the electron beam is not concentrated on the one spot so the target does not burn up. However, some higher-power tubes require cooling. Either way, it is quite a trick to build a vacuum-tight seal around a rotating tube and, in fact, some companies use magnetic fluids for the seal—still trickier stuff.

Vibration. For precision lithography, the problem is that the rotation of the target causes vibration. In a mask-exposure system this, in turn, causes the output beam to jiggle, reducing resolution—and it is resolution that is the goal in the first place. Moreover, the jiggling can cause the wafer to move, producing misalignment.

A fixed target avoids these problems, but then runs into the difficulty of getting the power level up for sufficient beam brightness. This is where the Kevex design comes in, with its means of cooling the target so it will be able to yield sufficient output power.

Kevex has had the design in mind since 1973, when it patented the fixed-target source. Cooling is the key to tube life, vital for production X-ray sources. According to Skillicorn, "we've run our source at full power (4.5 kilowatts) for over 100 hours and at reduced power for 500 hours and have not seen any deterioration. The tube should be good for at least 1,000 hours."

In operation, a stream of electrons is focused on a 3-millimeter-diameter fixed target that is cooled by water. Very pure water is forced under high pressure onto the anode target. The pressure prevents a vapor barrier from forming so heat removal is rapid—on the order of tens of kilowatts per square centimeter.

20-kv water. The tube, which measures 4 inches in diameter by 11 in. high, is designed with the cathode—the case—at ground potential. This reduces overall size since the case need not be electrically isolated. As a result, the anode, and hence the cooling water, is at 20 kilovolts.

Skillicorn says that this high potential is no problem since the very pure, ion-free water is nonconducting and in a sealed system. The X-ray source will sell for about $148,000 with the power supply and the cooling system. X rays emerge from a 1.4-centimeter-diameter be-

Source. An X-ray tube measuring 11 in. high and 4 in. in diameter, has a sealed internal water-cooling system to keep its stationary target at a low enough temperature.

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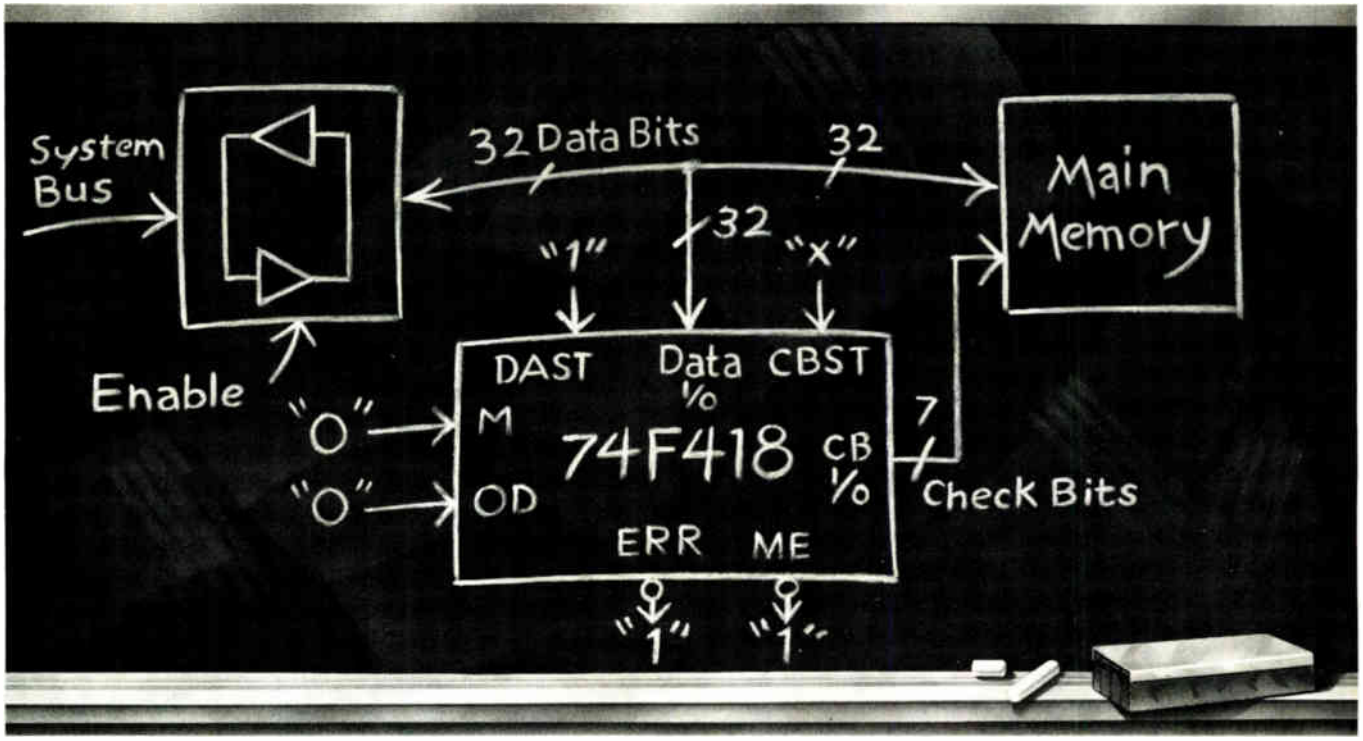

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ryllium window in a cone with an apex angle of 12°. "Different target materials are available so that the source can be matched to the X-ray–sensitive resist being used," Skillicorn adds. **-Stephen W. Fields**

Communications

Bell switch calls on internal fiber optics

Distributed processing for high-speed digital call handling moves to new levels in the Bell System's No. 5 electronic switching system. It combines sophisticated modular hardware and software design with the first use of fiber optics inside a switch for fast communication among internal processors.

By using varying numbers of 8086-controlled interface modules that handle up to 4,096 customer lines or 512 trunk lines each, American Telephone & Telegraph Co. plans to serve a wide range of office sizes with the switch architecture. Indeed, the phone giant is counting heavily on the switch's flexibility and cost-effectiveness to help it compete in the deregulated environment following divestiture of its local operating companies.

Shipments of the switch are planned to reach one a day by 1984, says Fred W. Wallitsch, general manager at Western Electric's northern Illinois works. The Lisle, Ill., facility built the first production No. 5 ESS, which was put into service late last month by Illinois Bell in Seneca, Ill.

Microcoded. The heart of the Bell switch is the 3B20 central processing unit, a 32-bit medium-scale integrated microcoded machine that is a big brother to Bell's Bellmac 32 microprocessor [*Electronics*, Oct. 6, 1981, p. 106]. Equipped with 6 to 7 megabytes of main memory, the 3B20 runs an operating system known as DMERT (for duplex multi-environment real time) that handles switch administrative functions like traffic counts and billing.

Call processing in the No. 5 ESS is handled by the interface modules—up to 30 a switch—that communicate with the 3B20 over fiber-optic links at rates of 32 megabits a second. This rate is twice the speed of Bell's next fastest switch and 16 times faster than most switches currently in use, says W. B. Smith, executive director for Bell Laboratories' Local Digital Switching division in Naperville, Ill.

Smith, project manager for the No. 5 ESS design, says the wide fiber-optic bandwidth is necessary for handling the 16-bit channels that will be required for the provision of future Bell services such as alarm and energy-management systems. These will require telemetry in addition to voice. Fiber optics also avoid the interference problems common to copper-wire or coaxial-cable transmission—requiring special error coding or other techniques.

Crosspoint. Contributing significantly to holding down costs in the switch is Bell's first use of a gated-diode crosspoint integrated circuit [*Electronics*, Jan. 31, 1980, p. 41]. The GDX circuits withstand the high voltages for telephone ringing and line testing. In the No. 5 ESS, these devices provide channel-to-line concentrations up to 8-to-1, thus reducing by that ratio the need for expensive circuitry to handle the so-called Borscht functions as well as codecs and filters, Smith notes.

Also employed for the first time is a special-purpose n-channel MOS microprocessor as a digital signal processor that contains 45,000 transistors and performs more than 1 million calculations per second. Thirty-two of them handle functions including tone detection and generation in the interface module.

As for distributed processing, "the concept is taken far further on the No. 5 ESS than in any previous system," Smith says. A measure of that is the fact that each 8086 used for interface module control has two megabytes of memory associated with it, compared with only 60,000 bytes for distributed processors used in previous switches.

In addition to the DMERT operating system, a second operating system known as OSDS (operating system for distributed processing) is also employed for high-capacity call processing. OSDS resides in each of the interface modules and is also in the 3B20. **-Wesley R. Iversen**

Business computers

Japanese company relies on U. S. design

A Japanese company is tackling the small-business computer market in the United States with an unusual division of responsibilities. Design and marketing is being handled in the U. S., and manufacturing is being done by the Japanese.

Starter. Model 680/10 single-user computer from CIE Systems starts at $8,700 with 128-K bytes of main memory.

The U. S. firm is CIE Systems Inc., Irvine, Calif., formed nearly three years ago with $7 million in capital by C. Itoh Ltd., a $53 billion trading company. Hitachi Ltd. will build the machines, aimed at original-equipment makers, in Japan. "The Japanese do not know how to market computers in the U. S.," states Mark Takeuchi president of both C. Itoh Inc. of New York and CIE. "We have combined American design ideas with Japanese mass-production expertise." CIE expects to sell, starting in June, about $4 million worth this year. Takeuchi is the only member of the top staff who is Japanese.

Wide range. CIE is now offering a family of systems, ranging from an IBM Personal Computer look-alike at

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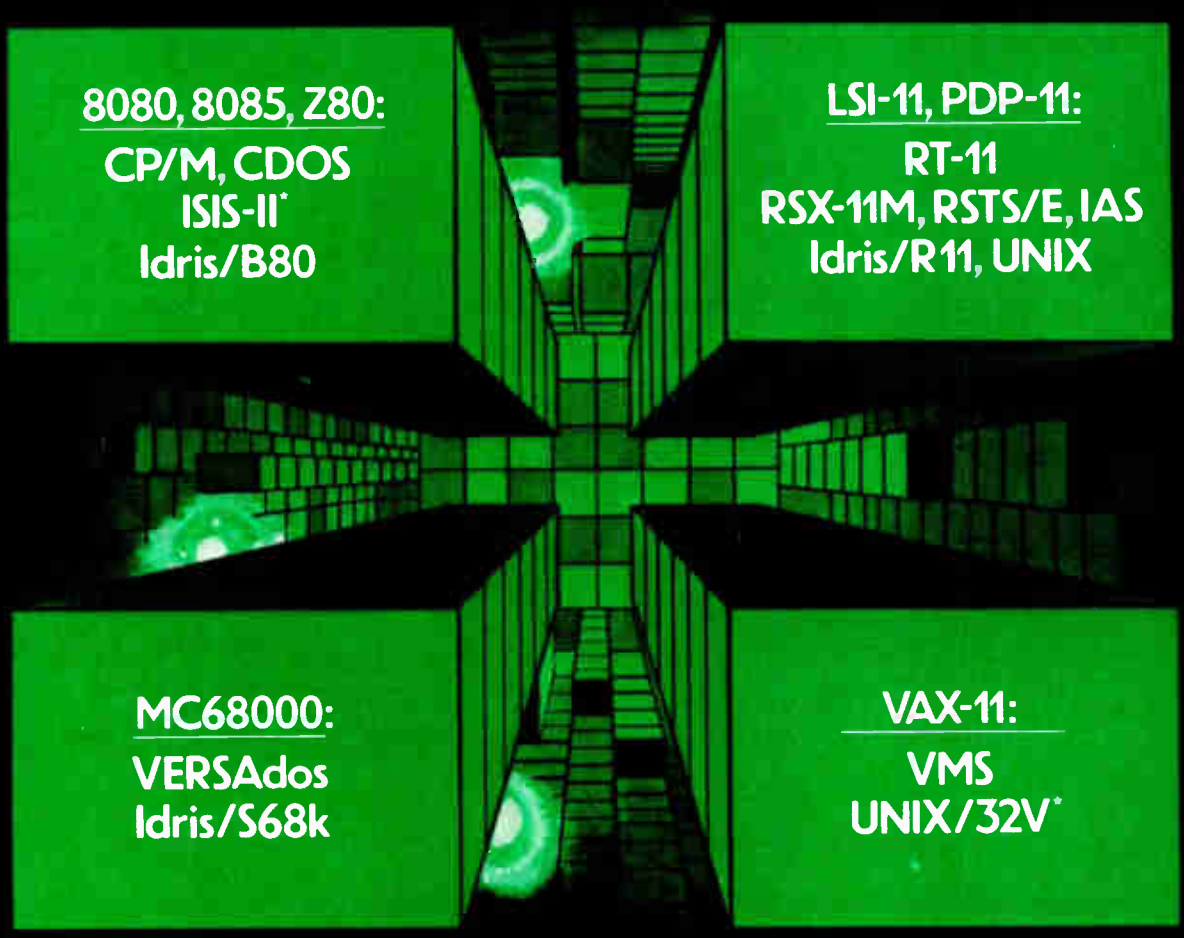

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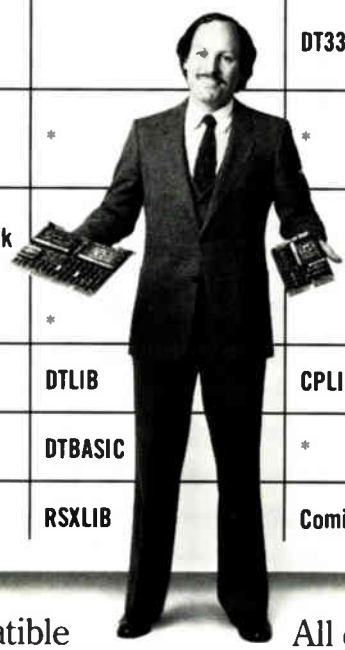

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Software compatibility consolidates the line

CIE Systems Inc. will maintain software compatibility across its line of small-business computers first of all by implementing the Pro IV applications generator on every member. Pro IV, from Data Technical Analysts Inc. of Honolulu, Hawaii [*Electronics*, April 7, 1981, p. 39], allows applications to be developed without writing actual programs. It uses a fully interactive application-definition phase to specify the sort of data that will be used, the format that data entry will take, and the format and calculations for producing reports from the data base. It uses only about 22-K bytes of main memory, keeping most of its routines on disk. In this way, applications can be developed fast and maintained easily. Any of the program steps may be edited to produce updates, and documentation is produced automatically.

To date, Pro IV has been available on General Automation Inc.'s minicomputers and Microdata Corp.'s 32-bit Sequel minicomputer. Capro Inc.'s 16-bit Dimension One system running MP/M will be introduced in June.

For those wishing to write their own programs, CIE will also offer Cobol, Fortran, Pascal, and Basic compilers, as well as a C compiler when Unix III is brought up later this year. All current software offerings run under the Versados operating system.

Also CP/M-68K—being developed by Digital Research for Hitachi Ltd. [*Electronics*, March 24, p. 117]—will be implemented on the 68000-based machines. Thus programs written in Digital Research's high-level languages can be run on the CIE computers either under CP/M-86 in the case of the IBM Personal Computer look-alike or under CP/M-68K with the rest. **-R. C. J.**

the low end to a 16-user system at the high end. This look-alike, the only system not designed by CIE, is being introduced by Hitachi at the National Computer Conference in June and will be compatible with the IBM unit right down to its 5.25-inch disk format.

Other members of the CIE line are the 680/10—a single-user system with an integral terminal, 128-K bytes of main memory, and a 5.25-in. Winchester-technology disk drive with floppy-disk backup; the 680/20—a four-user version; and the 680/40—a 16-user system that is housed separately from its terminals and has up to 768-K bytes of memory and a 20-megabyte Winchester with a 90-in./second streaming drive for backup.

All of the CIE line, except the IBM look-alike, are based on Motorola's 16-bit 68000 processor. CIE will maintain compatibility among its offerings with an automatic program generator called Pro IV as its primarily business software tool. Programs developed under it can be run on any of the machines (see "Software compatibility consolidates the line," above).

The hardware will be compatible too. All boards use Intel's Multibus for easy expandibility with products from other vendors. Also, no board is specific to any one machine—the more powerful computers just use additional boards, not different ones. For instance, the video electronics on the 680/10 and 680/20 are the same as that used in Itoh's VT-100 terminal emulator, the CIT 90.

CIE's prices position the line against systems being offered by Wicat, Convergent Technologies, and others. The single-user 680/10 starts at $8,700, and the Pro IV applications generator will vary in price from $900 to $4,400, depending on configuration. The 680/20 four-user system with 256-K bytes of memory is $9,300. **-R. Colin Johnson**

Instruments

Work station unites design, service

For the first time, product designers can easily link tools into a cradle-to-grave support system for microprocessor-based products. They can do it with a work station that can

change itself from a hardware into a software development station or logic analyzer or microprocessor emulator, depending on which plug-in cards are used.

The 55-pound work station was introduced this month by Hewlett-Packard Co.'s Colorado Springs (Colo.) division. Designated the 64110A, it can be linked via telephone lines to a remote 64000 software development network introduced by HP in 1979. Thus people fixing faults in the field can pull test routines directly from the design data base without custom hook-ups, a capability not seen before and one that eliminates rewriting of test programs for field test.

Until now, software and hardware design, production needs, and service problems in the field have been separate. For example, a software designer would work on a development system while the hardware designer used a logic analyzer. Now the units can be used together easily, asserts John Marshall, product marketing manager for development systems.

Production tools usually consist of timing analyzers and stand-alone emulators, while important field tools are signature analyzers and, more rarely because of their sophistication, logic analyzers. Thus, data could not be readily shared among these groups. "Now," says Marshall, "the whole engineering process can be approached in a unified manner."

What allows that systematic approach is the fact that the transportable 64110A and the other, larger stations of the 64000 system can all be configured for any of these functions with the same cards—say, existing emulator cards or the new logic analyzer cards. Thus a hardware designer in plant can build and test a system, using maybe an eight-channel logic timing card, and store his findings in a remote data base. At a later date, the field-service technician can compare design to field data using an identical card.

Silver lining. But the cost of this integrated support comes high. A stand-alone eight-channel logic analyzer will sell for $23,150, more than any competitor's price and double some. And as both hardware and software analyzer, the box could cost about $55,000, more than triple Tektronix' card-configurable analyzer, the stand-alone DAS 9100.

But Hewlet-Packard is not really aiming at the market for stand-alone systems, according to Marshall. Rather, it is after companies with far-flung design, production, and service organizations that would appreciate the savings due to using everyone's work more efficiently, he says. "It's mainly the large, high-technology companies that can equate price with benefit."

For example, he points to the savings gained by using remote analysis instead of sending an expert from home to the field site. He also points out that a company might find it sufficient just to insert plug-in cards into the product, rather than use a 64110A work station whose base price is $13,000 for processor, display, and keyboard.

Applications. The cards are designed for two different applications—software and hardware analysis—and differ primarily in sampling rate and number of channels. The faster cards, for hardware timing analysis, consist of two eight-channel cards run by one control card. They work at 200 megahertz or, using half the channels on each card, up to 400 MHz.

Of equal importance are the software analysis cards. Data can be sampled on up to 120 channels at 20 MHz and, for up to 60 channels, there is a special overview mode.

The overview mode helps to optimize software and fix it faster by making it easier to see what the software is doing. For example, in this mode the designer can display captured data as a bar graph.

This easy-to-read graph can show which routines were used most frequently and which took the longest to run—in other words, it presents a performance profile. Then programs can be modified to make them faster. "We have shown the new system to some potential customers," Marshall reports, "and have found that profiling can improve efficiency by 10 to 1." **-Richard W. Comerford**

Legislation

Congress pushes to help industry

Congress is readying legislation to aid the U. S. electronics industries in their fight to survive Japanese semiconductor imports and to help in training technicians for industry.

Rep. Don Edwards, chairman of the California Democrat delegation, says his bill, H. R. 5579, seeks fair trade and open markets for U. S. semiconductors—40% of which were made in California in 1981. Countries invoking barriers of any type would be subject to various punitive measures at the discretion of the President. The bill is dubbed "the SIA bill" after its industrial sponsor, the Semiconductor Industry Association. Prospects for passage are considered chancy.

Possibles. The "EIA bill" to protect Government-approved joint research and development ventures from civil antitrust suits may have a better chance [*Electronics*, March 10, p. 66]. Also in this category is H. R. 5573, called "the Apple bill" after the Cupertino, Calif., small-computer maker that proposed it to Rep. Fortney H. "Pete" Stark Jr. (D., Calif.). It would boost tax deductions on corporate charitable gifts to 30% of gross earnings from the present 10% [*Electronics*, March 24, p. 34].

Then there is Rep. George Miller's (D., Calif.) H. R. 5820, a bill to stimulate the training of technicians with increasing Federal funds contingent upon money also coming from each state and its industry. Miller's bill faces problems, too, in that it deals with a narrow, though important, special interest.

Miller's mouthful—the Electronic and Computer Technician Vocational Education Incentives Act—would require states to contribute an initial 2% of existing vocational education grants, rising to 6% in two years. Beneficiary companies in each state would have to contribute 25% of the funds. **-Ray Connolly**

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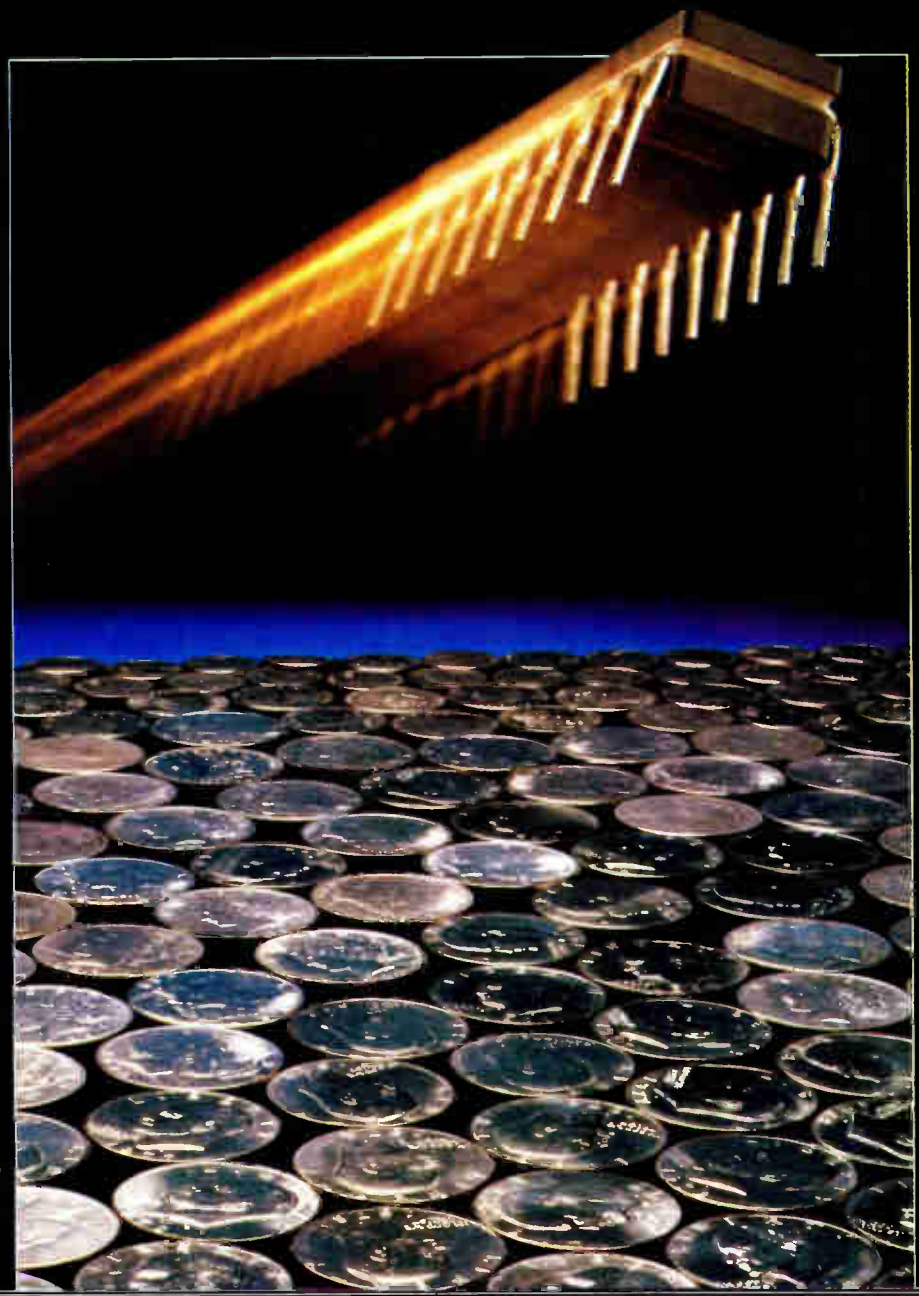

Special Report: Get the full range of low power μP products from National

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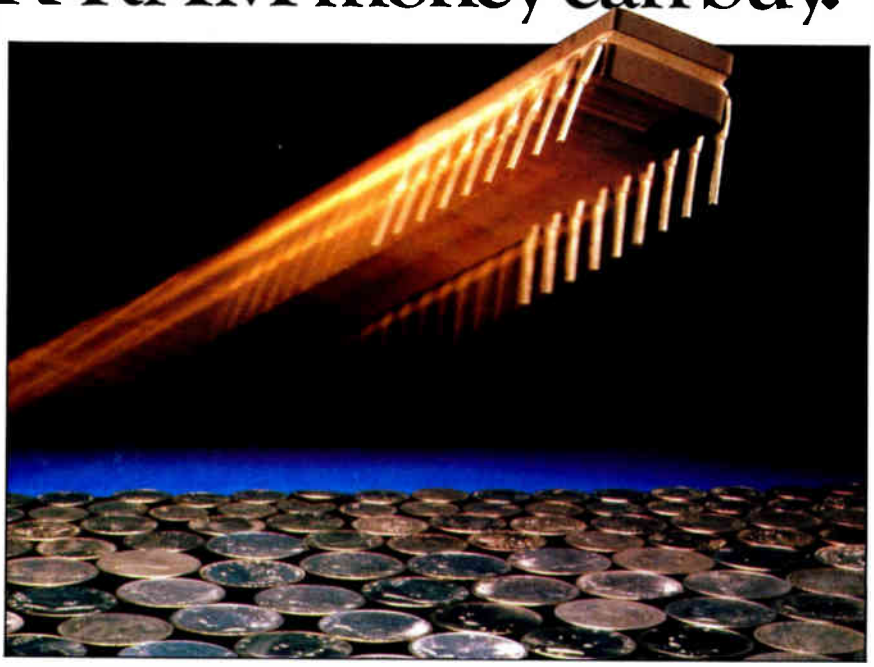
The Practical Wizard's standard DM10470 offers higher speeds (25 ns max.) and lower power supply current (200 mA max.) competitive with any other 4K ECL RAM available. This, combined with its inherently better quality and reliability, makes the DM10470 the most cost-effective device in its class.



Special high performance versions. The DM10470A is absolutely the fastest RAM that money can buy. It offers a maximum address access time of 15 ns, while consuming only 200 mA.

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The Practical Wizards are proud to introduce a new family of high speed, low power, CMOS logic chips: the MM74HC family.

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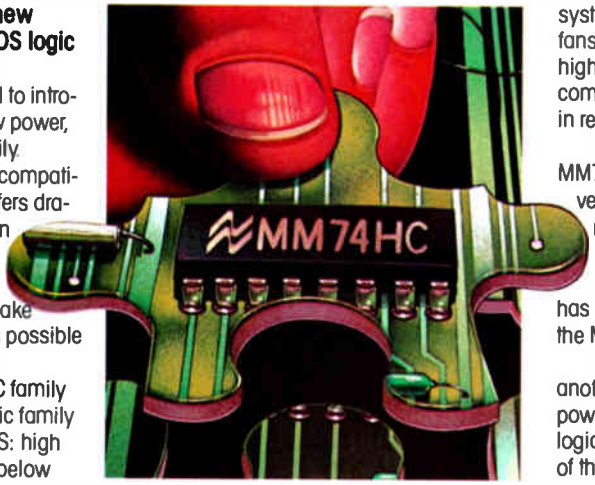

than conventional CMOS. A modification of this advanced process, optimized for producing high volume logic devices, is used to produce the MM74HC family.

Translated into system benefits, those features mean: less expensive and smaller system power supplies, the elimination of fans, heat sinks, and cooling systems, higher density/lower cost PC boards, more compact systems, and a substantial increase in reliability.

Ideal for military service. Of course, the MM74HC will be available in full mil-spec versions (MM54HC) and with National's rigorously controlled A+ and B+ processing.

All versions feature the high quality that has made National one of the top suppliers to the Mil/Aero market.

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It's a revolution in filters that greatly simplifies the design of all filter applications. At a cost that most conventional filters will find hard to match.

Clock-tuning simplifies frequency adjustments. All other active filters must have their center frequencies tuned with external resistors and capacitors, a lengthy and delicate procedure which must be performed in assembly and during replacement or repair.

The MF10 eliminates this headache with a unique design concept that sets the center frequencies of various second-order functions directly proportional to an external clock frequency within an accuracy of 0.6%.

This design minimizes frequency tuning, since the complicated resistor/capacitor interrelationship is eliminated. Once the clock frequency is set, no further tuning is needed. Gain and filter selectivity (Q) are determined with external resistors.

Improved frequency stability. The MF10 has unprecedented frequency stability. Since the only necessary external components are the clock and three to four resistors (depending on the application), the MF10 is far less sensitive to external component variation than conventional filters. So the need for costly retuning is all but eliminated.

The stability and repeatability of the center filter frequency in the MF10 is directly dependent on the quality of the clock. In addition, the design allows one clock to drive an unlimited number of cascaded MF10s.

A filter for all applications. Most monolithic filters are single purpose. The MF10 is general purpose, capable of performing a wide variety of functions: allpass, lowpass, highpass, bandpass, and notch up to 20kHz with a Q as high as 500.

Typically, the lowpass and bandpass outputs can sink .75mA and source 3mA. Other functions can sink 1.5mA and source 3mA.

Built into the MF10 are two independent filters. Both are second-order building blocks which can perform all classical filter functions. Functions up to fourth-order and filter configurations such as Butterworth, Bessel, Cauer, and Chebyshev can be performed easily by cascading the two second-order building blocks.

Low cost, immediate availability. The MF10 is not only a breakthrough in circuit design, but also a breakthrough in cost. There is simply nothing on the market today that can match it for price and performance. The filter is available in a 20-pin (.3" wide) plastic package at a cost of $3.70* in quantities of 100 and up. Delivery is from stock, so waiting time is next to nothing.

For more information on National's filter breakthrough, check box B9 on this issue's coupon.

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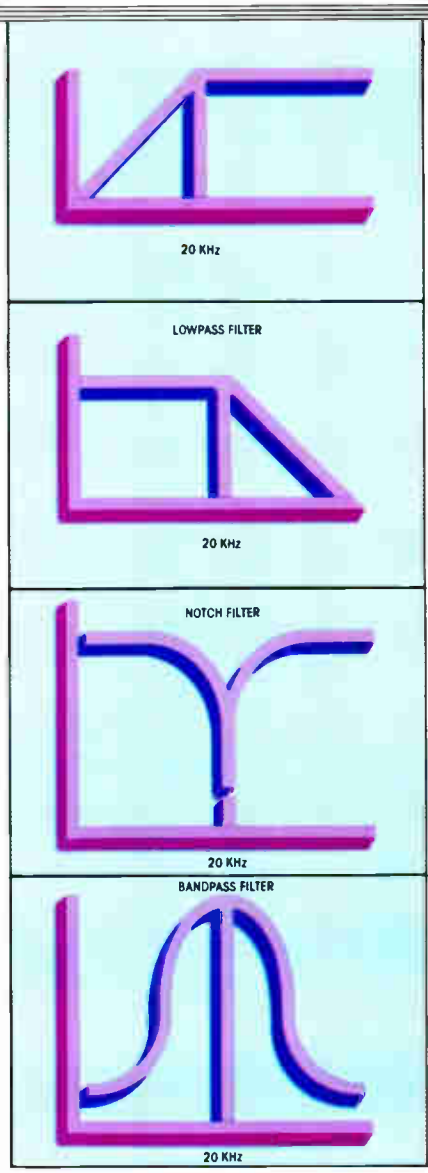


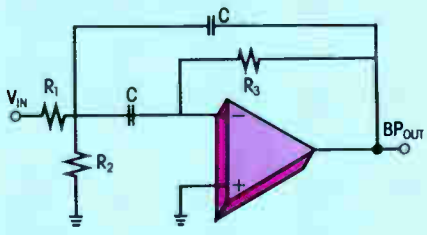
With the MF10, only 3 or 4 resistors and a clock are required to build filters with a frequency response of up to 20kHz. The characteristic frequencies shown above can be programmed by varying the clock frequency and/or by varying an external resistor.

Active filter design made easy.

Designing a simple bandpass filter with the new, monolithic MF10 is far easier than the conventional discrete R, C design.

Compare the complicated interrelation of R and C values in the discrete design with the simplicity of the calculations for Q, bandpass gain, and center frequency using one-half of the MF10.

DISCRETE R, C, ACTIVE BP FILTER

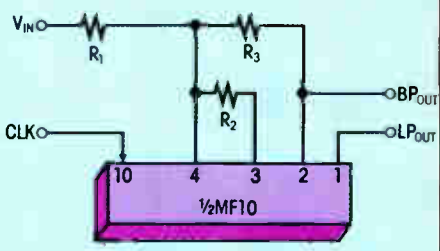


$$R_1 = \frac{Q}{H_{0_{BP}}\omega_0 C}$$

$$R_2 = \frac{Q}{\omega_0 C(2Q^2 - H_{0_{BP}})}$$

$$R_3 = \frac{2Q}{\omega_0 C}$$

MONOLITHIC MF10 ACTIVE BP FILTER



$$\frac{R_3}{R_2} = Q$$

$$f_0 = \frac{\omega_0}{2\pi} = \frac{f_{CLK}}{100} \text{ or } \frac{f_{CLK}}{50}$$

$$\frac{R_3}{R_1} = H_{0_{BP}} \text{(bandpass gain)}$$

SPECIAL REPORT

Putting high performance, low power

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Now a single source can solve virtually any low power system design problem with a complete spectrum of processing capabilities.

National's CMOS line extends from efficient 4-bit COPS™ microcontrollers all the way to high performance board level systems. Highlighting their line of powerful CMOS processors are the NSC800™ and the NS80CX48.

These new P²CMOS™ processors not only greatly reduce power consumption in existing systems, but can also be used to develop new ultra-low power designs.

So now it's no longer necessary to choose between the advantages of CMOS and the performance of NMOS.

NS80CX48: extra features at no extra cost. Using their field-proven P²CMOS process, the NS80CX48 features the same speed of the industry standard 8048 Series, but consumes a mere fraction of the power.

National offers both the standard NS80C48, plus the NS80CX48. The "X" represents an "Extra Features" register that allows—among other things—software control of its power consumption. And the price for the "X" version is the same as for the NS80C48.

NSC800: the most powerful CMOS μP available. The popular NSC800 combines the multiplexed address/data bus of the 8085 with the sophisticated register structure and instruction set of the Z80.® Yet the NSC800 typically dissipates only 50mW operating at 5V at a 2.5MHz clock speed.

Watch for announcements of the new NSC800A version, which offers 4MHz Z80A computing speed with CMOS power.

Complete the design with the NSC810 RAM-I/O-Timer and the NSC830 ROM-I/O. These two ciruits are packed with just the right amount of data and program storage memory, programmable input/output interface lines and versatile timers to complete an efficient minimum system or the heart of a larger system.

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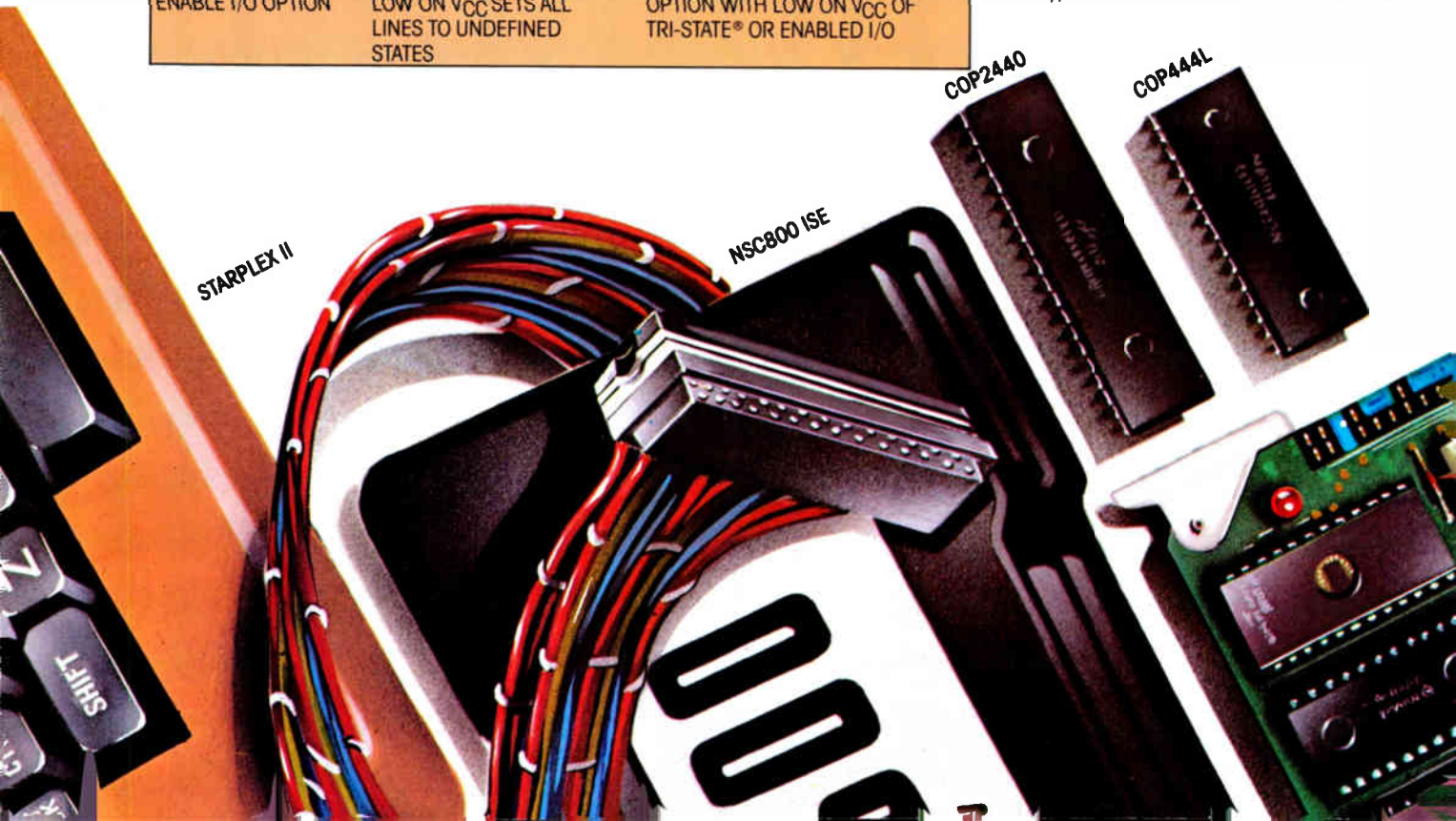
NS80CX48 EXTRA FEATURES COMPARISON

	STANDARD 8048	NEW NS80CX48
PRESCALE VALUE	32	PRESCALE VALUES: 5, 10, 20, 40, 80, 100, 160, 200
MODULO OPTION	MUST USE MOVT, A TO LOAD EACH TIME	AUTOMATICALLY LOADS SAME VALUE AT ROLL-OVER
GATE OPTION	N/A	GATES PRESCALER OUTPUT TO TIMER/CRT REGISTER INPUT
CONTINUE OPTION	LOW ON V_{CC} STOPS OSC, RESETS CPU	OPTION WITH LOW ON V_{CC} OF RUN OR IDLE
ENABLE I/O OPTION	LOW ON V_{CC} SETS ALL LINES TO UNDEFINED STATES	OPTION WITH LOW ON V_{CC} OF TRI-STATE® OR ENABLED I/O

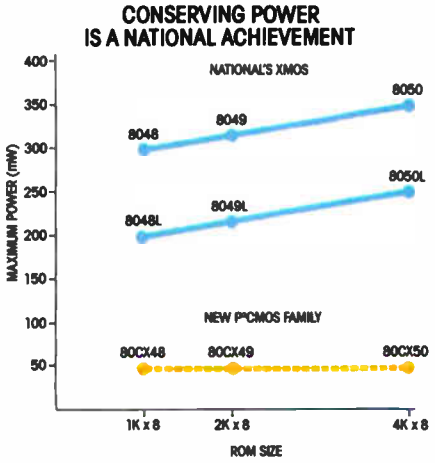
A complete board level system for less than 5 watts.

The Practical Wizards have also designed a board line around their low power standard NSC800 P²CMOS microprocessor. So now the board level market can enjoy all the advantages of low power, high performance technology.

The Series/800™ CMOS Industrial Microcomputer (CIM™) boards use so little power that a fairly large system can be configured to draw less than 5 watts. Compare that to a typical NMOS CPU board which alone can



processing to work.



National's P²CMOS NS80CX48 family draws only 10mA max at full 6MHz operating speed. Watch for announcements of the P²CMOS NS80CX49 and NS80CX50 with larger memory on board.

draw 15-30 watts.

The new boards offer all the inherent benefits of low power dissipation—higher reliability, portability, battery operation, sealed enclosures, smaller systems, and lower system costs—with speed that can handle the most demanding industrial applications.

A complete performance family. There are 19 Series/800 products, a complete family for all system needs (with still more on the way).

The family already includes three CPUs, memory expansion boards, discrete I/O interfaces, A/D and D/A boards, card cages, a voltage regulator, a battery charger, a firmware monitor, plus extender and prototyping boards. The BLMX-80 real-time multitasking operating system is also available.

Built for the harsh environment. Series/800 boards are designed to thrive in environments that conventional boards can't take. Ambient operating temperatures can be as low as −40° C or as high as +85°C.

Smaller systems, higher reliability, lower costs. The series also offers the smallest form factor around— 3.9" x 6.3" (100mm x 160mm). That's 69% smaller than Multibus™ and 15% smaller than Std. Bus. So many systems can be made smaller and for less total system cost.

Every Series/800 board comes with a 12-month warranty and the built-in reliability that goes into every National product.

Complete development support, prototyping, evaluation, and documentation.

STARPLEX II™, National's highly interactive development system, supports and speeds the overall development effort for both the 8048 and NSC800 families of μPs. With real-time In-System Emulation (ISE™), engineers can develop, test, analyze and debug prototype software and hardware with ease. In fact, National offers the only 11 MHz emulator for the 8048.

Aside from real time In-System Emulation, the upgraded STARPLEX II offers high level languages, including PL/M, PASCAL, BASIC, and FORTRAN. Cross-assemblers are already available for all supported products, and other system enhancements are on the way.

National's NS87P50 (for up to 4K emulation) and their new CMOS NS87PC48 "piggyback" μPs greatly simplify design prototyping.

NSC800 evaluation made easy. Immediate evaluation of the NSC800 family of products is made easy and inexpensive with NSC888 Evalulation Board. The fully assembled board includes the NSC800 CPU plus memory, timers, I/O, wire-wrap area, an RS232 interface plus complete documentation. An on-board monitor provides the necessary tools to write, modify, and execute NSC800 programs.

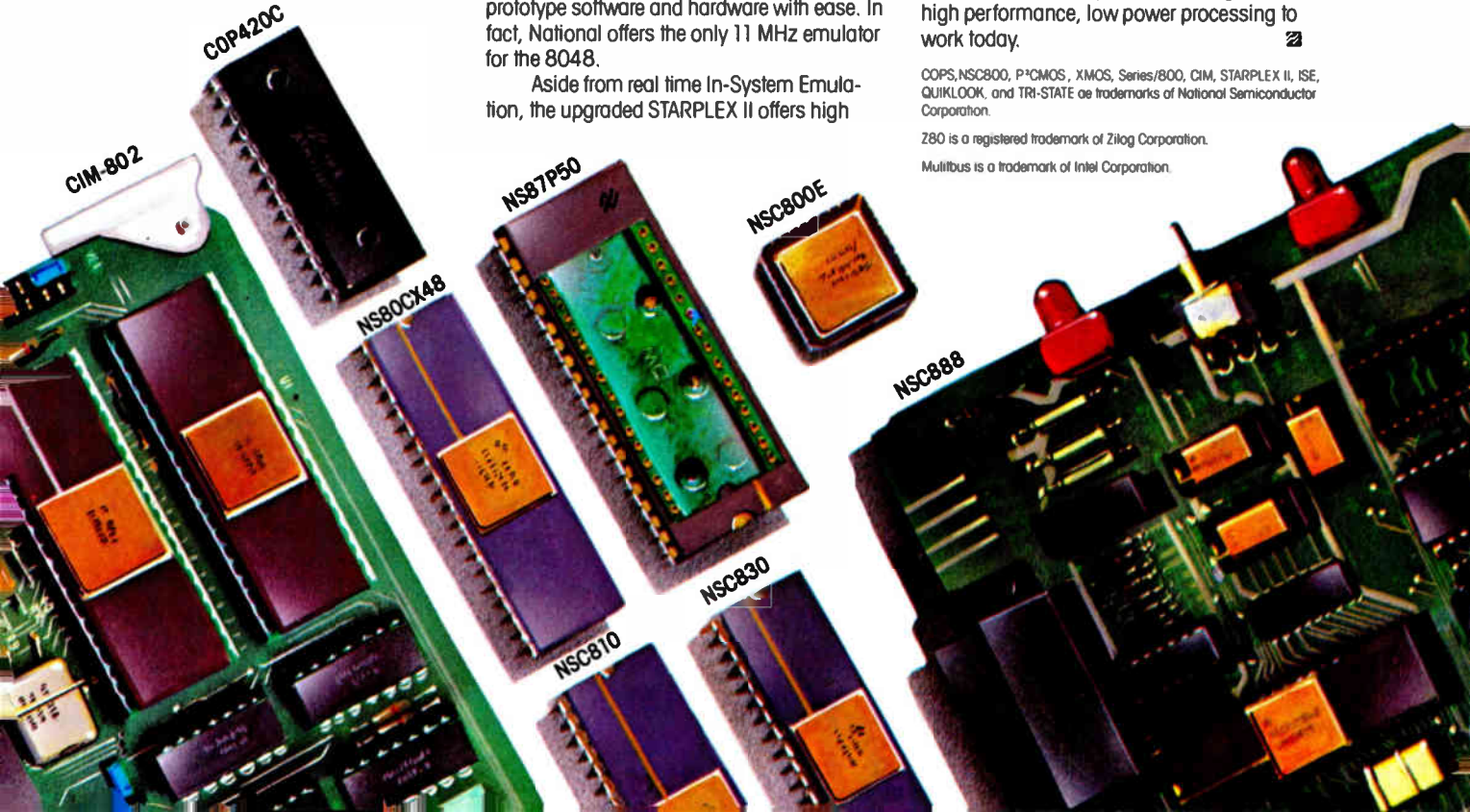
COPS microcontroller development products. The COP400-PDS is a low-cost concept-to-product tool designed to expedite every phase of COPS microcontroller system design.

National's STARPLEX system also provides the same capability when equipped with the COPS ISE.

The COPS QUIKLOOK™ tester is a simple and cost-effective way to perform incoming GO/NO GO inspection of COPS family devices.

How to get all the details. To receive all the specifics on National's high performance CMOS microprocessors and board level systems and their powerful development tools, simply check box D2 on this issue's National Archives coupon.

It's the best way to start putting high performance, low power processing to work today.



NATIONAL ANTHEM

The first full spec low power op amps.

The linear leader strikes again with the first true BI-FET™ op amps for low power designs.

National continues to set new industry standards in op amps.

This time, it's their LF441 family of low power op amps. These devices offer the same AC characteristics of the industry's currently available low power BI-FET™ op amps, but also provide vastly improved DC characteristics (see the Data Comparison Table below).

Higher performance for the same price. The LF441 family—which includes the LF441 single, LF442 dual, and LF444 quad op amps—provides very distinct performance advantages over the current low power industry standards. Advantages one would expect of a true BI-FET op amp. Consider:

- low input offset voltage—0.5mV max.
- low input offset voltage drift—10μV/°C max.
- high gain (V_O = ±10V, R_L = 10k)—25k min.
- supply current—150μA (typ) per amp.

Yet despite these and other significant enhancements, National's LF441 family costs no more than the pin-compatible parts they now obsolete.

In quantities of 100 and up, the LF441 is now available for only $.55*, the LF442 for $.90*, and LF444 for $1.55*.

The BI-FET lineage marches on. This new family of products is a further extension of National's powerful LF4XX line of BI-FET op amps.

Other recent additions, the LF411 and LF412 (also pin-compatible with the LM741 and LM1458, respectively), are ideally suited for designs requiring superior performance specs.

Leave it to the Linear Leader to come up with unbeatable price/performance in low power BI-FET op amps. All others pale by comparison.

For complete information on the LF441 family and National's entire line of BI-FET op amps, check boxes 53 and A8 on this issue's coupon.

LOW POWER BI-FET OP AMP DATA COMPARISON TABLE

SPEC	NEW LF441 OP AMPS	COMPETITOR'S OP AMPS	UNITS
SUPPLY CURRENT	250 (max)	250	μA
INPUT BIAS CURRENT	100 (max)	200	pA
INPUT OFFSET VOLTAGE	5 (max)	15	mV
INPUT OFFSET VOLTAGE DRIFT	10	10	μV/°C
GAIN (V_O = ±10V, R_L = 10k)	25 (min)	3 (min)	V/mV
NOISE VOLTAGE	40	42	nV/$\sqrt{Hz}$

*U.S. prices only

BI-FET is a trademark of National Semiconductor Corporation.

The BI-FET lineage.

In 1975, the linear leaders at National made significant strides forward when they first introduced BI-FET technology. Because the op amps that resulted were the first monolithic op amps that combined low input bias current and high impedance with high speed.

This winning combination was further reinforced with each new BI-FET product introduction. The LF355, LF356 and the LF357.

Then, in 1978, these same Practical Wizards pioneered an extension of their field-proven technology: BI-FET II. The enhancements incorporated into BI-FET II include faster FETs and trimming of the input offset voltage of each amp.

The results of these efforts, beginning with the LF351 and LF353 and epitomized by the LF411 and LF412 op amps, show up in higher performance at a lower cost.

And now they've taken the same technology one step further to produce the only full performance, low power BI-FET op amp series—the LF441 (single), LF442 (dual), and LF444 (quad).

This is exactly the kind of practical innovation that has maintained National's linear leadership for over ten years.

Cost-saving replacements for 2910 and 5116 codecs.

National's new line of improved codecs are directly interchangeable with four industry standard parts. They also introduce a next codec that the telecom industry has been waiting for.

National's leadership in high performance low power technology is answering several critical needs of the telecommunications industry.

In particular, they have now introduced a family of five new codecs for Central Office and PBX switching systems.

Cost reductions and transparent improvements over industry standards. Four of these devices represent pin- and function-compatible replacements for industry standard codecs, but with some very important improvements.

National's TP3020 and TP3021 codecs plug directly into Intel's μ and A Law sockets yet require considerably less power.

So, in addition to reducing system operating costs, these new codecs cut battery back-up costs way down. They also eliminate the need for external +12V supply, sample and hold, and auto-zero components on future board designs.

The TP5116A and TP5156A devices replace Mostek's μ and A Law codecs, yet also provide on-chip precision voltage references. As with the TP3020/21, there are no internal connections to these pins. So the external components create no problem for direct codec interchangeability and can be eliminated for cost reduction on future designs.

CODEC EQUIVALENCY CHART

NATIONAL PART NUMBER	STANDARD	INDUSTRY EQUIVALENT	TRANSPARENT ADVANTAGES
TP3020	μLAW	Intel 2910	LOWER POWER & FEWER EXTERNAL COMPONENTS
TP3021	A LAW	Intel 2911	LOWER POWER & FEWER EXTERNAL COMPONENTS
TP5116A	μ LAW	MOSTEK 5116	ON CHIP REFERENCE
TP5156A	A LAW	MOSTEK 5156	ON CHIP REFERENCE
TP5117A	μ LAW	VARIATION OF MOSTEK 5116	D3 COMPATIBLE

D3 compatibility allows design simplicity. The fifth member of National's new codec family is the TP5117A. By including an on-chip inverter on the TP5116A, this adds a D3 compatible member to National's new family of codecs.

What this means to board manufacturers is that now they can produce common board designs for both μ Law and A Law systems.

The potential savings from this development alone are significant. All thanks to a little Practical Wizardry.

The P²CMOS™ advantage. All five of these new codecs take full advantage of National's exclusive low power, double-poly silicon-gate P²CMOS technology. It's the reason they manage to operate efficiently on a mere 50 mW (typical) and 1mW (standby).

National, always committed to the systems approach, previously introduced a low power P²CMOS PCM filter—the TP3040.

As a natural complement to any of their new codecs, the TP3040 is a breakthrough in performance over the industry standard 2912 and 2912A filters. It demonstrates significant performance advantages in lower power noise, crosstalk and frequency rejection, leaving the competition far behind.

Coming soon: a low power codec/filter combo. The next step is to combine their high performance P²CMOS filter and codec onto a single chip—the combo. This sets the standard for advanced line card designs and further cost reductions on existing systems.

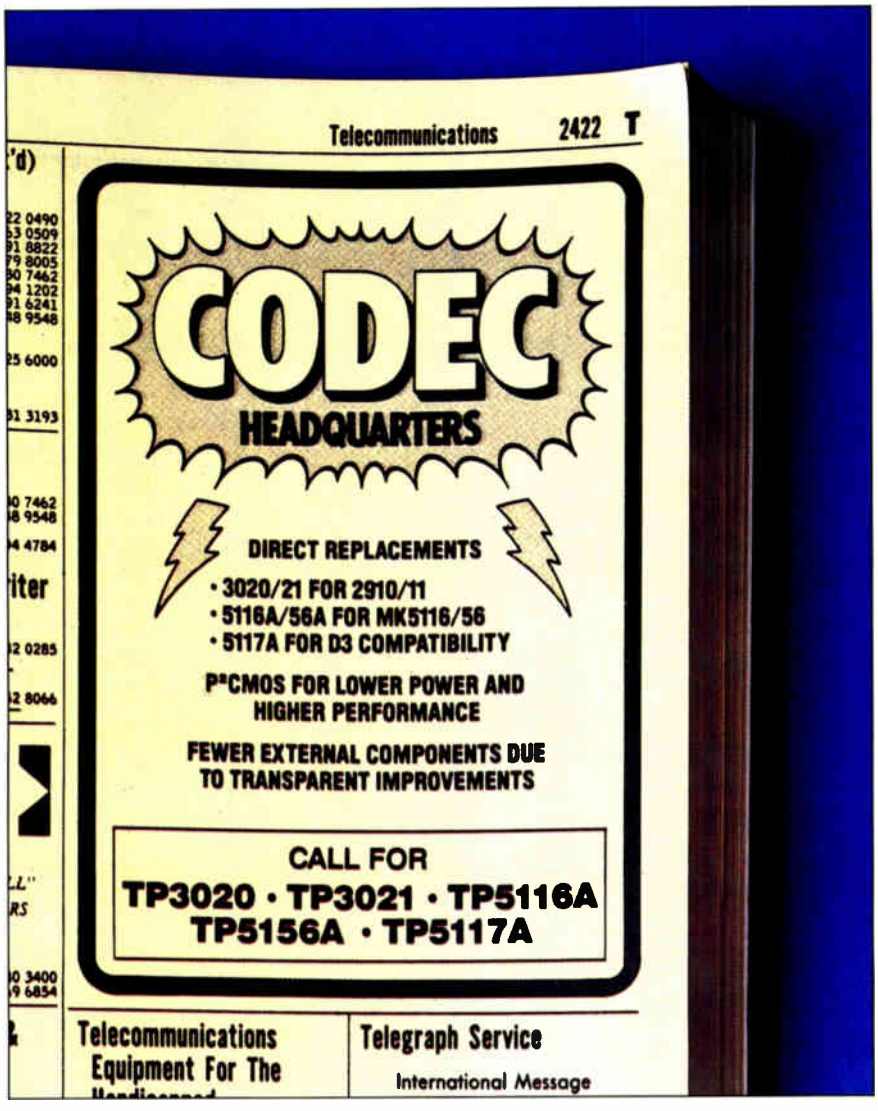
Telecom's most versatile family. So now there's a single source where engineers can satisfy their PCM codec and filter needs.

Whether it's a low power alternative for the industry standard approaches to codec applications, the convenience of an internal precision reference, the technical superiority of an on-board inverter, or even a high performance PCM filter, National is the telecom supply center.

To get more information on these new low cost power misers, just check box D3 on this Anthem's coupon.

They're quickly becoming the talk of the industry.

P²CMOS is a trademark of National Semiconductor Corporation



LP311 comparator leads low power push.

The Linear Leaders redesigned the popular LM311 and reduced the power drain by a factor of 30.

National Semiconductor, the long-time leader in linear circuit design, has launched a major effort toward the number one spot in low power linear IC design.

To accomplish this goal, National is redesigning many industry standard devices to produce pin-compatible replacements that will require considerably less power. At the same time, they intend to maintain as many of the original high performance features as possible.

This effort, in combination with recent and continued introductions of low power devices, will afford engineers the alternatives needed for today's power conscious designs.

30:1 reduction in power drain. The first of this new generation of linear IC's is a redesign of the LM311 voltage comparator.

Designated the LP311, this new comparator consumes 30 times less power than its predecessor—a scant 900 μW on a $\pm$5V supply.

The LP311 operates over a wide supply voltage range (from 36V down to a single 3V supply). Although it operates with less than 200μA supply current, it's still capable of driving a 25 mA load.

Only a 6:1 reduction in response time. Other than power consumption, the only change in overall device performance is a 6:1 reduction in response time. The LP311's typical response time is 1.2 μsec.

It is therefore ideal for battery-powered systems and use in opto coupler output comparators where a slight reduction in response time is tolerable.

For complete details on the LP311, check box D4 on the coupon below.

Low power linear from National. The technology of efficiency.

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B9 ☐ MF10 Data Sheet
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NA 40

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Washington newsletter

FCC insiders fear AT&T could dominate world digital net

Standards for and access to the new worldwide telecommunications system known as the Integrated Services Digital Network may be controlled by default by American Telephone & Telegraph Co., say some fearful Federal Communications Commission staff members. AT&T played the dominant U. S. role at a February meeting in Munich of the International Telecommunications Union on the issue, contend FCC insiders, simply because U. S. terminal equipment makers and potential ISDN users did not know that the meeting was scheduled. **An open follow-up session on the U. S. ISDN position is set for April 14** in Room 1105 of the State Department, where a study group will lay out plans for standards adoption on an accelerated basis by the ITU's Consultative Committee on International Telegraph and Telephone Programs. The State Department says attendance at the meeting will be limited to persons notifying its International Communications Policy office by telephone not later than April 13.

Panel to study relationship between research, security . . .

Very high-speed integrated circuits, artificial intelligence, cryptology using computers, magnetic-bubble memories, and lasers are the leading candidates for selection as the two or three technologies to be examined in a year-long study of the relationship between unclassified academic research and national security. The study by an 18-member panel of leading U. S. engineers and scientists from industry, universities, and Government **"will focus on how the Government seeks to control the transfer of knowledge and information** with potential military applications," according to National Academy of Sciences president Frank Press.

. . . six on panel have electronics ties

Dale Corson, president emeritus of Cornell University and a physicist, will head the panel, which expects to issue an unclassified report by March 1983. A first progress report is due by September. **Leaders in electronics on the panel include:** Varian Associates president Edward Ginzton; Massachusetts Institute of Technology president emeritus James R. Killian; Itek Corp. chairman Franklin Lindsay; Wolfgang Panofsky, director of the Stanford Linear Accelerator Center; William J. Perry of San Francisco–based consultant Hambrecht & Quist and former undersecretary of defense; and Gen. Samuel C. Phillips (ret.), vice president of TRW Inc.'s Energy Products Group.

Japan's barriers hike U. S. trade deficit, Baldrige tells EIA

The inaccessibility of Japan's telecommunications market held 1981 U. S equipment sales there to $29 million while imports from Japan climbed to $700 million, says Secretary of Commerce Malcolm Baldrige. Not only are there "high tariffs for use of Japanese telecommunications channels, which bar U. S suppliers of data-processing services," says Baldrige, **but Japan is considering "a proposal to license data processors that could exclude U. S. exporters of processing services."** The Commerce Secretary's critique was delivered at the end of March to the Electronic Industries Association's spring conference in the capital. U. S. fiber optics also are barred from the Japanese market, says Baldrige, adding that he "could paper the walls with other examples." U. S exports of all types to Japan could rise by $12 billion to $14 billion annually, according to Baldrige, "if Japanese markets were as open as ours."

Washington commentary

No more Zeroes for Japan

There is a bizarre incongruity between the race among legislators on Capitol Hill to see who can do the most the fastest to help American manufacturers beleaguered by Japanese imports, on the one hand, and the separate actions of the Pentagon and the Boeing Co., on the other, to build up Japan's infant aircraft industry by the transfer of more U. S. high technology.

That mismatch of actions can be rationalized, however, by anyone who can utter the magic phrase "short term, long term." The first half of the expression explains the attitude of most of corporate America; the latter half represents the Japanese approach. During the 1960s, American electronics manufacturers scrambling to make as many bucks as quickly as possible licensed some of their best technology to their Japanese counterparts.

The results are well-documented: it took the U. S. consumer electronics industry roughly a decade to roll over and die under the onslaught from Japan. Now Congress is scurrying to prevent a recurrence of that event in the U. S. microelectronics and computer industries, a number of whose members also licensed their technological souls in days gone by (see p. 12).

The Pentagon helps Japan

Whereas U. S. commercial electronics producers now seem somewhat wiser, American military and civil aircraft builders appear not to be. Neither are the makers of military avionics and communications subsystems who—guided by a Pentagon anxious to see Japan strengthen its commitment to self-defense—are licensing U. .S aircraft technology to Japanese companies under coproduction contracts. Investigators for the Congress's General Accounting Office found, for example, that 47 of the 100 U. S. weapons systems and parts licensed for coproduction by the Japanese between 1976 and 1980 were for electronics.

The case of Boeing Co. is somewhat different. Economics, not the Pentagon, pushed it into its 1973 deal with three Japanese companies to pay for and produce about 15% of the new medium-range B-767 commercial jet. Boeing, which likes to remind listeners that it has built approximately half the world's airliners now in service, may live to regret its Japanese deal, just as Rolls Royce may rue its arrangement with Japan on jet engines.

As soon as the two agreements were consummated, MITI created two industrial consortiums for developing aircraft and engines. MITI funds these programs by picking up 75% of the tab for initial development, 66% for prototype production and flight test, and 50% of remaining development costs. Between 1978 and 1981, MITI laid out more than $100 million for both programs and increased its funding of civil aircraft programs by 300%. Moreover, the U. S. Trade Representative's office is convinced that when the time comes for deals with Boeing or McDonnell Douglas on the next generation of transport, "Japan will want to be at least a 50-50 partner."

The price of the F-15

The Pentagon's biggest aircraft deal with Japan came in 1978 with the coproduction agreement for the McDonnell Douglas F-15 fighter. After that, Japan will go it alone under license, buying some classified subsystems from the U. S. Both DOD and McDonnell Douglas cheered on beating such competitors for the Japanese market as France's Mirage, Sweden's Viggen, and the Tornado, a joint effort of Britain, West Germany, and Italy—all planes with far less sophisticated technology.

For the short term, the export sales business of planes and tools to build them with, plus license and technical assistance fees of $1.6 million per plane to be paid to recoup Pentagon R&D costs, should help the U. S. trade deficit with Japan a bit. The long term is something else, however.

The Japanese see those outlays as peanuts. Even though Japanese production costs for the F-15 will be more than double that of planes exported from the U. S., the payment to the U. S. is far less than the cost of that technology to Japan if it had to start from scratch.

Japan also sees the obvious complementary and supplementary relationship between military and civil aircraft technologies, says GAO, because, as MITI puts it, "development and manufacturing techniques of both are closely related, and technological spinoffs can be mutually anticipated."

Boeing and the rest of the U. S. aircraft industry, now in severe recession, ignore Japan at their peril. Before further technology transfer, Boeing especially should recall the famous billboard not far from its corporate headquarters during a recession some 20 years ago. The sign showed only a naked light fixture and the legend: "Will the last person leaving Seattle please turn out the light?"

-Ray Connolly

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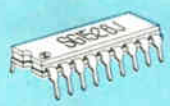
• High-Performance • Fully-Protected • Maximum-Versatility • 8 to 35V Operation • Precision Reference • Dual 100mA Outputs • Programmable Soft Start • Programmable Deadtime • Double-Pulse Suppression • Undervoltage Lockout	 	ULN-8126R	SG3526J	0°C to +70°C	27466.10
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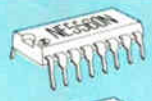
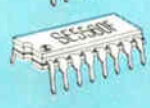
• Full-Feature • Fully-Protected • 40mA Output • Feed-Forward Control • Remote ON/OFF Switching • External Sync. • Double-Pulse Protection	 	ULN-8160A	NE5560N	0°C to +70°C	27466
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TMC means supplying every employee with the best equipment to do the job. From pencils to computers. TMC also means investing the resources to make it work. And invest we do. Of 1981's capital expenditures of $317 million, nearly 70% was put behind TMC.

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Motorola's R2001. In one "in-the-field" test unit: a signal generator, a frequency, modulation, and RF power meter, a spectrum analyzer, a duplex generator, RF memory tables, a code synthesizer, an audio frequency counter, a digital voltmeter, an oscilloscope, and a sweep generator.

As participants in management, Motorola people know that better tools produce better quality, higher productivity, increased demand in the marketplace. And that helps reduce costs, preserve jobs, and make the company's products more competitive.

Take our Communications Sector for example. With thousands of people in the field servicing land mobile communications products with dozens of separate pieces of test equipment, our people saw a need for something better. So they invented the R2001, a single in-the-field test unit that could handle 12 functions in one test unit.

There isn't another piece of service equipment like it. Amazingly, it not only services all Motorola's land mobile communications products, it can service anyone else's. As a result, the R2001 has expanded the test equipment market for us, in addition to providing a better tool for our own people.

Clearly, it's for reasons like this we're a world leader in land mobile communications. And it's also an example that proves our point.

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And once you do that, they'll help you compete with anybody at home or abroad.

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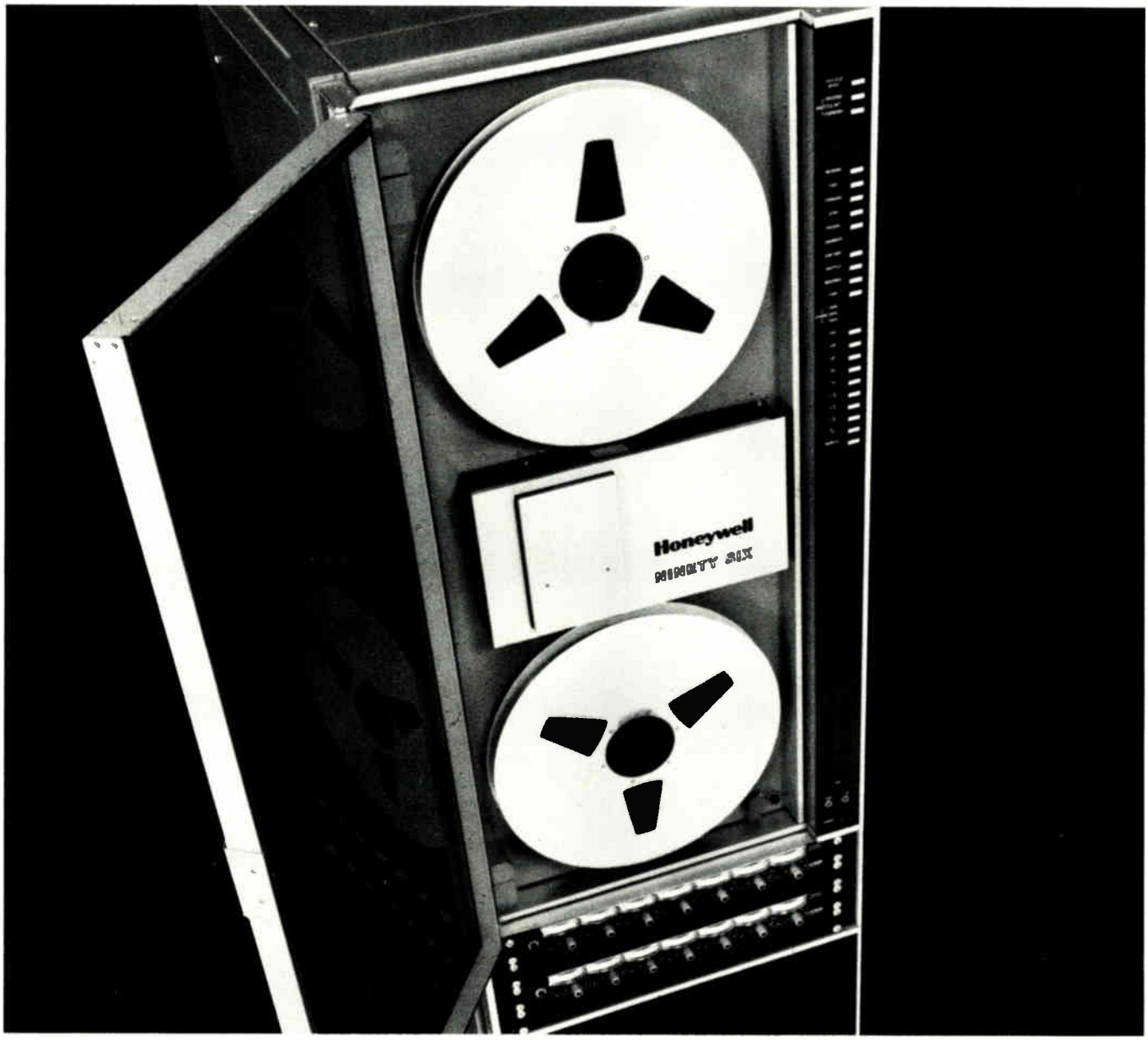

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International newsletter

Ferranti logic array holds 120,000 gates

Enhancements to Ferranti Semiconductor Ltd.'s collector diffused isolation (CDI) process, now being evaluated at its Hollingwood, Lancs., Development Centre, could realize uncommitted logic arrays with 120,000 gates by 1985—**an order of magnitude better than the pace-setting 10,000-gate array structures shortly to be released.** When the new process gets to market, it will likely be optimized for microcomputer use, with gate arrays and read-only and random-access memories on a single chip. The shrink will come from a more compact logic than Ferranti's present current-mode structure, a greater use of self-aligning processes, and a move to direct-wafer-stepping lithography to reduce line widths from 3 μm to as low as 1 μm.

Japan pushing for world standard for 5¼-in. floppy

Japan is making a move for worldwide standardization of 5¼-in. floppy disks with the same capacity as IBM Corp.'s 8-in., 1.6-megabyte (unformatted) floppy disks, the same data rate, and a compatible format. The technology developed by Yokosuka Electrical Communication Laboratory of Nippon Telegraph & Telephone Public Corp. is already being licensed by floppy-disk–drive makers. **The biggest advantage would be the ability to use identical software with either size of disk.** A prototype drive, only 40 mm thick and developed by disk-drive manufacturer Y-E Data Inc., will be shown at West Germany's Hanover Fair in April and at the National Computer Conference in Houston in June. A prototype disk was developed by Hitachi Maxell Ltd. Both these firms expect to have commercial products by June or July, to be followed by Sumitomo 3M Ltd., Teijin Memorex Co., and, in the U. S., Verbatim.

GaAs amp family reaches 3 GHz

Siemens AG has extended the operating range of its CGY family of monolithic gallium arsenide broadband amplifiers from 1 GHz for the CGY21 to 3 GHz for its new CGY31. The latter device—suitable for cable-TV systems, intermediate-frequency amplifiers in satellite TV receivers, measuring applications, and as selective amplifiers with outputs up to 100 mW—**will be offered as samples at the end of the month.** Noise over a bandwidth from 0.5 to 3 GHz is equal to or less than 5 dB, and the amplification is 15 dB.

Honeywell continues R&D with French affiliate

Despite continuing negotiations with the French government that will eventually reduce Honeywell Inc.'s 47% holding in CII-Honeywell Bull of Paris, the Minneapolis-based company is going ahead with development of its Distributed System Architecture (DSA) in conjunction with its French affiliate. Complying with the International Standards Organization's reference model for open systems interconnection, **DSA will provide to the 64DPS, DPS7, 66DPS, and DPS8 host computers** improved cooperation between host and satellite computers as well as enhanced network capabilities and control.

International newsletter

Video recorder is first move for joint Europe-Japan venture

West Germany's Telefunken Video GmbH, an affiliate of AEG-Telefunken, will start production of VHS video recorders at its West Berlin plant in May. Telefunken Video is a member of a holding company just established by AEG-Telefunken, Tokyo-based JVC Victor Co., and Britain's Thorn-EMI. The new firm, the J2T Holdings BV, based in Rotterdam, the Netherlands, **constitutes the first European-Japanese joint venture in the video sector.** In addition to video-recorder production, the joint-venture agreement provides for the other partners to produce VHD video disk players and for JVC to supply video cameras.

Olivetti introduces personal computer . . .

Ing. C. Olivetti & Co. SpA, Ivrea, Italy, will make its entry into the small-business and personal-computer markets this year with its model M20. **Based on the 16-bit Z8001 microprocessor, the computer will offer** 128-K bytes of random-access memory, one or two built-in minifloppy-disk units with an unformatted capacity of 320-K bytes each, and a video display based on bit-map technology that permits "windowing," or the simultaneous display of several independent screen areas. The price of the most basic configuration will be around $3,000.

. . . and acquires yet another hi-tech firm

Olivetti continues its aggressive high-technology acquisition strategy [*Electronics*, Feb. 24, p. 64] by purchasing a 20% interest in Micro Office Systems Technology Inc., a recently formed Fairfield, Conn., company **that specializes in advanced office-automation systems, particularly portable management work stations.** Olivetti is participating in the development effort in order to coordinate the forthcoming Micro Office product line with its own electronic typewriters and word processors.

Digital Research to write CP/M for Hitachi's 68000

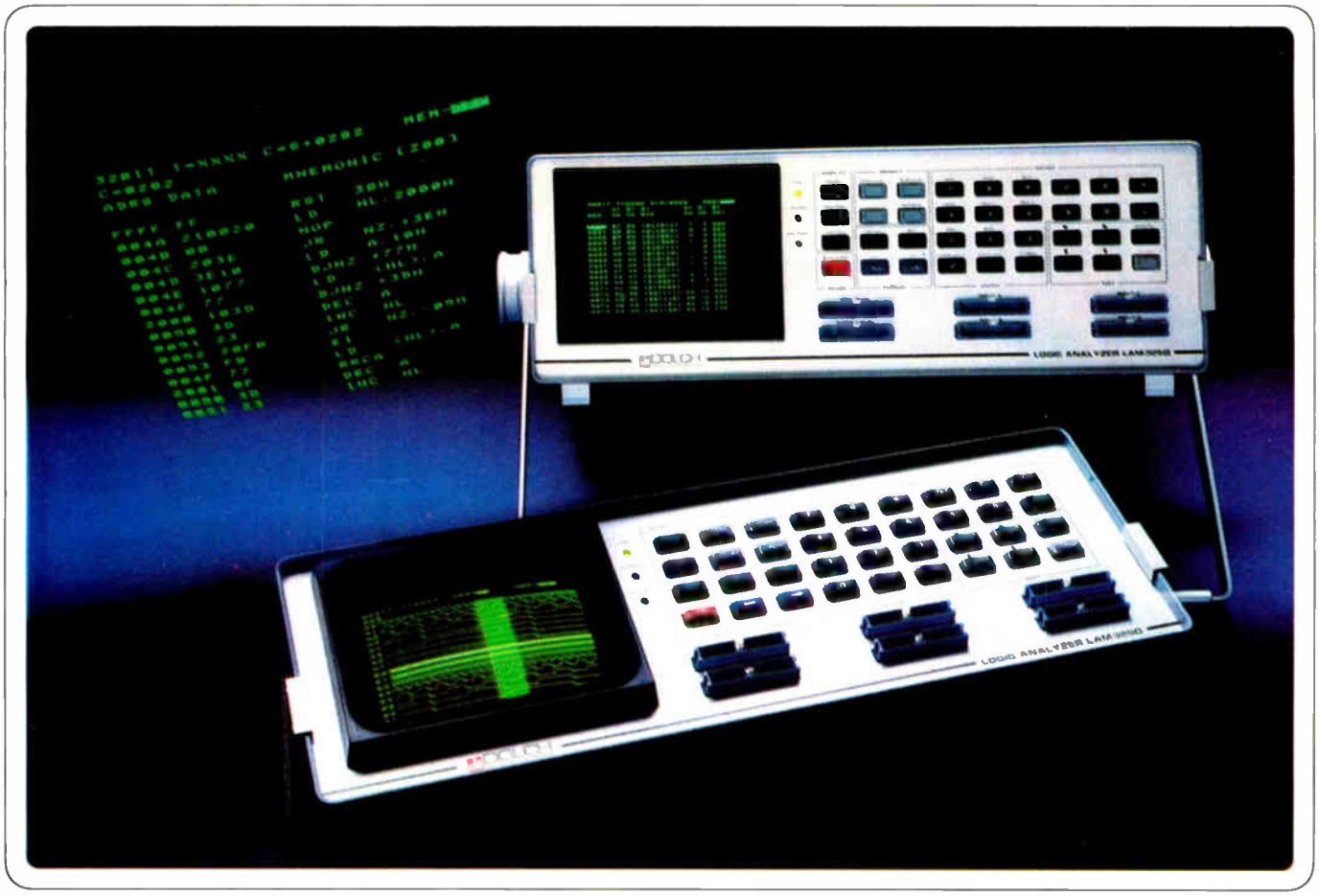
Hitachi Ltd. has contracted with Digital Research, Pacific Grove, Calif., to develop a CP/M-68000 operating system and a Pascal-68000 compiler for the 68000 microprocessor. Completion of both is scheduled for the third quarter of this year. **The new operating system will be similar to CP/M-86,** and it is expected that present hardware-dependent portions of applications programs will be compatible. The announcement was made before all details were fully thrashed out in an attempt to persuade firms about to decide on a 16-bit microprocessor for new applications to select the 68000. In the future, Digital Research will also develop versions of the multiuser MP/M-II and the networking CP/NET for the 68000.

Digital capacity doubler for phones on the way

Look for Electronics Corporation of Israel Ltd. to introduce a digital version of its telephone-line capacity doubler at the April 20 Communications 82 meeting in Birmingham, England. The 8088-based machine uses only standard large-scale integrated parts **to implement the time-assignment–speech-interpolation principle** (TASI). In this approach, the absence of speech on any trunk line is detected, and the line is assigned to an active talker on a dynamic basis. All this is done without any loss of speech quality, the Tel Aviv–based company claims.

Dolch.

advanced logic analysis



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dli DOLCH LOGIC INSTRUMENTS

Circle #65 for demonstration

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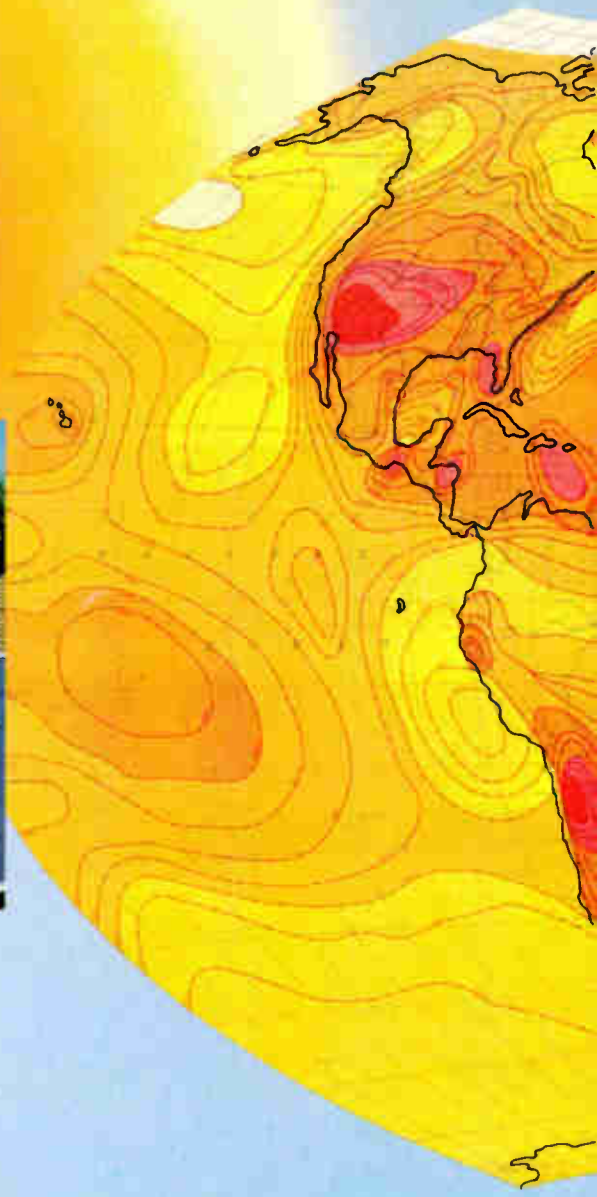

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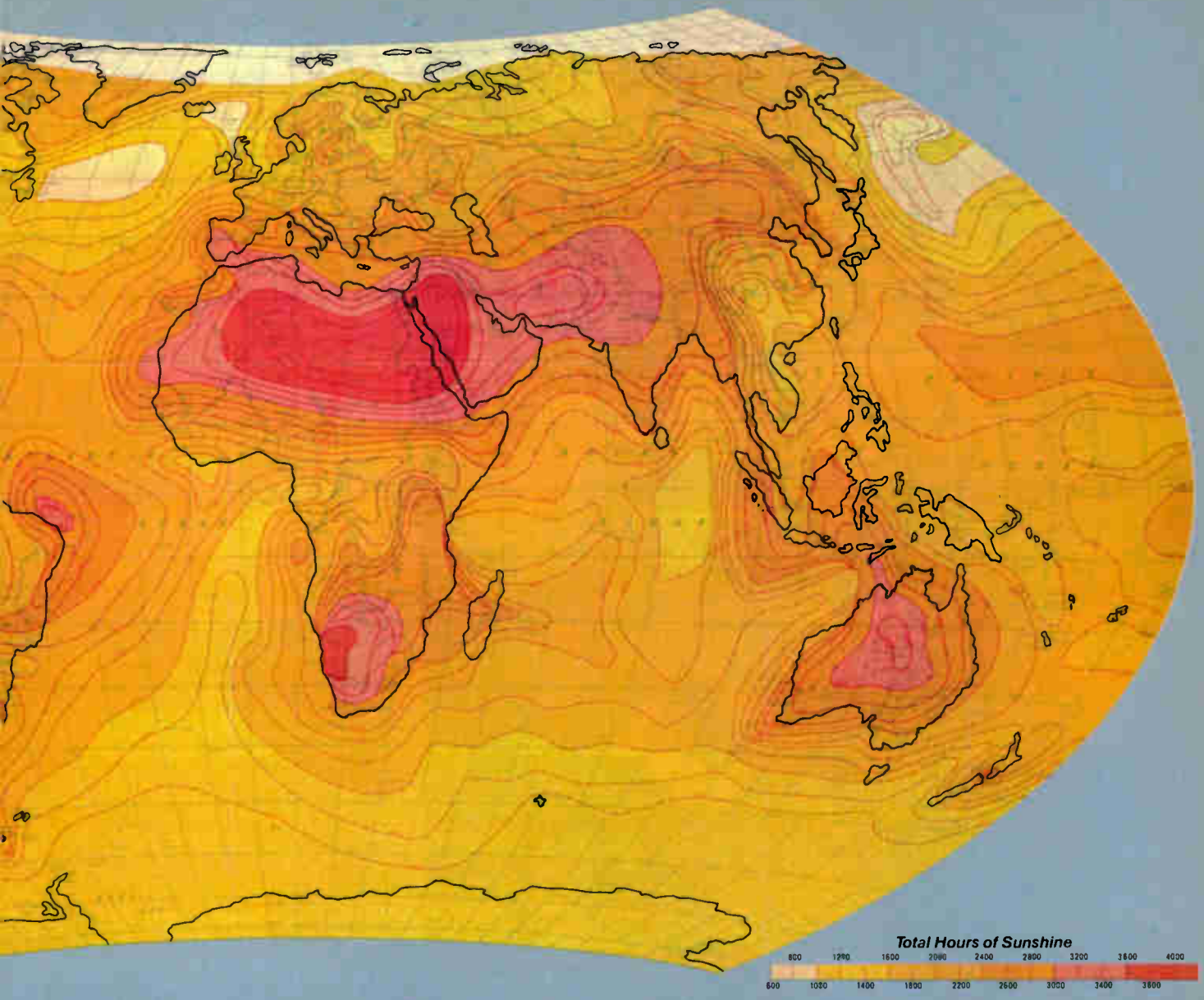

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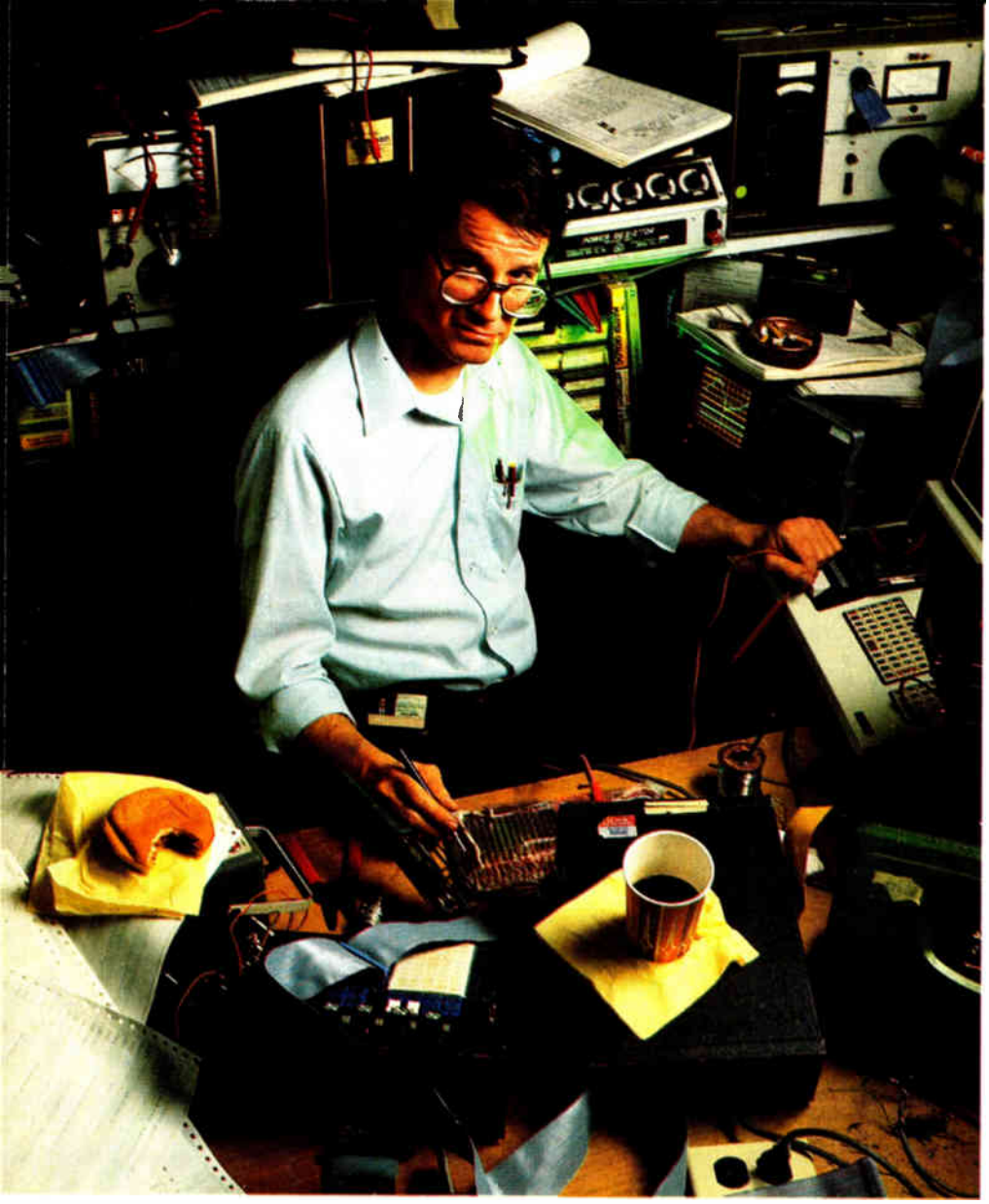

At first glance, the Data 6000 belies its vast capabilities. That's because we've arrayed more than 300 independent front-panel manipulations behind a simple, human-engineered 60-key array.

It works like this. You touch a button to access a set of processing functions. Immediately, the "soft" keys below the 9-inch CRT screen are labeled with pertinent parameters. You don't have to hunt through a panelful of knobs and dials, because only the keys you need are available.

Every function—including integration and differentiation auto- and cross-correlation—is executed by a single keystroke. You can automatically chain an infinite number of functions or calculations in series, for complex analysis without complex fingerwork. And any such operation can be automatically re-executed for every new data acquisition. The Data 6000 lets you concentrate on your data, not on hitting the right series of keys.

Simple Setup...Yet Unlimited Capability

Power the Data 6000 on, and it's up and running. Investigate a full range of signal-processing problems in research, development and manufacturing, with just a few simple operations. Because software pre-programmed groups of direct performing buttons give you access to multiple levels of setup and control.

This ingenious software is designed to be totaliy transparent to the user, for fast setup for even the most demanding measurement and analysis tasks. Yet its simplicity doesn't limit its flexibility. In fact, if you wish, you may even program the microprocessor yourself in BASIC to suit your unique algorithm needs.

Buy a Roomful of Equipment, or the

Stop juggling racks, patch cords, knobs, buttons and interfaces. The Data 6000 Universal Waveform Analyzer puts an entire benchful of powerful equipment at your fingertips—in a single, compact instrument.

You get an incredible 100MHz sampling rate, for the fastest transient capture and analysis anywhere.

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Averaging of up to 32,000 Sweeps
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Plug-in data acquisition modules let you instantly customize your sampling rate to your application. The high-speed Module 620 samples an incoming waveform as frequently as 100MHz (every 10nS), with 7 bits of resolution! Or you can multiplex 2 channels at 50MHz, (20nS), with 8 bits. The low-frequency Modules 610 (2 channels) and 611 (4 channels) digitizes at 100K samples/second or as slow as every 600 sec at 14-bit resolution.

Digital Control for Integrity of Measurement

Not only are results easier than ever to get at with the Data 6000, they're easy to trust.

For example, every waveform measurement or calculation listed (opposite) is made by the microprocessor directly from the digital memory. So you get measurements to 5 significant places.

For in-depth waveform analysis, you have independent control of 2 timebases. 4 screen traces can be overlaid or viewed separately, with expansion control up to 64 times on the x axis, 512 on y. You may select any interval between full pre-trigger and full post-trigger.

Since the Data 6000 is completely digitally-based, any waveform may be stored in memory or indefinitely on the dual floppy disk option, for instant recall, comparison or measurement. You can even store your complex user-programmed algorithms or standard Data 6000 measurement setup on the disk—so you can set up the system automatically in 30 milliseconds! You can also store and transfer to the Data 6000 max/min or hi/lo waveshapes for comparison.

There is virtually no limit to the kind of information this incredible instrument gives you. Sweep-to-sweep weighted averages. A min/max envelope function over any time period. Spectrum analysis. Transient signal capture and analysis. And every 60 seconds, the Data 6000 verifies its calibration to assure you an accuracy of 0.05% reading +0.05% range for the Module 610, 0.5% reading +0.5% range for the Module 620.

The 6000 talks or listens—or both—on the IEEE 488 bus, or RS232. Everything you can perform from the front panel can be done over these I/O options. XY plotter and external keyboard options also available.

Optimum Use of State-of-the-Art Technology

The heart of the Data 6000 is the sophisticated 16-bit M68000 microprocessor with 32K bytes memory (expandable to 128K bytes). So you get much more functionality and flexibility than component-type systems. With the fast response and cost-effectiveness of the microcomputer.

The 100KHz 14-bit A/D converter is manufactured by Analogic Corporation, where high-speed A/D conversion is already beyond the state of the art. Analogic also developed the unique 9" magnetic-deflection CRT, whose versatile display and labeling functions set the 6000 apart.

The result of all this engineering efficiency? The Data 6000 not only gives you more capability than any other instrument you can select, it is simpler. It's compact, just 7¾" × 15" × 19". The mainframe costs* only $4995; the low-frequency plug-in module (610) is $1995; and the high-frequency module (620) is just $3995. The floppy disk option, with up to 1.5M bytes of storage is $3395.

Forget the headaches associated with the setup, integration, accuracy and servicing of multiple instruments. The Data 6000 gives you every feature of the best digital storage oscilloscope on the market today. Plus the functions of a waveform analyzer, transient signal analyzer, spectrum analyzer, computer, and data acquisition system.

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LCD replaces cathode-ray tube in digital scope

by Kevin Smith, Senior Editor

Although lacking a CRT's resolution, portable unit offers compactness, ruggedness, and safety

A flat-panel liquid-crystal display with over 32,000 elements replaces the conventional cathode-ray tube in a portable two-trace digital storage scope developed by Scopex Ltd., a small British oscilloscope manufacturer located in Letchworth, Herts. The highly original display technology used by Scopex in its Voyager low-frequency oscilloscope was developed by a group under Cyril Hilsum at Britain's Royal Signals and Radar Research Establishment [*Electronics*, March 24, p. 63].

The development is significant because engineers now have an alternative to the cathode-ray tube with the advantages of compactness, ruggedness, extremely low power consumption and low-voltage operation, as well as legibility in bright sunlight. Against this, the technique can only represent single-valued functions, cannot be used for alphanumeric displays, and can be operated only in a digital mode, limiting maximum frequency response. Nor can it match the CRT's resolution.

Accordingly, Scopex's first LCD instrument is targeted at applications for which conventional oscilloscopes are ill-suited—in potentially explosive atmospheres such as petrochemicals or mining, for example. Its ruggedness and portability will also suit it to military and geological applications, and though its maximum frequency is at present limited to 150 kHz, the bandwidth still takes in most physical parameters, as well as audio band signals.

Easily legible in bright sunlight, weighing just 2.5 kg, and capable of operating continuously from 5 to 12 hours, the new Scopex scope features a 10-by-6-centimeter liquid-crystal display built up from a 128-by-256-dot matrix, with traces interleaved on alternate columns. The display itself is just 3 millimeters thick and

Licking the LCD's multiplexing limit

Basic to the Scopex oscilloscope is the Royal Signals and Radar Establishment's discovery of how to drive a liquid-crystal display continuously. The LCD's lack of persistence has always limited its multiplexing abilities. But the RSRE overcomes this by driving all elements in the display continuously, save one in each column. These "off" elements can be used to trace single-valued waveforms.

The technique was originally developed for twisted nematic LCDs. But it is equally applicable to the newer dye-phase-change type, which also cannot be driven by conventional multiplexing methods. Because they do not need polarizers, they are brighter than earlier LCDs, offer better contrast, and are visible from a wider viewing angle. This is the type Scopex uses.

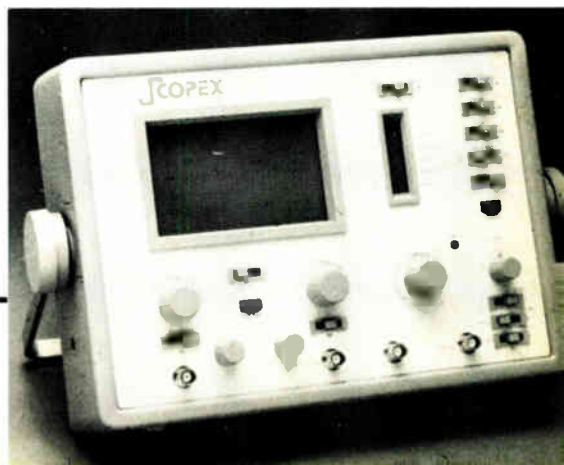
However, the RSRE method works only for single-valued functions and not for alphanumeric displays. Because the displayed function is single-valued, a trace can be built up by switching off one element in every column, holding all other elements on. The function then appears as a dark blue trace against a bright background.

Instead of multiplexing column electrodes, both row and column electrodes are continuously driven by two sets of reference waveforms, each of which is a unique binary sequence repeated every 30 microseconds. Each waveform is applied once only to one row and one column.

If the column waveform is identical to the row waveform at a particular display element, the voltage difference will be continuously zero and that element will remain off. All of the other display elements in the column experience dissimilar row and column waveforms, so that the voltage difference at these is non-zero in many of the clock periods.

A careful choice of pseudorandom sequences ensures as many plus one as minus one periods in the difference voltage. Consequently there is no dc component, and the LCD material does not depolarize. Also, since the rms value for any dissimilar waveforms is a constant 0.707 of the 15-V drive voltage, the display's 320,000 background elements operate at a uniform brightness.

Such isogonal binary sequences, says Ian Shanks, are well known in electronics and computing and are very easily generated by forming the exclusive OR of certain inputs of an n-bit register. **-K. S.**



is operable over a 0° to 40°C temperature range. Connection is via an elastomer, with inset conductive tracks pressure-clamped to the LCD. The display was developed for Scopex by Lucid Displays Ltd. of Chelmsford, Essex.

The scope samples analog inputs at a constant rate of 1.25 MHz. Therefore, at its maximum frequency of 150 kHz, it takes eight samples per cycle. Data is displayed with 7 bits of resolution. The instrument consumes 2 watts supplied from six C-sized rechargeable nickel-cadmium batteries from a 12-volt supply.

Among the operating features is a pretrigger facility that can occupy three quarters of the display. Also, waveforms can be stored for subsequent display or printout. A liquid-crystal flag display shows a variety of operating conditions, including an aliasing warning, a battery low condition, and trigger status.

Medical. Ian Shanks, developer of the display at RSRE, sees other potential markets for it. One is medical electronics, displaying, for example, cardiac waveforms as flicker-free, complete traces, updated point by point as they are viewed.

Similar X-Y matrix displays could serve in other instruments, such as spectrum analyzers and correlators. They can also be used as an array of independent linear analog meters, with each strip meter indicating a separate control or error function from a number of transducers. A polar coordinate or other format matrix might provide, for example, a simple LCD radar screen or analog meter or a horological display with hands.

As with all digital instruments, the maximum frequency displayed is set, not by the display itself, but by the rate of conversion of analog into digital signals. The usable bandwidth, says Shanks, is limited to about a tenth of the conversion speed in order to adequately trace a waveform. But his restriction could be avoided by the use of a charge-coupled device at the front end. This would sample the signal voltage at a high clock rate, then clock it out again at a slower rate matched to the converter employed.

The Netherlands

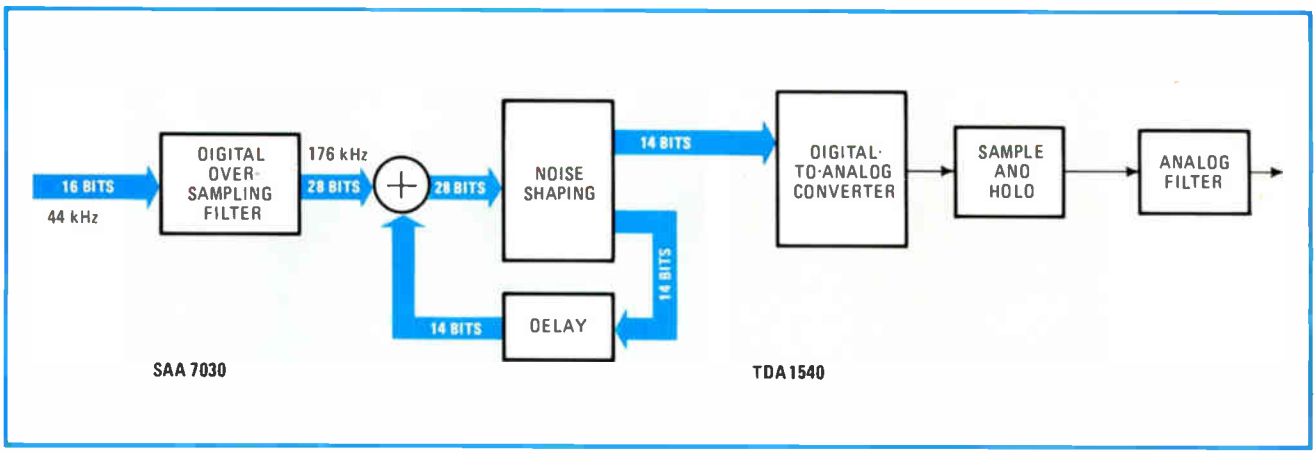
Digital oversampling filter can improve audio d-a conversion economically

A digital oversampling filter that extracts a 16-bit system's signal-to-noise ratio and accuracy from a less costly 14-bit digital-to-analog converter is being marketed by Philips Gloeilampenfabrieken NV. The filter is one of four n-channel MOS large-scale integrated circuits developed by Philips' Audio Products division in Eindhoven, the Netherlands, for d-a conversion in its Compact Disc audio system. Mounted on a single 10-by-22-centimeter Eurocard, the quartet performs the 4 million control, decoding, and error-correction operations necessary every second of the d-a conversion.

The Philips one-card d-a converter meets the same standards as a 2½-card system designed by Sony Corp. for its compact disk. "Compact Disc is now a worldwide standard with regard to formats, functions and interfaces, but within that standard there is a large area of design freedom," says Jens Jensen, Philips International product marketing manager for n-MOS integrated circuits. "Obviously, 16-bit data has to be decoded and put back into analog form, but a conventional 16-bit digital-to-analog converter simply was not sufficient."

There are two areas in which conventional d-a converters need help with audio playback. First, the original analog signals contain high-frequency components that require attenuation. Otherwise, they may overload output amplifiers and tweeter loudspeakers, causing distortion in the audio frequency range. In addition, there is always the uncertainty of half a least significant bit in the quantized value obtained by sampling the original audio signal. After d-a conversion for playback, this error is heard as noise. The

Hard worker. A digital oversampling filter that provides a 97-dB S/N ratio is one of four integrated circuits for d-a conversion in Philips' Compact Disc audio system.



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Circle 75 on reader service card

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extent of this quantization noise largely determines the signal-to-noise ratio, or dynamic range, of pulse-code modulation systems.

Solution. For this reason, filtering is of critical importance in the conversion system. Though the obvious solution might seem to be on the analog side, digital processing offers several advantages. Matching digital performance with passive analog filters would require many stages of precise and hence expensive passive components. Active analog filters still require several stages and also would have to deal with dissipation from the high signal level. Also, all analog filters require phase correction. Philips' solution is its digital oversampling filter, which includes a noise shaper, and a 14-bit d-a converter with a hold function. A simple analog filter is then enough to remove the unwanted higher frequencies—the passband noise is already reduced significantly by the previous digital filtering.

The system works thus: two 16-bit data streams, one for each audio channel, that have sampled the audio signal at a frequency of 44.1 kilohertz, are fed into the conversion system at a clock rate of 2.1168 megahertz. This input signal is first fed into a shift register where the sampling frequency is increased four times to 176.4 kHz. The data is then applied to a transversal filter with 96 taps. Using 12-bit–accurate coefficients, the filter computes the weighted average of a large number of values for each of the original samples. The output from the transversal filter is a 28-bit signal at a sample frequency of 176.4 kHz.

Uniform. The principal advantage of the system is that it attains 16-bit accuracy with only a 14-bit d-a converter because, by oversampling four times, it distributes the original amount of noise uniformly over a band four times as wide as the audio band of 0 to 22 kHz. Since only the noise in the audio band is relevant and the rest is filtered away, only 25% of the quantization noise remains, resulting in a 6-decibel improvement in the S/N ratio. Another 7-dB improvement is achieved by noise shaping.

In a d-a conversion system, each bit used in the quantizing improves the S/N ratio by 6 dB. Thus, a 16-bit d-a converter theoretically offers a ratio of 96 dB. The Philips system gets 84 dB from its 14-bit d-a converter and a total of 13 dB more with oversampling and noise shaping.

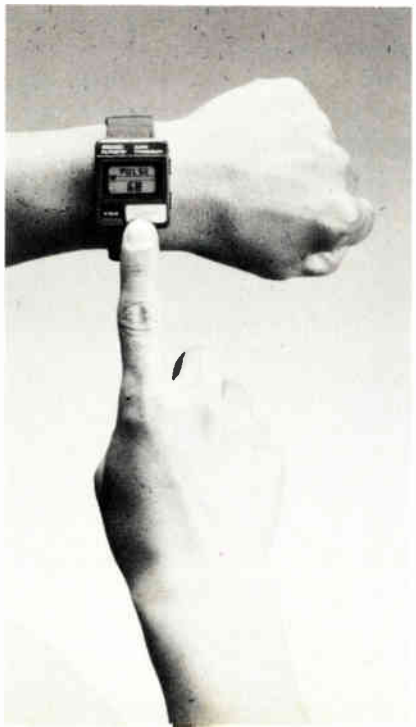
The Philips compact-disk digital audio system and the SA 7030 oversampling filter will be available by year's end. **-Robert Callagher**

Japan

Watch takes pulse by copying ECG

As an indicator of its wearer's pulse rate, a new digital watch uses part of the same electrical signal from the heart as an electrocardiograph does. Developer Daini Seikoshi Co. (Seiko) points out that it therefore needs no external sensor and uses little current, unlike other pulse-taking watches. The Seiko Runner, as it is called, is already on sale in Japan and will start overseas sales in May or June.

Signal pickup is between the wrist beneath the watch's stainless steel back and a finger pressed on a stainless steel electrode on the watch front (see photograph). An amplifier in the watch detects what cardiologists call the R pulse—that portion of the ECG signal with the highest amplitude.



Lots of heart. The pulse meter of the Seiko Runner detects the heart's R pulse at the surface of the body, converts it into the rate per minute, and displays the result.

The R pulse can vary in different people from about 0.2 to 2.2 millivolts when measured between the left and right arms. The sensitivity of the pulse-metering circuit's amplifier—actually a bipolar operational amplifier—is 0.4 mV, high enough for 90% to 95% of the population but not so high as to pick up too much noise and thus degrade accuracy.

Other watches with the pulse-metering function measure the pulsating blood flow in a fingertip by sensing the varying amounts of light it reflects from a light-emitting-diode source. But noise is generated by the varying ambient light let in by the finger's tendency to move, and the high current required by the LED soon runs the batteries down.

The Seiko pulse meter uses every second R pulse as a start or stop signal to gate the number of 128-hertz clock signals fed into a counter. Thus, for a pulse rate of 60 a minute, the sampling period is 2 seconds, and 256 clock signals are counted. The counter output forms an address for a small read-only memory in which 9 bits store pulse rates in binary-coded–decimal form.

Quiet. Luckily, the R pulse generated by most persons has a length corresponding to a strong fundamental component centered at 20 Hz, which facilitates reduction of noise. A 20-Hz bandpass filter having a Q of about 1 is connected to the amplifier to reject noise, including any from 50- and 60-Hz power lines. A masking signal lasting 266 to 297 milliseconds after the detection of the R pulse further removes noise or double triggering, including any due to the heart's T pulse. This mask also limits the maximum measurable pulse rate to 199/min.

Because it has no need for an LED, the Seiko watch can employ only low-current devices. The complementary-MOS watch device, which

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includes the counter and ROM, needs 1 microampere. The bipolar operational amplifier requires the addition of just 35 μA, so the 3-volt lithium battery lasts more than two years if the pulse-metering function is used up to 10 minutes a day. In the future, C-MOS op amps may become available and cut current drain further. **-Charles Cohen**

West Germany

Nixdorf's PBX aims at domestic market first, can hook up to data terminals, Teletex

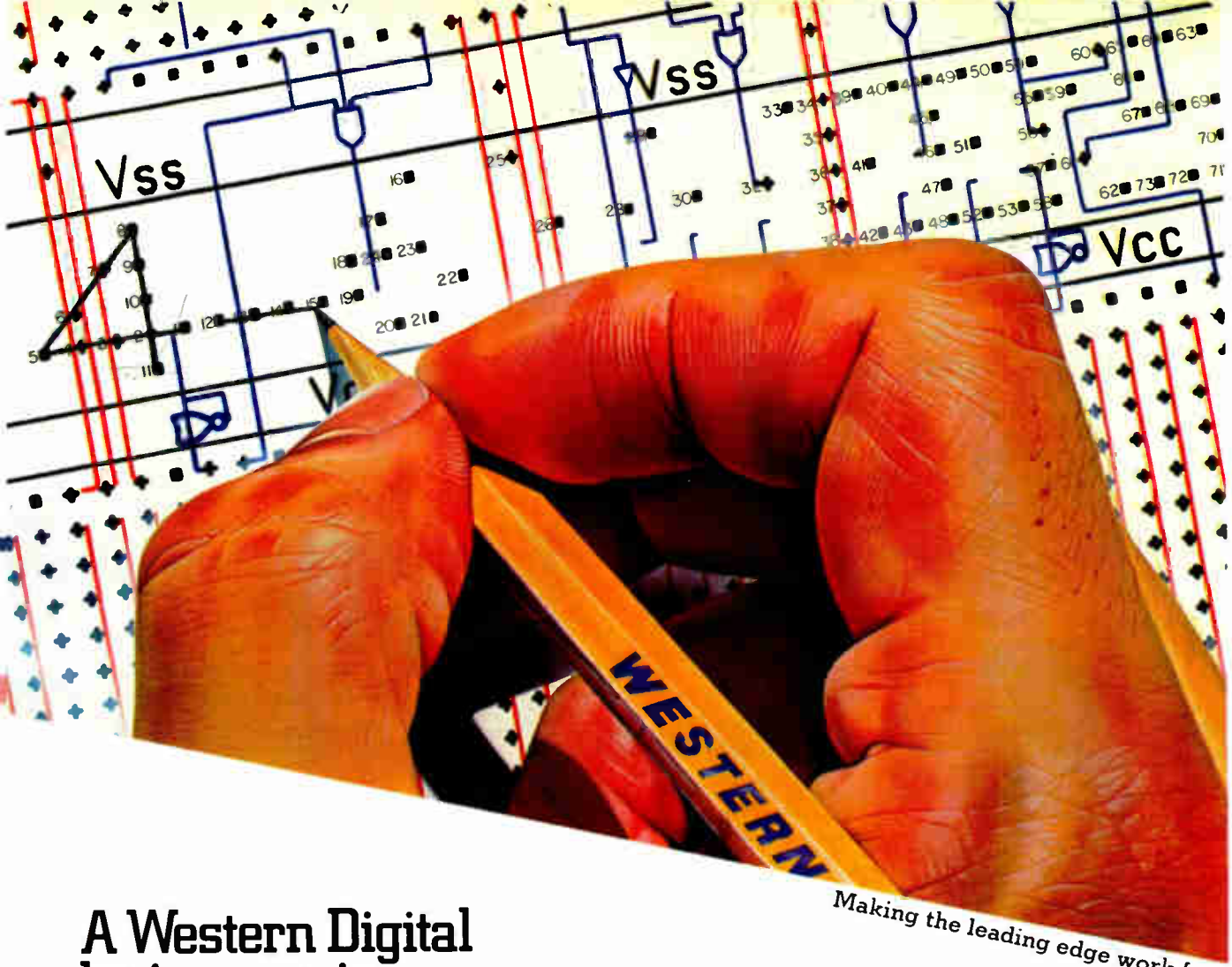
The first all-digital private branch exchange from a West German company, and the first available on the West German market, is now being offered by Nixdorf Computer AG, the data-processing equipment maker located in Paderborn. With this system, plus an Ethernet-based local network, Nixdorf can meet users' needs for in-house networks based either on digital PBX or on cable-oriented systems.

Using pulse-code modulation techniques, Nixdorf's PBX system 8818 handles voice in digital form—the same way as it does text and data. Its digital interfaces can hook up to data terminals and, by way of a simple X.21 interface with the public network, the system can switch Teletex, the new form of electronic mail involving communications between electronic storage-type typewriters [*Electronics*, April 7, 1981, p. 101]. The exchange is designed to handle store-and-forward voice switching when it becomes available in 1983.

Operating at a rate of 64 kilobits per second, the 8818 is compatible with both the digital public switches that the West German post office will start using this year and the Integrated Services Digital Network, a European integrated speech and data network due to come on line later this decade.

Accommodating. Nixdorf's PBX transmits 256 time slots per second over the PCM highway, and that, says product marketing manager Wieland Hess, considerably enhances its traffic-handling capabili-

Entry. Computer maker Nixdorf's first move into the field of office-of-the-future communications is an all-digital private branch exchange using pulse-code modulation techniques.



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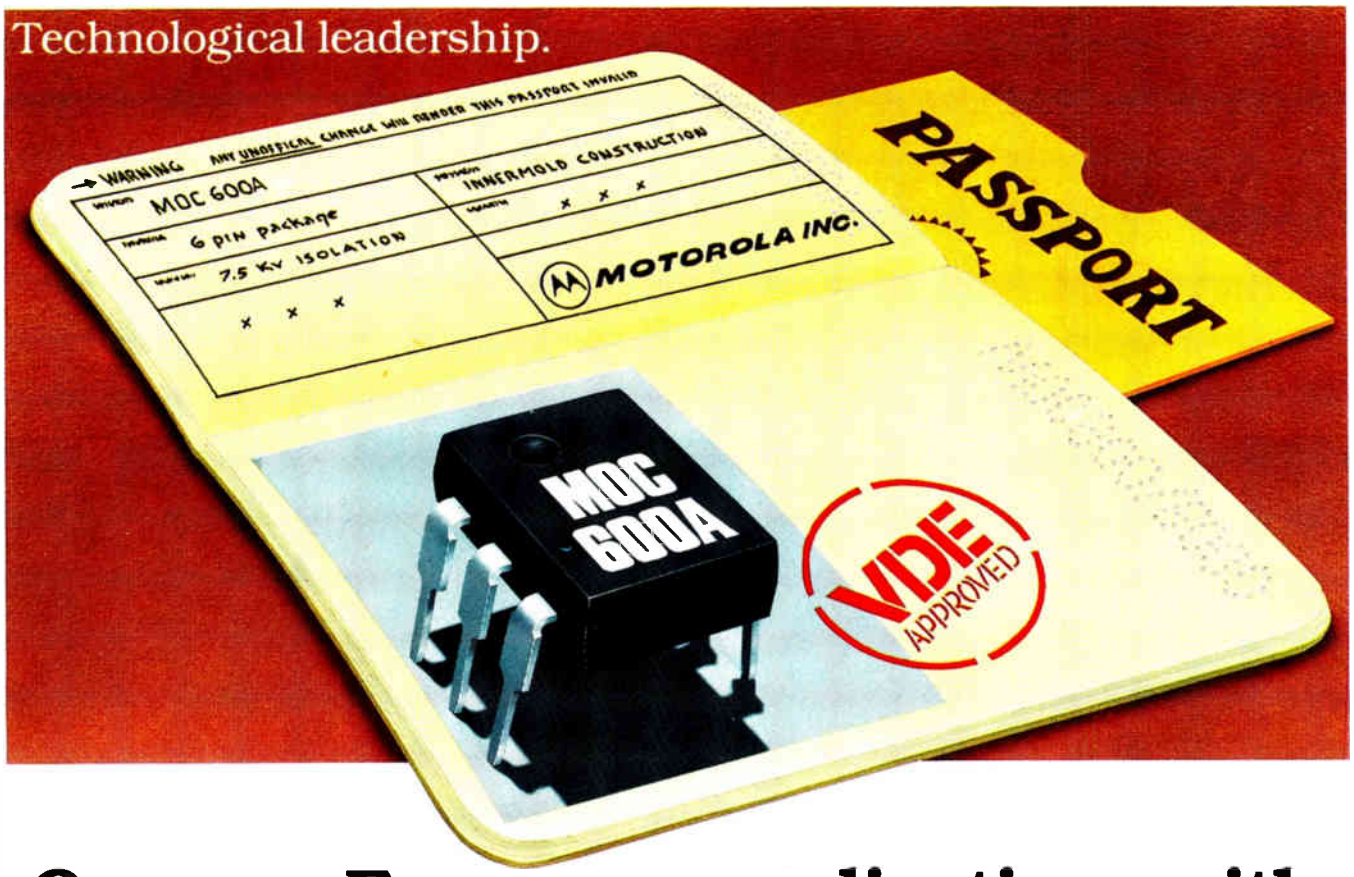
ty. For example, the system model 600, intended for the West German market and for up to 600 subscribers, can easily be made to accommodate up to 1,000 subscribers, making it also attractive for larger foreign markets. The 8818 system can switch up to 226 subscribers simultaneously, according to the company.

The Nixdorf engineers feel they have hit upon an elegant means of keeping track of call charges. The system monitors each call made, and a printer at the switching center produces a list showing the length of each call made by individual subscribers, the call charges, and the called number. This information can be fed to a computer for accounting purposes—producing a monthly bill, for instance.

New user features, according to Rainer Pausch, head of telecommunications equipment development, are call rerouting, repeat of a dialed number at the push of a botton, telephone conference capability with up to six subscribers, and the ability to call a second subscriber while still connected with the first. There is a dial memory for 10 digits, and often-used numbers with up to 20 digits (which may be needed for international calls) can be reached by abbreviated dialing. Further, if a line to a wanted subscriber is busy, a signal can be initiated, alerting the subscriber to the fact that an urgent call is waiting.

On screen. The 8818 is self-diagnosing, with any system errors printed out or shown on its cathode-ray tube. It also offers the ability to change the software—to allow call rerouting or access to the public telephone network by an individual terminal, for example.

Although the first 8818 systems will be installed at outside customers within two months, Nixdorf's local office communications project is still in the pilot stage. This integrates office equipment such as telephones, electronic typewriters, Telex machines, copiers, dictating machines, and data-processing terminals—equipment that till now has operated autonomously. **-John Gosch**



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MOC625A	1000	30
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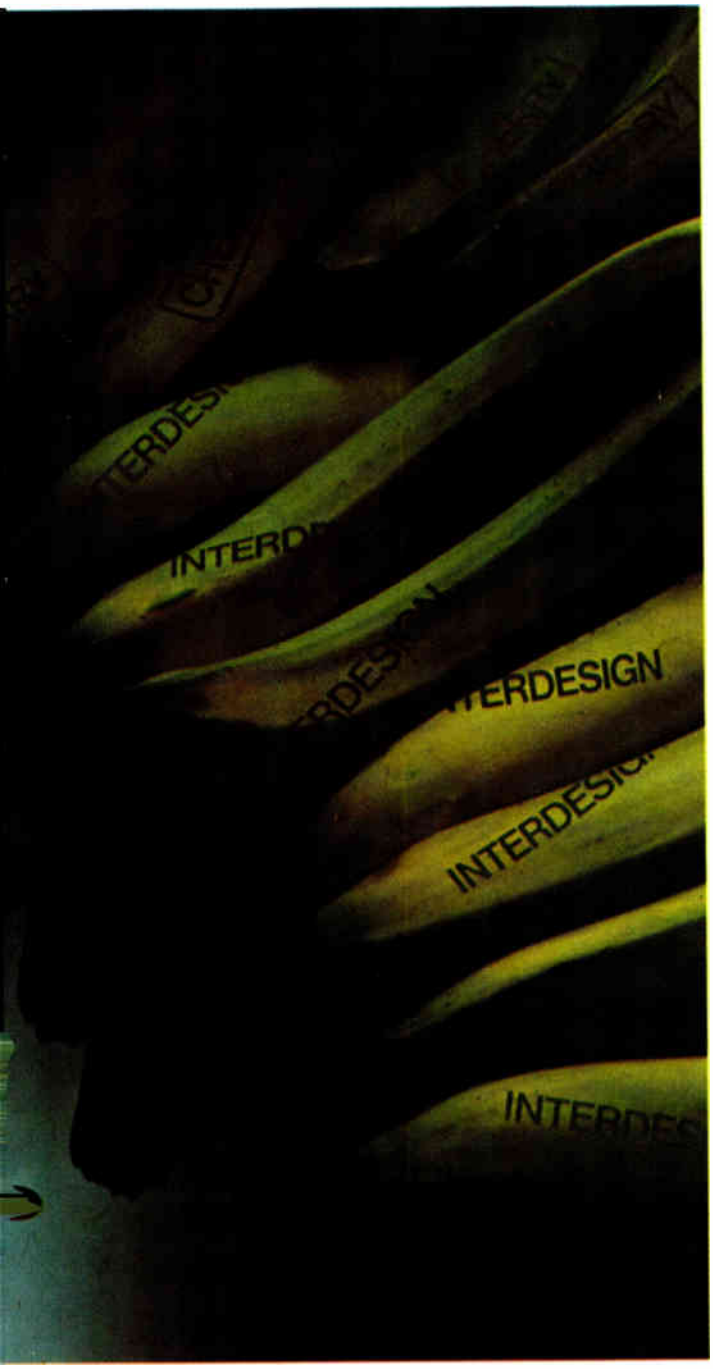

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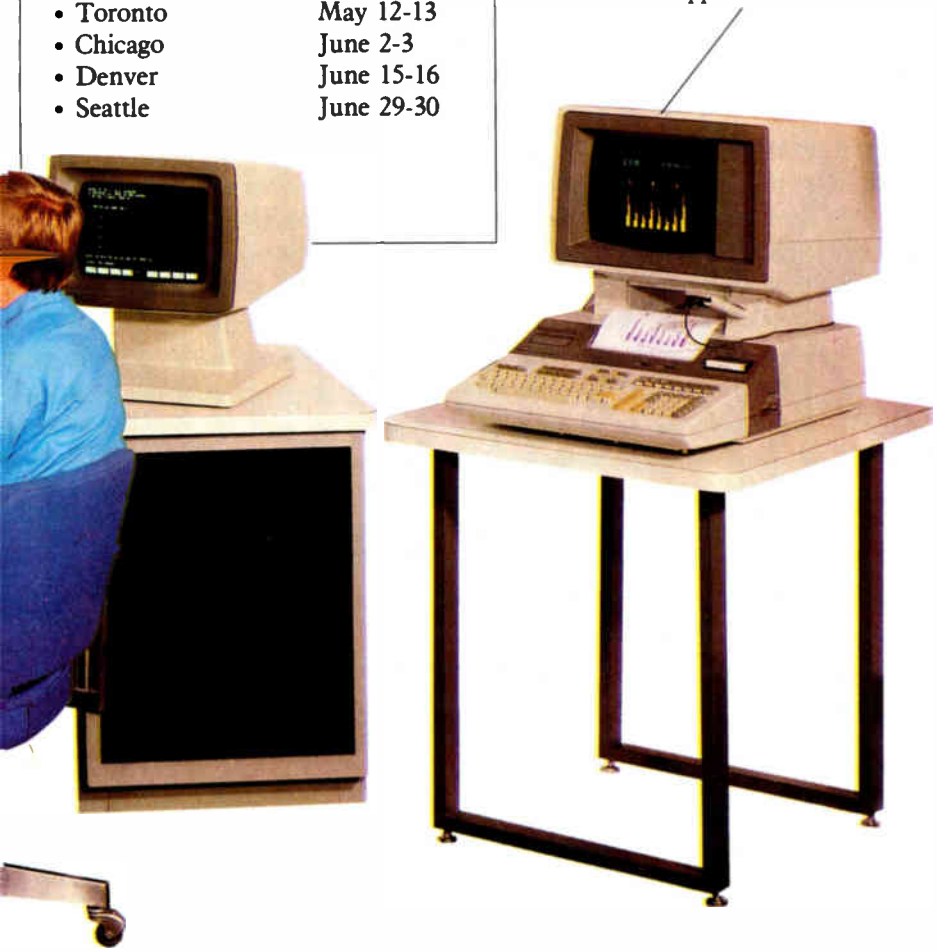

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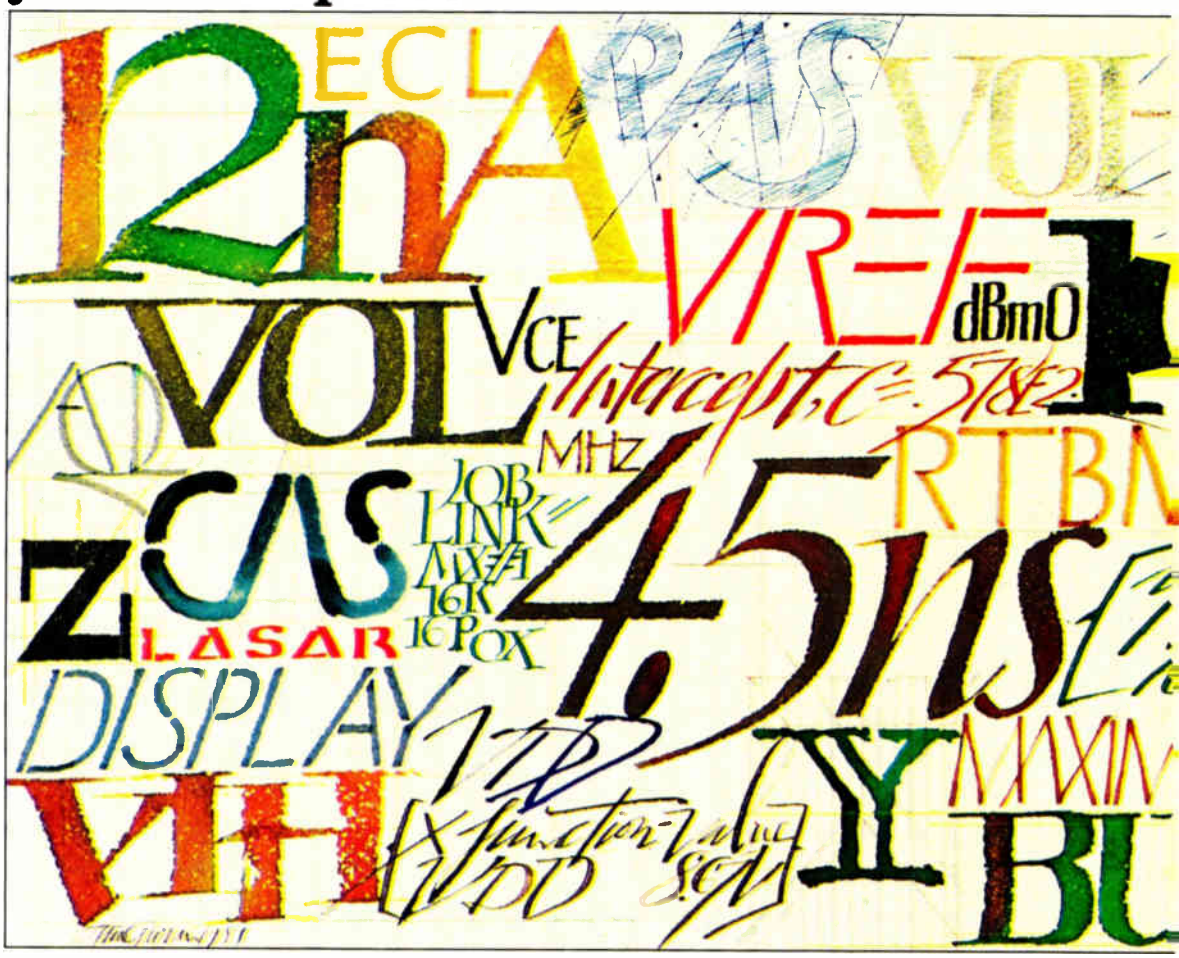

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Vision systems gain smarts

New generation can interface with robots to perform complex tasks like materials handling

by Wesley R. Iversen, Chicago bureau

For years, machine vision systems in factories have been relegated largely to simple inspection. However, a new generation of computerized devices capable of interfacing with industrial robots to perform more sophisticated tasks like welding, spray painting, materials handling, and assembly appears on the verge of reaching the factory floor.

Though General Motors Corp. and others have experimented extensively with integrated robot-vision systems, few commercially available units have yet found their way into production applications. In fact, fewer than 85 vision systems were sold last year in the U. S. for integration with robots.

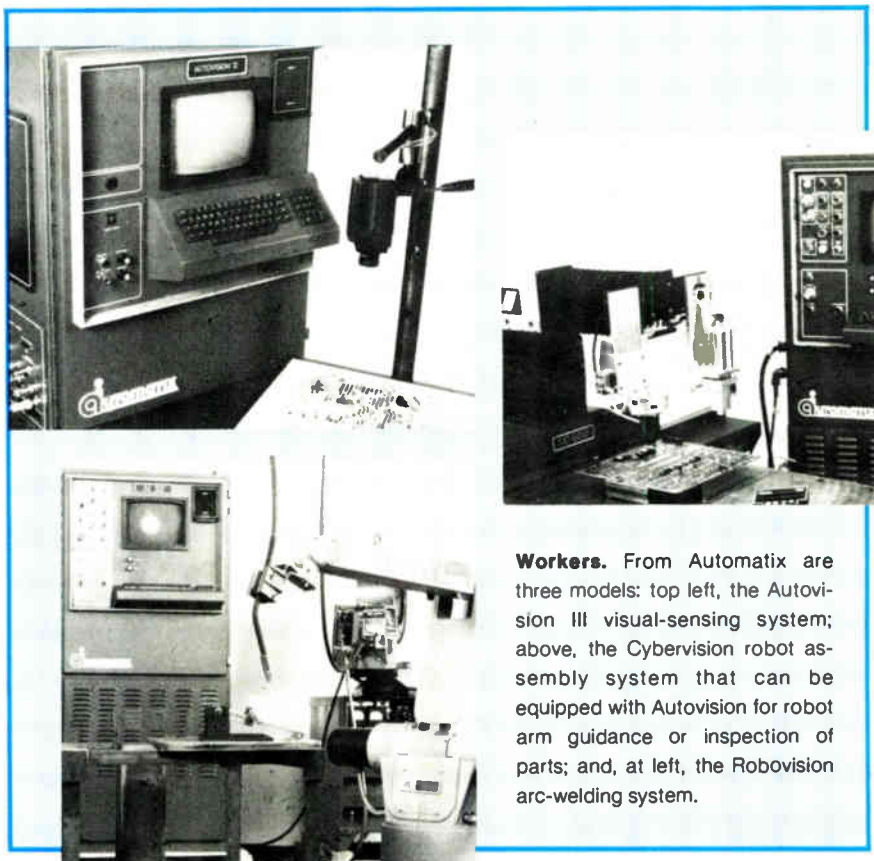
In addition, many of those systems were purchased by universities and large corporations for experimental and prototyping purposes, says James A. Kimberlin of Insight Associates, a Carson City, Nev., market-research firm. However, at last month's Robots VI show in Detroit [*Electronics*, March 10, p. 42], several firms reported that they would install seeing robots in factories later this year.

Robots VI exhibitors showing integrated robot-vision systems with video cameras ran the gamut from established suppliers such as Unimation Inc. to recent entrants like giants General Electric Co. and Westinghouse Electric Corp. Also represented were a raft of smaller firms hoping to make their mark, like Control Automation Inc., started in Princeton, N. J., by former Western Electric engineers.

In general, industry watchers say sales of vision systems tied to robots may eventually account for one third of the overall market for vision equipment. Although estimates vary widely, some believe that 50% or more of all robots sold annually by the decade's end will be equipped with vision. In addition, by 1990, the worldwide market for robot-vision systems could amount to more than $750 million, says John Artley, president and chief executive officer at Object Recognition Systems Inc., another Princeton, N. J., vision-system supplier.

As with the fledgling robot business itself, the perceived potential for vision is attracting a growing number of new suppliers. Altogether, machine-vision components or systems are currently supplied by about 35 companies, about a quarter of which have entered the market within the last year, says Perry C. West of Automated Vision Systems, a Campbell, Calif., consulting firm.

"The venture-capital market is beginning to ante up more and more for vision companies just as it did for robot companies a couple of years ago," points out Laura Conigliaro, a vice president with Bache Halsey Stuart Shields Inc. in New York, "and that leading indicator means



Workers. From Automatix are three models: top left, the Autovision III visual-sensing system; above, the Cybervision robot assembly system that can be equipped with Autovision for robot arm guidance or inspection of parts; and, at left, the Robovision arc-welding system.

that three to seven years from now we'll begin to get a real proliferation in the use of vision systems."

Native Californians. Interestingly, of some 15 vision systems on display at the Robots VI show, about half trace their origins at least in part to a vision module developed in the 1970s under government funding at SRI International, Menlo Park, Calif. (see p. 14). In general, these systems rely upon binary image processing in which thresholding circuitry is used to assign a 1 or a 0 to each picture element corresponding to black or white.

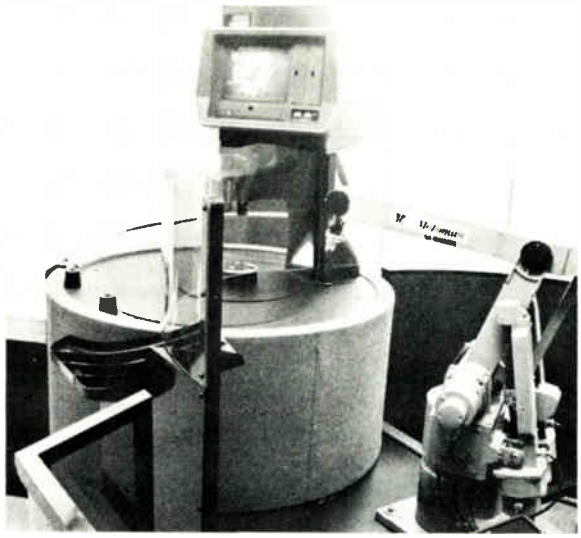
As a result, objects in a scene are reduced to silhouettes. A software approach known as connectivity analysis breaks up the binary image into its connected components, enabling the system to build up and then store information on each connected "blob" (either an object or a hole) in the scene. Recognition of an object is achieved by comparing objects or features in the scene with the image of known objects shown earlier to the system—a technique known as training by showing.

A prime example of a robot-suitable vision system based on the SRI approach is the $35,000 VS-100 from Machine Intelligence Corp., Sunnyvale, Calif. The SRI origins of this system are not surprising because the company was founded in 1978 by former SRI project leader Charles Rosen.

Utilitarian. The VS-100 employs an LSI 11/2 with a 64-K-byte memory to handle image-processing tasks and can work with one to four solid-state or vidicon cameras. It can join a robot for tasks like recognizing and picking up randomly oriented parts on a conveyor belt. The Univision I system offered by robot industry leader Unimation Inc. of Danbury, Conn., for one, mates a VS-100 with its Puma-series robots.

The binary-processing technique used in the SRI approach can speed system cycle times by reducing the amount of video data to be handled. However, its limitations include the need for special lighting and high-contrast backgrounds—requirements that critics say are difficult to meet in the typical factory—and an inability to recognize objects lying on top of one another.

Such problems are already being addressed by some suppliers with systems said to be capable of some gray-scale image processing and other enhancements. Indeed, many industry observers expect that designers of future vision systems will employ very large-scale-integration techniques to build special-purpose vision computers with multiple processors and highly parallel architectures for handling vast amounts of visual data quickly.



Long look. Noncontact dimensional inspection is being performed at the Robots VI show in Detroit last month by a system from Machine Intelligence Corp. of Sunnyvale, Calif.

One firm regarded for its innovative approach to integrated robot systems, including vision, is Automatix Inc., a 2-year-old Burlington, Mass., firm. The set of vision algorithms used in its Autovision II system draws from "the best of three ancestors," says president Philippe Villers: the SRI system, the Consight system developed at General Motors, and an arm-mounted camera vision system developed at the National Bureau of Standards.

Employing a bit-slice preprocessor board for camera interfacing and other functions, the Autovision II is capable of processing 16 gray levels. The unit is designed as a stand-alone inspection system or for use in an integrated fashion with the Automatix A132 robot controller, a 68000-based processor that Villers says was "designed for vision from the ground up."

Two shown. Automatix demotrated two integrated robot-vision systems at Robots VI: a programmable assembly system known as Cybervision III that uses the company's AID-600 robot and a single-pass vision-directed arc-welding system known as Robovision IIA. Both are scheduled to be available by mid-year. The Cybervision III with vision will start at slightly more than $100,000, and the Robovision IIA will start at $130,000.

A unique robot-vision demonstration at Robots VI came from Object Recognition Systems. Tapping research done at the University of Rhode Island in Kingston, the company used a Puma 600 robot in a single overhead camera system for picking felt-tip pens jumbled randomly in a bin.

The necessity for such a bin-picking capability by industrial robots has been a subject for debate within the industry. Critics contend that the function could easily be handled with such techniques as bowl feeders or shakers that dump parts one at a time on a conveyor belt. On the other hand, Object Recognition senior scientist Joseph Wilder contends it is "premature to say that bin picking is not an important problem."

Showing its stuff. Though the bin-picking robot worked somewhat sporadically at Robots VI, with cycle time ranging in some cases up to 35 seconds, company officials stress the unit was set up only to demonstrate capability. The demonstration system employed an 8-bit Intel microprocessor, says Wilder.

The firm is currently evaluating 16-bit microprocessor families with an eye toward producing a production-level bin-picking system with 1-to-2-second cycle times that will also integrate other vision capabilities. That system is scheduled to become available late this year or early in 1982. □

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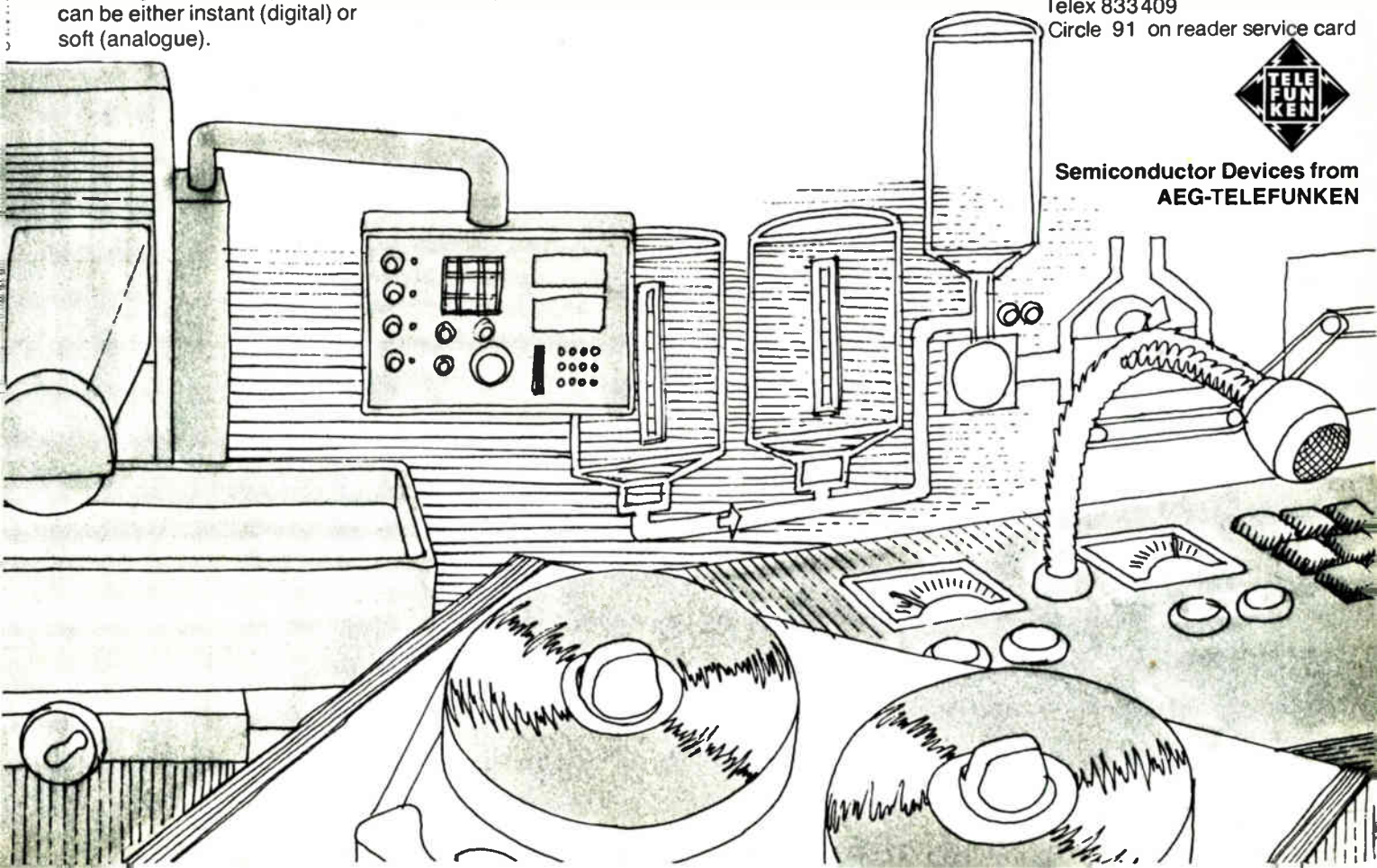

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Instrumentation

Upturn due, instrument makers told

New forecast holds that slowdown in growth rate will end with upturn continuing through 1984

by Martin Marshall, San Francisco regional bureau

It's no news that the instrumentation market has softened. But now leaders in the industry have been told that business should pick up.

They got the word late last month in Monterey, Calif., when 150 of them attended the annual instrumentation industry conference held by Dataquest Inc., the Cupertino, Calif., market research firm. Dataquest senior analyst Charles Taylor told them that "1981 should be the last year that we see a decreasing growth rate in the instrumentation industry—at least for the current business cycle."

Taylor treated his audience to a glimpse not just of Dataquest's 1982 forecasts, but an overall analysis through 1986. And the forecasts were encouraging—at least through 1984, when the prediction is for another slowdown in growth rates. Taylor ascribes that deceleration to forces in the general economy predicted for that time.

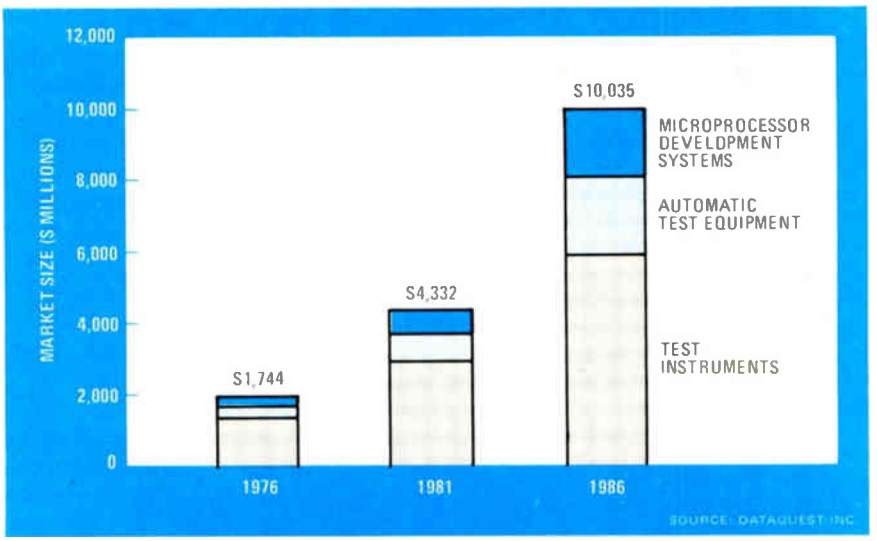
He also pointed to some hard numbers accumulated for 1981. "In the U. S., instrumentation orders picked up during the fourth quarter, although the short-term economic outlook remains uncertain," he says. As an industry, instrumentation reached a total market of $4.332 billion in 1981, with microprocessor development systems accounting for $398 million of the total, automatic test equipment registering $880 million, and other test instruments comprising the bulk at $3.054 billion. "The majority of instrumentation companies maintained a cautious posture through 1981," Taylor points out. "Discretionary spending was cut back and in some cases there was a reduction in the level of employment in the industry."

There was a good reason for such strategies. Though absolute dollar values were increasing over the past few years, microprocessor development systems were the only major instrumentation category that grew more than it had the previous year. In automatic test equipment, the growth rate slowed from 35% in 1980 to only 10% in 1981, due to the reluctance of ATE customers to make large capital outlays during a recession. The total test instrumentation industry has undergone a slowdown in growth—from 26% in 1979 to 19% in 1980 to 11% in 1981.

Regarding oscilloscopes, Taylor notes they "got a shot in the arm because of the microprocessor, but in general [their] annual growth rate . . . has been declining since the late 1970s. In some cases, scopes have been displaced by specialized instrumentation." The scope market last year rose 5.9%, to $715 million in 1981, up from $675 million in 1980. The compound annual growth rate over the past five years was 15.7% from a $345 million level in 1976.

The leaders. As was to be expected, Dataquest credits Tektronix Inc. with the lion's share of the scope market. The Beaverton, Ore., company is followed in order by Hewlett-Packard, Philips, Gould, and Nicolet. All others account for a small market share. Though the figures showed that the Japanese scope makers have yet to place a company in one of the top five positions, U. S. manufacturers should not become too complacent. Japanese companies place sixth through tenth in the 1981 market ranking, according to Dataquest.

The highest growth area in the scope market during 1981 was in low-cost models (under $1,500), primarily paced by last year's introduc-



Better times coming. Although there has been a slowing growth rate in sales of instruments, Dataquest believes that activity will quicken and move upward through 1984.

tion of the Tektronix 2200 series. Low-cost scopes as a group showed sales of $90 million in 1981, for a growth of 12.5% over the previous year. Portable scopes remained the dominant force in the scope industry, weighing in with $415 million in sales, a 6.4% growth over 1980.

The second largest piece of the general-purpose test instruments market, the digital multimeter, registered $230 million in sales in 1981, with system DMMs growing at 12.5% to $72 million, bench meters slumping 1.6% to $63 million, portable bench meters showing a rise of 8% to $27 million, and handheld DMMs rising 9.7% to $68 million.

The market remains dominated by Fluke and Hewlett-Packard, followed by Keithley, Data Precision, Racal-Dana, Philips, and Beckman. The growth in the total DMM market was a modest 7.0% over 1980. In the handheld area, the increase was just 10% after growth of about 80% during 1980.

Cooling off. The growth rate of the logic analyzer market is not as meteoric as it was, but the logic analyzer remains one of the brighter elements in the instrumentation sky. It showed a healthy 19.8% rise in 1981, up to $121 million from $101 million in 1980—somewhat slower than its 46.4% compounded annual growth rate over the past five years. Taylor broke up the market into logic-timing analyzers (those machines used primarily for high-speed, asynchronous measurements), state analyzers (which offer more channels and use the system clock), and combination of the two. "Hewlett-Packard still has a strong orientation toward state analyzers, although it is currently trying to link the logic analyzer to the microprocessor development system," he notes (see p. 47). "Biomation has leaned toward combination analyzers, and that approach is currently doing very well, especially in Japan."

The logic analyzer market is split surprisingly evenly, with the major players all placing heavy research and marketing emphasis on what they perceive to be a hot, growing market. The three leaders, Hewlett-Packard, Gould/Biomation, and Tektronix are about even, followed by Dolch, Nicolet/Paratronics, and the rest. Growth in the timing analyzer market was essentially flat last year at $5 million, while both state analyzers at $24 million and combination analyzers at $92 million registered growth rates of over 20%.

Sitting pretty. The healthiest of all segments in 1981 was the microprocessor development system market. It registered a 35.4% growth in 1981 to $398 million from 1980's $294 million. Universal systems—those that can handle more than one vendor's microprocessors—showed the strongest growth at 42.4%, reaching $94 million. Dedicated versions, such as those by Intel, Motorola, and National, retained 76% of the market, however, posting a 33.3% growth of $304 million in 1981. Taylor attributed the strong growth to heavy new product development in the industry with a particular emphasis on the increase in 16-bit system design starts. "The average selling price has also moved up because of this emphasis on 16-bit systems," Taylor adds.

Intel still has the largest share of the development system market, which, Taylor claims, "makes Intel the fifth-largest instrumentation manufacturer overall, just based upon its development system business." The distant seconds are Motorola, Hewlett-Packard, Tektronix, and National Semiconductor. Distributor markups and all other vendors combine to form the rest of the market. In looking toward the future, Taylor points to a $1.21 billion market for development systems in 1986, using current dollars as a base.

Growth of 15%. Although obtaining accurate figures on recent shipments of the different types of instrumentation is hard enough to accomplish, coming up with an accurate forecast of the coming year's totals is even riskier business. Nonetheless, Taylor sees an improving picture for instrumentation in 1982, with a total growth of 15.3%, paced by a 26.9% growth in microprocessor development systems, a 15.3% gain in automated test equipment, and a 13.8% gain by general test instrumentation. □

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Telecommunications

Will Britain be rewired?

The government wants to push on with a $4.5 billion project involving direct-broadcast satellites and narrowcasting

by Kevin Smith, London bureau manager

The United Kingdom is poised on the brink of an ambitious project to rewire its cities with broadband cable networks. For an investment of $4.5 billion, says a blueprint report from the Cabinet Office's Information Technology Advisory Panel, half of Britain's homes could have access to a modern cable-television system piping in direct satellite broadcasts and narrowcast services such as local news, not to mention providing banking, armchair shopping, security, and other interactive services.

The project, which has already won Cabinet approval and awaits the results of an inquiry into its impact on broadcasting, could provide a shot in the arm for the UK's aerospace and consumer industries and indirectly, the office equipment business. Moreover, by freeing the cable networks to compete with the establishment broadcast networks the scheme will be made self-financing, generating revenues of $2 billion a year.

In March the government underscored its support for the cable-TV project by authorizing Britain's first direct-broadcast satellite, to be launched in 1986. The big incentive to potential regional cable franchise operations is the prospect of piping the first direct satellite broadcasts into UK homes. The $208 million project will be financed by British Aerospace, British Telecom, and Marconi Space & Defence Systems Ltd., part of the British General Electric Co. Ltd. conglomerate.

It will carry business as well as direct-broadcast transponders transmitting two new British Broadcasting Corp. services. Ultimately there could be five channels as the nation's independent broadcasting authority joins in. At least four other services are planned in Europe that could be distributed internationally.

Subscribers could bypass the cable network, picking up satellite broadcasts from small rooftop antennas. However, says the government-commissioned report on cable systems, the high cost will deter most viewers. Instead, they could pay, say, $10 a month to receive satellite broadcasts beamed to more sensitive 3-meter community antennas and relayed to their homes over the cable network. The report says that a domestic rooftop antenna might cost in the region of $760 with an additional $187 installation charge.

The ITAP report, prepared by six industry figures, concludes that U. S. experience indicates that cable systems and direct broadcasting are mutually complementary. It urges immediate action to put the first networks in place before the UK satellite is lofted.

The government has responded by ordering an urgent three-man inquiry into the impact of cable TV on British broadcasting with a report due by September. Warning that any delay would have the same consequences as a rejection, the report wants a UK technical standard for the new network settled by year-end, with any legislative hurdles cleared by 1983—that is, before the next general election.

Hands on. Midway through its first term in office, the government has good reason to give the project top priority. Compared with Japan's government-driven programs and

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MCT

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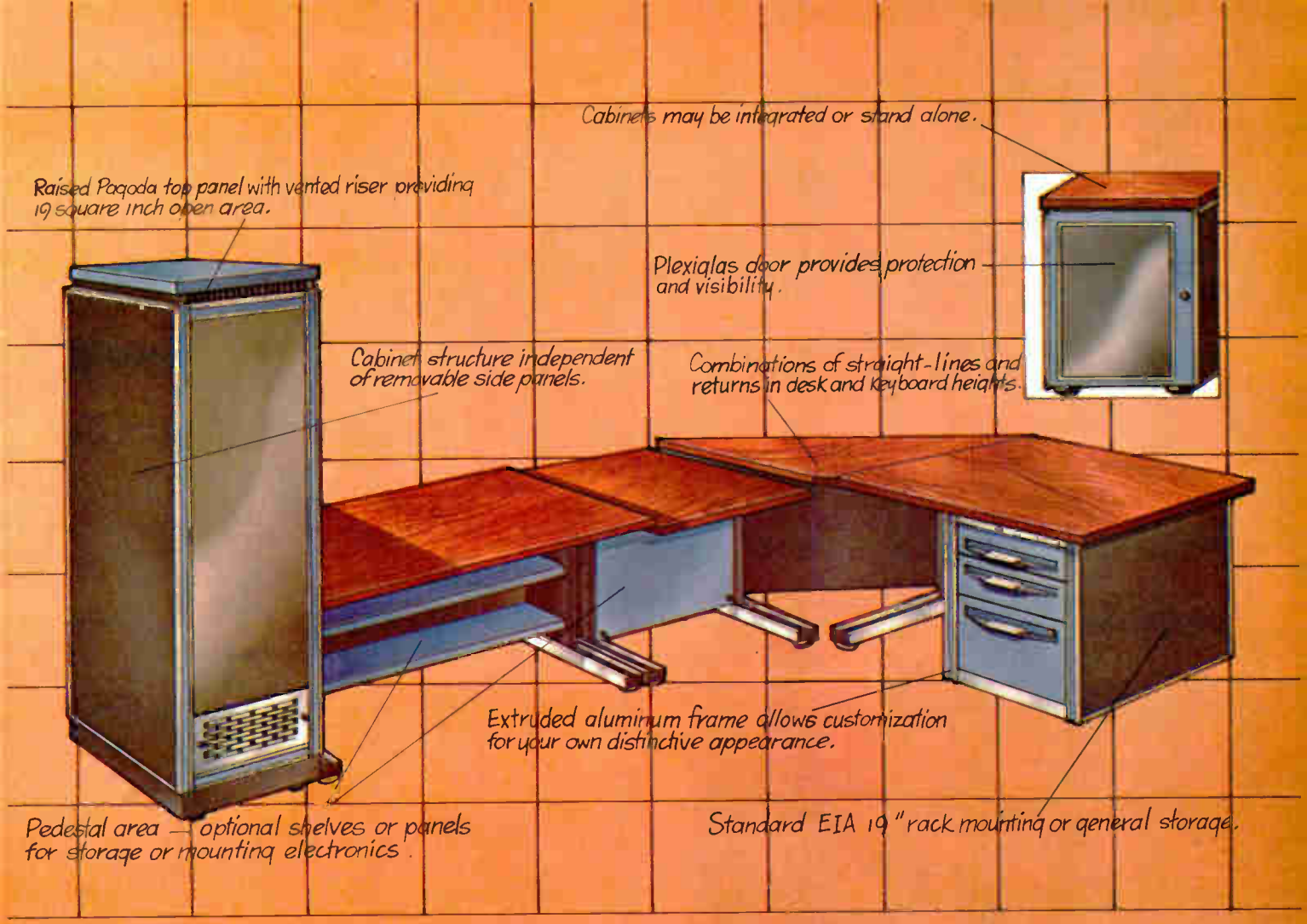
France's initiatives, the Conservatives' early hands-off industrial policy is looking decidedly threadbare. Now, by riding the crest of a technological wave, it hopes to propel British industry to the fore in satellite and fiber-optic technology at no cost to the taxpayer.

Britain's antiquated cable networks are due for a face-lift. This new initiative would allow UK operators to move directly to the latest broadband switched-cable-TV technology on the line of Japan's Hi-Ovis or France's Biarritz schemes. The British Rediffusion Group already has such a system in operation experimentally and is likely to play a lead role in setting standards.

In concept, 350-megahertz wideband fiber-optic systems would feed street-mounted head-end switching units, each serving 50 to 100 houses. Individual subscribers would be able to select from 30 or more channels. Up to five independent channels could be piped into each subscriber's home over conventional 35-MHz coaxial cable. Fiber-optic links could eventually be used as the price becomes right, says Rediffusion.

Nonetheless, the road to a single British standard may not be all that smooth. Significantly, the report warns that the technical standards of the network should not pay too much attention to any eventual integration with the national telecommunications network. British Telecom, it says, could certainly have a role to play, linking regional cable-TV networks and as a cable-TV operator in its own right. However, it should not be dominant in the role of setting standards; otherwise there is a risk of "over-engineering" and a consequent reduction in commercial incentive.

There is also a case for sharing underground ducts with British Telecom and even providing shared fiber-optic cable runs. In fact, one plan under consideration by Britain's Department of Industry calls for a start on modernizing Britain's local telecommunications network, but that pump-priming exercise would probably require taxpayer money and might not be viewed kindly by Prime Minister Thatcher. □



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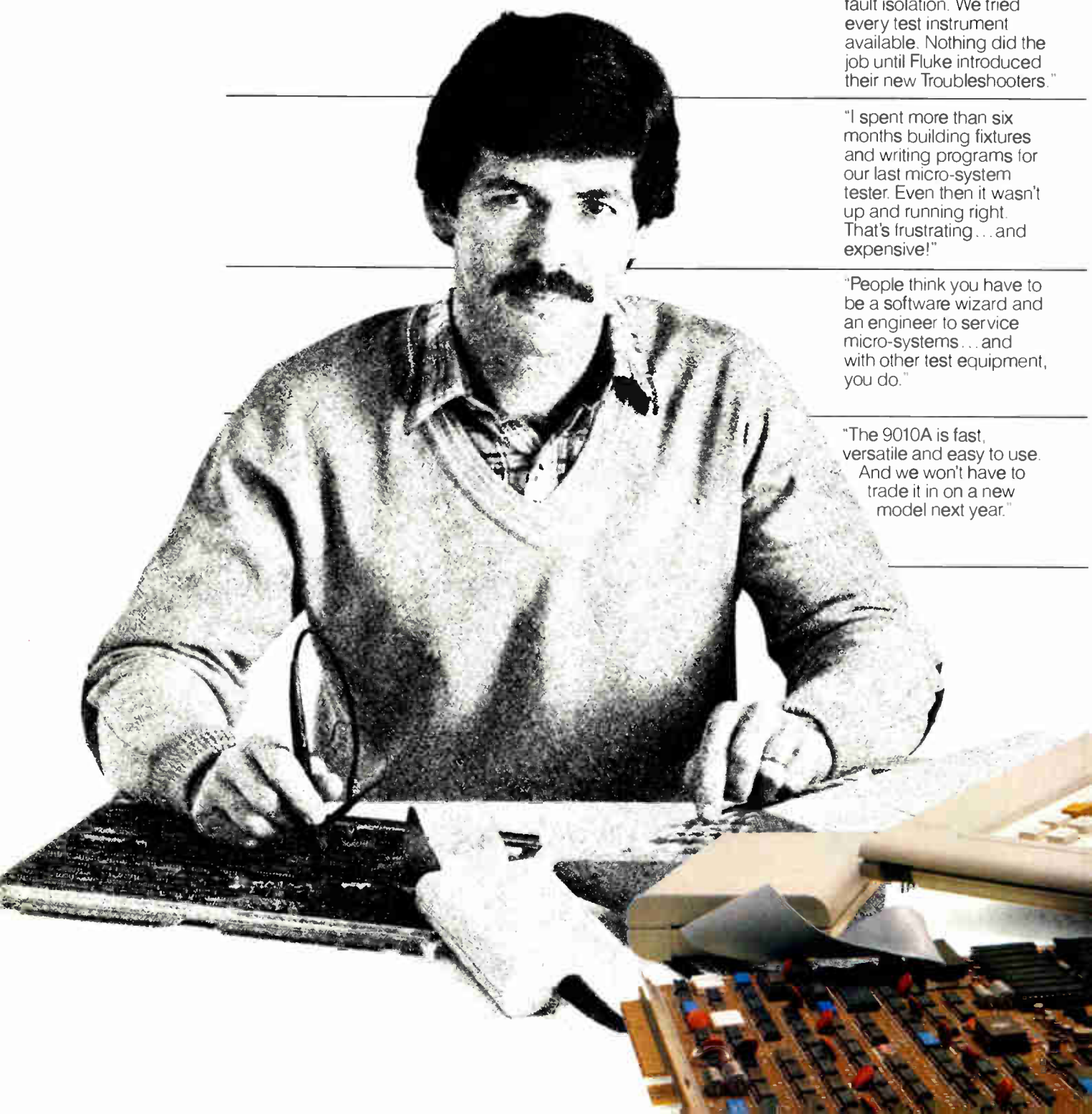

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Companies

At Motorola, balance bucks recession

Semiconductor sales last year rose 8% despite U. S. decline of 6%; company and industry watchers credit product mix

by Larry Waller, Los Angeles bureau

The first estimates now trickling in that show a 1% drop in 1981 world semiconductor shipments contain few surprises for industry executives and canny observers. For example, they have recognized that hard-charging Japanese firms with their MOS parts were gaining fast on U. S. rivals. Indeed, the Japanese racked up an estimated 25% rise, while U. S. sales fell 6%, according to a preliminary report from Dataquest Inc., the Cupertino, Calif., market-research firm [*Electronics*, March 24, p. 33].

Causing something of an industry stir, however, is the performance of Motorola Inc.'s Semiconductor Group, which grew 8% in the teeth of both a recession and the Japanese onslaught. Moreover, there is a marked contrast with the company's performance in the last recession. "Of all the major companies, they did the worst in 1974–75. This time they did the best," comments James Magid, technology analyst for the Wall Street firm L. F. Rothschild Unterberg, Towbin.

In that recession, the Motorola semiconductor operations went deeply into the red for six quarters, to the tune of an estimated $60 million or so loss. For 1981, it reported $1.28 billion in sales and $131 million in profits. The profits may be down from 1980's $187 million but still lead those of its U. S. high-technology rivals.

As might be expected, Motorola is coming under intense scrutiny from competitors and financial analysts alike who are eager to dig out any secrets of success. But the cause turns out to be so obvious that it only becomes apparent during a recession, when the fast-moving glamour components often hit turbulent air pockets of softer demand and price cutting. "Their strength is in a balanced product mix that does not expose them too much in any one segment," points out research vice president James Barlage of New York's Smith Barney, Harris Upham & Co. Other Wall Street sources concur.

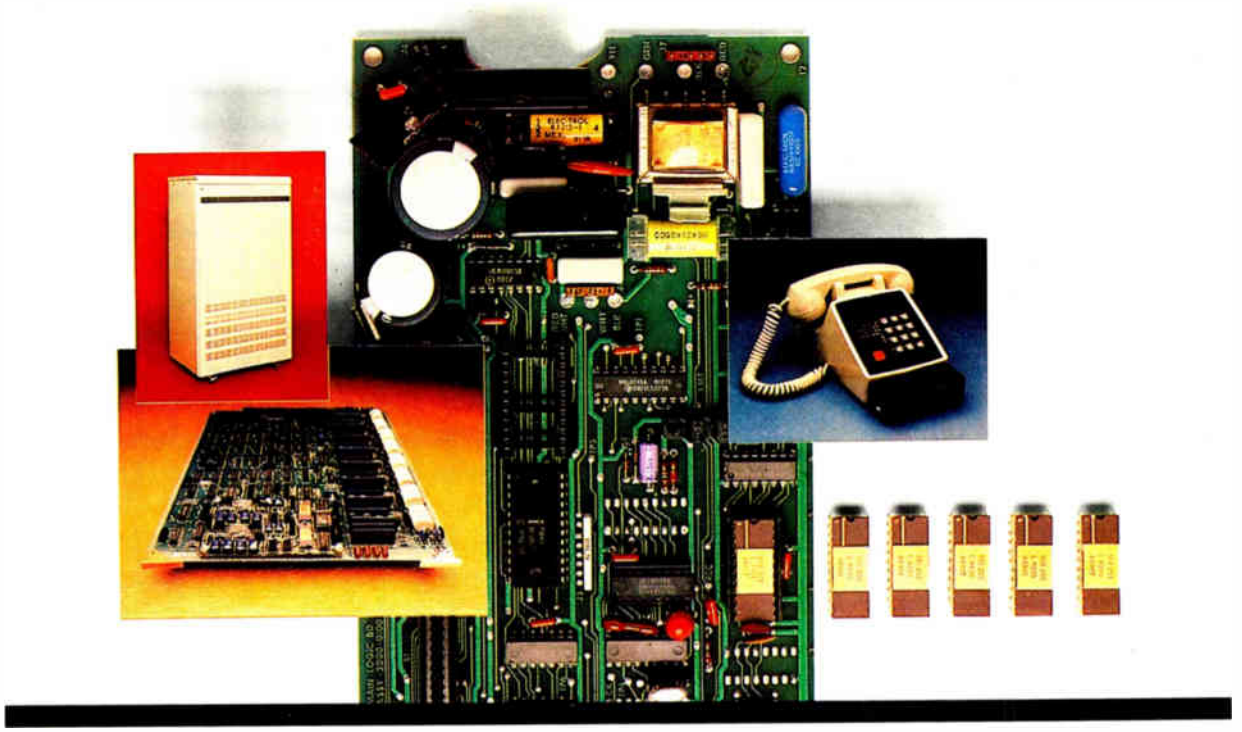
Not surprisingly, so does Charles Thompson, Motorola vice president and director of world marketing, who credits his firm's "broad products portfolio." Furthermore, the veteran executive says this balance is more than just defensive. Many products introduced over the past several years target growth niches that competitors overlook, he says.

Leaders. Gary Tooker, above, is general manager of Motorola's Semiconductor Group. Al Stein, left, shares credit for pulling it out of its 1970s nosedive.

The staid discrete components business is a good example, noted by all observers, which Motorola expanded with investment in product improvements, although rivals Texas Instruments Inc. and National Semiconductor Corp. played it down. Even in last year's sluggish market, the Phoenix-based semiconductor group pushed sales up to some $465 million from $430 million. Thompson observes, "Our competitors are backing away from discretes," and his firm is happy to fill the void. In profitability, business in discretes holds up nicely, "since they're not impacted by price cutting like MOS," notes Smith Barney's Barlage.

Sticking to it. The strategy of selling discretes in ever bigger volumes as "glue" chips that support new microprocessor applications plays a key role, too, and Thompson says that since 1980 several such projects "grew from zero to several million units." One of them controls under-the-hood works of automobiles with a custom 6800-family microprocessor package, including discretes, for which Motorola gets more than $40.

Another stellar performer is the Bipolar IC division, where a stream of integrated-circuit introductions inflated sales to some $390 million. Although Motorola does not itself split out division results, Wall Street sources put pretax profit margins at about 10%. Henri Jarrat, vice president and division general manager, counts 229 new products in 1981, with 118 custom arrays, and an increase this year of 468, including 300 custom arrays. One example of a leading-edge product is the way



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Probing the news

the bipolar Mosaic (Motorola oxide self-aligned implanted circuit) process is being put to work building faster, denser memories, says Jarrat.

Only in MOS products did Motorola trip up, with sales slipping to $390 million from $450 million, according to Dataquest. It likely lost money in MOS memories, along with most other firms, but not as much because, as Thompson points out, "less than 5% of our sales came from these." Not being a factor in 16-K random-access-memory parts worked in Motorola's favor since "this is where the price-cutting bloodbath took place."

Planned growth. Even competitors admit that Motorola's heavyweight market stance grew not haphazardly, but by plan from forceful management decisions. Interestingly, the two prime movers are gone: John R. Welty, who as general manager guided the Semiconductor Group out of the dark days of 1974–75 [*Electronics*, Nov. 13, 1975, p. 96], and Alfred J. Stein, lured from TI in 1976 to rationalize product lines and, most critically, to straighten out process troubles. Welty was promoted to Motorola's corporate suite last year, and Stein is now at VLSI Technology Inc. after a short stint as president of distributor Arrow Electronics Inc. He resigned in mid-1981 over differences with Motorola corporate officers.

The combination of Welty's deft handling of business matters and Stein's hard-driving, shirt-sleeve approach that refurbished IC operations from top to bottom are together credited with giving Motorola its present muscle. The successor to Welty is youthful Gary Tooker, 42, who has kept a low profile since taking over last summer. He previously ran Motorola's international operations and before that, discretes.

Tooker, however, still must be regarded as a question mark. He has relatively little top-management background in ICs and so far has not shared his views in any depth with either financial analysts or industry media. His close-mouthed approach worries some on Wall Street. "Whatever his professional capabilities are, he remains a cipher to us," remarks L. F. Rothschilds' Magid. Others suspect Tooker is being held in tight rein by corporate management, which does not want to risk hard-won semiconductor gains with bold moves that might backfire. Smith Barney's Barlage, bullish on Motorola, disagrees, saying he sees Tooker "having a firm handle on direction."

Going easy. If Tooker becomes more comfortable in his post, and hence more available, he likely will dispel many doubts. But one influential analyst cautions that he sees signs the newcomer is becoming more conservative than his predecessors. "This may limit up-side potential," notes Michael Krasko, vice president for technology research at Merrill Lynch, Pierce, Fenner & Smith, New York. In fact, Krasko thinks disturbing signs already could be surfacing with Motorola's 64-K RAM: the 300,000 monthly production rate cannot fill orders. Stepped-up rates are still seven months out, he says, "and if an upturn occurs in the meantime, it could lose critical market share." Motorola's Thompson confirms "we're selling all the 64-Ks we're building," but declines to speculate on future rates.

A key factor for the future centers on how Motorola's 16-bit 68000 microprocessor family is doing against Intel Corp.'s established 8086 in penetrating new systems. Opinions vary, but Krasko thinks "Motorola is winning the 16-bit battle handily." Others put the present design-in market share as split almost evenly, and even analyst Magid, a strong Intel proponent, gives the nod to the 68000 for high-end, most-sophisticated applications.

In the fickle semiconductor business, with its roller-coaster dips and ascents, many are loath to go out on a near-term limb, but the consensus is that Motorola has a bright outlook. Says Barlage, "Everything already is in place" for a continued surge. He and others single out operating managers Jarrat and Murray Goldman, who runs MOS operations, as "unsung heroes who deserve recognition." Coming in for praise, too, is William J. Howard, vice president of technology and strategic planning, whose influence is growing. □

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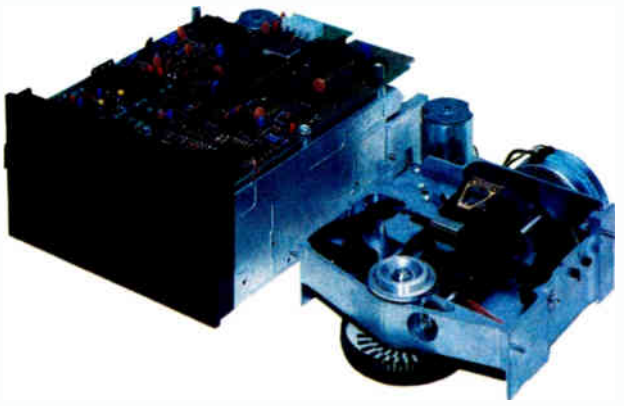

Left: Model 1115 with industry standard mounting holes and bezel. Right: Inner chassis, model 1105, available separately for integration into OEM systems.

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SY2316B-3	2048x8	300ns	98mA	–	24	2716
SY2332	4096x8	450ns	100mA	–	24	TMS2532
SY2332-3	4096x8	300ns	100mA	–	24	TMS2532
SY2333	4096x8	450ns	100mA	–	24	2732
SY2333-3	4096x8	300ns	100mA	–	24	2732
SY2364	8192x8	450ns	100mA	–	24	TMS2564
SY2364-2	8192x8	200ns	100mA	–	24	TMS2564
SY2364-3	8192x8	300ns	100mA	–	24	TMS2564
SY2364A	8192x8	450ns	100mA	12mA	24	TMS2564
SY2364A-2	8192x8	200ns	100mA	12mA	24	TMS2564
SY2364A-3	8192x8	300ns	100mA	12mA	24	TMS2564
SY2365	8192x8	450ns	100mA	–	28	2764
SY2365-2	8192x8	200ns	100mA	–	28	2764
SY2365-3	8192x8	300ns	100mA	–	28	2764
SY2365A	8192x8	450ns	100mA	12mA	28	2764
SY2365A-2	8192x8	200ns	100mA	12mA	28	2764
SY2365A-3	8192x8	300ns	100mA	12mA	28	2764
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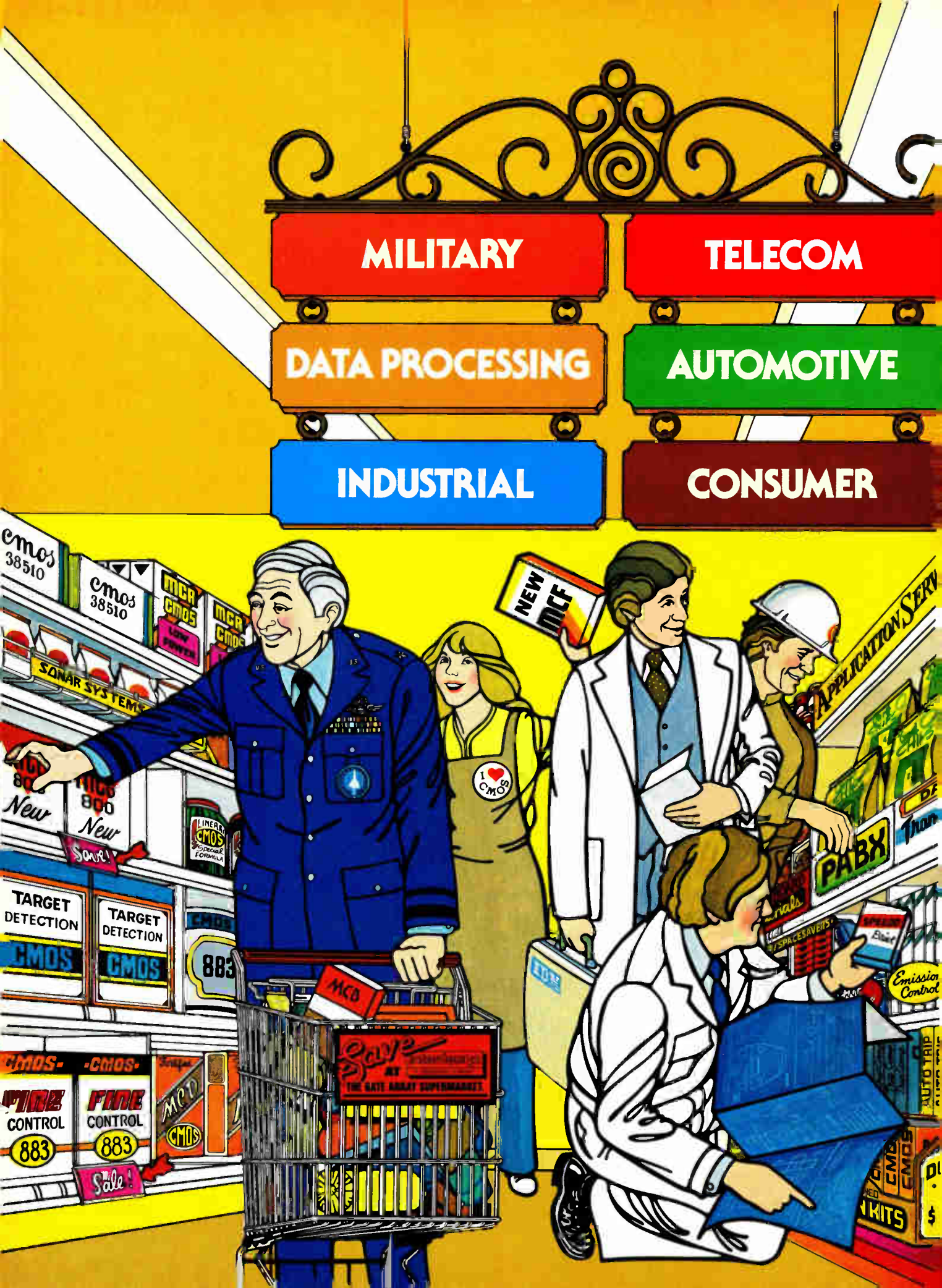
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Automation promises to lighten the field-service load

Among the aids for increasingly complex troubleshooting are remote diagnosis, smarter service tools, and self-testing chips

by Richard W. Comerford, *Test, Measurement, & Control Editor*

☐ Help is on the way for the overburdened service technician. New service strategies, self-testing systems, and new kinds of automated testing tools are beginning to lighten the ever-increasing load placed on field-maintenance organizations.

Much of the burden may be traced to the spread of complex electronic systems into many new applications. The number of machines to be serviced has outstripped the supply of technicians; worse, the manpower pool has been dwindling. What's more, the systems are becoming so complex that tracing faults takes much longer.

Many service organizations are striving to increase the efficiency of their operations through such tactics as better management of board float. However, such remedies are not enough to stem the tide of work that threatens to engulf the service technician.

Therefore equipment manufacturers are designing their products to incorporate self-testing features and to facilitate remote diagnosis of malfunctions in field equipment. Further, instrumentation companies are introducing powerful new gear that automates many troubleshooting tasks. The bottom line, as always, is measured in dollars and cents, and the demand in field maintenance is to control the mushrooming costs of servicing customer equipment.

The cost of keeping up

One change in service in the past few years is the rise of board swapping as the predominant means of field support, according to Doak Hefner, systems division manager of technical support for Triumph-Adler's subsidiary, Pertec Computer Corp. in Irvine, Calif. "The increased demand by customers to keep the system up has resulted in this philosophical change in the past four years," he says. Although this approach does result in faster service, he points out, "it's very expensive, in terms of spares inventory."

The ascendancy of board swapping over on-site repair is due to the changing nature of the electronics business itself. The electronics industries once dealt primarily with technical specialists who understood and made allowances for repair of complex systems, but today's typical user is more likely to be a businessman who sees dollars flying out the window for every second of downtime for his system—whether it be a mainframe computer or an electronic cash register. Thus, his primary concern is to get the system working; the cause of the failure can be found later.

Gains in repair speed, however, have come at the expense of rising parts cost. "Whereas a service person would once carry a couple of dollars worth of components on site, he now has to have a couple of thousand dollars worth of boards," remarks senior engineer James Bussert of ManTech Inc., San Diego, Calif. Moreover, supplying those boards to the technician is just one link of a cycle referred to as the board float.

The board float, or spare-board supply cycle, is typically a four-part process (Fig. 1a) that begins when the technician swaps boards in a system. The boards he removes must be shipped to a repair facility, where they are next tested. When the cause of the failure is found, the boards move to a repair area and are fixed. Once repaired, the circle is closed by placing the boards back into the field-support stock, from which the technicians draw when they make a service call.

The estimated worldwide cost of inventory in this loop is about $9 billion, according to J. Thomas Zender, until recently with GenRad Inc.'s Service Products division in Phoenix, Ariz. In many companies, the field-spares inventory represents 5% of their total assets. The investment, coupled with the increased cost of service calls and personnel, adds up to a total annual cost for field support of more than 15% of a product's price tag. For what a customer pays to support a system for six years, he could buy an extra one.

Decentralizing the float

To reduce board float, companies with large installed systems bases, such as Digital Equipment Corp., International Business Machines Corp., Xerox Corp., Sperry Univac, and General Electric Co., have added regional sites at which test and repair work can be done. This strategy (Fig. 1b) helps reduce board float in two ways.

First, it puts good boards back in stock more quickly. Since board swapping consists of replacing boards successively in, say, the arithmetic and logic unit of a large computer until the problem is solved, often several of the boards removed are actually good. However, a failure

can be due to the interaction between two or more boards, so those removed prior to the failure's disappearance must all be checked. Then, too, the failure can be due to connector contamination, which often is fixed by just removing the "bad" board.

No matter what the cause, Zender estimates that as many as 25% to 30% of the boards returned are actually good. Thus, the sooner boards can be returned to inventory, the fewer boards in the float.

The second way in which decentralization reduces the float is simply by getting repairs made faster. Rather than sending all support boards back to the factory, where they often must compete with new-product boards for test time, companies are letting service centers tackle many units of medium logical complexity with automated testers, signature analyzers, and processor-socket testers. Thus these boards return to stock sooner, and the factory need tackle only the high-technology units requiring more sophisticated test systems.

International help

The decentralization of test and repair facilities has been particularly helpful for companies that sell in the international markets. Pertec's Hefner points out that in many a foreign country, the repaired boards returned to that country must be the same ones that leave, or the item will be taxed as a new unit. Thus Pertec has a European central repair depot that treats boards on a country-by-country basis.

Since many small companies cannot afford the cost of supporting multiple repair facilities throughout the world, they have turned to the third-party service organizations to provide the support needed [*Electronics*, May 5, 1981, p. 108]. Generally, the original-equipment manufacturer and the service organization negotiate a fee for the support, based on whether the manufacturer will supply training, documentation, and spares and on a mutual estimate of the mean time between failures and the mean time to repair. Obviously, the OEM can greatly benefit from such an arrangement, if its product is designed for reliability, testability, and repairability. If the service company is efficient, the product will be well supported at a minimal cost to the manufacturer and thus at a minimum increment in the cost of the end product. In this way, smaller companies can compete head on with larger ones.

'Man in the van'

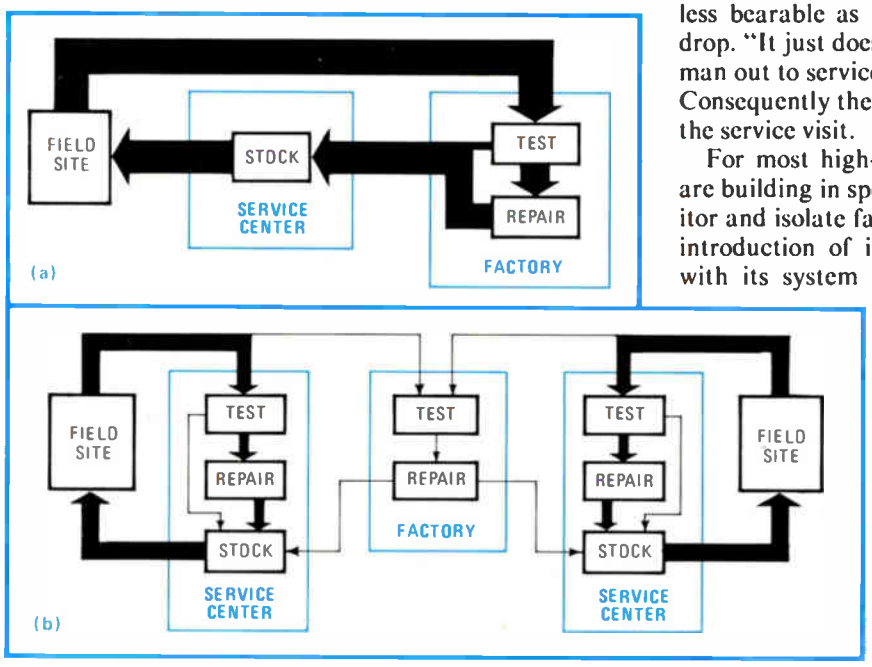
Although scattering many service locations around the world can help reduce the number of boards in the float, there is still the problem of reducing the personnel requirements of the service industry. There is almost universal agreement that the shortage of trained service personnel is at least as severe, if not more so, as in the electrical engineering profession. Many factors contribute to this shortage, most prominently the cessation of the supply of technicians trained by the U. S. military services.

Moreover, competition for existing technicians is high, with as much as 30% of the service force changing positions every year. Richard Turner, general manager of GE's instrument and communications service department in Schenectady, N. Y., says that about 15% of his force leaves each year.

"Often, they move to other organizations within the company, into production or supervision," he points out. Thus trained personnel do not always stay within the field-service area, and the industry cannibalizes itself. GE's way of trying to cope with the service crunch has been to start a school for technicians in which it trains its own personnel, as well as those from other service organizations. It also optimizes the use of existing personnel by keeping a data base of its technicians' various skills to match the repair man with each service problem.

Even using these techniques, the shortage will continue to worsen for some time, Turner and others believe (see "A really good technician is hard to find," opposite page). Further, the cost of a service call will be less and less bearable as it rises while system costs continue to drop. "It just doesn't make sense to spend $100 to send a man out to service a $500 terminal," Turner states flatly. Consequently the industry is searching for alternatives to the service visit.

For most high-end computer systems, manufacturers are building in special support-processor systems to monitor and isolate faults. This trend, begun by IBM with the introduction of its 4331 processor and Sperry Univac with its system 80, has also been upheld by Control



1. Away from home. Returning failed boards to the factory or central repair facility (a) most often creates a bottleneck that slows down repair—and the slower the flow, the more boards needed. Decentralizing the repair (b) means that boards get back into supply sooner and thus fewer are needed.

A really good technician is hard to find

The most common plaint heard in the electronics service industry is that it is getting harder and harder to recruit people with a high enough skill level to doctor modern malfunctions. The traditional source of such service technicians, the U. S. armed forces, dried up with the end of the draft, and even the military is having its difficulties finding people to service its electronic systems.

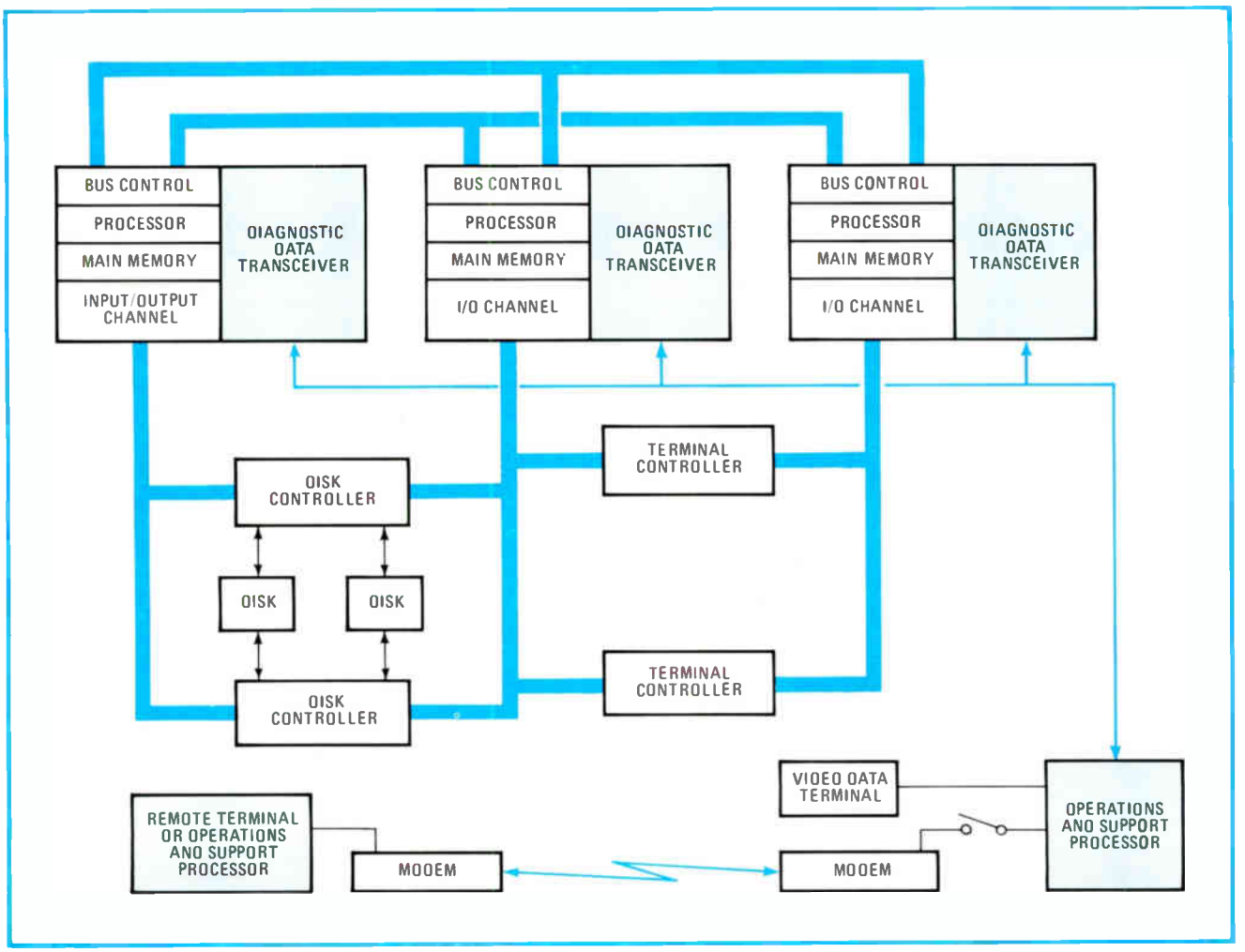
Training such individuals within a company does not seem to be a successful technique. According to one source in the industry, "we just manage to get a guy to the point where he's really useful to us, when somebody steals him." The company that invests in the training usually requires about two years' work from a technician in order to break even.

Although some independent two-year technical schools are graduating individuals with enough knowledge to be useful, such new employees require additional specialized training, which, in turn makes them more attractive to other companies. Moreover, the changing face of electronics servicing is making demands that most new technicians, whether tech school grads or not, are unprepared to meet, say many firms. For one, they say, the technician has to now have better interpersonal skills. With electronic gear going to nontechnical, less sympathetic users, the serviceman must try and soothe a customer who has no feel for the nature of the equipment.

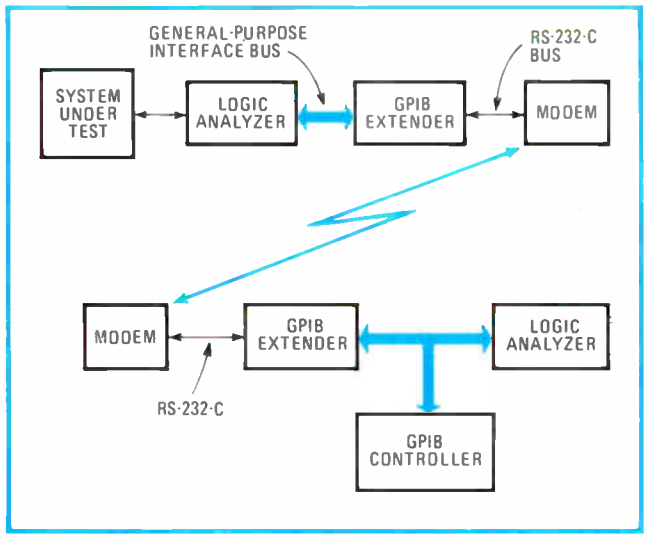
The technician may also have to become an educator, say, explaining to a customer why it is not such a good idea to use the Winchester drive as a coffee table. Also, because the technician is closest to the customer, the company often looks to him or her for details on how its product is really being used and what sort of features the customer would like in the next generation.

Companies that seem to be enjoying the best reputations in service seem to be doing so because they employ a well-paid, well-educated individual in that post. Hewlett-Packard Co.'s service force, for example, is made up of individuals with engineering degrees who have the same opportunities for advancement in the company as do most other engineers. However, such a service force seems to be a luxury that few companies can afford.

Thus, most companies are planning a threefold attack on service. They will boost product reliability to diminish the need for service, provide technicians with better tools to increase their efficiency, and establish more open relationships with customers to keep information flowing.



2. Modem operandi. In large systems, such as the Tandem Nonstop II, that must stay on line constantly, designers are not only building in on-line diagnosis systems, such as the operation and support processor, but also means for remote diagnosis of software through a modem.



3. Modem addendi. Systems without special diagnostic tools already built in can still be remotely diagnosed with the above configuration. Although such systems require more hardware, the tradeoff is that they save a service expert's costly time.

Data Corp., Minneapolis, Minn., with its Cyber 205 and most recently by Tandem in its NonStop II and Stratus in its system 32.

Tandem Computers Inc. of Cupertino, Calif., employs an architecture (Fig. 2) in which multiple parallel processors eliminate the possibility of catastrophic failure due to errors in a single central processing unit. In addition, associated with each of these major processor modules is a separate microprocessor, called the diagnostic data transceiver, or DDT, which monitors the status of the main communications bus, input/output channel processor, memory, the CPU, and the module's internal data paths.

The information gleaned by the DDT is communicated to the operations and service processor (OSP), housed in an operator's console supplied with the system. In addition to providing an operations interface with the system, the OSP allows hardware and software problems to be diagnosed on site or remotely.

For example, it can tell the DDT to put a module's main processor into a single-step mode and then monitor the contents of that CPU's registers before and after it executes a specific instruction. Remote diagnosis is accomplished by means of a modem built into the OSP, which communicates with a distant terminal or another OSP. This setup allows Tandem service personnel to diagnose and, in software cases particularly, even correct problems. To prevent unauthorized access, the modem is designed so that the system's user must initiate connection to the remote-diagnosis system.

Recently, Stratus Computers Inc. of Natick, Mass., has taken the "built-in technician" philosophy even further. Self-diagnosis and checking is built into each board of the system 32; when a board powers up, it executes an extensive set of diagnostic routines. If it fails any routine, a red light on the board goes on.

When a hardware error occurs, either at power up or during operation, the board sends a signal to inform the operating system of its status. A hardware-maintenance program then checks the board and records any component or circuitry failure in a system log. It tells the operating system that the board is unusable and signals the operator through a light on the console to replace the bad board at his convenience. If the fault is transitory in nature, it is logged, but the maintenance program turns off the light and releases the board for further use and collects more data.

Periodically, the maintenance program checks the comparator circuits on the board, which are used to sense faults. This check is done once a day automatically, but can be done more often at the user's request.

The program can also be called up over the system's remote-maintenance communications line, and software can also be serviced remotely. The operating system contains tools for debugging; but if these aids are not enough, faulty software can be partially or completely transferred to the service office, which has more powerful program-maintenance tools.

Capitalizing upon built-in facilities in each machine will undoubtedly be the means by which mainframe and larger minicomputer systems will be serviced remotely. At a recent conference, Pauline Nist, 11/780 engineering manager of DEC's Tewksbury, Mass., engineering center, Thomas A. Phillips, director of systems maintainability for Sperry Univac, in Blue Bell, Pa., and John W. Marvill, staff programmer of IBM's signal processor project office Research Triangle Park, N. C., all agreed that remote service would be an important part of their forthcoming strategies.

Retrofitting automated service

However, the existing base of sophisticated systems must also be serviced, and those systems were designed and sold before remote diagnosis was a serious consideration. Certainly, users will not want to abandon them simply to obtain remote capability.

Nor do they have to. Remote diagnostic capability can be added to existing systems through the use of tandem logic analyzers hooked together with modems. Gould Inc.'s Instrument Division Biomation operation, Santa Clara, Calif., has already performed demonstrations of such systems, which it refers to as Relags: remote logic-analysis General-Purpose Interface-Bus system.

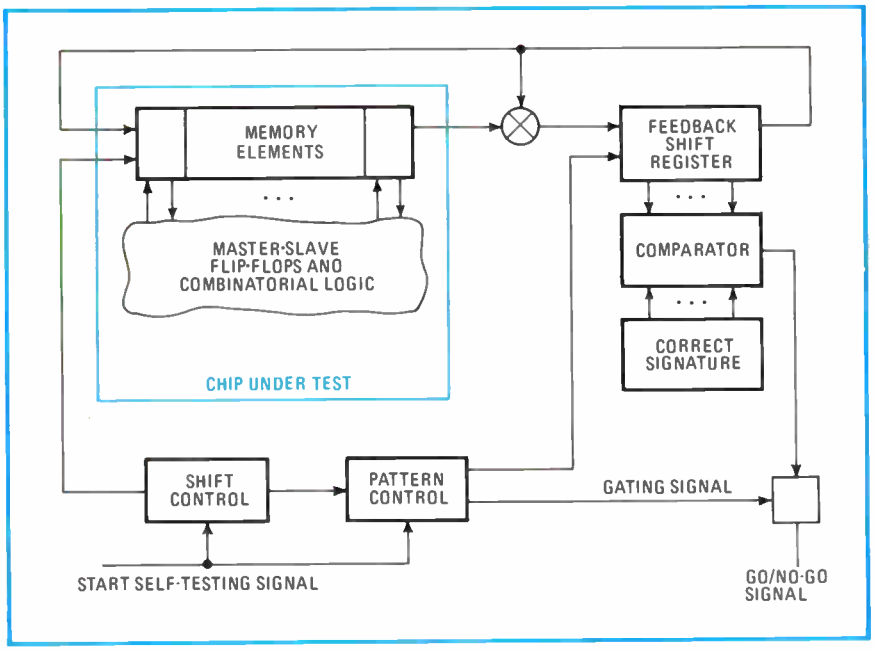
The most sophisticated Relags hardware is configured as shown in Fig. 3. Using both GPIB and RS-232-C links, this setup allows a troubleshooting expert to manipulate a remote logic analyzer as if he were actually on site.

After the logic-analyzer probes are connected on site, the expert can take over completely, setting up the unit to gather the appropriate data and transfer it back to his analyzer. Then the expert can interpret the data and instruct the on-site operator as to what type of repairs or board swap should be made.

In setting up this system, Biomation used its K100 and K101D analyzers, which have a comparison feature in which the expert downloads a pattern corresponding to correct operation. The on-site analyzer may be left to function on its own until an incorrect pattern occurs—thus making it possible to capture infrequent faults.

The modems are hard-wired, rather than acoustically coupled, so that adjustments can be made for line loss on

4. Self-service. Chips or boards that can diagnose themselves are the ultimate service systems. Such techniques, which may employ a special pattern controller against which chip outputs are checked, as does this example, do require more real estate—but reduced production and service costs generally are worth the price.



an unconditioned, switched network. The bus extenders perform cyclic redundancy checks to ensure that data is not lost, and RS-232-C lines with clock pins are used so that the modems can be run synchronously at speeds to 1.2 kilobits a second. At this speed, setup takes about 5 minutes. With conditioned lines, speeds up to 19.2 kb/s are possible.

Any number of logic analyzers can be used in a similar manner, and Tektronix Inc. has indicated that it foresees these types of applications for its DAS 9100 [*Electronics*, Sept. 8, 1981, p. 119]. A forthcoming analyzer from Hewlett-Packard Co.'s Colorado Springs, Colo., division, working as it will with a powerful minicomputer in the 64000 development system as well as in a stand-alone configuration, will also be extremely well-suited to such applications.

With any remote diagnostic systems, the major saving is in technician time. The expert service man need not travel to the site and can thus totally devote his time to solving a problem and locating a fault. Then too, other OEM experts are there to help with particularly thorny problems, so the level of technical help quickly available to the customer increases dramatically. If necessary, even the system's designer can be called in.

Service on a chip

Although remote diagnostics can do much to reduce service calls, the end result is still swapping out a board. As previously noted, the cost of board float today is staggering. Considering that future boards will contain a heavier mix of large-scale and very large-scale integrated circuits, their values are likely to rise astronomically.

Thus major companies that have or are developing captive semiconductor facilities are turning to self-testing ICs so that faults can be more easily isolated to the chip level. IBM, Sperry Univac, NV Philips Gloeilampenfabrieken, Nippon Electric Co., and GE have already developed or are working on VLSI chips that contain special test modes to determine, with as much as 99% confidence, whether they are functional (Fig. 4).

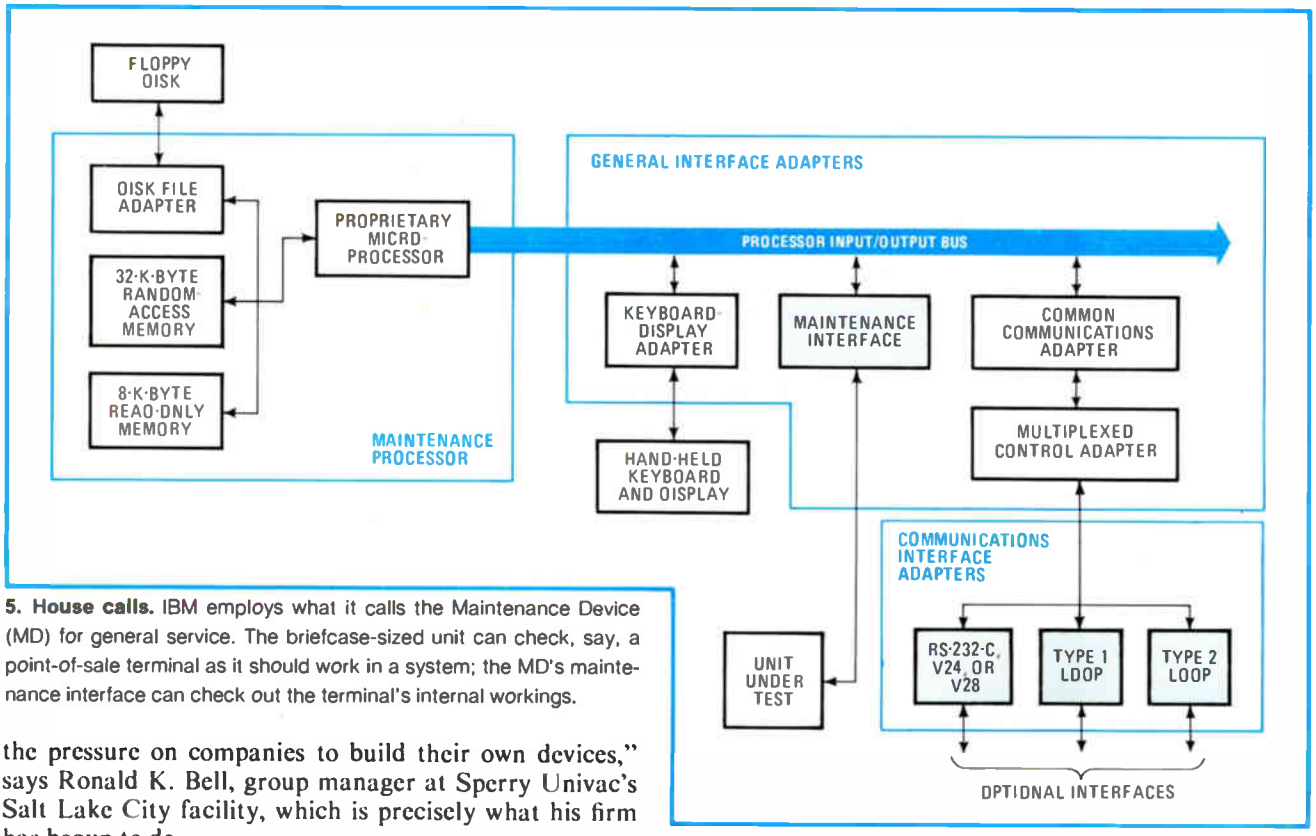
ICs developed by IBM and Sperry Univac can be put into a self-scanning mode, in which on-chip registers record what amounts to a cyclic-redundancy-check code. Using these chips and self-diagnostic programs, it is possible to isolate faults to an on-board VLSI chip. As for LSI parts, built-in board-testing features make it possible to isolate a failed IC even without on-chip self-test.

Whereas on-chip testing is quickly becoming a way of life for manufacturers with captive semiconductor facilities, the picture is not so bright for users of commercial parts. The primary demand that the commercial semiconductor manufacturers say they have been seeing is for greater IC functionality.

Although self-testing has been championed at the highest technological levels, most purchasers of commercial parts have not yet made it an important consideration. According to Robert Patrie, manager of the new-products test group for Zilog Inc. in Campbell, Calif., "the bulk of our sales are to people who don't do any chip testing at all."

Intel's component manufacturing manager at the special systems operation in Aloha, Ore., William Richardson, points out that customers have so far been demanding increased functions on chip, and that is where the competition has been. He also notes that adding 15% to 20% to a chip's real estate for self-testing would, after die sort, result in a doubling of a chip's cost—a premium he feels users have not shown they would be willing to pay. Motorola Inc.'s Thomas Gunter, high-end microprocessor operations manager for high-end and MOS components, in Austin, Texas, points out that, "we really don't know the marketplace well enough to be able to predict whether users will be willing to pay for self-testing." He notes that the 68000 has about 8% of its real estate devoted to self-testing, but "we get the 8% back in manufacturing effort saved."

Moreover, the failure to bite the self-testing bullet may backfire on the IC makers. This attitude has "put



5. House calls. IBM employs what it calls the Maintenance Device (MD) for general service. The briefcase-sized unit can check, say, a point-of-sale terminal as it should work in a system; the MD's maintenance interface can check out the terminal's internal workings.

the pressure on companies to build their own devices," says Ronald K. Bell, group manager at Sperry Univac's Salt Lake City facility, which is precisely what his firm has begun to do.

OEMs who have to rely on commercial chips are therefore left for now with quite a bit of homework. It is up to them to determine what the dollar value is for the benefits they could gain both on the production line and in the field through using self-testing chips.

Tektronix, which consumes on the order of 100,000 processors a year, has done such an evaluation and can see quick results. "Doubling the cost of the chip pays back almost instantly in terms of the reduction in time spent generating test software and system diagnostics for the product in which it will be used," claims Gary Nehr, instrument division engineering manager at the Beaverton, Ore., company.

If a systems maker can see such benefits, he has two recourses. One is to work more closely with other OEMs and the chip supplier to see if the latter is willing to make certain concessions to testability. In fact, user demand for testability is already beginning to have some impact on semiconductor makers. For example, Zilog's Patrie says that the Z800 single-chip processor will be much more testable than previous microprocessors, as it will sport a special test bus accessible to users.

The other recourse is to work with the semicustom gate-array houses to build chips with self-testing circuitry. At LSI Logic Corp., the Santa Clara, Calif., gate-array maker, engineering vice president Rob Walker encourages the use of such designs. "Such things as level-sensitive scan design are not really that complex to understand," he notes. "In practice, level-sensitive simply means use of a two-phased clock." Walker finds that, with a clear understanding of such techniques and with tools such as his firm's Logic Development System I, more firms are creating self-testing parts.

The cost of developing hardware and software for self-testing and remote diagnostics can, of course, price a product out of the market. Although companies such as DEC and Sperry Univac see a place for such capabilities, their overall strategy includes other service modalities, too. "We plan to take a multifaceted approach to service, using built-in test, remote diagnosis, and portable test systems," says Sperry's Phillips. "We will use them all."

Automated field tools

DEC's Nist concurs, outlining a three-tiered approach, in which large systems make maximum use of built-in service tools and remote diagnostics. For medium-sized systems, however, service tools will still be needed at the customer's site, she believes. Finally, for systems that are easily serviceable, local depots or service centers will repair units that the customers bring in.

However, even these smaller systems are growing dangerously complex, so new service tools must perform more analysis on the systems under repair and must show greater capability in guiding the operator in the isolation of a fault. Both end-user equipment and instrumentation companies are developing such tools, and more will be available this year. Thus OEMs can plan support strategies, based on what can best be described as service computers, for the products they will be delivering in the near future.

IBM already has equipped its field-service personnel with a portable, microcomputer-based multipurpose tool. Called the Maintenance Device, or MD, it comes in a briefcase-sized carrying case and weighs a mere 15 pounds, and so can easily be transported to the site of an ailing product, typically a small-business system.

As shown in Fig. 5, the MD consists basically of a microprocessor-based computer and a series of different interfaces that tailor the hardware to work with a particular unit under test. The computer, built around a proprietary microprocessor, devotes 8-K bytes of its read-only memory to self-testing of the processor, storage, interrupt logic, I/O bus, and floppy-disk adapter. Also included in ROM is the control code for the hand-held keyboard-display and for the floppy-disk drive.

Of the 32-K bytes of random-access memory in the MD, half is allotted to system operating programs and the other half holds product-specific maintenance programs downloaded from the floppy disk.

The interfaces IBM created for the MD consist of three serial communications adapters and a product interface. The most general-purpose communications adapter is for systems that use the RS-232-C, V24, or V28 link, which can be connected to the machine or modem side of a business system. The two other communications interfaces are for what IBM calls its retail and store loops—communications links that the company uses to interconnect point-of-sale, inventory, and other business systems to a central computer.

For directly interfacing with the machine to be tested, IBM provides a special eight-wire connection to an adapter that must be designed into the product to be tested. This, according to the company, is the primary interface for product maintenance. In addition, there is a byte-wide interface for a processor bus socket, for which the user must provide buffering and powering.

The unit employs a layered software structure. At the highest level is the product-maintenance package, one or more floppy disks containing a set of maintenance analysis procedures (MAPs), and diagnostic routines for a particular product.

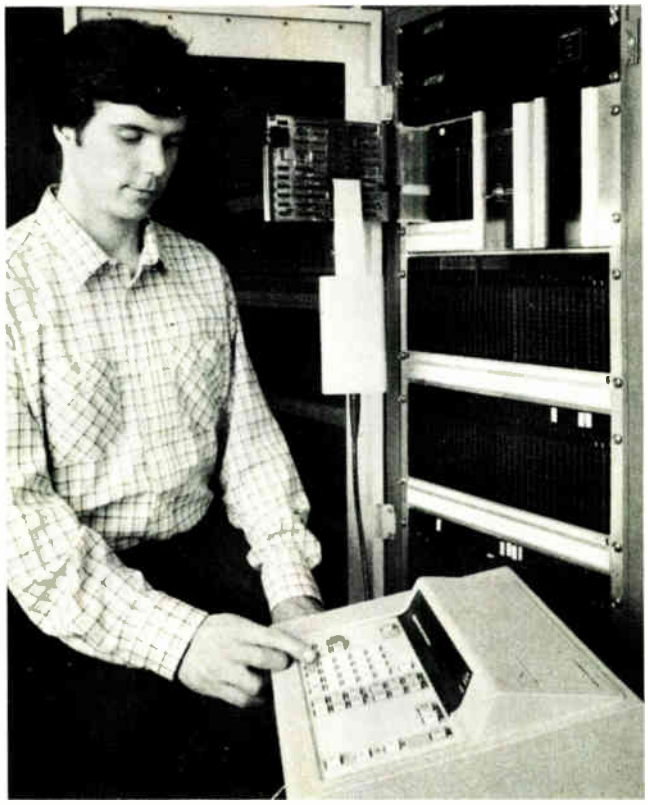
Automatic diagnosis

In the next software layer, execution of the product-maintenance package is controlled by the MAP diagnostic integration supervisor. Based on its evaluation of the test results and keyboard inputs, the MDI supervisor selects testing steps, one at a time. Furthermore, it keeps a record of the decision path taken to permit backtracking and to allow evaluation by product engineering.

In the third software layer, the MDI supervisor interfaces with the MD control program, which interprets instructions and performs the operations. Below it are a set of I/O device-handler routines to interface adapter and keyboard-display hardware with the program.

The MD, which has been in use for over two years "is a proven success," says IBM's Marvill. Average repair time has been reduced between 10% and 29%, depending upon the product's complexity. Also, products designed for MD maintenance can cost several hundred dollars less because there is no need for maintenance panels (special built-in keyboards for running product diagnostics). Furthermore, repair calls that do not succeed in finding the failures have been reduced by as much as 40%.

A similar maintenance philosophy can be employed with a commercially available unit, the 9010A (Fig. 6) from John Fluke Manufacturing Co., Everett, Wash. Introduced last summer [*Electronics*, June 16, 1981, p. 153], it is similar to IBM's MD in that it is configured as a microprocessor-based computer, called the mainframe by Fluke, and interface adapters, called pods.



6. Smart service. John Fluke Manufacturing Co.'s 9010A is similar to IBM's maintenance device (Fig. 5), but lacks some of the latter's interfacing ability at present. It speeds service routine generation by learning board layouts and applying "canned" tests.

The pods tailor the data flow to and from a unit under test so that it is compatible with the processing architecture of the mainframe. At present, Fluke provides pods that will let users test products based on commonly used microprocessors: the 8080, 8085, 6800, 6805, Z80, or 9900. The 9010A uses tape cartridges rather than floppy disks for mass storage and has a built-in keyboard and display rather than a hand-held unit.

The ability to gain access to the heart of a contemporary system, its processor, gives the user a similar capability to IBM's unit. Fluke does not yet provide interfaces for standard communications protocols, but according to James Dooley, general test and service product manager for the company, interfaces for both the RS-232-C and IEEE-488 standards are "possibilities that we are looking into."

The Fluke unit provides some special features to speed the generation of test procedures. Its learning mode, for one, automatically creates a software map of the processor's address space, identifying devices within that space as RAM, ROM, or I/O. This feature is particularly helpful when the person creating the troubleshooting program is not immediately familiar with the processor. There are also canned test routines in the mainframe, such as a marching 1s pattern, which are frequently used and can be called by a test routine. This feature saves having to

7. A new hand. The latest in signature-analysis equipment is the signature verifier, which uses a programmable read-only memory to store known-good signatures. Thus the instrument can signal when a test point is bad, so that the technician need not go to the bother of comparing the results with a table of known-good results.

recreate these tests for each product supported.

The basis for fault detection in the test procedures created for the 9010A is a simple match. A special bit stream flowing through the logic of a board under test is checked at test nodes by an instrument, such as the 9010A, that condenses the bit stream into a hexadecimal word called a signature. If a particular part of the board's logic is causing the malfunction, the signature at the associated node will not match that from a properly functioning board's node.

This troubleshooting technique, developed and patented by HP under the name of signature analysis, has become the major field approach to digital failure analysis in the past five years. Over 1,000 companies have purchased signature-analysis equipment from HP alone.

HP first introduced the technique as one engineers should design into systems to ease servicing; and, for new products, it is still best that they be built with signature analysis in mind if this route is chosen for field service. However, existing products can be retrofitted for signature analysis with the use of tools from HP and, most recently, Data I/O Corp. of Redmond, Wash.

Introduced last year for retrofitting signature analysis, HP's microprocessor exerciser family comprises four different models, each for a different processor family: the 6800, the 6802 and 6808, the 8085, and the Z80A. Unlike the Fluke unit that contains a microprocessor, the HP exercisers use the processor of the unit under test, which is plugged into the test unit. The exerciser first checks this processor to be sure it will respond properly to its instruction set. If a system malfunction is due to a processor failure, the user finds out right at the beginning. Such types of failures are, however, fairly rare.

Programmed into the exerciser are as many as 17 different kinds of tests, including the microprocessor test and a self-checking test. Some tests stimulate RAM and I/O by writing and reading various patterns to them. In a test of ROM space, placing the probe of a signature analyzer on one pin of the exerciser generates a unique signature that depends directly on the data stored in ROM. Thus an entire block of ROM can be checked very quickly since only one signature must be verified.

Data I/O this month is introducing its first products for field service, the model 1320A stimulus control unit and the model 1310A signature verifier. Like the HP microprocessor exerciser, the stimulus control unit is intended for products that do not have signature-analysis test programs designed into them. However, where the HP units are designed for specific processors, the 1320A is configured for different processors by means of personality modules. Data I/O supports the same processors as does HP, and the 8080 as well.

The 1310A signature verifier, shown in Fig. 7, adds an important feature to signature analyzers in that it will automatically compare a known-good signature with one from a unit under test, thus giving the operator a simple go/no-go readout. The verifier has a built-in programmable ROM burner that can be used to store signatures from a known-good board in a PROM pack. When the unit is to be employed for troubleshooting, the operator plugs in the relevant PROM pack and checks the faulty board by going from test point to test point in a prescribed manner. The verifier automatically checks each newly acquired signature against the corresponding one in the PROM.

The invisible time gobbler

Watching signature-analysis techniques applied in the field provides clues to its popularity. With very little training, an operator can find a fault in a complicated logic board in a matter of minutes. In addition, faults are isolated to the component, rather than the board level, so the cost of support can be reduced.

However, there is a hefty price tag associated with obtaining that type of repair speed, and it is not the price of the test hardware alone. It is the expense of generating the diagnostic procedure for a particular product.

Whereas it is a fairly simple matter to generate the good signatures for a board—that is, gather them from a known-good board—the process of creating a fault tree generally consumes much time. An engineer, preferably the board designer, must sit down and figure out what

8. Service sight. In the five years since the first practical one appeared, hand-held digital multimeters like the Fluke unit above have become common in service kits. Over the next few years, more types of instruments will make their appearance in the same form.

9. Continuous improvement. The market size for handheld DMMs assures that improvements in the units will continue. In its model 128 above, for instance, Keithley added a visual and audio indicator that will go off when any reading exceeds a user-set limit.

kind of failure will result in bad signatures appearing and where those bad signatures will appear. Then the engineer must figure out ways to differentiate among causes and establish a logical means of isolating the cause to a particular component.

More than one company, in trying to retrofit signature analysis, has put such projects on the back burner because it has needed its engineering talent for what it perceives as more important tasks—such as designing new products to stay ahead of the competition. If a company has a test engineering force, that group is often tied up with creating tests related to the manufacturing cycle and tests for incoming-component inspection and for assembled boards.

However, most companies perform board tests before a product leaves the factory. Because those tests are designed to find faulty components, it is conceivable that a means will soon be found to leverage this software into the field-service area. HP may be the first to do so, since its 3060A board tester already uses signature analysis.

Another yet unaddressed area of service using the new tools is that of standard troubleshooting procedure packages. Gawain Tomlinson, a field engineer with Computer Service Group Inc.'s Ace subsidiary in San Diego points out that the computer terminal market is ripe for such a move. "There are actually about a dozen or two different types of computer terminals in widespread use, and with the right software package for an instrument like the Fluke 9010, servicing them could be a dream," he says. Indeed, Fluke is looking into developing a software library for its system, but a definite time when such support will be available has not yet been set.

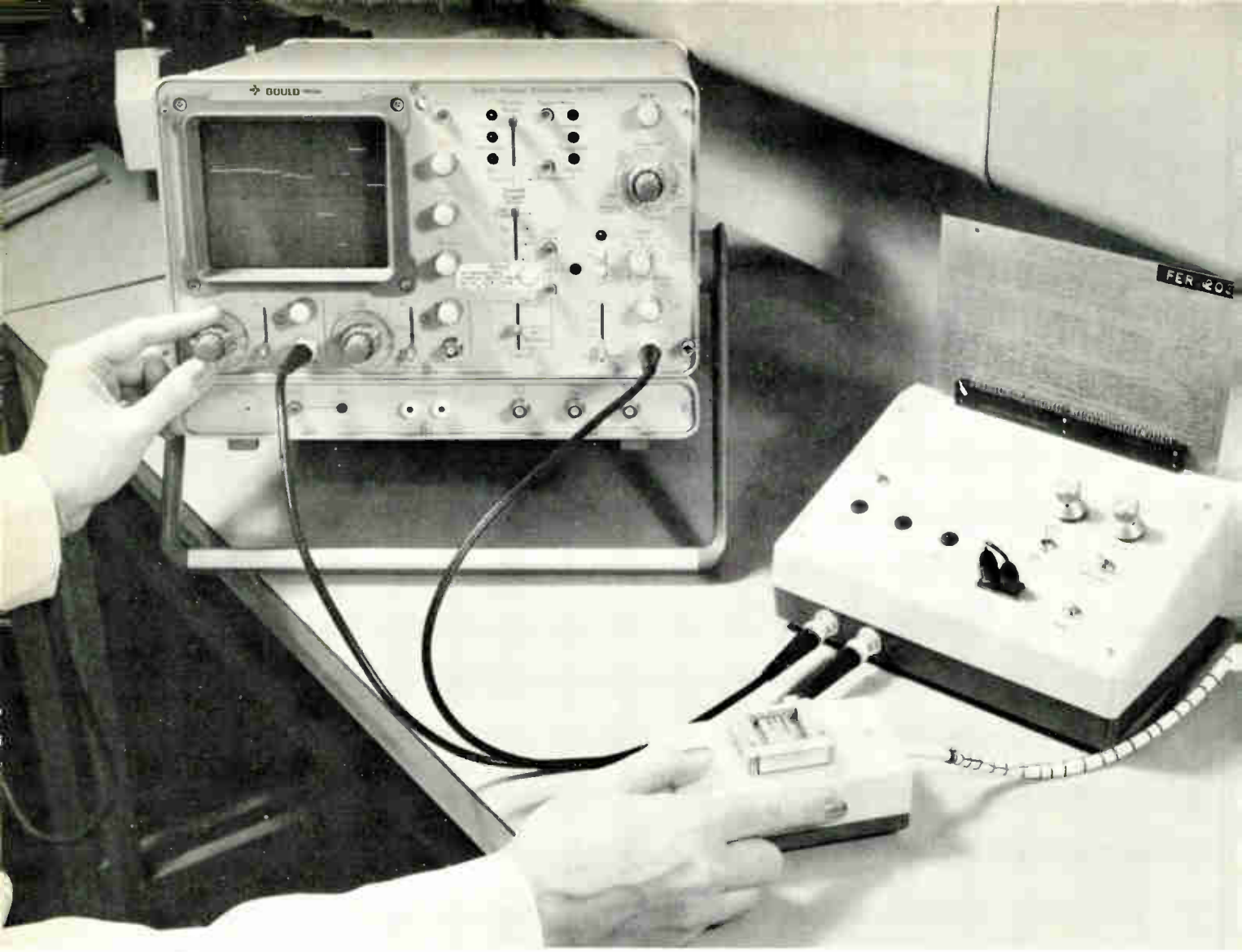
Yet another aspect of field service that is heading for automation is the generation of field reports. Periodically—after each call, once a day, weekly, or monthly—the service technician must report his travel time and distance, costs associated with that travel, time spent making a repair, parts used, results of the repair effort, and in many instances, the overall state of the customer's equipment and possible future maintenance required.

Paper dragon

Although tedious to generate, such information is fundamental to a well-concocted support menu. The manufacturer must know these details to improve product design, and, what is even more important, he must be able to catch failure trends early so that problems can be remedied before customers become disenchanted with a product's performance.

Devising a fairly simple way to satisfy both the technician's desire to avoid laborious paperwork and the home office's need for accurate performance data has been the target of a three-year-old company called Pinetree Systems Inc., of Grand Prairie, Texas. Recently [*Electronics* Dec. 15, 1981, p. 176], the company introduced the DPR 2002, a pocket-sized unit much like a hand-held point-of-sale or inventory terminal. Programmed to a customer's specifications, the unit prompts a technician to enter pertinent service-call data. This information can be stored in the unit and downloaded into the main computer through a front-end processor also provided by Pinetree, the DPR 1004.

The DPR 2002 is also a boon to fault-finding because it can receive and store diagnostic routines, which the technician can call up step by step. Results of a routine can be reported back to the OEM's computer, which will download the next logical set of diagnostic steps, continuing until a fault is found. The unit also provides a



10. Analogous. A Ferranti Ltd. test method is to the analog world what signature analysis is to the digital. Used by the company in production testing, it employs a set of voltage and current sources interconnected by a hardwired personality module and a scope for display.

means of communications with an OEM specialist and a way in which software patches can be communicated to the technician or system operator.

Even with all the automated troubleshooting equipment coming on stream, fault isolation remains largely a manual technique. A high-density board may have hundreds of test points to be probed, and, once a component has been replaced, the board must still be rechecked. On-site board repair simply will not be a viable technique until the time-consuming procedure is streamlined.

Heading for the site

However, there are signs that repair time can be cut, notably in the operations of NCR Corp. The Dayton, Ohio, system maker for some years has been moving toward on-site repair, with an important way station being the establishment of local repair depots backed by automated repair tools such as the portable service processor, or PSP.

Developed with what is now the Advanced Technology division of GenRad, the PSP helps an unskilled operator to find a fault by directing him or her to place a probe at various test points on a board and then analyzing the resulting data to decide which component failed. This technique, commonly known as guided-probe fault isolation, is available commercially, for GenRad sells the PSP as its model 2225.

NCR has found that the PSP is an important factor in its repair scheme, because, by facilitating the use of local repair depots, it made the repair pipeline "six times shorter, which reduces the number of spare boards needed," says Charles Frusterio, manager of corporate field engineering at NCR. Further, he notes, the PSPs got around shipping boards across international borders where high import duties and delays could double the cost of the repairs. Then too, the PSP provided a means of quickly checking the repaired or modified board.

While PSPs in local depots or in the back of the service van will still be used by NCR to repair boards that must be swapped for critical applications, Frusterio believes that in this decade the optimum strategy will be on-site repair at the component level. To that end, his company, together with GenRad's Advanced Technology division in Phoenix is developing what Frusterio calls a universal field tester or UFT.

The UFT is intended as a total fault-isolation tool,

finding the unit in a network, such as a computer peripheral, responsible for the failure, the board within the unit that is bad, and then the bad component. Even more, it is designed to check software on a bit-by-bit basis and provide PROM programming to patch software. It can also download data from a customer's system and then replace it once the system is repaired.

The briefcase-sized UFT can function on its own to find problems that may only occur over extended periods of time. Also, it provides communication with a home office so that the technician can get expert help, as well as report repair actions and service data. More than a pipe dream, the concept has already been checked in preliminary field trials, and Kodak reportedly is negotiating with GenRad to purchase similar units to service new photographic development equipment.

One of the questions that such an instrument raises is whether customers will accept on-site repair; a fairly widespread supposition is that they will not. However, NCR Corp.'s Frank Meade, manager of the rework division in Peach Tree City, Ga., who oversaw a six-month experiment, found that "the prospect of high-technology on-site repair was well accepted by the field engineers and the customer." He notes customer acceptance was spurred by the fact that service costs dropped as a result of replacing components rather than boards.

Failures rare

Among the mounds of data NCR has amassed over the years on field service, one figure stands out. "Over 80% of the faults on mature products are [electrical] adjustments or mechanical in nature," Meade says. In other words, four times out of five, the service call does not turn up an outright failure of a component or board.

Another implication of this statistic is the likelihood that the primary circuit-adjustment tools—digital multimeters and oscilloscopes—will continue to be prominent in tomorrow's field-service calls. Thus their manufacturers are constantly applying the latest technology to make them more capable and compact. The DMM is by far the more common of the two, since it is useful even with the simplest electromechanical devices. It is also simpler to use than the scope is. Yet even this tool has benefited from the microprocessor age.

A company that serves to demonstrate the changes manufacturers have brought in field-service DMMs in the last decade is Simpson Electric Co. of Elgin, Ill. Long dominant in field service with its 260 series of multimeters, the company has just recently bridged the analog and digital worlds with its model 467.

The 467 uses a liquid-crystal display consisting of both a digital readout and a bar graph. For precise readings, the digital readout serves, and for trend indications and quick nulling, the bar graph is easier to use.

Another bridge between the two worlds is the 467's logic-level detection feature. The meter will detect excursions through a ±0.4-volt level, provided they last longer than 50 microseconds. Thus it can be used like a logic probe for a quick check of logic levels, such as to check that a flip-flop is toggling correctly.

Simpson's move to produce a compact meter (it measures 2 by 5.63 by 4.6 inches and weighs 21 ounces) usable on both the bench and in the field was prompted by the growth in popularity of the hand-held DMMs of the form factor first practically employed by Fluke in its 3½-digit model 8020. Since that unit's introduction five years ago, many companies have emulated and embellished the original design, including Fluke itself (Fig. 8).

Analogic Corp.'s Data Precision division in Danvers, Mass., was the first to come out with a similar meter, improving the dc accuracy specification, a spec that Fluke later matched. The division was also the first to take the hand-held form factor into another type of meter, the model 983 capacitance meter, an interesting field instrument that has proven its versatility.

For example, at Farnell International Ltd. in Wetherby, Great Britain, the 983 was used to locate cable breaks. Simply measuring a cable's capacitance and dividing that value by the cable manufacturer's capacitance per-foot (or per-meter) rating gives the distance to the break. Widespread acceptance of this technique could give rise to a hand-held fault locator into which the user would enter the cable rating for automatic calculation and display of the distance to the break.

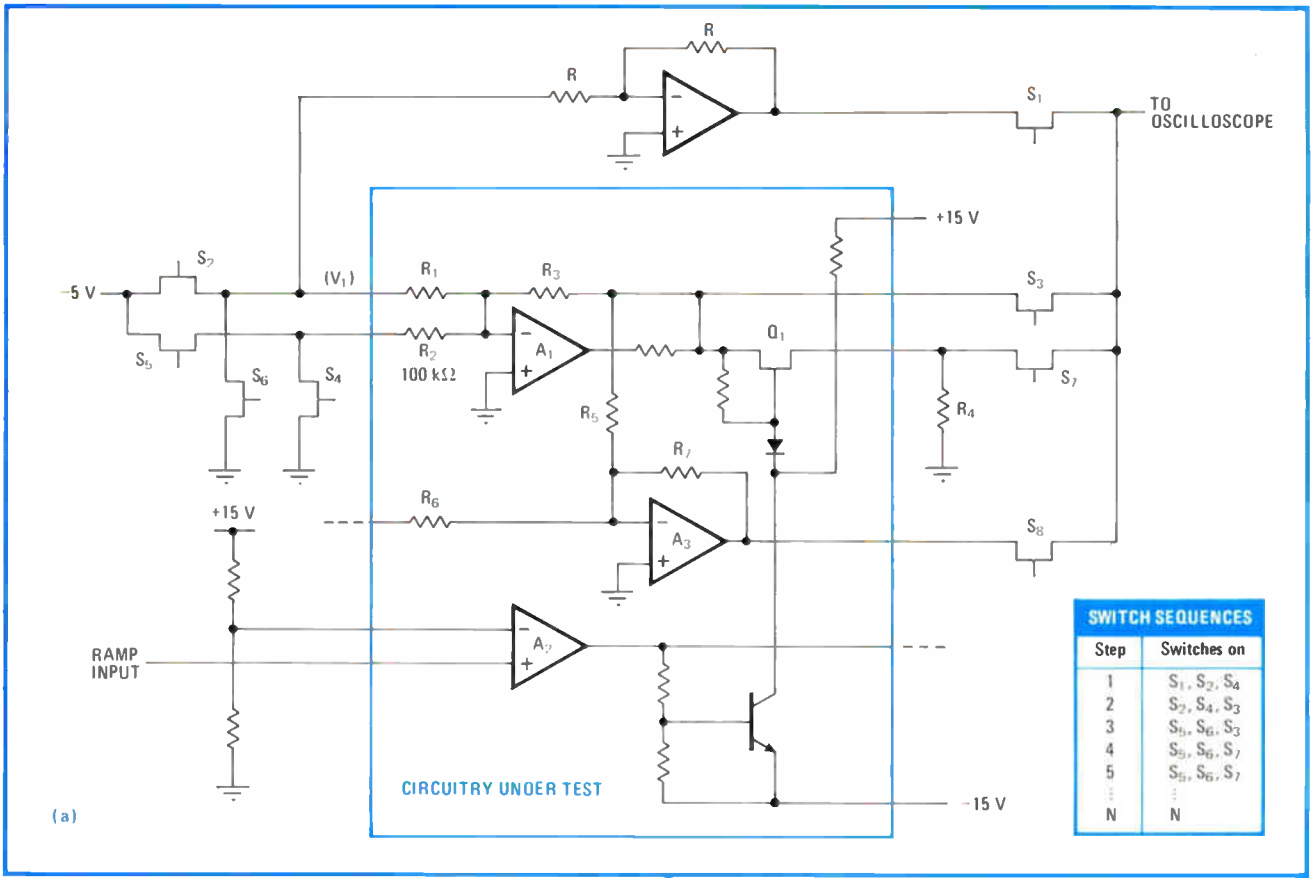
Finding out if a line is broken in the first place is another of the handy capabilities many such meters now have. The continuity test with an audible beep-beep was the contribution of Weston Instruments Inc. of Newark, N. J., in the model which it appropriately named the Roadrunner. The audible signal saves the troubleshooter the extra step of having to look at the display each time a probe is moved and thus speeds the fix.

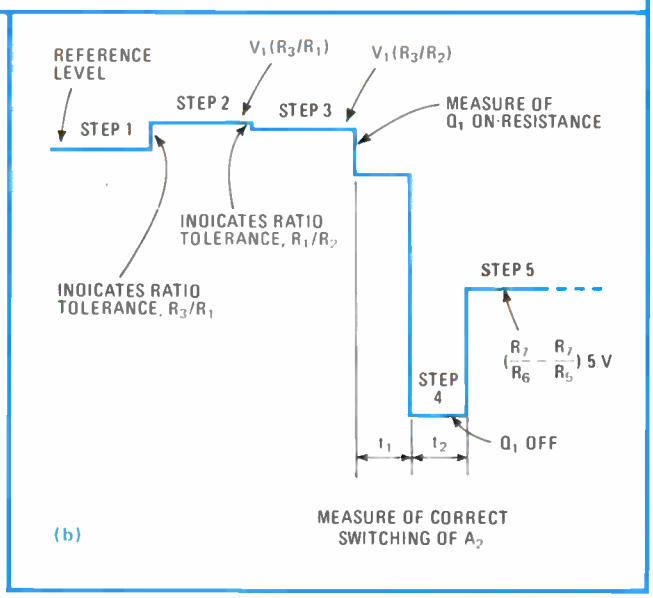
However, not all continuity testers are suited for all continuity tests. "Some meters of this type will indicate [continuity] even when there is a resistance of 600 ohms," points out Joseph P. Keithley, commodity products manager of Keithley Instruments Inc. in Cleveland, Ohio. His company's model 128 (Fig. 9) allows users to adjust the level at which a continuity is signaled, and this level can also be used for indicating whether any measured value is below a certain user-set tolerance.

Most of the companies now producing hand-held DMMs offer a wide range of units with a variety of different feature options, and the lines can be expected to grow. One firm is readying a unit for introduction next month that will not only be a 4½-digit unit, but will also put another commonly used field instrument, the frequency meter, in the same box.

Eventually the hand-held form factor is likely to reshape the oscilloscope. A small Los Angeles company called Renaissance Technology Inc. at last year's Wescon show briefly demonstrated a hand-held scope mockup that would employ a light-emitting-diode dot matrix to display a digitally stored waveform. The circuitry of the mockup was outside the unit because it was still too bulky to be squeezed in. As VLSI circuitry and custom logic design become more common, however, such instruments are a sure bet to appear in the next few years.

While the service scope will not reach hand-held proportions this year, it will continue to shrink in size and rise in frequency. Whereas the most popular service scope of the last decade, the Tektronix 465, has a carrying weight of 25 lb, a number of scopes in the same





11. Analog signature. Using the equipment in Fig. 10, the analog circuit in (a) can be put through a series of states shown in the accompanying table to create the pattern shown in (b)—the analog signature. Such a scheme may eventually be used in the field.

general frequency range now pare the weight by more than a third. Scopes in the Tektronix 2300 series weigh about 17 lb, as does Philips's recently introduced 75-megahertz PM3254, and San Diego, Calif.-based Vudata Corp.'s model 4100 weighs a mere 15 lbs. But high-end computers are quickly pushing up the bandwidth needed for service, so within the year scopes in the same weight class but with bandwidths of 150 MHz and above could appear.

With the decline in the availability of highly trained technicians, however, the service scope will likely undergo some very significant changes along the lines of the HP 1980 scope. That is, it is likely to be able to guide the technician through test routines, giving instructions on its screen about what waveforms should be examined in a unit under test, and display tolerances against which the actual waveforms can be examined. At present, the 1980 can perform these functions in a production environment, directed by an IEEE-488 controller.

Such units are likely to be used in the manner that Ferranti Ltd. has used scopes in the production of analog hybrid circuits, a method designated analog signature testing by the Hollinwood, Lancs., UK, company. In analog signature analysis, a complex set of measurements is encoded into a single waveform consisting of a number of step functions. At present, this waveform can be displayed on a screen and quickly read by an experienced production technician who has been taught what to expect. However, the whole process could be automated as in the 1980 scope.

Ferranti's equipment (Fig. 10) includes uncommitted field-effect-transistor switches and amplifiers connected to the unit under test by a hard-wired plug-in card, or personality module. Like signature analysis, Ferranti's method requires that a designer precisely identify the circuit functions and parameters to be tested and arrange an appropriate switching configuration so that the fault-detecting pattern can be displayed on the scope.

Foreign service

Drop a well-trained service technician into any country, and apart from the language barrier he would feel right at home in his work; electronics is an international meeting ground. In fact, the problems seen in the U. S. are almost identical to those seen in Europe; but each area still has its own unique flavoring.

In West Germany, for example, both Siemens AG and Nixdorf Computer AG report that the cost of field support has risen considerably and is still going up as more and more microprocessors are being used. Says an executive at Paderborn-based Nixdorf, "new support tools, the higher expense for qualified technicians, and the drop in hardware costs are raising the percentage share of field support in relation to computer prices."

Is there a shortage of field technicians? "Definitely," says Joachin Sähn, an engineering manager of Munich-based Siemens. The Nixdorf executive agrees, but adds, "while there is a big shortage of high-quality, top specialist types—there is no shortage for low- and medium-level technicians who simply exchange boards."

Both companies cite self-diagnostic methods that automatically perform system tests as one of the prime measures to reduce the cost of field service. Sähn also emphasizes quality assurance, component burn-in, and local service depots as effective cost-cutting means.

The East too has seen the cost of service rising, but according to Yasushi Fukuda, senior vice president at Nippon Electric's Field Service Co., a wholly owned subsidiary, not as quickly as in the U. S. The cost of continued service for company products is about 5% to 6% of the purchase price per year. Nor is service a profit center; the company's income just about equals the cost of providing service. Fukuda's company uses local depots, where often-used repair parts are stocked, to keep costs down, and NEC is beginning to incorporate facilities for remote analysis by phone.

Service costs for equipment supported by Melcom Business Co., a wholly owned subsidiary of Mitsubishi Electric Corp., has also risen to about 5% to 6% of the purchase price. According to Kotaro Ohtoba, the executive vice president of the firm, the rise has been due to increasing wage and fringe benefits, a statement with which a spokesman for Hitachi Denshi Service agrees. All three firms claim no problem recruiting service people.

Japanese service personnel are usually recruited from high school and given a three-to-six-month training course before they are sent out on calls. Initially, they accompany an experienced technician, and it is three years before they are able to work completely on their own.

Melcom's technicians also meet in groups, in effect quality circles, every six months to propose new test systems and diagnostic programs. It is Ohtoba's belief that these programs are crucial to cutting maintenance costs. **-Charles Cohen and John Gosch**

Once this has been done, the appropriate personality module can be constructed.

Figure 11 demonstrates how the method is applied and the pattern created by a properly working circuit. The pattern is based on the ratios of various critical elements in the circuit performing in tolerance, as well as the correct switching of amplifiers in the circuit.

With the aid of relatively simple gear, the measurement of analog parameters is reduced to a pattern that can easily be compared with the correct pattern, even by an unskilled operator. Ferranti also notes that the technique is applicable to the measurement of such parameters as amplifier slew rates, capacitance, circuit bandwidth, offsets and biases of operational amplifiers, and even to digital comparators and switching circuits. Further, the process can be automated to a considerable degree by a microcomputer. Consequently, analog measurements could be tackled in the field as easily as digital checks are at present.

Last call

Ultimately, however, the solution to current field-service dilemmas lies not in the hands of the instrumentation manufacturers or the service managers, but further back in the production cycle—at its very beginning, in fact. No matter what tools become available or how efficiently manpower is used, service will not keep up with the growth of electronics unless from their inception systems are designed for high reliability.

Indeed, reliability is already of major concern to U. S. component manufacturers, who have seen their share of the market for memory chips decline as the share of the Japanese has increased. While many have cried unfair trade practices and turned to the Government for more protection from alleged dumping, none has been able to deny the statistics set forth by HP on the low failure rate of Eastern-made parts.

As it is with parts, so it can be with systems; U. S. equipment makers may soon find themselves competing head on in their own backyard with microcomputers, minicomputers, mainframes, terminals, disk drives, and any number of high-volume products manufactured by foreign companies. Moreover, although the ability to provide quick support for those systems can be the plus that wins the day, it is only a positive factor if the system being supported is every bit as reliable as that of the competition.

The service schemes coming on line today can help the manufacturer in that competition if he chooses to use them properly. Now, service must not be regarded primarily as a necessary evil, or even as an opportunity for profit. Rather, it must be seen as a chance to learn how products perform in a real environment and as a way of gathering information that is essential to a company's survival. Failures detected now must not only be quickly eliminated but also thoroughly examined and understood, so that the design and production processes can be suitably modified to be certain that those failure modes can never recur.

There may come a day when the electronics service technician is as idle as the washing-machine repair man once seen in television commercials. If so, then not only the customer but the entire industry will have won a not inconsiderable victory. □

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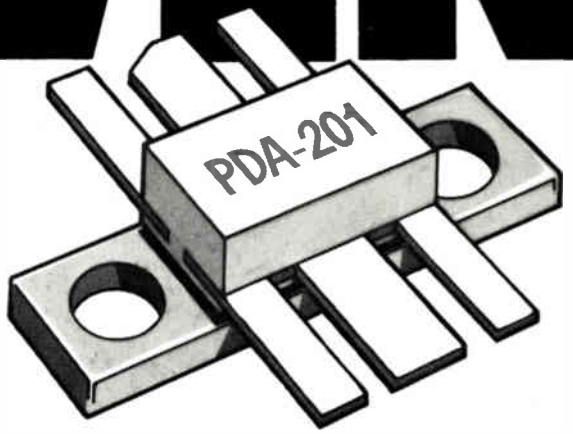

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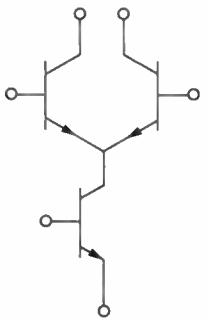

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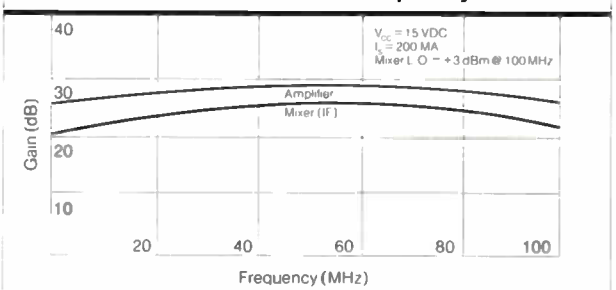
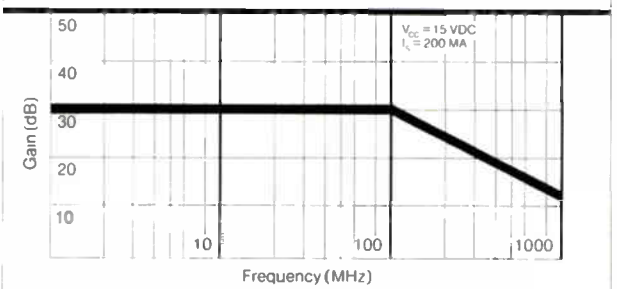


Maximum Device Gain vs. Frequency (Typical)



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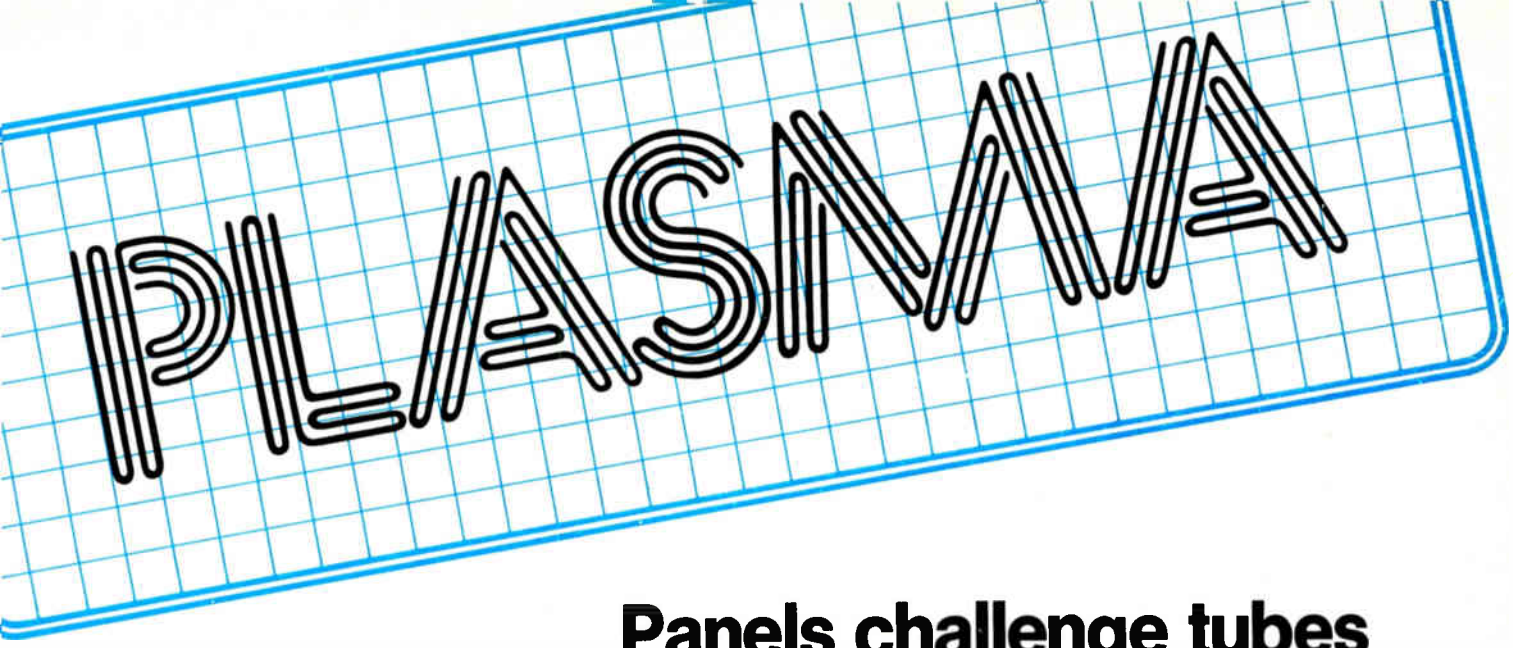


Panels challenge tubes in alphanumeric display

Fewer drivers per panel and more drivers per chip at last make a reality out of the sturdier, flatter, more compact units

by Roderic Beresford, *Solid State Editor*

☐ The simplicity of raster scanning compared to matrix addressing has been enough to keep the cathode-ray tube at the forefront of information display since its invention nearly a century ago. Ultimately, this bulky and eye-straining screen may give way to flat, nonemissive panels (liquid crystals are the current low-power favorite). But even before then—indeed quite soon—plasma-panel technology looks to give it serious competition, at least in the area of text display.

Unlike some other contenders, dense dot-matrix plasma panels employ materials and methods of fabrication that place few restrictions on their speed, reliability, or legibility. Only the onus of addressing a large number of picture elements has hampered their advance. Bringing costs down to par with CRTs depends almost entirely on progress with the drivers and their connections to the panel—the panels themselves are simple to make.

The present state of the plasma art on this front is well represented by the developments discussed in the two articles that follow. The first takes a close look at how the panel itself may help out with the burden of addressing. Burroughs OEM Corp. is well along in the prototyping of Self-Scan Memory panels that reduce the number of required drivers by more than an order of magnitude compared with standard ac plasma technology.

In the second article, Texas Instruments Inc. shows where semiconductor technology must go to rescue plasma displays from the mire of bulky and unreliable discrete drive electronics. The seemingly obvious solution of integrating the drive electronics on a chip or two took more than any one standard fabrication process could give. TI's answer calls on the process known as BidFET (for bipolar, diffused-MOS field-effect transistor) and combines 32 high-voltage drivers with complementary-MOS addressing logic in one package.

Present work at Burroughs has produced prototype matrixes large enough for 5 lines of 80 characters. Instead of the more than 600 drivers a standard implementation would need, this panel requires only 25. The improvement is achieved at the expense of a more complicated panel that is split into two sections, one for addressing and one for display. The tradeoff is likely to be well worth it. With the cost of the electronics running up to as much as half of the total display cost in standard ac panels, Burroughs stands to offer significant savings when these panels are brought to market. They can also be extended well beyond 5 lines, as shown by the company's experiments with 25-line versions.

The development of the BidFET process at TI bodes well for standard ac plasma systems (as well as other applications, such as voltage regulators). The demanding high-voltage ratings—100 volts or more—are met by lateral diffused-MOS transistors, similar to those used in discrete power devices. The price paid in processing complexity is sure to be outweighed by the benefits of lower system cost and greater reliability. However, simply reducing package count still leaves the problem of making a large number of connections from the ICs to the display's electrodes.

Later this spring at the Society for Information Display meeting in San Diego, TI will describe the next logical step. It puts these panel drivers in chip-carriers and mounts them directly on the glass substrate of the display, eliminating connectors.

At least one other significant development in plasma technology will be on view at the SID meeting. Sony Corp. will announce one of the highest-resolution panels to date. This dc plasma displays a matrix of 512 by 1,024 dots at 127 lines per inch and gets by with 30-v drive signals. The implication is that more or less conventional ICs can provide the interface with the display.

PLASMA

Panel taps ac and dc cells to thin driver ranks

Just two dozen high-voltage devices address five lines of 80 characters, and one more sustains the display

by G. Holz, J. Ogle, N. Andreadakis, J. Siegel, and T. Maloney*, *Burroughs OEM Corp., Plainfield, N. J.*

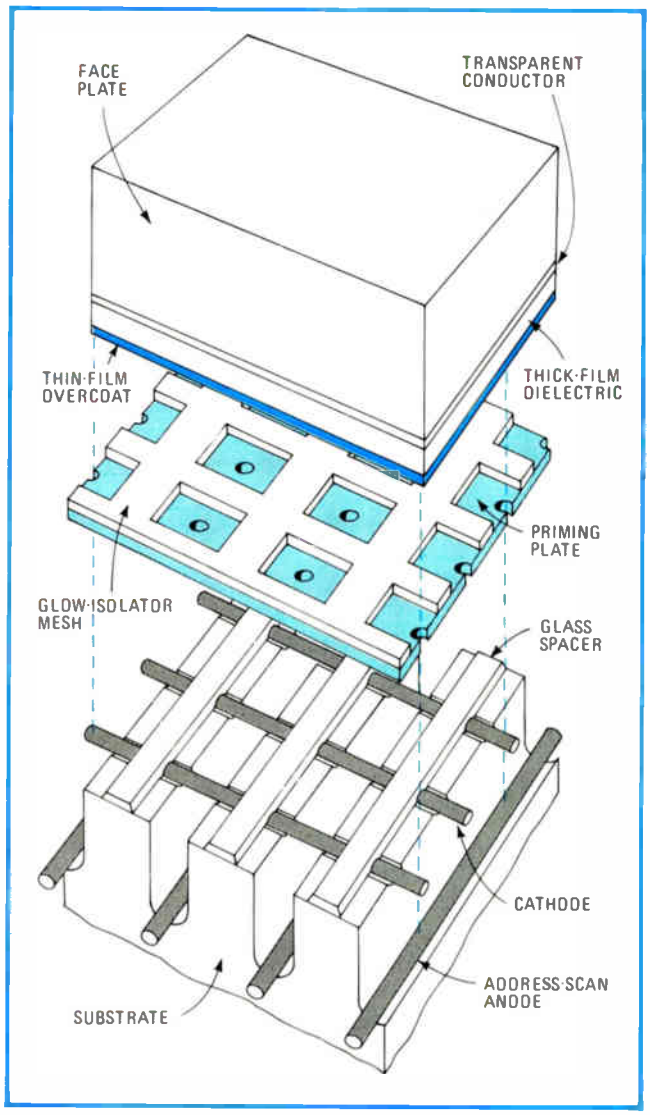
☐ Smaller and lighter than a cathode-ray tube, easier on the eyes, and no more costly to produce—these are the claims that have put the wind in plasma panels' sails. Meanwhile, designers have busied themselves trying to reduce the number of components that must be connected to the panel, for in this area the flat, flicker-free display finds itself becalmed.

Total cost quickly escalates past that of CRT-based systems as the number of dots in a matrix display increases. In the last decade, a dc plasma panel that incorporated an internal addressing scheme achieved commercial success through its reduction of driver costs. Now a combined ac-dc plasma technology further drops these interface requirements, with the result that head-on competition with CRTs in alphanumeric display is conceivably just around the corner.

The task of addressing a high-resolution dot matrix demands a display medium with a fast response and a sharp threshold. Plasma technology meets these requirements readily, unlike some competing approaches such as liquid crystals. Furthermore, conventional dot-matrix plasma displays are simple to make. Holding back their development has been the large number of connections and drivers needed. Discrete drive electronics not only add to the cost and bulk, but also make for a less reliable system.

The *status quo*

In the conventional ac plasma technology a matrix of m by n picture elements, or pixels, requires m + n drivers and connections. Whereas this approach may still allow cost-competitive systems that have small numbers of pixels in nearly square matrixes (the optimum arrangement to reduce drivers), in larger displays it must be counted out. For example, an 80-character display composed of seven-by-nine-dot characters would require more than 500 drivers for the horizontal axis alone.

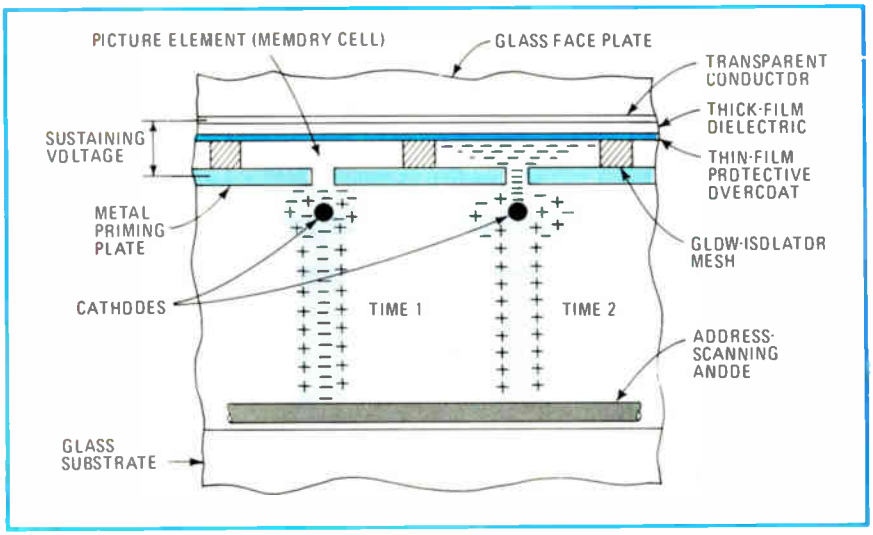


1. Scanning address. A thin metal priming plate separates this plasma display into dc scanning and ac memory sections. Address signals transfer the glow discharge from the scanning section to the picture elements defined by the glow-isolator mesh.

A refreshed dc plasma matrix display introduced in 1970 by Burroughs under the trademark Self-Scan succeeded in reducing the number of drivers and connections through an internal addressing scheme [*Electronics*, March 2, 1970, p. 120]. In these panels a glow discharge that is hidden from view extends the length of a column and is transferred along the horizontal axis by clocking the cathodes (the column electrodes) in sequence. From 3 to 12 clock-phase drivers are needed on the horizontal axis instead of one for each cathode.

The Self-Scan Memory panel further reduces the number of drivers with a combination of the earlier dc scan and address techniques and an ac display cell that has a memory [*Electronics*, April 21, 1981, p. 39]. Once a glow discharge is initiated in the display cell, a single ac sustaining signal applied to the entire matrix suffices to

*Thomas Maloney is now with Panelvision Corp., Pittsburgh, Pa.



2. Glowing. The discharge pattern of time 1 is transferred by clock signals from one cathode to the next along a selected anode. The pattern at time 2 shows how a data pulse that is applied to the anode deposits electrons on the memory-cell wall in order to either write or erase a picture element.

keep the pixel in the on state. Thus each pixel remains on after selection, giving the same high brightness regardless of the duration of the scan and its duty cycle.

In the standard dc version, the pixels themselves are addressed by separate display anodes, causing a transfer of the discharge from the hidden layer of priming cells to the display cells. Since the pixel glows only when addressed, the displayed data must be refreshed at least 60 times a second for a flicker-free display. This refresh rate in turn limits the length of a line, since the display will grow dimmer and illegible if the duty cycle of the cathode is made too short. As a result, the maximum line length available in a refreshed Self-Scan display is about 40 characters in a five-by-seven-dot format.

A drop in drivers

However, in the new panel, the scanning serves only to address pixels for a data change and not to refresh previously written data, so the total scan duration may far exceed the period that would introduce unacceptable flicker in a refreshed display. This technique has already been applied to a panel of 60 rows by 576 columns. Each of 5 lines has up to 80 5-by-7-dot characters in 7-by-12-pixel blocks. Compared with the standard ac plasma display, the number of drivers is reduced thirtyfold to just 25; compared with the Self-Scan dc technology, the reduction is fivefold.

The combination of ac and dc plasma techniques in one panel takes advantage of the best features of both. Ac displays have intrinsic memory, with a picture that is flicker-free. The capacitor formed by the insulated electrode of each cell limits the cell currents and forces a uniform distribution of current to all of the selected cells. A thin-film coating over the insulator protects the electrode from sputter etching and lowers the operating voltages. On the other hand, dc plasma displays—as exemplified by Self-Scan—are far more simply addressed than were previous ac displays.

Merging cells

Putting these features to work in one panel required the invention of specialized forms for both ac and dc cells. Consequently, an asymmetrical display cell was designed, and the Self-Scan technique was modified to allow data input on the scanning anodes with positive column addressing.

Long device life is ensured by the relatively high-pressure gas content and the low duty cycle of the scan section in most applications. The low duty cycle also translates into a much lower average power consumption for the panel.

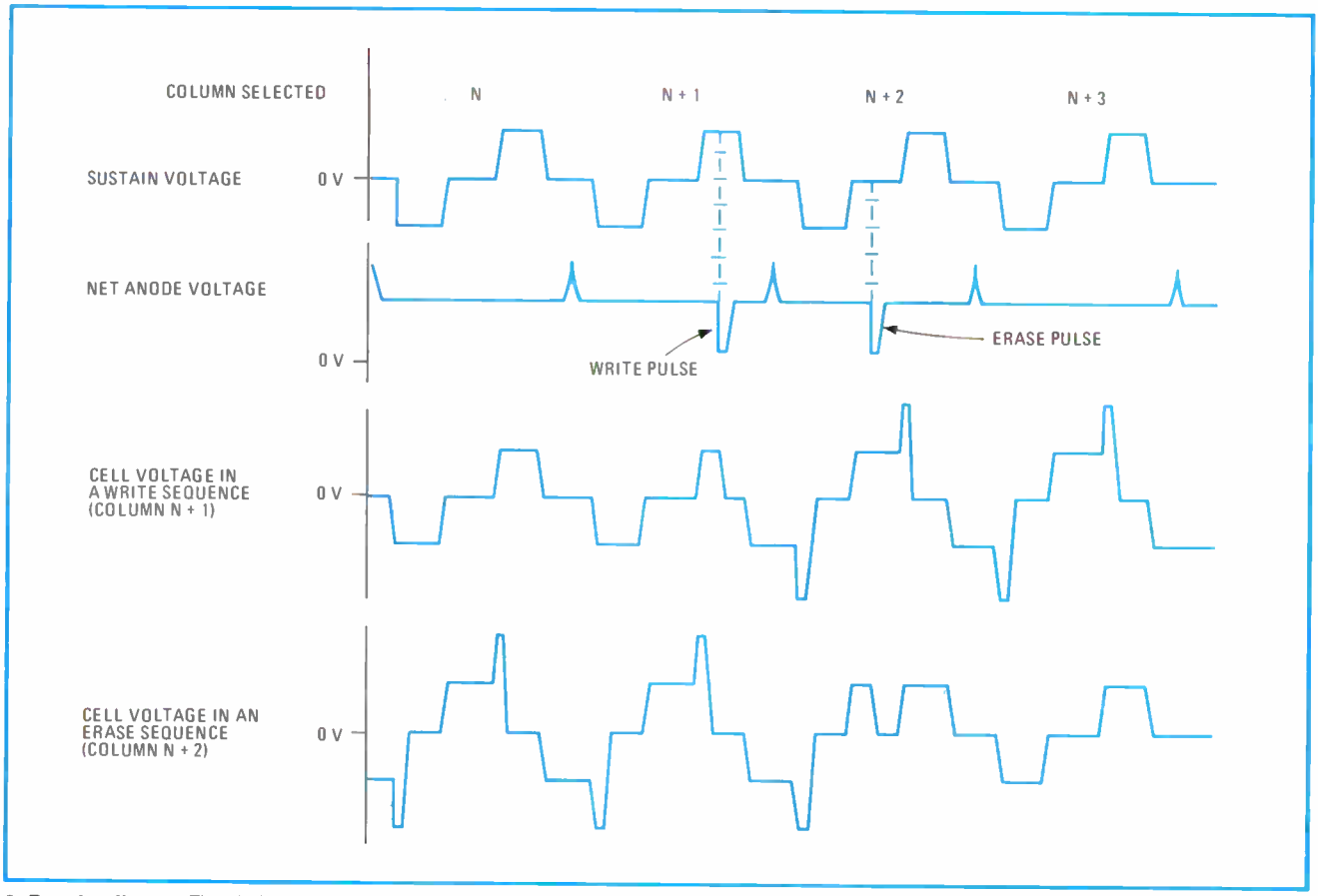
Figure 1 gives an exploded view of the new design. It is constructed in three subassemblies. The scan plate, consisting of a glass substrate with grooves cut in it, supports the scanning electrodes that guide the addressing discharge along the array a column at a time. The face plate includes both the transparent conductor that forms one electrode of the memory cells and its thick-film insulator. The priming plate is the other electrode of the memory cells and separates them from the scan section. Tiny holes in this thin metal layer let electrons pass from the scan section to the display cells. Cell boundaries are defined by the glow isolator, which takes the shape of a mesh atop the priming plate.

The face-, scan-, and priming-plate sections are aligned, clamped in a fixture, and heat-sealed around the periphery. Then the panel is evacuated and filled with a neon-xenon mixture to about half atmospheric pressure. Flexible wiring secured by epoxy makes connections to the completed panel.

Scanned discharge

The operation of the scanning section is similar to that of the earlier refreshed Self-Scan display. However, only a single register—in this case 12 consecutive anodes or rows—is scanned at a time. A scan is initiated only when changes are required in the displayed image. As in the company's earlier panels, a scan starts with a reset signal to the first column, and the resulting discharge is transferred from one column to the next as the cathodes are clocked in succession. The ac memory layer allows both writing and erasing to be done by the scanning anodes while the scanned discharge selects the column.

When a data pulse interrupts the scan current on one of the anodes of a selected register, supported positive columns are formed through the small holes in the



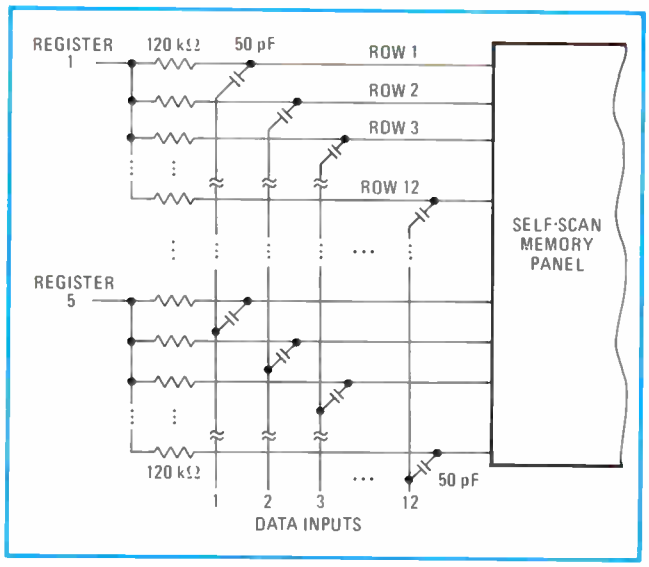
3. Panel voltages. The timing of the data pulse relative to the ac sustaining voltage determines whether the selected cell is written into or erased. The cell waveforms show the voltage of the surface of the face-plate dielectric during writing and erasing.

priming plate, as illustrated in Fig. 2. The portion marked time 1 indicates the ionization pattern of the scanned discharge in an unaddressed cell; the pattern at time 2 occurs when an address pulse has been applied to the scan anode. The positive columns deposit electrons on the ac-cell wall, making the cell voltage more negative. Whether the added electrons write or erase the cell depends on the time during the sustain cycle at which the address pulse is applied (see Fig. 3)—that is, if the pulse is applied during the positive portion of the sustain signal, the added charge writes the cell.

Only negative changes in cell voltages are possible using the positive column. Therefore, an asymmetrical design, in which essentially all of the cell-wall voltage is developed on the front electrode, provides the largest addressing margins.

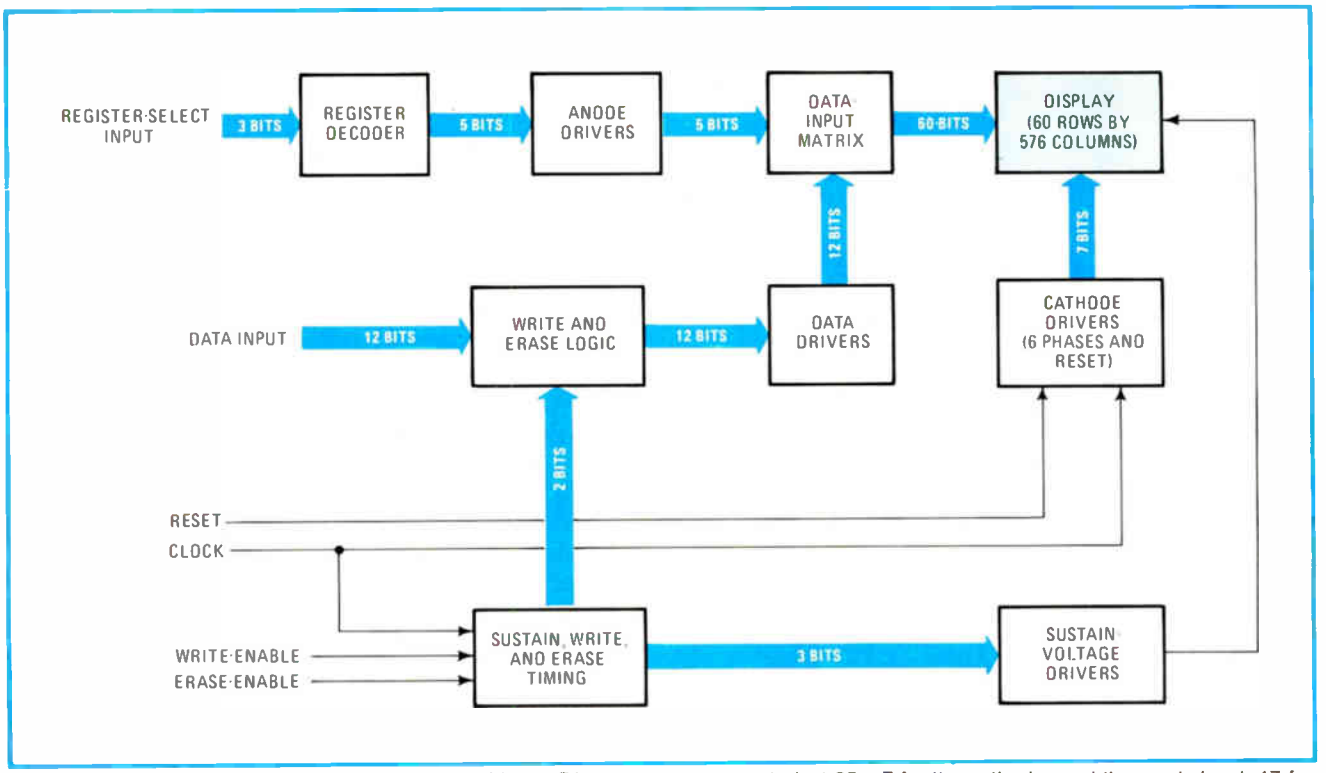
Asymmetric memory cell

The front portion of the memory cell uses the transparent electrode, reflow glass insulator, and a low-work-function refractory overcoat similar to other ac plasma cells. However, the rear electrode of the memory cell is formed by the metal priming plate, more like a dc electrode, with a refractory coating for a uniformly low work function and sputtering rate. Current flow in the cell is limited by the small front-electrode capacitance. Thus, the relatively high capacitance of the thin-film overcoat on the metal priming plate prevents any significant voltage buildup on this electrode.



4. Passive matrix. One line of characters is addressed at a time by selecting 12 anodes at once. As the cathodes select successive columns, data pulses coupled through the matrix of capacitors write or erase the pixels of the selected rows.

The priming-plate overcoat need not be free of pinholes. Because it has a lower work function than the oxidized metal surface, the glow forms selectively on the coated portions. This difference in work function helps keep the memory discharge on the front of the priming



5. Interface. The high-voltage drivers needed for a 60-by-576-dot matrix amount to just 25—7 for the cathodes and the reset signal, 17 for the anodes, and 1 for the ac sustaining voltage. Timing circuits align the data input pulses with respect to the sustaining voltage.

plate, obviating undesired interactions between the memory and scanning sections.

Typical operating waveforms are shown in Fig. 3, along with the corresponding changes of the voltage of the front memory electrode. Since the ac sustaining signal supplies the display current and the average duty cycle is reduced by the elimination of continuous refresh requirements, simple passive driver circuitry can be used for each scan anode without a significant reduction in overall power efficiency.

Passive drivers

The resistor-capacitor matrix used to drive the scan anodes and feed data to the panel is shown in Fig. 4. This choice of driver components will allow them to be integrated as part of the display panel or its connector using screen-printed thick-film fabrication techniques.

A block diagram of the interface circuitry for a Self-Scan Memory panel is shown in Fig. 5. The data-input matrix contains the circuit shown in Fig. 4. The three register-select inputs and the two write-erase inputs are set before a column scan is initiated. In this simple interface, data must be synchronized with the system clock. Since a single register requires 12 bits of parallel data during a 60-microsecond column-select period, and because the update frequency is relatively low in most applications, this minimal interface may be used without unduly occupying a microprocessor's time.

The dots of this panel are on 30-mil centers in the vertical direction and 20-mil centers along the horizontal. The average luminous intensity is 30 microcandelas, and the total viewing angle is more than 140°. The power dissipated in a single cell is about 225 microwatts, giving a total power consumption of 10 watts with all cells on. With the 60-μs column-select period, one line of the display—in this case one register of 12 rows—may be rewritten in about 35 milliseconds.

The introduction of the Self-Scan Memory technique invites a cost comparison with the standard ac plasma panel and the CRT. Obviously, the multilayer construction of the new display is more complex. However, the reduction in driver and connection costs can make up for its resultant more expensive fabrication. Furthermore, this economic impediment has become less intimidating after 10 years of processing experience that has pared the costs of the two most challenging steps, the scan-address slots in the glass substrate and the priming plate.

The scan slots currently are cut by a ganged arbor of diamond wheels, a technique borrowed from the semiconductor industry, which employs it to scribe wafers. Similarly, the priming plate benefits from a technology developed for Self-Scan cathodes—lasers are put to work to drill precisely sized gates between the scanned address layer and each display cell. Though lasers originally drilled at about 50 holes per second, the state of the art has upped that rate by a full order of magnitude.

The success of these techniques promises to make the panels economical for a variety of uses. Applications for multiline alphanumeric displays include terminals for word processing, data input and retrieval, process control, and financial transactions. To address these rapidly expanding markets, a 60-by-576-pixel matrix was selected, a size particularly well-suited to word-processing systems that require the display of a limited number of text lines, along with diacritical marks, editing symbols, and operator-oriented instructions. □

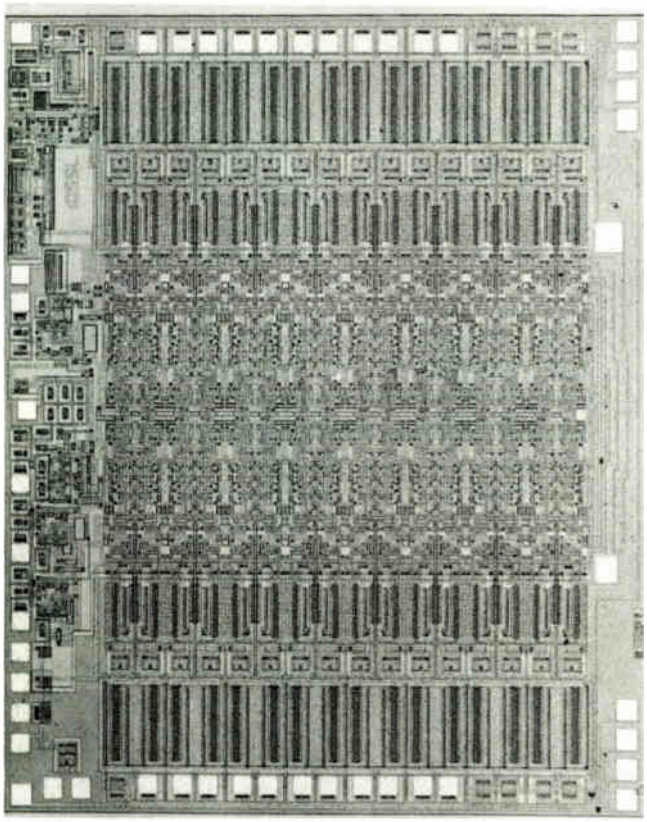
PLASMA

High-voltage ICs supply the drive for ac panels

Threefold process divides the labor among bipolar buffers, C-MOS logic, and diffused-MOS lateral transistors

by Pat Curran, Tom Engibous, and John D. Spencer
Texas Instruments Inc., Houston, Texas

☐ Although high-voltage integrated circuits may spark the designer's imagination in a host of applications, few systems are so hungry for these chips as plasma display panels. The bulk and cost of their drive electronics have even discouraged improvements in the basic panel technology because complete systems that could compete with cathode-ray-tube displays have been impossible.



1. Three in one. Lateral diffused-MOS output transistors withstand the high voltages needed to drive plasma displays. The same chip includes C-MOS circuits for low-power logic and bipolar input buffers. The IC replaces 32 discrete drivers and accompanying logic.

A new line of large-scale ICs will soon end this situation. The first members of this family of plasma drivers are the SN75500 and the SN75501. Each holds 32 high-voltage transistors and controls 32 lines of a standard ac plasma panel, and each unites bipolar, complementary-MOS, and diffused-MOS field-effect-transistor devices on one chip (Fig. 1).

Prior to this BiDFET process, a purely bipolar technology appeared to be the one approach capable of tackling the 100-volt and higher requirements of plasma panels. But the positive temperature coefficients of bipolar transistors and their secondary breakdown phenomena detract from their reliability. Nevertheless, as low-voltage input buffers on the 75500 and 75501, standard bipolar devices lend the driver chips both precision and ruggedness.

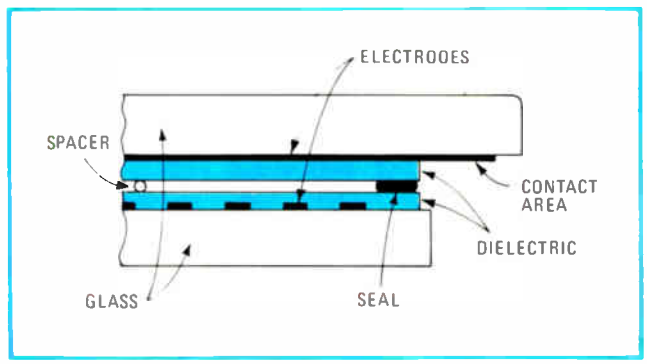
Logic operations are handled by C-MOS circuitry in the interior of the chips. There it not only saves area and power but also is isolated from any destructive static discharges at the device terminals.

At the outputs, diffused-MOS structures similar to those used in high-power discrete transistors cope with the high voltages needed for the displays. Basically lateral n-channel devices, D-MOS transistors are free of the destructive secondary breakdown and thermal runaway present in bipolar devices. Their high input impedance is easily driven by the C-MOS logic gates, and of course they switch much faster than bipolar devices.

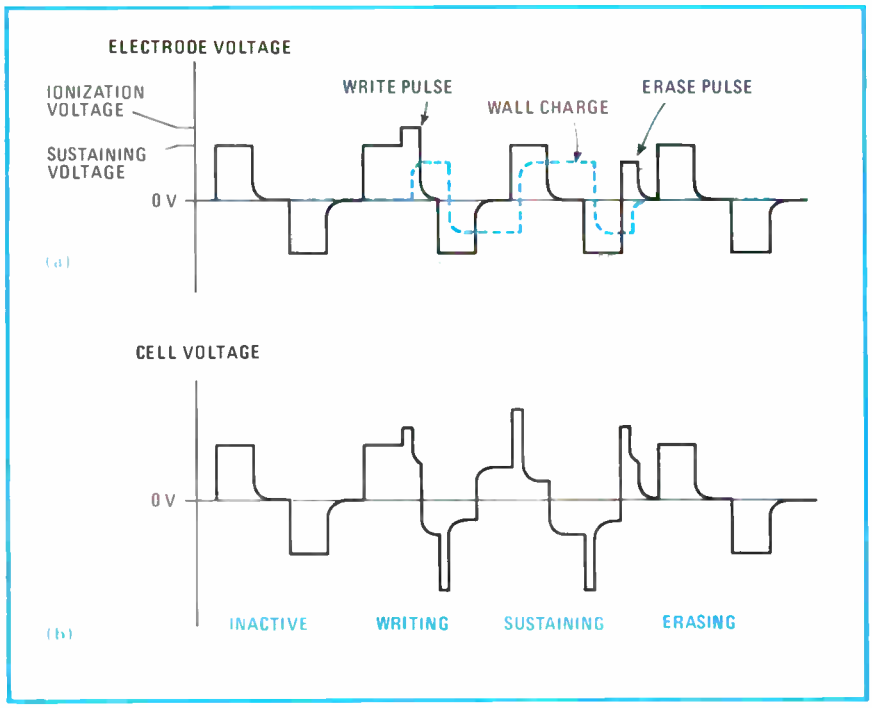
Cost tradeoff

Of course, the bipolar, C-MOS, and D-MOS elements of a BiDFET chip require complex processing, involving 12 mask levels. Nevertheless, the chips can be fabricated on a standard linear-IC production line, and the cost of their complexity is more than offset by cost reduction at the system level.

As shown in Fig. 2, the standard ac panel consists of two flat pieces of ordinary glass with electrodes and a dielectric layer deposited on them, held apart by spacers



2. Flat matrix. The standard ac plasma panel is a simple sandwich of glass plates, hermetically sealed and filled to low pressure with noble gases. The picture elements are defined by the crossings between two orthogonal sets of electrodes deposited on the glass sheets.



3. Added charge. The drive voltage to a plasma display consists of an ac sustaining signal, with data pulses superimposed (a). Once ionized, charge in the cell adds to the applied voltage, raising the cell voltage above the threshold for discharge (b).

and hermetically sealed around the outside edges. The space between the glass is evacuated and filled with a gas—generally a neon-argon mixture—under a pressure of approximately ⅕ atmosphere.

A visible orange discharge occurs at the intersection of selected electrodes when the voltage applied between the electrodes exceeds the ionization voltage of the gas. Once initiated, the discharge can be sustained by an ac voltage less than the ionization voltage. This data retention eliminates refreshing and its attendant flicker, simplifying the display system and enhancing the display.

In early ac plasma displays, a third piece of perforated glass defined the individual picture elements, or pixels. Individual cells in the latest displays are defined instead by the electrode intersections. A discharge is confined to the area where it was ignited with the proper choice of gas pressure, electrode width and pitch, glass spacing, and the excitation and sustaining potentials.

The simple construction of ac plasma panels results in a rugged sandwich containing just a few cubic centimeters of an inert gas. There is no danger of implosion, as with CRTs, and operators do not come in contact with high voltages through the faceplate. The fabrication steps are inexpensive and yield one of the safest display panels available.

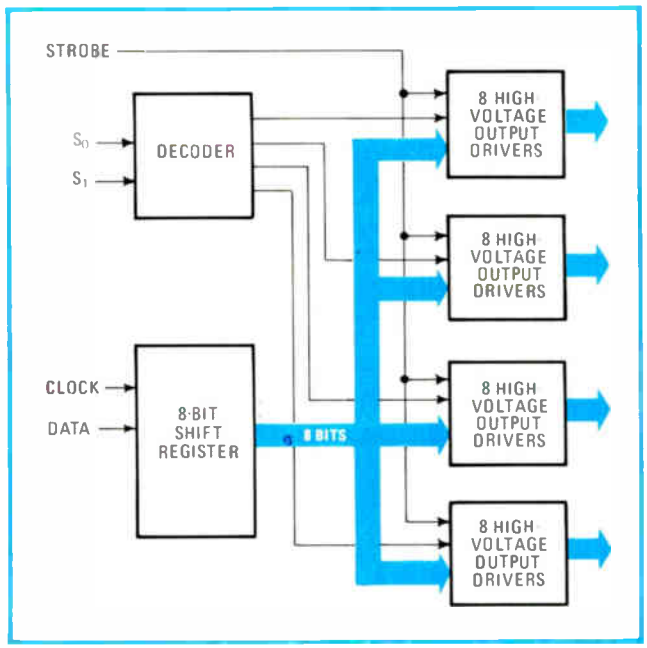
Because capacitive coupling is used to ignite and sustain cells, the frequency of the driving signals as well as their amplitudes must be quite precisely controlled to ensure consistent operation of the display.

Controlling the glow

The basic sequence of signals needed to control a plasma panel display is shown in Fig. 3, along with the cell voltages that result. A blank, or extinguished, cell is unaffected by the ac sustaining voltage applied to all of the electrodes. When a write pulse adds its energy to this continuous ac waveform, the ionization voltage of the gas is exceeded, initiating a discharge.

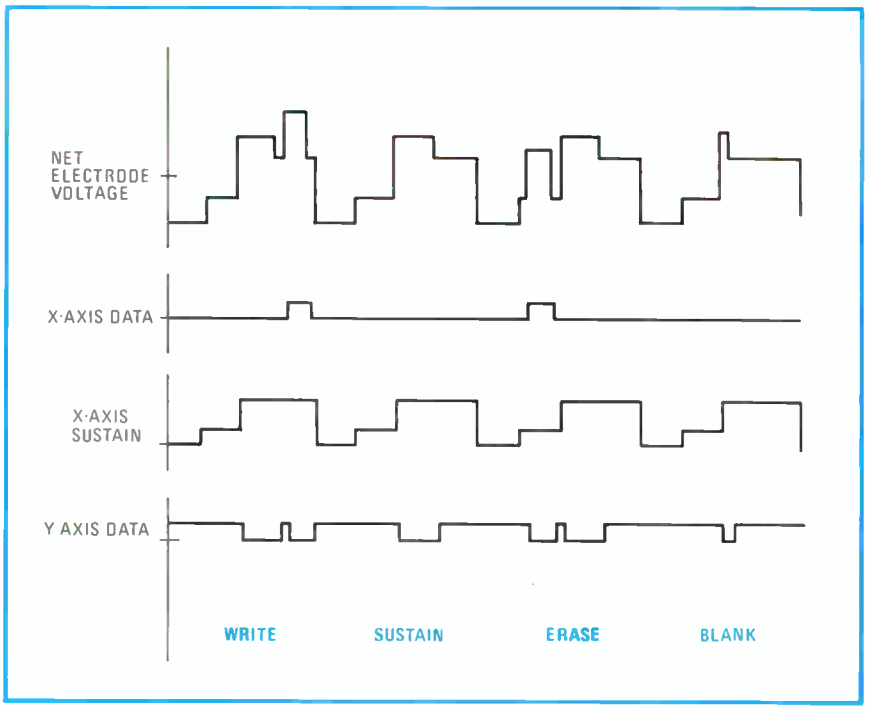
The high electron and ion currents that are present in this discharge together build up charge in the cells. This wall charge initially opposes the applied voltage, causing the cell voltage to decay below the ionization voltage. However, during the following cycles of the sustain signal, the wall charge adds to the electrode voltage, keeping the discharge alive.

Since the sustaining voltage is less than the firing voltage of an extinguished cell, it has no effect unless the



4. Data driver. The SN75500 panel driver provides data to 32 electrodes along one axis of a display. One section of eight lines is selected at a time. Data shifted serially into the register is transferred in parallel to the high-voltage diffused-MOS outputs.

5. Composition. The waveforms for the cell electrode have the three contributions shown. The sustain signal is applied to every X electrode. Half-select pulses on an X-Y pair combine to write or erase a cell, depending on their timing relative to the sustain voltage.



cell has been fired previously. Consequently, the sustaining signal may be applied indiscriminately to the entire plasma panel.

Addressing circuitry superimposes a pulse on selected X and Y electrodes to initially fire a cell. Similarly, an erase pulse produces enough excess charge in a cell to counterbalance the wall charge, thus breaking the sustaining sequence.

Outshining discrete devices

The 75500 and 75501 are specifically designed to generate these signals. Prior to the development of Bid-FET technology, the high voltages were provided by discrete components. In large panel systems, the number of discrete components escalates quickly, making large designs uneconomical both in package size and cost. Each driver contains the circuitry to address and sustain 32 plasma electrodes. Thus, the interface to a 256-by-256-line display requires just 16 ICs—eight of each type—instead of over 500 discrete devices.

The 75500 (Fig. 4) is called an X-axis driver, though in practice it drives either the horizontal or vertical electrodes, depending on how the panel is applied. The outputs from this chip are normally low and switch high selectively when the strobe input goes low. Consequently, the device provides a positive half-select pulse for addressing a cell.

Selection of one of the 32 outputs is accomplished using the select signals S_0 and S_1 and the data inputs. The 32 outputs are divided into four sections of eight outputs each. Only one section can be activated at a time; the outputs of the other three remain low. Because of this architecture, text-display systems, for example, would use this chip to select the horizontal electrodes to update a line of characters.

When one section is selected, the states of the eight outputs are determined by the data stored in an 8-bit shift register. Data is serially shifted into the register on positive transitions of the clock signal at a maximum rate of 4 megahertz.

The 75501 generates the negative half-select pulses and also contributes part of the sustain signal. In this chip, a 32-bit shift register controls all of the output gates. However, if the sustain input is low, all the outputs are low, regardless of the data in the register.

Because the 75501 operates on all 32 outputs in parallel, it is usually used along the panel's horizontal axis to update all the pixels of a selected row simultaneously.

Both of the chips are available with C-MOS- or TTL-compatible inputs. The D-MOS output drivers swing 100 V in just 300 nanoseconds and can supply 20 milliamperes. In the quiescent state, the chips consume only 100 milliwatts of power.

Waves upon waves

Figure 5 shows how the basic waveforms from the two chips combine to provide the required voltage differences between the X and Y electrodes. The sustain signal is composed of two parts, a base pulse applied to the X axis and a negative sustain pulse applied to the Y axis. The base pulse is not generated by the 75500s, but is applied to all electrodes along the X axis through the clamp diodes that are included on all of the 75500's outputs. The Y-axis sustain pulse is created by the 75501.

Since the write and erase signals are selectively applied, the pedestals superimposed on the basic sustain waveform appear only at the pixels where information is to be altered. All other nodes receive either a standard sustain waveform or a half-select waveform. Whether a pulse writes or erases a pixel depends on its timing relative to the sustain signal. The blanking waveform, however, is applied to all electrodes indiscriminately. Thus, it is most easily created by altering the basic sustain waveform. □

Low-voltage-inverter logic: a better bipolar option for VLSI

Parallel transistors combine level sensing and output drive into one stage for a lower power-delay product than TTL or emitter-coupled logic

by Richard R. Konian, *International Business Machines Corp., General Technology Division, East Fishkill, N. Y.*

☐ A new bipolar circuit technology is faster than emitter-coupled logic yet offers much the same density as TTL. It promises to make very large-scale integration available to high-performance computers (Fig. 1).

Among bipolar technologies, TTL particularly suits dense, low-power integrated circuits. But, it lacks the speed necessary for high-performance machines. On the other hand, ECL is much faster than TTL, though it is less dense and consumes considerably more power. In contrast, the new circuit configuration—low-voltage-inverter or LVI logic—currently shows a power-delay product of just 0.6 picojoule, half that of TTL and about a tenth that of ECL.

LVI logic's design incorporates a push-pull output with the logic level-setting stage. This makes it even faster than ECL, which cannot use a push-pull drive without incurring additional delays. MOS circuits, particularly those of complementary-MOS, exhibit lower power-delay products—but only because they consume less power. LVI circuits, being bipolar, are much faster than MOS versions and, in fact, are among the fastest bipolar circuits available.

A new figure of merit

Behind the development of the new circuit lies the perception that with each new generation of circuit technology, the ratio of signal-line capacitance to device capacitance has increased. Not long ago devices were larger, and several generations back they were huge relative to today's dimensions, so that line capacitance was a very small percentage of the total that the circuit had to drive.

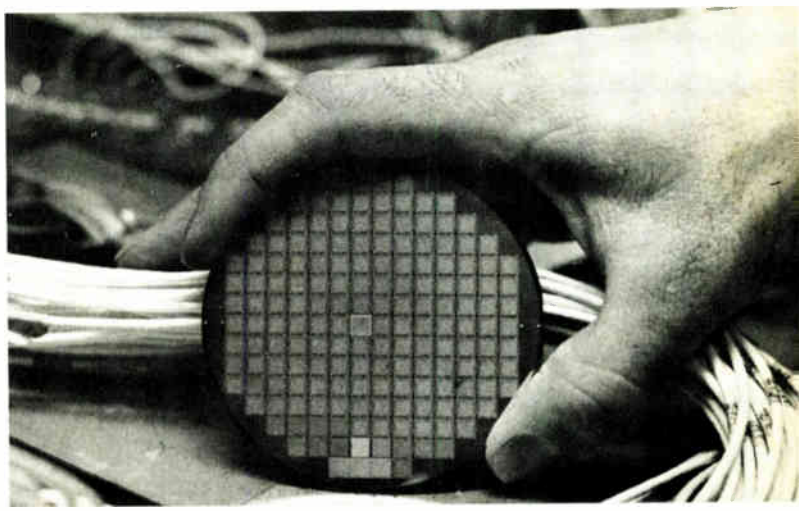
Like older configurations, the LVI circuit first drives its internal capacitances, then any line capacitance, and finally, the internal capacitances of the following circuit. Impressive innovations over the past 15 years have markedly reduced device capacitance. Minimization of line capacitance, on the other hand, being relatively straightforward, has remained essentially a brute-force operation. Designers have tried to keep line capacitance as small as possible, but with less success, so the ratio of line to device capacitance has gradually inflated. As this ratio rises, the power required to switch the line must also be increased, placing ever more importance on line-driving capability as integration continues.

The advent of the polysilicon base provides one example of how device capacitance has been lowered. In this type of substrate, the base contacts do not have to be within the base diffusion area. The contacts are located outside the base region, thereby decreasing the size of the collector-base junction as well as the transistor's overall measurements. Junction size is one of the two most significant performance parameters that are associated with capacitance, the other being the diffusion capacitance that is controlled by the circuit's vertical geometry.

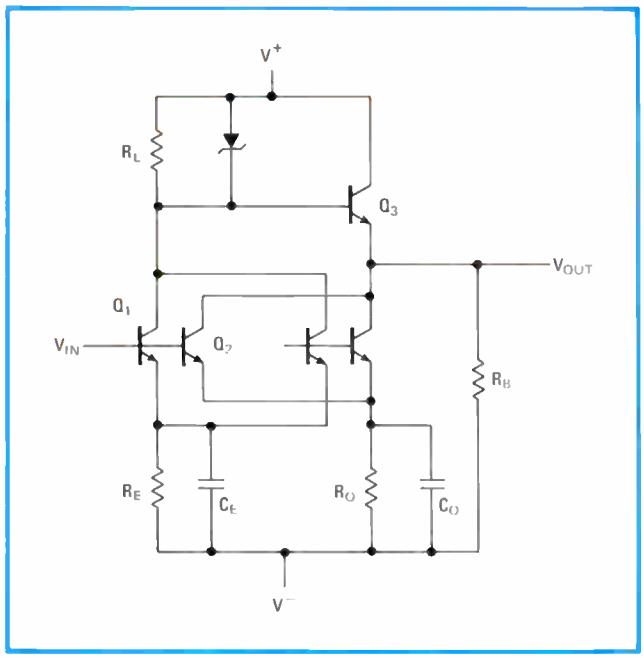
Another novelty

A second example of device innovation is self-alignment of the emitter with the base-diffusion area. Again, this has a direct impact on the collector-base area and the size of the device itself. Both these innovations, in addition to sophisticated isolation schemes to subdue device interaction, have decreased horizontal device geometry. In contrast, line-capacitance reductions have derived essentially from improvements in the particular methods of lithography used to produce circuits and interconnections.

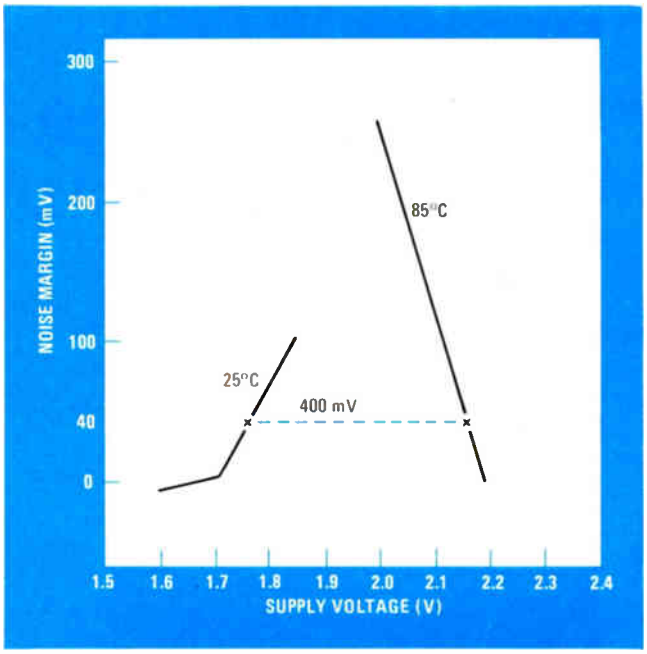
These lithographic advances have narrowed linewidths, and that evolution is continuing into the submi-



1. Low-voltage inverter. These circuits were made with a new form of bipolar technology called low-voltage-inverter or LVI logic. The unique interconnection of conventional transistors results in a power-delay product lower than for circuit forms such as TTL.



2. One collector delay. With LVI logic, logical switching and push-pull amplification are integrated into a single stage to reduce intracircuit delay. As a result, a signal traveling from input to output only encounters a single transistor and its associated delay.



3. At a glance. The noise margin of LVI circuits is plotted as a function of power-supply voltage for the temperature extremes expected. For example, if the system needs a 40-millivolt margin or better, the supply voltage must be held to within 400 mV.

crometer area. At the same time, however, the resistive component of line impedance increases, canceling much of the benefit of the reduced capacitance. Moreover, in the evolution into higher levels of integration, more lines are needed for each cell, meaning that a greater proportion of the chip becomes associated with signal paths. Eventually, with designers concentrating only on vertical device geometries, the problem of an increasing ratio of line to device capacitance would be steadily compounded. LVI logic attempts to short-circuit such an undesirable eventuality in a straightforward manner.

A single logic stage

LVI logic's unique intracircuit connections dramatically minimize intracircuit delay. Logic-level determination and push-pull amplification are performed in a single stage (Fig. 2). In all previous technologies, these functions were treated as separate responsibilities, requiring more than one collector-area delay and, often, two logic stages. In ECL, for example, an input has to pass through two collectors, looking much like two stages of logic. This is the major reason the push-pull current switch, though attractive from a drive standpoint, has not been used for internal logic by the semiconductor industry: appended to a traditional circuit, it adds yet another period of delay.

In the LVI circuit, each of two input gates comprises two branches (Fig. 2). The left branch, with its associated transistor (Q_1), sets the switching levels of the logic. The right branch, with transistors Q_2 and Q_3, provides the drive capability. These branches are joined through a shared base connection. The signal passes from input to output through just one collector area, so it experiences only one collector delay. Thus, with the push-pull output integrated as part of one logic stage, its superior drive capability can—for the first time—be obtained without adding delays.

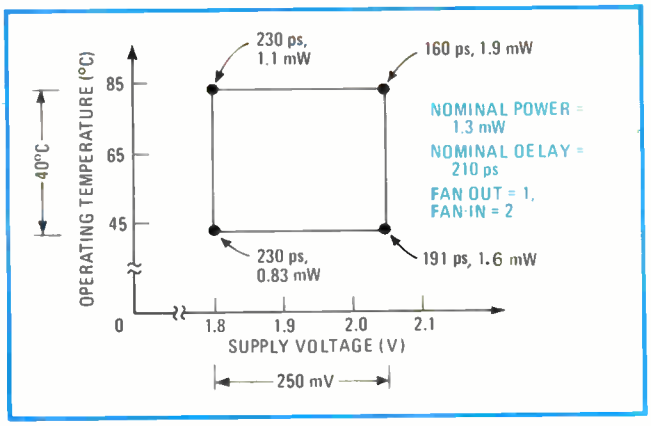
The output branch of the LVI circuit exhibits the high-driving capability afforded by active elements on both sides of the output terminal. The output voltage is pushed high by Q_3 and pulled low by Q_2. Resistors are needed for dc control on both branches, and capacitors are used to speed up the circuits, as in other bipolar logic-gate configurations.

In sum, this simple configuration merges two independent branches, one providing the basic ingredients for logic and the other providing high-drive capability. The branches are connected in order to minimize intracircuit delay and to supply the lowest possible voltage that can support push-pull operation at the output. This has been done by placing the input transistors in parallel, with their bases connected so as to meet the low-voltage requirement. As a result, signals travel from input to output in one collector period, which is the shortest possible propagation delay for an inverting circuit.

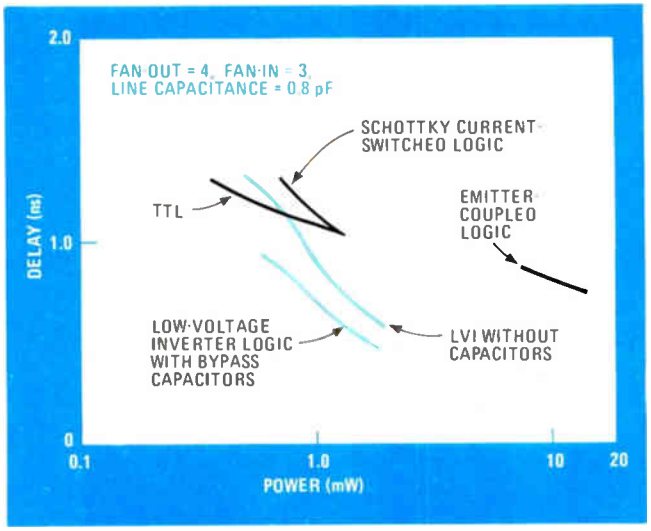
Toward high-performance VLSI

In all, a number of factors make the LVI circuit attractive in terms of both speed and power for VLSI. Independent paths supply driver current and set internal dc voltages. Line-driving current passes through one branch and dc-level–setting current through the other; they do not conflict, so the dc level is set independently of driver charge-and-discharge cycles.

In contrast, dc-level setting in a TTL circuit is hampered by output charging current; the same transistor that sets the dc voltage must try to drive the line capacitance, an arrangement that brings about circuit delay. ECL has independent paths but, as noted, it does not have push-pull drive or minimized intracircuit delay.



4. Square of interest. The operational space of LVI is square because its voltage and temperature limits are independent. At the extremes, a 160-picosecond circuit requires 1.9 milliwatts of power; a 230-ps circuit can get by with as little as 0.83 mW.



5. Speed-power curves. The power-delay product of LVI logic, with and without bypass capacitors, is here compared with other bipolar technologies. LVI technology will yield chips with thousands of 2.5-mW gates, or the power can be lowered for twice that many.

The LVI circuit offers a low output impedance in both directions; an emitter follower assists output signals on their way up, and capacitive overdrive helps on their way down. The overdrive capacitors reduce dc power because they help overcome differences in the horizontal geometries of the transistors, and they provide a discharging pad for the line capacitance. Once the capacitors are charged, a lower steady-state power is consumed, because current flows only 50% of the time.

Low-impedance source

All transistors in an LVI gate are switched by a low-impedance source, which is yet another novel characteristic of the new circuit. The two bottom transistors in Fig. 2 (Q_1 and Q_2) are switching devices, and the third (Q_3) is the emitter follower. That all the transistors are charged and discharged via their base regions with low-impedance sources is one of the major factors contributing to the high performance of LVI logic.

The LVI circuit may completely cover the TTL and ECL operational ranges. Logic circuits are evaluated using three basic criteria: speed, power requirements, and density. LVI logic can match or surpass other bipolar technologies in all three contests.

An important consideration is the noise margin as a function of the power-supply voltage (Fig. 3). A spurious signal present at the circuit's input must not propagate through subsequent cells—even under worst-case conditions. On the other hand, the dc noise margin of the circuit does depend on the dc gain—established by resistor ratio—needed to satisfy a particular application. Like all circuits, LVI logic presents a tradeoff between dc noise margin and performance. Figure 3 shows how a given noise margin dictates the allowed power-supply variation or *vice versa*. A designer can see the different variations at a glance, making it easy to choose the center point best suited to accommodate differing circuit and packaging requirements on noise margin.

In terms of layout, the compactness of LVI logic exceeds that of Schottky current-switched (SCS) circuits and does well against TTL. SCS circuits currently make for some of the densest bipolar chips in the industry, with some 1,500 circuits already possible. Using a master-slice cell as an example and allowing for about 19 interconnection channels, the LVI cell takes up 116.9 by 86.65 micrometers, or about 10,000 μm^2. A TTL circuit needs about 9,500 μm^2 and the SCS cell about 12,000 μm^2 under the same conditions.

Thus, the new circuit is competitive in terms of area using similar ground rules. Standard ECL would be two to three times larger.

Performance data

In order to test the speed of LVI logic, a loop of 49 stages was simulated, and the signal across two stages was measured so there would be no crossover problem. The two stages yielded a delay of about 200 picoseconds for each stage.

One way to categorize the LVI circuit is by its operational space. Figure 4 shows the voltage and temperature limits between which the circuit is expected to operate without using any temperature compensation of the power supply. Voltage and temperature are independent, leading to a square operational space and a power-delay rating of from 0.27 to just less than 0.3 pJ. At the extremes, a 160-ps circuit requires 1.9 milliwatts of power, whereas a 230-ps circuit needs but 0.83 mW.

Figure 5 serves as a summary, recapping some of the key points concerning the LVI circuit. The technology is compared with TTL and ECL with and without bypass capacitors. Clearly, in comparison with ECL, the new circuit shows a significant improvement in power requirements and performance. With typical load characteristics, LVI logic is four times faster than TTL.

The advantages of the LVI circuit stand out at both ends of the spectrum. If the designer wants high speed, a circuit with a few thousand devices might be configured on a chip using a per-circuit power in the 2.5-mW range. Alternatively, utilizing the new circuit as a low-power device, twice as many circuits might be connected on a chip, with each chip then consuming a matter of 0.5 to 0.7 mW for each circuit. □

Parallel power MOS FETs increase circuit current capacity

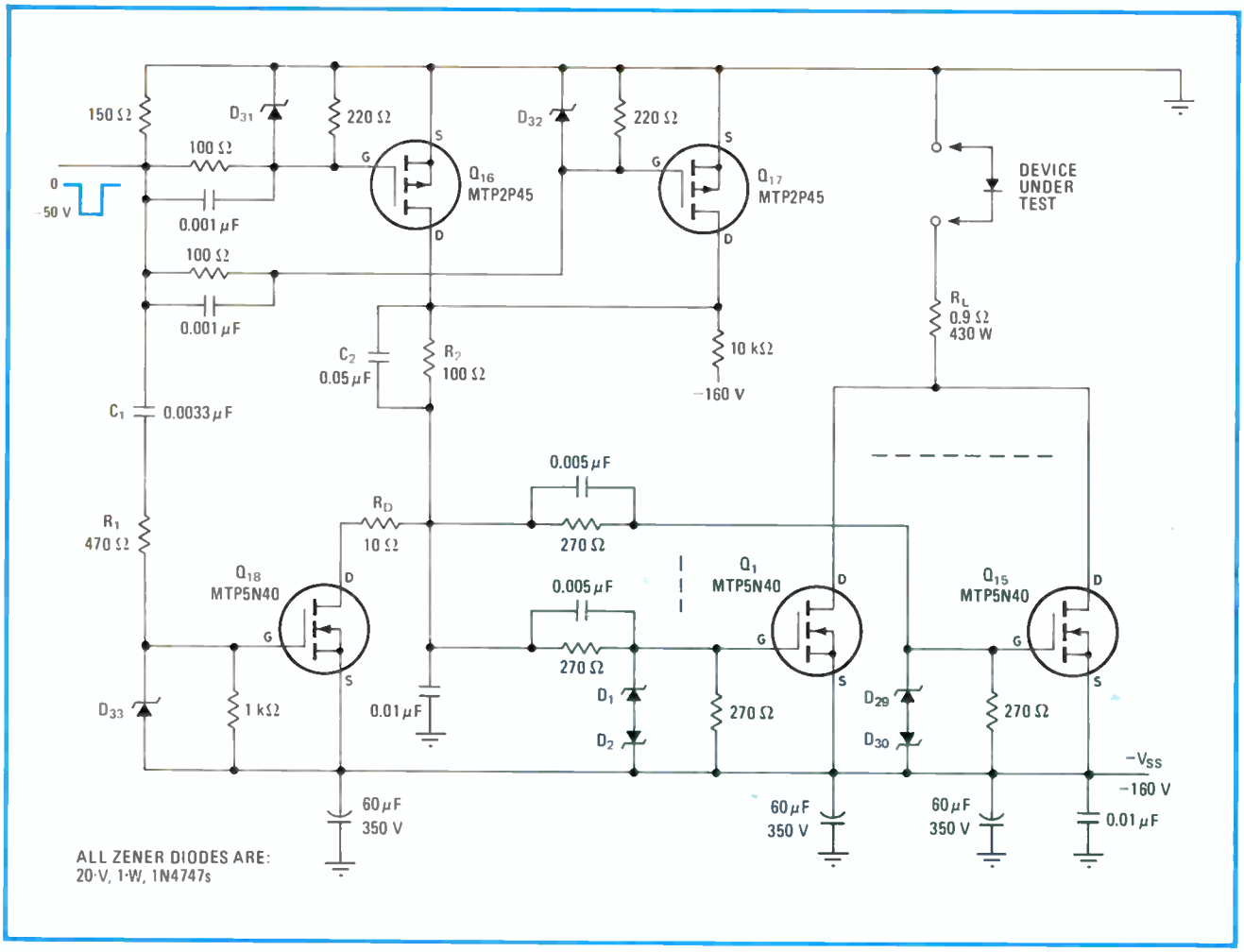
by Herb Saladin and Al Pshaenich
Motorola Semiconductor Products Sector, Phoenix, Ariz.

A fast high-voltage and -current pulse is often needed to evaluate the characteristics of a switching power device. For such applications, the semiconductor switch must be much faster than the device under test. Power MOS field-effect transistors serve this function well, but are limited by their current-carrying capability. However, this current capability can be increased without altering the switching speed of the generated pulse by paralleling the transistors.

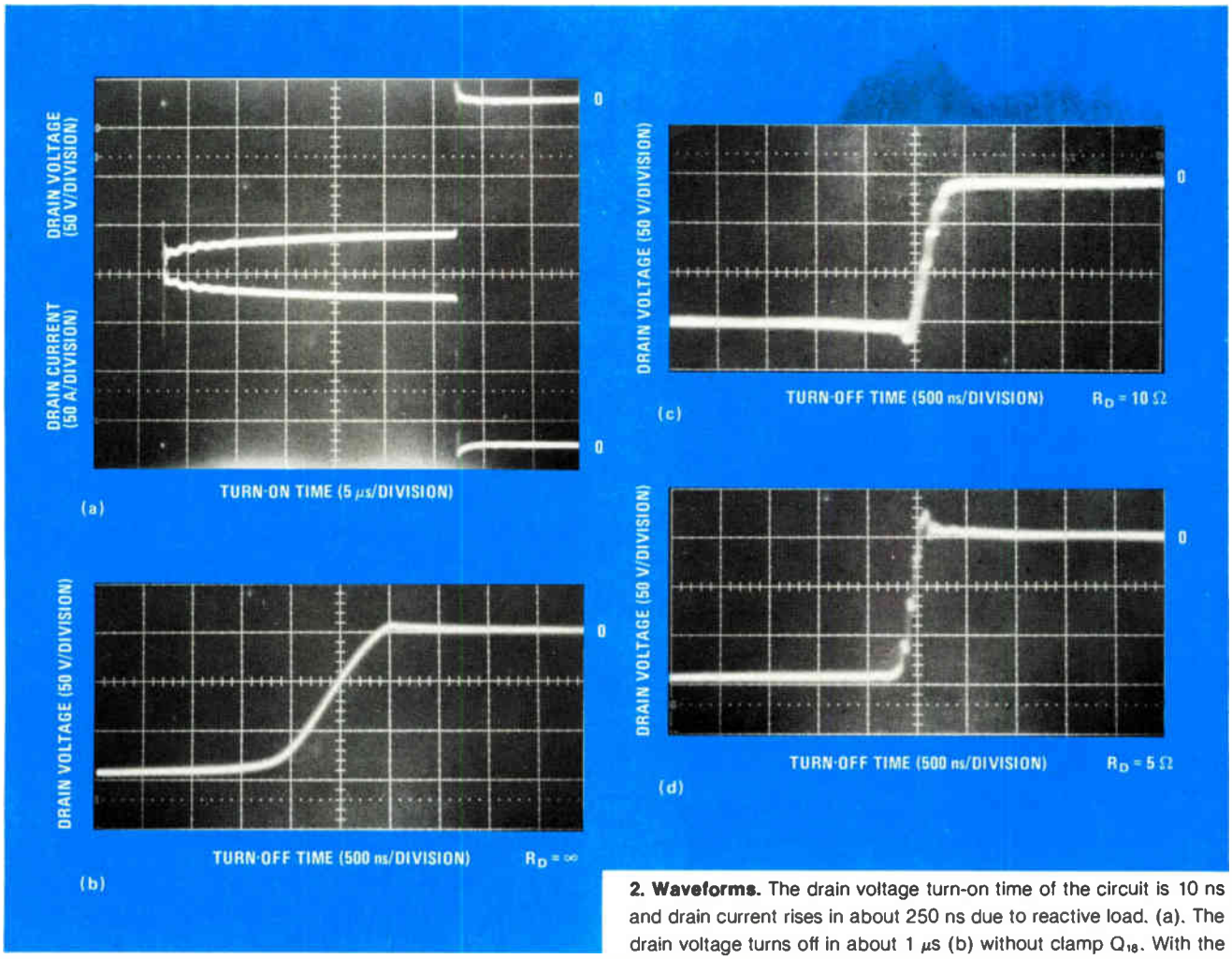
Power MOS FETs Q_1 through Q_{15} (Fig. 1) are connected in parallel to obtain 150 amperes of peak pulsed current for the system. Initially, the FET with the highest transconductance (g_{fs}) draws the largest drain current and consequently causes high dissipation. The resulting temperature rise increases the drain-source on-resistance $r_{ds(on)}$ and self-limits the drain current. This process will continue until all of the FETs in the circuit have equal drain currents.

Two p-channel FETs (Q_{16} and Q_{17}) are connected in parallel to provide the drive current for the MOS FET switch. These FETs are turned on by the negative-going input pulse. Limiting resistor R_2 and speed-up capacitor C_2 in the drain path of Q_{16} and Q_{17} feed the 15 gate circuits of Q_1 through Q_{15}. For simplicity, only the gate circuits of Q_1 and Q_{15} are shown, each formed by a directly coupled resistor, a speed-up capacitor, and back-to-back zener diodes for protection.

In the circuit, approximately 150 A at 140 volts is switched extremely fast, with voltage turn-on time being



1. Power switcher. This high-speed and high-current semiconductor switch uses 15 n-channel power MOS FETs in parallel to achieve the circuit capability of 150 A of peak pulsed current. Unmatched FETs are used because the self-limiting ability of each FET tends to equalize the drain current. A low-duty-cycle, 50-V input drive pulse has a rise time of 10 ns.



2. Waveforms. The drain voltage turn-on time of the circuit is 10 ns and drain current rises in about 250 ns due to reactive load. (a). The drain voltage turns off in about 1 μs (b) without clamp Q_{18}. With the clamp the turn-off time is reduced to 0.2 μs (c). The FET switch turns off faster as the value of resistance R_d is reduced (d).

less than 10 nanoseconds and current rise time about 250 ns (Fig. 2a). The turn-off time for the power switch is improved with the n-channel FET clamp Q_{18}, which turns on at the input pulse's trailing edge and supplies a reverse gate voltage to the power switch. The drain voltage turn-off time of about 1 microsecond (Fig. 2b) is reduced to 0.2 μs with this clamp (Fig. 2c). Reducing resistor R_d further lessens turn-off time (Fig. 2d).

Extreme care must be exercised in the layout of the 15 parallel MOS FETs. Lead lengths must be kept as short as possible and rf bypass capacitors placed at several points along the source bus line to minimize reactive effects. A duty cycle of less than 1% is used to ensure safe operation. □

5-V converter powers EE-PROMs, RS-232-C drivers

by Richard A. McGrath
Studio 7 Technical Documentation, San Carlos, Calif.

Many of today's electrically erasable programmable and electrically alterable read-only memories require different voltages from the RS-232-C drivers needed to interface them with microprocessors. This dc-to-dc converter changes 5 volts into ±11 V for these drivers and 21 V for programming or reading EE-PROMs. Because the RS-

TYPICAL TEST RESULTS FOR A 5-V SUPPLY

Test point voltage (V)	Logic state of IH5143 analog switch, pin 15			
	Switch S_2 open		Switch S_2 closed (grounded)	
	Low	High	Low	High
MC1488* pin 1	−0.2	−11.8	−4.3	−13.5
MC1488* pin 14	+21.7	+10.6	+8.7	+7.5
2817 pin 1 1.5-kΩ load	+20.7	+10.7	+3.5	+3.0
$+V_{output}$	+22.4	+11.3	+9.4	+8.2
$-V_{output}$	−0.9	−12.4	−4.9	−14.0

*300-Ω load on output pin 3, logic high on pin 2

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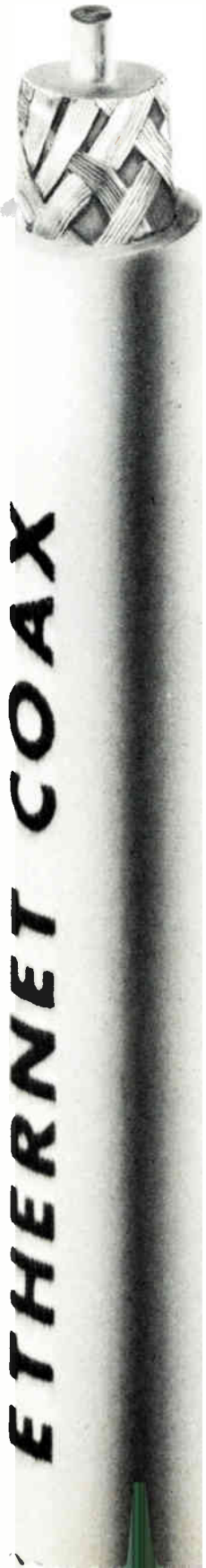

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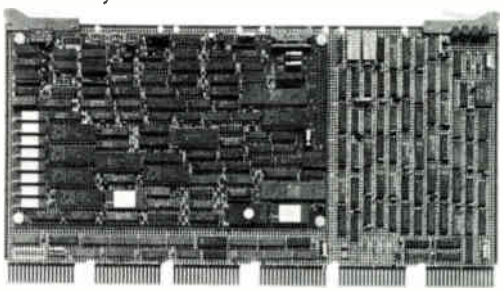

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Circle 138 on reader service card

232-C drivers and EE-PROMs operate at different time intervals and the circuit's switching time is much shorter than that of serial communication, power requirement conflicts do not occur.

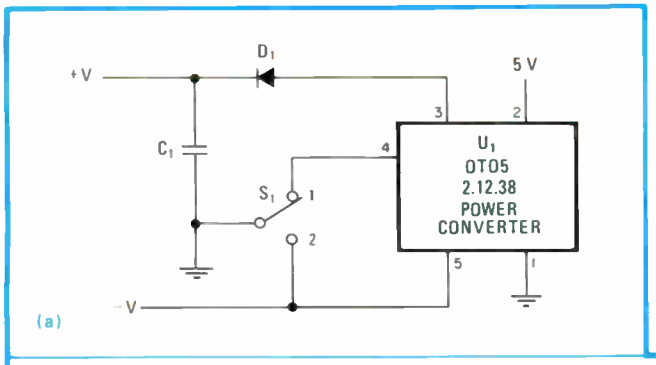
Semiconductor Circuits' power converter U_1 can generate ±12 V or +24 V with the addition of single-pole double-throw switch S_1, diode D_1, and capacitor C_1(a). If S_1 is in position 1, ±12 V are produced. In position 2, this switch gives +24 V. In addition, D_1 ensures that a positive voltage is generated from pin 3 during switching, and surge voltages are suppressed by C_1.

The dc-to-dc converter (b) uses Intersil's analog switch S_1 (1H5143) to switch the converter more quickly from ±11 to +21 V. The switching is controlled by logic, and many voltages can be selected from the circuit with switch S_2 and the logic at pin 15 of S_1 (see table).

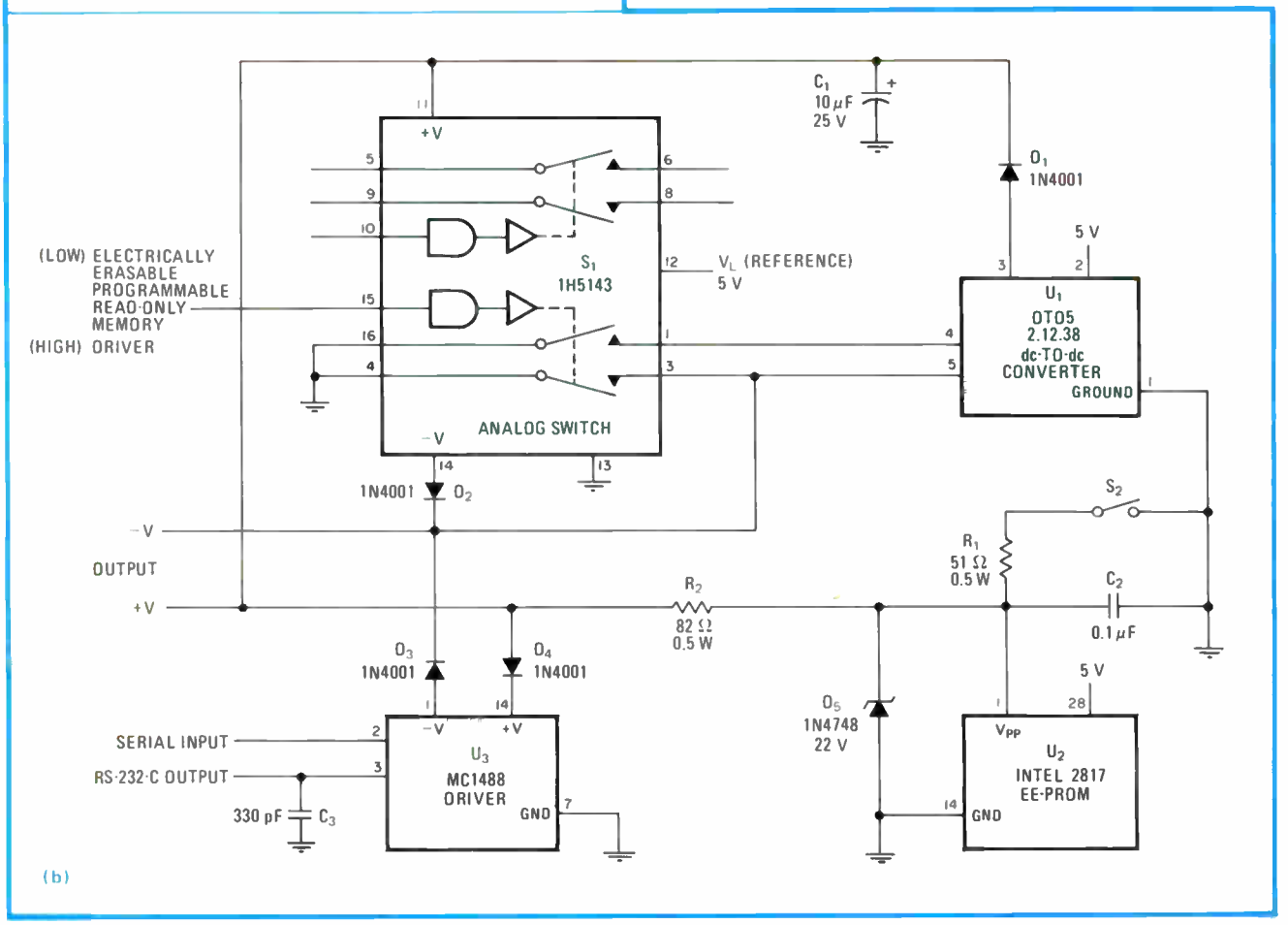
Any negative voltage across the drain-to-body junction of the body-puller field-effect transistor of S_1 is stopped by diode D_2. Zener diode D_5 and resistor R_2 reduce +24 to +21 V when EE-PROM U_2 is programmed or read. In addition, this combination reduces ±12 to ±11 V, which powers RS-232-C driver U_3. Capacitor C_2 prevents voltage override when the switching frequency is about 5 kilohertz. Grounding resistor R_1 together with S_2 provides correct power switching for EE-PROMs when the circuit is turned on or off. The 5-V supply also is directly tapped in order to power one of the inputs of the EE-PROM.

Tradeoffs in memory organization (2-K by 8 bits), programming convenience, product availability, and power requirements led to the choice of Intel's 2817 EE-PROM for U_2. Many other voltages can be selected from this circuit, and as a result, any EE-PROM may be used in it. This cost-effective design eliminates bulky transformers and voltage regulators and thus requires only a few external components. It finds applications in lightweight airborne or robotic systems. □

Designer's casebook is a regular feature in *Electronics*. We invite readers to submit original and unpublished circuit ideas and solutions to design problems. Explain briefly but thoroughly the circuit's operating principle and purpose. We'll pay $75 for each item published.



Converter. The dc-to-dc converter (a) uses minimum components to generate ±12 or +24 volts. To provide faster switching, mechanical switch S_1 is replaced with the Intersil's analog switch IH5143 (b). The switching of this converter is controlled by logic and used to program or read 2817 EE-PROMs or to power RS-232-C drivers.



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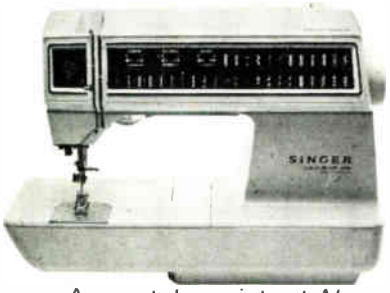

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Printed circuits get a new boarder: the plastic leaded chip-carrier

Space-efficient packages cut costs and can be reliably surface-mounted to standard pc board materials using a variety of existing methods

by John Orcutt
Texas Instruments Inc., Dallas, Texas

☐ As the size of monolithic integrated circuits continues growing and the dimensions of the devices on ICs continue to shrink, components packagers are faced with the double-edged challenge of housing a physically large chip whose density demands an increasing number of leads or pads for input/output lines. Because of this, the dual in-line package will gradually be replaced by plastic leaded chip-carriers. The transition will demand many adjustments, but it is being eased by new attachment techniques that do not require expensive retooling and permit a mixture of carriers and DIPs to be attached to a single board in one operation.

DIPs have endeavored to keep pace with the increased size and density of large- and very large-scale integration by increasing their number of pins to 20, 28, 44, and 64, with the number of I/O leads from the chips running as high as 256 (Table 1). But a standard 64-pin DIP already occupies 3 square inches of board space, which is about as much as a package can realistically claim. Thus, the emphasis has been shifting to square packages such as the leadless ceramic chip-carrier.

By contrast, a 68-pin carrier conforming to the pinout standards of the Joint Electron Device Engineering Council, for example, needs only about 1 in.^{2} of board

1. The leaded and the leadless. This board has a mix of plastic leadless chip-carriers and leaded ceramic ones. The black types are the leaded chip-carriers. At the lower left are two 84-lead plastic carriers. Each of these units has an integral copper heat sink.

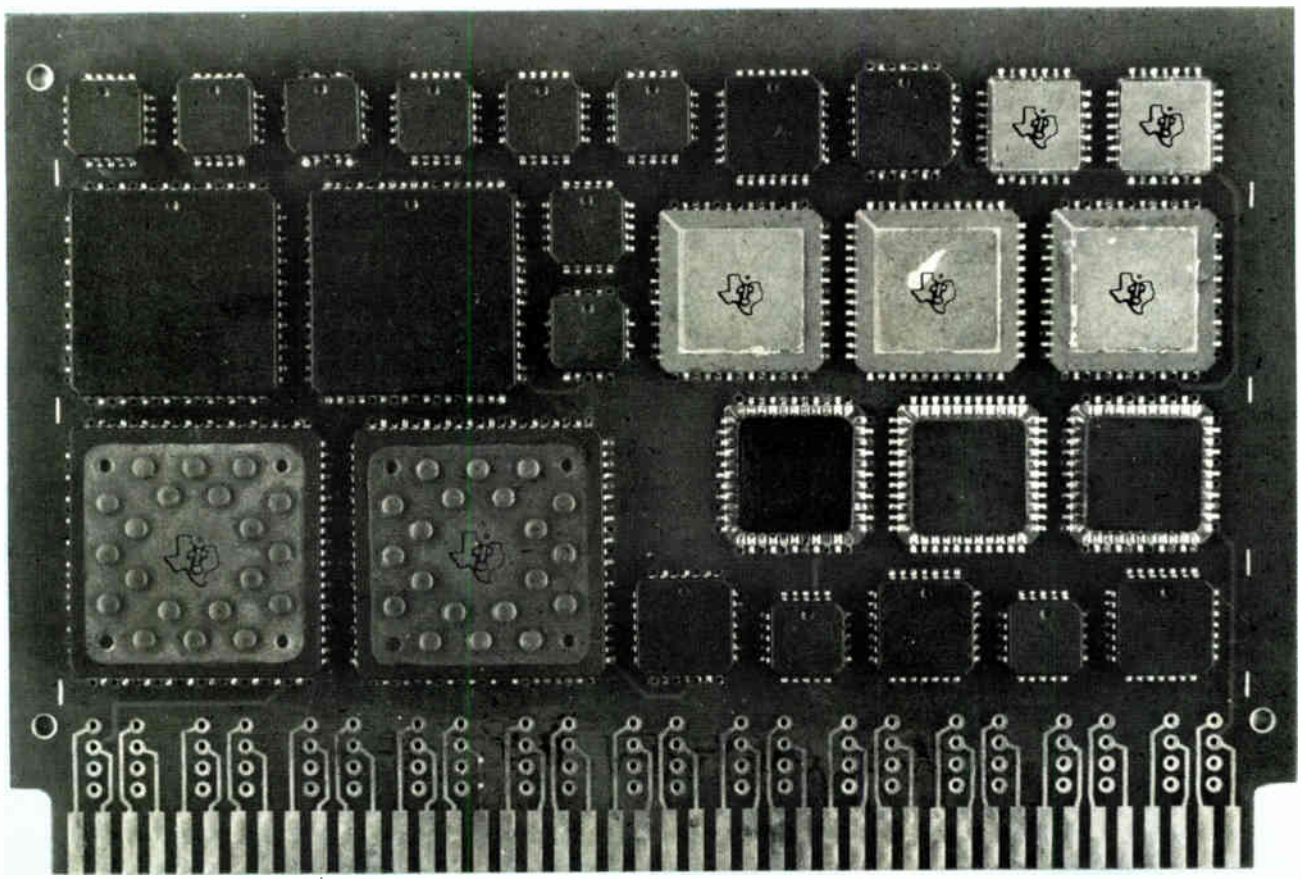


TABLE 1: DEVICE TECHNOLOGY TRENDS INFLUENCING PACKAGING			
Trend	1975	1980	1985
Feature size reduction (μm)	5	3	2
Larger chip size (× 1,000 mils^2)	40	90	90
Linear and MOS devices (%)	5	20	35–50
Higher voltage (V)	40	150	250–300
Higher power (W)	1	2	6–10
Higher impedance (Ω)	10^9	10^{12}	10^{15}
Higher pin count	40	64	256

space—a substantial 3:1 reduction in area. Yet, while the ceramic leadless chip-carrier is undeniably a space-efficient package, especially for chips requiring large pinouts, there are two sizable obstacles to the widespread acceptance of this package. First, the cofired multilayer construction of ceramic carriers makes them quite expensive. Second, it is extremely difficult to reliably attach ceramic carriers to the popular glass-epoxy variety of printed-circuit board because of the large difference in the temperature coefficient of expansion (TCE) between the board and packaging materials. This TCE differential causes carrier-to-board solder joints to crack and break under conditions of thermal shock—a situation that is particularly critical in carriers that have a greater number of pinouts.

TI's solution to these problems is the post-molded plastic leaded chip-carrier. Not only is it impervious to thermal shock, but plastic leaded carriers, in terms of cost-savings, will do for the ceramic chip-carrier what the plastic DIP did for the ceramic DIP. Plastic carriers replace expensive, difficult-to-work-with ceramics with low-cost easily molded thermoset plastic. And as in the case of the interchangeability of ceramic and plastic DIPs, plastic carriers match the Jedec standards for chip-carrier patterns and socket dimensions.

The plastic chip-carriers from TI are square types that conform to a coming Jedec specification for leaded plastic chip-carriers. They are currently available in 20-, 28-, 44-, 68-, and 84-lead versions. However, by mid-year, the company will come out with a rectangular 18-lead carrier developed specifically for its 64-K random-access memories. Both package types have leads on 50-mil centers. TI also has a long-range program to develop a family of fine-pitch plastic chip-carriers with leads on 25-mil centers [*Electronics*, Oct. 6, 1981, p. 42], but the first significant application of carriers should already be felt with the units on 50-mil centers.

Tooled like a DIP

Almost the same material, tooling, and processing used to make plastic DIPs is used for making plastic chip-carriers. For example, chip-mounting and -bonding equipment does not know whether it is mounting or bonding a chip to a DIP or chip-carrier leadframe. Of course, the mold shape is different for the two packages, but the plastic material and molding machines are the same. The carrier leadframes are different and are made of copper, unlike most DIP leadframes, which are made of Alloy 42.

The forming and trimming processes, however, are somewhat more difficult as the leads on the carriers are on 50-mil centers, rather than the 100-mil centers on DIPs. Moreover, the DIP requires only one angle bend, whereas the carrier leads are bent around into a J shape, close to the plastic body, which requires more precise and careful handling.

These problems, however, have been solved, and when production volume builds up, carrier-housed ICs should rapidly reach cost levels competitive with plastic DIPs.

Higher conductivity

Another area where the plastic carrier competes favorably with the DIP is in thermal conductivity. The carrier's leads are of an alloy with a high copper content that has a higher thermal conductivity than the DIP's Alloy 42 leads. This relatively ductile material can be used because the carrier leads do not need the stiffness required by those of a DIP, which serve as plug pins and must withstand socket insertion and extraction forces not imposed on the leaded carrier. The alloy has 95% of the thermal and electrical conductivity of pure copper but still can be tempered for a good measure of tensile strength. On the other hand, since the carrier's leads are wrapped around and tucked in close to the carrier body, they do not need the rigidity of the straight pins that are used on a DIP.

The Japanese also offer some competing leaded plastic chip-carrier designs, but these units do not follow any pinout convention. As a result, there has been a proliferation of styles, making a selection very difficult. Moreover, the Japanese extend their terminal leads straight out or with a gull-wing bend from the package body, which is very difficult to handle during production and later during shipping and mounting.

The plastic leaded carrier produced by TI, however, fits the Jedec footprint precisely and is being kept in

conformance with any changes promulgated by the council's standards committee. Standardized packaging for electronic parts (and their sockets, if any) have always been of benefit to the industry, lowering costs and permitting production to be automated.

After testing and burn-in, ICs are packaged for shipment and later loading into automatic board-assembly machines. Here is where the square, flat, and nonprotruding lead configuration of the plastic carriers also shows its advantages. Not only do the carriers save space on pc boards, but they also can be densely stacked like poker chips or coins in tubes—unlike DIPs, which generally must be packed end to end and thus take up a lot of room per unit. Automatic stacks need to be reloaded less often and take up less storage space. Because no delicate leads or pins that easily bend out of shape are exposed, the carrier can even be shipped loose in plastic bags—they are as rugged as that, especially in the sizes with smaller lead counts.

Traditionally, plastic packaging has followed ceramic versions as a low-cost alternative for those who do not need the higher temperature capabilities, hermeticity, and perceived reliability of ceramics. The question of reliability, however, hinges on how much is enough.

In telecommunications, for example, systems often are designed for a life cycle of 40 years. But that figure was based on the pace of innovation in electronics 50 years ago. Today, 10-year-old equipment in perfect working order is ripped out to be replaced with more complex, energy-efficient, and easier-to-maintain systems. Money is saved and increased performance and capabilities are achieved. And as the rate of advances in electronic technology increases, this new equipment may be replaced, perhaps in five years, with even more advanced, better-performing, and lower-cost equipment.

Accordingly, though the plastic enclosure may not last as long as a hermetically sealed ceramic package, it probably will outlast the obsolescence of its contents. Billions of plastic-packaged DIPs and transistors continue to function perfectly, though they were considered obsolete years ago.

Keeping a low profile

Nevertheless, boards populated with plastic chip-carriers are not expected immediately. At first, the more complex, more expensive large- and very large-scale integrated devices—where the DIP no longer can handle the required large numbers of pins—will be packaged in plastic carriers and mounted on small islands on pc boards. Gradually, as the advantages of the carriers are perceived, they may take over larger proportion of pc boards and even compete directly with DIPs having low lead counts, thereby taking full advantage of the carrier's space-saving potential as well (Fig. 1).

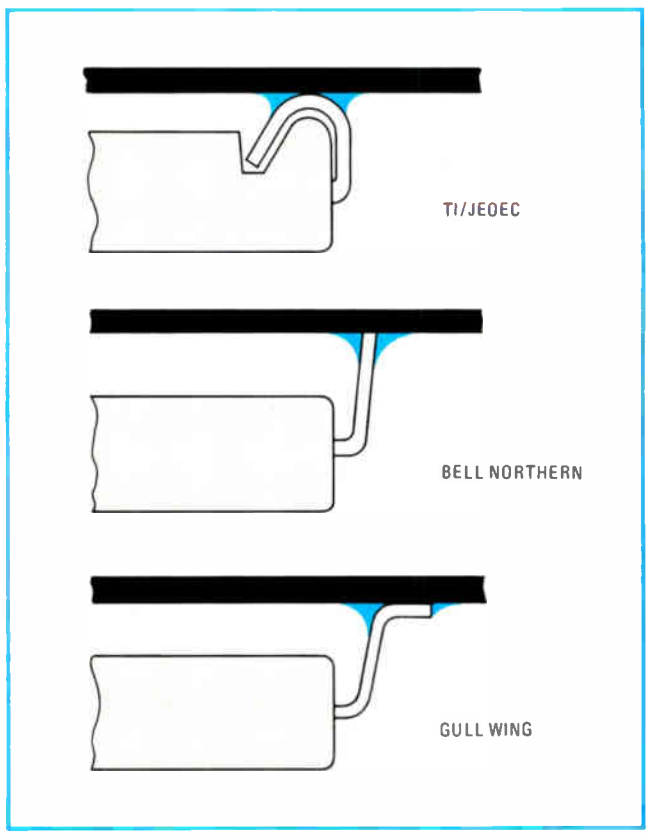
The plastic leaded carrier is compatible with existing flush-mounted components, such as chip capacitors, chip resistors, and the new small-outline packages, whose proliferation ultimately will lead to totally surface-mounted boards. However, as is often the case with a new packaging technique, new attachment processes and equipment must be developed in order for the packaging technique to take hold. Because the carrier's terminals are of a folded-under type, unlike the extended pins of a DIP, the carrier must be attached to the circuit board with the aid of a pressure-holding socket or, at lower cost and in less space, by being directly soldered to the surface of the board.

By contrast, the usual DIP unit is soldered through the board, and most available soldering equipment is geared to such an approach. With the through-the-board technique the leads of DIPs, resistors, capacitors, or other components go through a hole in the board and then are wave-soldered. Even chip components often are glued to the bottom of the board and then wave-soldered.

Since many users of plastic carriers already have in-house wave-soldering equipment, it is not surprising that these firms are looking into the feasibility of wave-soldering plastic chip-carriers to pc boards. The same techniques that have been found suitable for passive chip components are being applied. The wave soldering of various leaded carriers is depicted in Fig. 2. If this mature technique can be successfully applied (and there are indications that it might be) to production volumes, it would result in a large savings by eliminating the need for the new types of soldering equipment specifically designed for surface mounting.

Socketing versus soldering

For prototyping, testing, and low-volume production, sockets suit plastic leaded chip-carriers perfectly. For working at the bench, or for test quantities of boards, the



2. Wave-soldered. Recent work shows that it is possible to wave-solder the three types of plastic leaded chip-carriers shown to standard pc boards. The components are aligned to the board's solder pads, glued in place, and run through a solder wave.

plastic chip-carriers like DIPs can simply be inserted into standard sockets. Several companies manufacture them. Amp Inc. of Harrisburg, Pa., for example, offers 20-, 28-, 44-, and 68-pin sockets, with an 84-pin version just becoming available. The sockets make connection with the chip-carrier through high-contact lateral forces. In fact, the carriers often must be removed by being pushed out through a hole in both board and socket. Despite the high contact and removal forces, the sockets remain reliable for far more removal-insertion cycles than a chip-carrier is likely to experience.

However, for production runs, and for space savings of as much as 66%, directly soldering the carrier to a board is desirable, especially as the surface-mounting format really takes hold for all manner of components. Soldering directly to the board, however, requires new methods, such as mass vapor-reflow-soldering the whole board or using a collet-like tool for surface-soldering individual units. Fortunately, many new flush-mounting chip components, a large variety of European-developed 50-mil-centered small-outline component and transistor packages, in addition to the plastic carriers, contribute to a substantially large available device mix that may eventually drive the industry toward investing in surface-mounting methods like the mass vapor-reflow process.

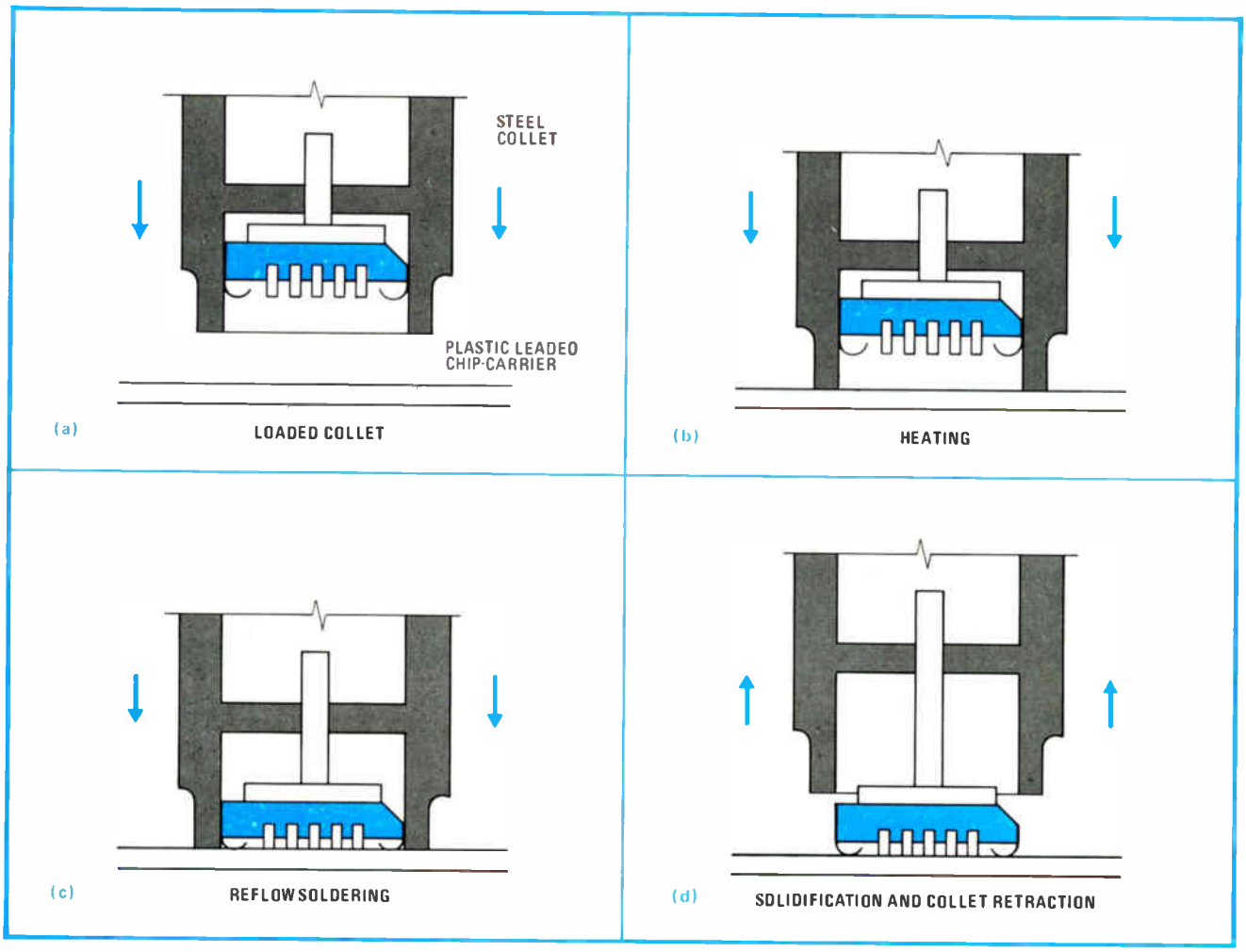
In this process, the bare, etched board is first plated with solder to coat the copper wiring traces. Then, solder paste is screen-printed over the traces. The paste contains both solder and flux plus a carrier that temporarily holds the components in place for soldering.

Taking the heat

The entire board is heated with the components in place. Generally, a densely saturated vapor from a fluorochemical liquid (like FC-70 Fluorinert from 3M Co., St. Paul, Minn.) heated to its 215°C boiling point raises all board components and the board itself to the same temperature. The vapor excludes air from the container, thus preventing oxidation. Also, the liquid-vapor relationship keeps the temperature fixed without the need for expensive temperature controls.

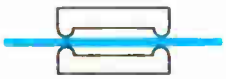
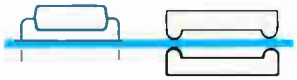
The board, or rather a stack of boards, placed in the vapor-phase reflow container, fuses the solder, creating excellently soldered joints. Moreover, the plastic chip-carriers thus attached are more tolerant of thermal cycling than leadless ceramic carriers.

Ceramic chip-carriers require boards with thermally matched properties. TI's plastic carriers do not, because their compliant leads are designed to absorb all thermally induced stresses that might develop. This ability con-



3. On the surface. A special collet tool can individually surface-solder leaded chip-carriers. The carrier is placed in the collet (a), lowered onto the solder-covered pads (b), and heated (c). The collet retracts after the solder solidifies.

TABLE 2: METHODS FOR ATTACHING FLUSH-MOUNTED COMPONENTS TO BOARDS

	Vapor phase	Heated collet	Wave soldering
Heat source	215°C Fluorinert (3M)	cartridge heaters in steel collet	solder wave
Solder and flux	solder paste with flux	solder-plated board with separate flux	fluxing followed by wave soldering
Placement	held by paste	aligned from collet	glued in place
Production use	mass-reflow flush mounting in high volume	individual or ganged attachment or repair of mixed components in medium volume	mass attachment of mixed components in high volume
			
Time and temperature	1 to 10 min/215°C	5 s/250°C	5 s/250°C
Status	proven for ceramic chip-carriers; currently being tested for plastic leaded types	process characterization under way	just recently demonstrated; experiments are under way

SOURCE TEXAS INSTRUMENTS

trasts with the ceramic carrier's screened-on I/O pads, which cannot withstand stress levels as well as the leaded carriers under thermal cycling. In testing, TI plastic carriers that were reflow-soldered to standard pc substrates have withstood over 500 cycles of thermal shock without a single joint failure.

Entire boards can be surface-soldered, even when DIPs are mixed in with plastic chip-carriers and chip components. The DIP leads are merely bent under the unit and soldered along with the other parts. Thus, when surface-mounted components become the majority part on boards, leaded DIP units still can be used as well with surface-soldering methods.

Until then, with through-the-board components in the majority, leaded chip-carriers can be individually surface-soldered with a collet tool (Fig. 3). The collet, containing the chip-carrier, is lowered to the board, and it applies heat to solder pads that will mate with the carrier terminals. The solder melts and a mechanism pushes the carrier against the molten pads. The collet retracts, but holds the carrier in place until the solder solidifies, after which it is removed.

Quick work

The whole process only takes from 1 to 3 seconds—almost as much time as inserting a DIP. If the process is done on a board that has just come off a wave-soldering machine for mounting the other components and is still hot, a 1-second soldering time can be attained. The tool, with a fluxing agent like type 611-RMA from Alpha Metals Inc., Jersey City, N. J., creates excellently soldered joints.

The collet tool is the perfect solution for situations in which just a few chip-carriers are mixed in with mostly through-the-board wave-soldered parts. With this tool there is no need to invest in new vapor-reflow equipment until surface-mounted components predominate. Table 2 compares vapor-phase soldering, the use of the collet tool and wave-soldering as attachment methods for the plastic leaded carrier.

At present, more and more surface-mounted parts are appearing on the market, and automatic equipment is being developed for placing such components on boards. Transformers, switches, light-emitting diodes and some other types of parts have yet to be manufactured in flush-mounting formats. However, the pressure is on, since designers are beginning to realize the potentially huge space savings that surface-mounted chip-carriers will bring about.

When a certain tilt-point in the availability of surface-mounted components, attachment processes, handling machines, and other automated assembly equipment occurs, the market will break loose and packagers will jump onto the chip-carrier surface-mounting bandwagon. Suddenly, the cost of retooling to new manufacturing processes will not appear so formidable.

This scenario for innovation has been played out over and over in electronic technology. Another oft-repeated part of this general scenario concerns the products that appear first. Since initial costs generally are relatively high, mostly because of low start-up volumes, the product first is applied to higher-priced components. Accordingly, plastic leaded chip-carriers will probably first be used for complex LSI and VLSI chips, where the package's cost is secondary, but its high pinout capability, substantial space-savings, and more efficient terminal wiring potential are the most important considerations.

When production volumes increase and tooling costs have been capitalized to some degree, then lower-cost products also can be housed in the plastic chip-carriers and priced competitively with low-pinout DIPs, where the packaging is a major cost factor. □

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Trim the cost of laser trimming

Rugged local network follows military aircraft standard

Low cost and a data rate of 500 kilobits per second also suit the C-Net to microcomputer-based industrial applications

by David Mandelkern, *Cromemco Inc., Mountain View, Calif.*

☐ Harsh industrial environments demand rugged local networks. To satisfy that need—and to ensure that its inexpensive network would stand out from the variety of others that have become available—Cromemco Inc. has based the C-Net local network's physical link and network interface on a military standard.

MIL STD 1553B is intended to govern the design of internal data buses for use aboard military aircraft. In applying the standard to the industry environment, the company retained the ruggedness of the physical link by using twin-axial cable, balanced lines, and differential transmission of phase-encoded data. However, the logical protocol of 1553 was dropped in favor of a collision-sensing, multiple-access scheme.

Normal network functions capable of being implemented by C-Net's network control software include electronic mail storage and delivery, error logging, data compression, and data encryption. The electronic mail program is a post office simulator that not only delivers electronic mail, but also holds mail for users who are not logged onto the network. In contrast, the error logging is not directed to end users but is part of a general housekeeping function that helps the system planner to keep tabs on a system's utilization and future expansion needs. It also enables him to monitor nodes that are error-prone and that may need preventive maintenance to obviate serious problems.

With the C-Net's data-compression programs, users will be able to make more efficient use of its data-transmission bandwidth (special software will be made available to perform this chore). And finally, data security is achieved partly by means of the relatively high safety of the physical link and its associated error-detecting codes and partly by the availability of the data-encryption standard (DES) for encrypting transmitted data. As the data-encryption standard requires, this is done by dedicated chips rather than software, which is susceptible to tampering.

These abilities and the military-like level of ruggedness do not mean that the local-network user is faced with a high price tag. Indeed, by avoiding sole-source custom integrated circuits and expensive high-speed circuitry, the cost of a basic C-Net system has been kept very low.

For example, as at present configured, the network interface will enable five work stations to communicate at a cost of less than $500 per station. With the aid of another interface, nine users can communicate over a single shared node. The cost of a single-node network-interface controller is projected at less than $1,000. A similar projection indicates that a gateway for linking networks will be available for less than $3,000. Cromemco intends to manufacture a line of C-Net local network products as well as network interface cards for the S-100 microcomputer bus.

Implementation

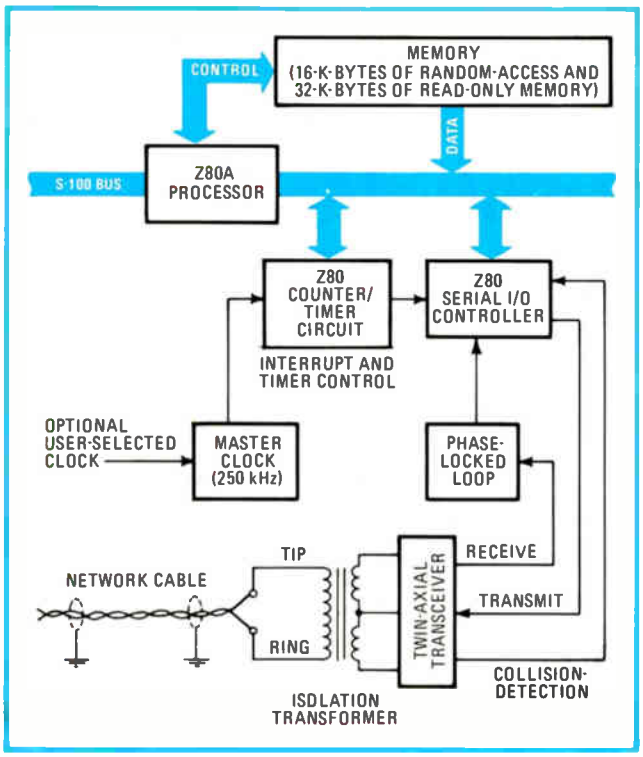
Architecturally, for greater acceptance among end users and compatibility with other local networks, the C-Net system conforms to the bottom four layers of the International Standards Organization's and American National Standards Institute's Reference Model of Open Systems Interconnection (see table). The physical link layer is implemented through twin-axial cable, while the data link is provided through a serial input/output controller. The network layer is furnished through a Cromemco-designed I/O processor, and the transport layer is taken care of by software services provided by the end user's computers. This setup is typical of local networks that are available today.

The low-cost twin-axial cable provides the reliability of a twisted pair inside a heavy braid. It is far better protection against the stray noise of a factory setting than are the commonly used unshielded twisted pairs.

Coupling to this cable is done by means of transformers. Consequently, the network electronics is completely

HOW C-NET COMPARES WITH THE ISO-ANSI NETWORK STANDARD

ISO-ANSI Reference Model	C-Net
Application layer	host computer software
Presentation layer	
Session layer	
Transport layer	software service for C-Net interface
Network layer	input/output Z80 processor
Data-link layer	serial input/output Z80510 controller
Physical layer	differential transceiver and twin-axial cable



1. Z80-based. The C-Net's interface hardware is built around the 8-bit Z80 microprocessor and its peripheral chips. The carrier-sensing, multiple-access local network also detects and remedies collisions of the data packets that travel over its shielded cable.

isolated from the physical link at all times. On the one hand, the node electronics is immune to such faults in the network cable as induced noise transients or electrical shorts. On the other, the network is physically isolated from each individual node and so cannot be affected by a node's failure.

Keep it down

External electrical noise is further suppressed by use of a differential transmitter and receiver that reject common-mode noise by more than 60 decibels. Moreover, a phase-locked loop for clock-pulse recovery minimizes noise sensitivity (Fig. 1). These functions are for the most part performed by large-scale integrated circuits, which are also in charge of the bit protocol in each network interface card, plus error checking, collision avoidance, and address decoding for up to 255 users per cable segment. The C-Net protocol has 6 bytes of software-decoded addresses for a maximum of 2.8×10^{14} individually addressable users.

The basic data rate of the C-Net was chosen to be 500 kilobits/second. This figure is more than enough to allow interfacing between various types of popular office and factory equipment. Similarly realistic, the standard C-Net cable can run up to 2,000 meters long between nodes. If desired, special low-loss RG-22 twin-axial cable can be used for distances of several miles. Moreover, amplifiers can be employed to serve even longer distances if necessary.

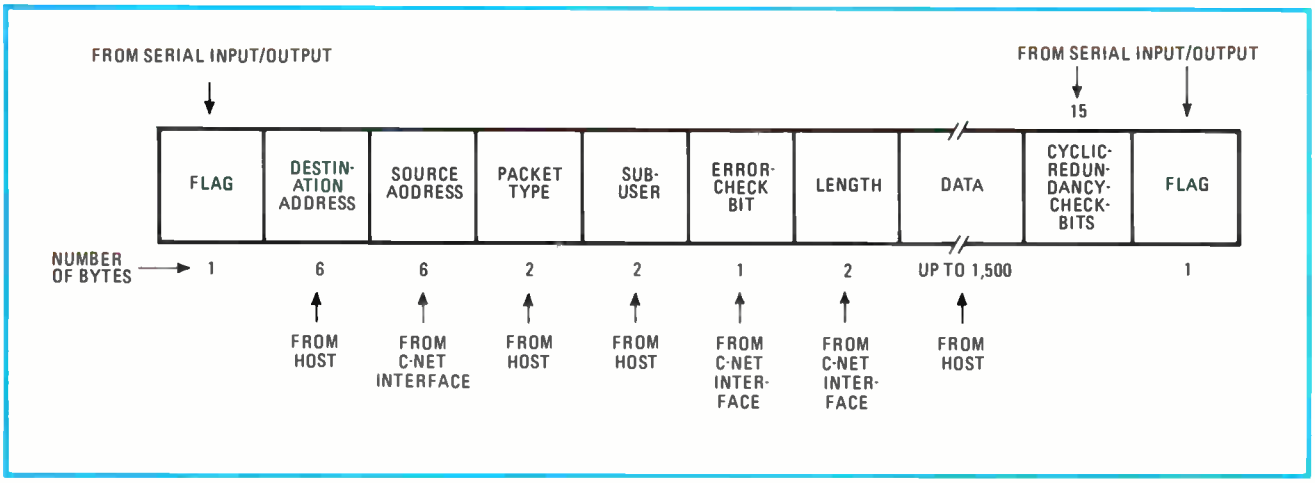
Z80-based hardware

The hardware implementation of the C-Net interface is based on the Z80A microprocessor for system control. Its peripheral, the Z80 serial-I/O chip, performs all the functions of the network's Synchronous Data-Link Control protocol. The Z80 CTC peripheral is used as a control and interrupt timer for the data-transfer process.

The network interface includes 16-K bytes of on-board random-access and 32-K bytes of read-only memory. These memories hold the network servicing software and message buffer space. To repeat, neither the RAM nor ROM chips, nor any of the other LSI devices used, are custom designs.

The standard data rate of the interface is locked to 500 kb/s by a crystal-controlled transmitter clock. But this rate is not fixed—the interface hardware itself gives the user the option of selecting any data-transmission rate from audio to 880 kb/s for use with an alternative transmission medium. For example, an engineer using fiber optics to connect high-speed microcomputers might choose an 800-kb/s data rate, whereas another user interested in linking networks over a voice-grade channel might require a far lower data rate.

Before a data packet may be transmitted over the network, a standard header must be added to it by the



2. Coming and going. The packet and header protocol shown indicates the source and destination of the data transmitted over the C-Net. The data can travel 2,000 meters on a cable segment before repeaters are needed. Interfaces to other local networks are possible.

Ethernet versus C-Net

For certain applications, C-Net is a distinctly attractive, lower-cost alternative to the Ethernet standard proposed by Xerox, Digital Equipment Corp., and Intel. Though transferring data at a slower rate than Ethernet, it has a link that is much more rugged both physically and electrically and is thus of particular interest to end users faced with installing a net in, say, a factory with high electrical noise levels. As the Intel local-network specification itself puts it: ". . . using shielded twisted-pair cable with differential drivers generally offers less susceptibility to most externally induced interference than a coax cable with an unbalanced driver." C-Net has followed that recommendation, whereas Ethernet uses unbalanced coaxial cable.

Both C-Net and Ethernet use similar and compatible specifications for the data-link layer. Consequently any higher-level software written for one network can be easily adapted to the other. Hardware interfaces between the two networks can also be built. The table summarizes the similarities and differences between the two networks.

TWO LOCAL NETWORKS COMPARED

Specification	Ethernet	C-Net
Maximum data rate	10 Mb/s	880 kb/s
Network topology	bus	bus
Maximum station separation	500 m*	2,000 m
Maximum number of stations	1,024	255 per cable segment
Physical medium	coaxial cable	shielded twisted pair
Driver type	unbalanced	differential
Maximum number of data bytes per packet	1,500	1,500
Minimum number of data bytes per packet	46	0
Cost per node (Dec. 1981)	$6,000	$1,000
Collision/contention detection?	yes	yes
Cyclic-redundancy-check error detection?	yes	yes
High noise rejection?	no	yes
Isolated medium?	no	yes
Custom cable required?	yes	no

*can run up to 1,500 meters with optional repeaters.

interface. This header is 19 bytes long (Fig. 2). It comprises 6 bytes each for the destination and source addresses, 2 bytes describing the type of package to follow (mail, file, data, and so on), 2 bytes of sub-user identification if more than one user is connected to one node, 1 byte of software error checking, and 2 bytes that give the length of the information to follow in the packet.

Then, after converting the data into the SDLC format, the next step is for the Z80 SI/O chip to add a start flag, an end flag, and 16 bits of a cyclic-redundancy-check error-detecting code. This code limits the maximum length of the packet information to 1,500 bytes. Values in excess of this figure will reduce the code's detection capability.

No bumping

The C-Net protocol is based on carrier sensing and collision detection, both standard local-network operating techniques. Before transmitting a message, the originating node monitors the network to see if the cable is idle. If no other carriers are detected, transmission of the packet begins. While the originator is transmitting the packet, it is also listening for collisions with other stations on the net. Ordinarily, there is little chance of another station breaking into the middle of a transmission. Collisions usually occur when two stations listen to an idle network at the same time and then simultaneously begin transmitting.

If a collision is detected, the contention may be resolved in one of two ways, depending on the amount of traffic and contention present on the net. In one, the network control software selects random time-out delays for each transmitting station. The alternative is to switch to a token-passing protocol, in which authorization to transmit is passed to each station in turn. This arrangement ensures that each station on the network is given an opportunity to transmit, although at the cost of decreasing the network throughput.

After a message is transmitted, the receiving station must acknowledge its arrival. If the originator obtains no acknowledgment within a set time or if it receives only a negative acknowledgment (indicating a transmission error), the message is retransmitted by the originator until a proper acknowledgement is received.

There are two methods of transmitting data among local network nodes. The first is the datagram, which is like a telegram in being a one-way transmission of information, sent by an originator who does not receive an immediate answer. The second method is called a virtual circuit, because it resembles a physical link between two network nodes. The virtual circuit allows a prolonged two-way exchange between two network users.

The C-Net is designed to form a virtual circuit between nodes on its network. At the same time, the software makes it possible to avoid collisions and contentions on the network and allow for priority transmissions. This approach overcomes the shortcomings of datagrams while retaining the advantages of collision and contention avoidance.

As it is designed, each node on the C-Net bus can be used either by a multitasking, multiuser, interrupt-driven computer operating system such as Cromix (a Unix-like operating system) or by multiple CDOS systems, which are based on CP/M. This approach distributes the cost of each network node over many users. It also fits in with the use of gateways, the means by which several similar or diverse local networks may be linked together into a "super" local net. Ethernet, Wangnet, or X.25 systems could all be connected to the C-Net in this way, as also could links to satellite ground stations for long-distance high-speed data communications.

Sight and sound, too

The C-Net is not limited to data transmission. Its circuit configuration and broadband cable also make possible the addition of voice and video transmission. Two frequency bands are reserved for these chores, one under 10 kilohertz for voice messages and all frequencies above 1 megahertz for modulated multichannel video, audio, and also data transmission. □

Tracing out program bugs for Z80A processor

by U. K. Kalyanaramudu and G. Aravanan
Bharat Electronics Ltd., Bangalore, India

Advanced microprocessors like Motorola's MC68000 assist in program debugging by providing instruction-to-instruction tracing. This ability, which most 8-bit processors lack, is granted to all microprocessors with this logic circuit. In the case shown, it uses three NAND gates and a D-type positive-edge–triggered flip-flop to create a trace mode for a Z80A microprocessor so as to aid program development.

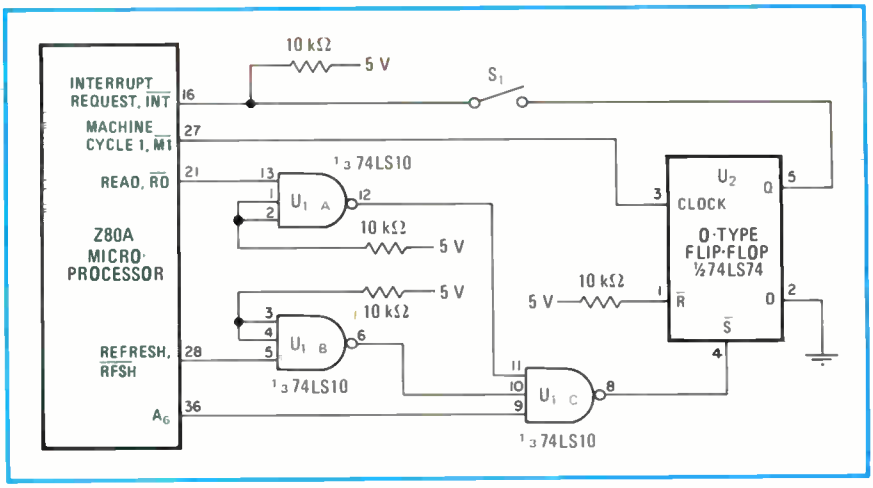
Trace-mode operation is selected and program 1 is executed once switch S_1 is closed. This program saves the contents of the refresh counter and loads it with value 7DH. For each fetch cycle $\overline{M}_1$, the refresh counter increments automatically until it reaches zero while executing the first user instruction—the one that follows RET. In addition, while the first user instruction is being executed, $\overline{M}_1$ resets flip-flop U_2.

Program 2 is executed as soon as the current instruction is over. This routine interrupts the user program and takes the Z80A's central processing unit to location 0038H, the point from where the trace program begins. During this interrupt routine, the refresh counter value is

PROGRAM LISTING FOR TRACE MODE AND INTERRUPT SERVICE

Location	Object code	Mode statement	Source statement		Comments
		1	*H TRACE PROGRAMS 1 & 2		
		2			;PROGRAM 1 : THIS PROGRAM IS
		3			;EXECUTED TO ENTER IN TRACE MODE
		4			
0100		5		ORG 100H	
0100	F3	6		DI	
0101	ED56	7		IM 1	;SET INTERRUPT IN MODE 1
0103	E5	8		PUSH HL	;HL–>STARTING ADDRESS OF USER PROGRAM
0104	F5	9		PUSH AF	;STORE STATUS
0105	ED5F	10		LD A, R	;READ REFRESH COUNTER
0107	320040	11		LD (RS), A	;SAVE REFRESH COUNTER VALUE
010A	3E7D	12		LD A, 7DH	;LOAD REFRESH COUNTER
010C	ED4F	13	RFSH	LD R, A	
010E	F1	14	R7D	POP AF	
010F	FB	15	R7E	EI	
0110	C9	16	R7F	RET	;ENTER USER PROGRAM
		17			
		18			
		19			
		20			;PROGRAM 2 : INTERRUPT SERVICE
		21			;PROGRAM
0038		22		ORG 38H	;MODE 1 JUMP ADDRESS
0038	F5	23		PUSH AF	;SAVE STATUS
0039	3A0040	24		LD A, (RS)	;RESTORE REFRESH COUNTER
003C	ED4F	25		LD R, A	;LOAD IN REFRESH REGISTER
		26			;
		27			;INCLUDE TRACE PROGRAM
		28			;
003E	ED5F	29		LD A, R	
0040	320040	30		LD (RS), A	;SAVE REFRESH COUNTER
0043	3E7D	31		LD A, 7DH	
0045	ED4F	32		LD R, A	
0047	F1	33	RC7D	POP AF	
0048	FB	34	RC7E	EI	
0049	C9	35	RC7F	RET	
		36			;ENTER USER PROGRAM
		37	RS	EQU 4000H	;RANDOM-ACCESS-MEMORY LOCATION
		38		END	

Tracing. The circuit uses the Z80 processor's machine cycle $\overline{M}_1$ and refresh counter to provide a powerful trace mode for program debugging. Flip-flop U_2 is set when refresh and read signals are low and address bit A_6 is high. It is reset when $\overline{M}_1$ is low.



restored for proper refresh operation.

Trace-mode operation continues as long as switch S_1 is closed. A few special Z80 processors using 2-byte operating-code instructions need more than two $\overline{M}_1$ cycles for successful completion. These cycles depend on the result and the BC register count. □

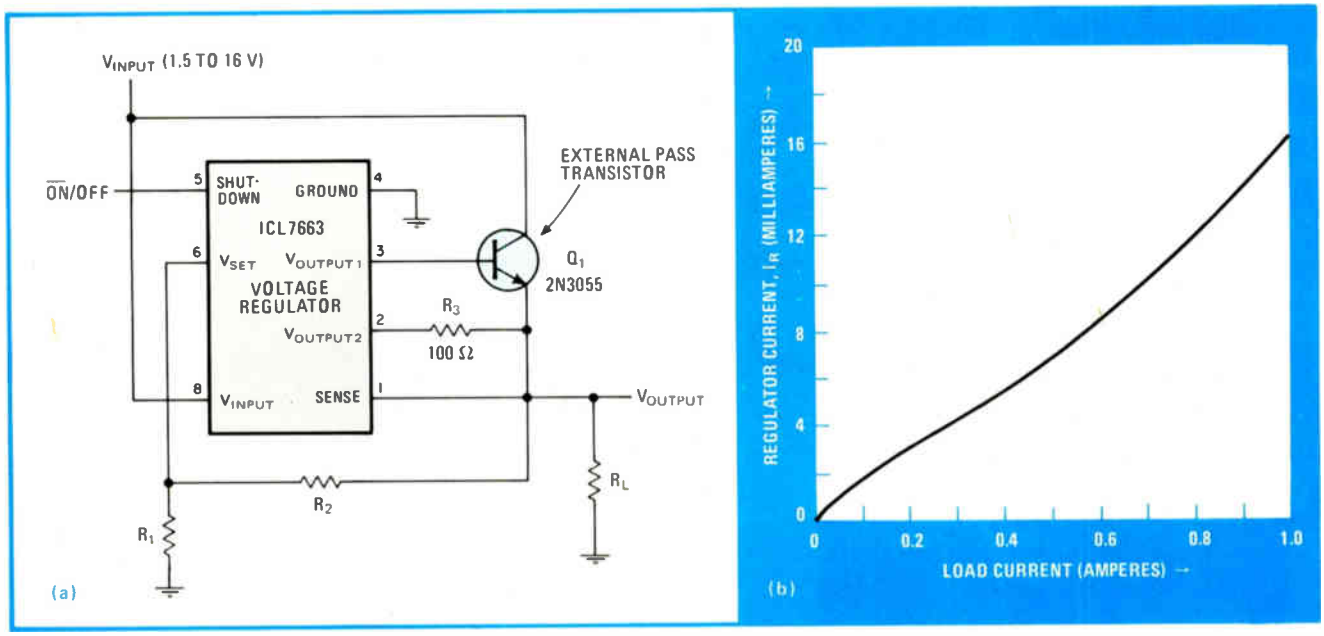
External transistor boosts load current of voltage regulator

by Dan Watson
Intersil Inc., Cupertino, Calif.

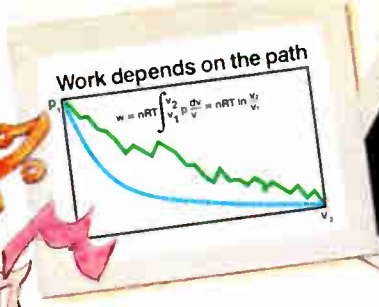
The current capability of Intersil's new low-power programmable voltage regulator may be increased from 40 milliamperes to 1 ampere through the use of an external npn pass transistor (a). The device is connected in parallel with the ICL7663's internal transistor.

The total current supplied by the regulator (I_r) is equal to the base current of the external pass transistor plus the load current of the internal pass transistor. The latter's emitter is situated at pin 2. A 100-ohm resistor is placed between the emitters of the two transistors, so that most of the load current will flow through the external device.

In addition, the circuit does not alter the programming ability of the regulator whose output (V_{output}) equals $(R_2/R_1)V_{set}$, where V_{set} = 1.3 volts. The device can regulate any voltage from 1.3 to 15.5 V for a load current up to 1 A. The load-current versus regulator-current characteristic (b) shows that for a 1.0-A load current, the regulator supplies only 16 mA, which is well within its operating range. A logic 0 or 1 at pin 5 turns the circuit on or off. □



Booster. The circuit (a) uses an external npn pass transistor to boost the current capability of the voltage regulator ICL 7663. This transistor carries the bulk of the load current. The graph (b) shows that for a load current of 1 ampere, the regulator supplies only 16 mA.



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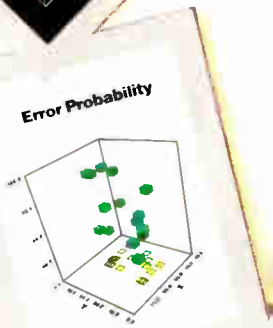

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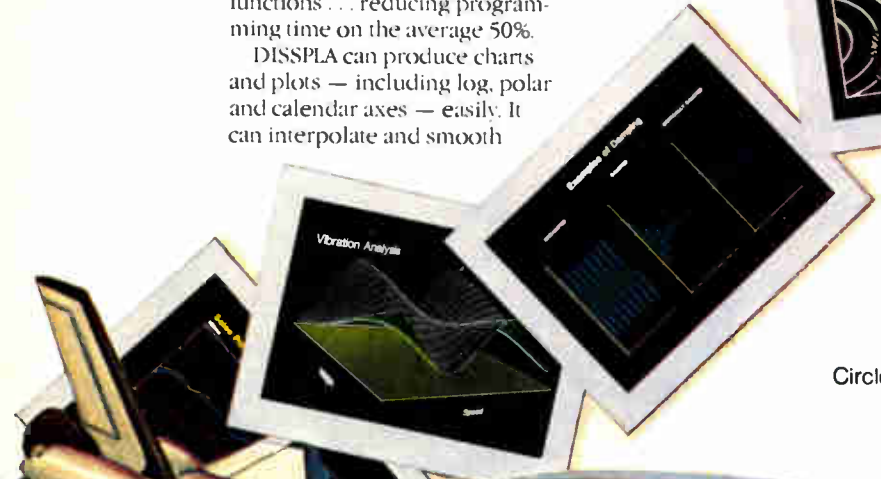


ISSCO GRAPHICS

The critical path to better understanding.

Circle 152 on reader service card

Wide-range capacitance meter employs universal counter

by Marvin Burke
Novato, Calif.

A wide-range capacitor meter (a) that eliminates the parasitic capacitance usually associated with capacitance measurements can be quickly built. This 1.0-picofarad–to–0.2-farad meter has a ±1% accuracy from 1.0 pF to 1 microfarad. It uses Intersil's universal counter, just a few integrated circuits and transistors, and a handful of passive components, yet can substitute for a more expensive hand-held device.

A square wave is generated by a relaxation oscillator formed from operational amplifier U_1. The period of this wave varies with the capacitance of unknown capacitor C_x. To avoid parasitic capacitance, the oscillator's output is fed to one-shot multivibrator U_2 through the driver consisting of transistors Q_1 and Q_2.

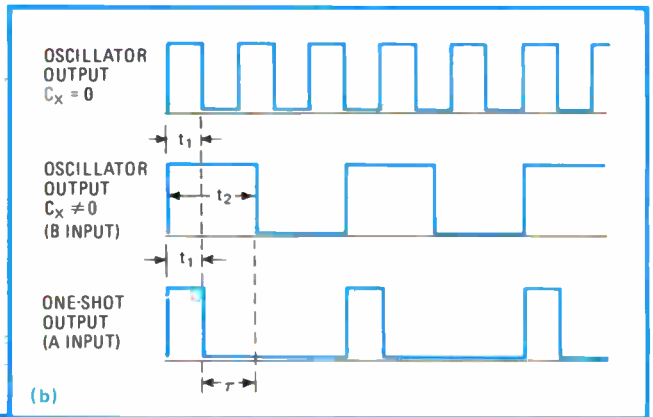
The pulse due to the parasitic capacitance at U_1's output, along with the one due to C_x, is shown in the graph (b). The value of C_x corresponds to $t_2 - t_1 = \tau$. The circuit thus compensates for the offset (t_1) produced with the oscillator and the driver by measuring only τ.

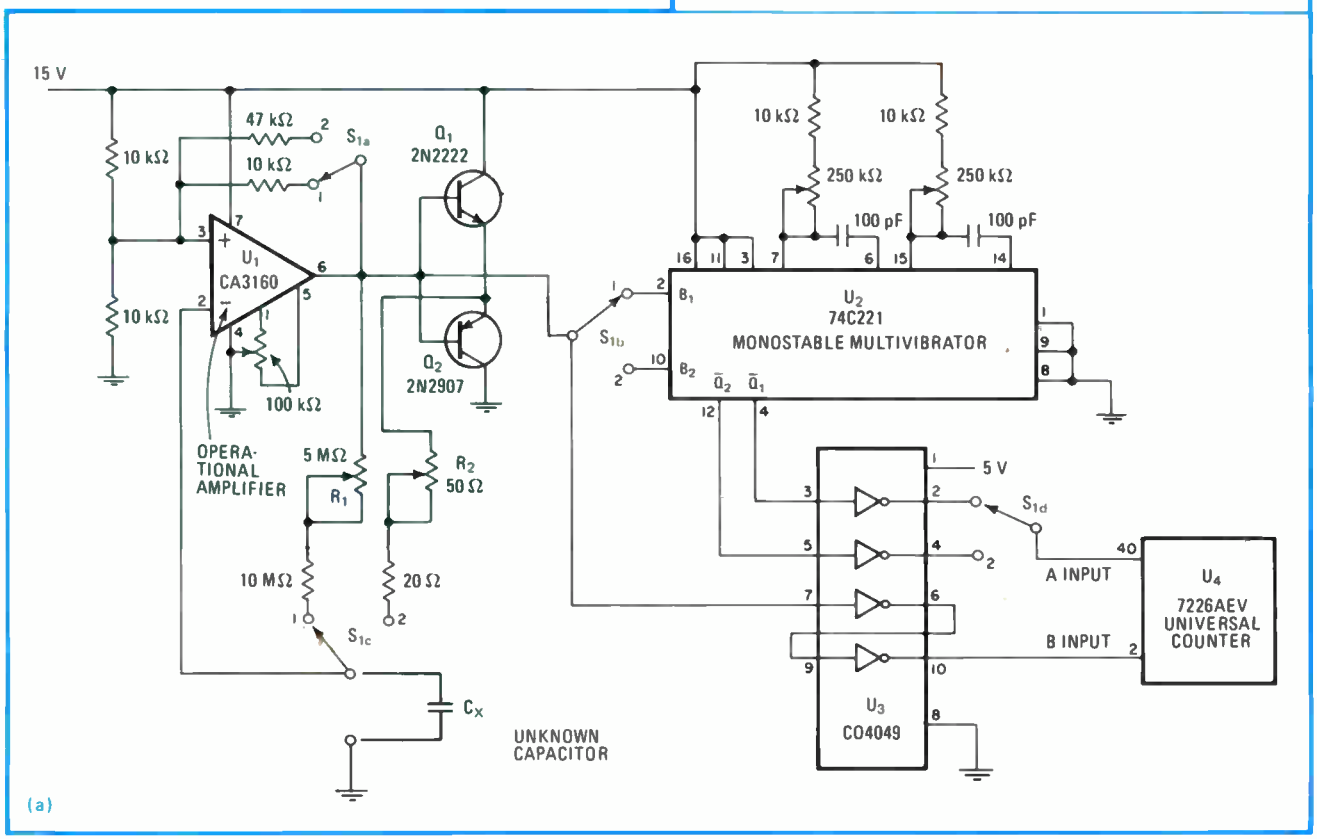
One-shot U_2 is adjusted with two potentiometers, one for each range of the two-range meter, so that its output is a pulse of interval t_1 that serves as universal counter U_4's A input. The oscillator's output, which is channeled through the driver, serves as the B input. The counter then takes these two inputs and measures the time interval τ between the falling edges of A and B.

Transistors Q_1 and Q_2 are used to increase the drive current, which enhances the circuit's range from 1 μF to 0.2 F. This range has an accuracy of ±3%. The ranges are selected by means of four-pole double-throw switch S_1, of which position 1 covers 1.0 pF to 1 μF and position 2 covers 1 μF to 0.2 F. The counter's light-emitting-diode display is calibrated to display the unknown capacitance with potentiometers R_1 and R_2. □

Capacitance meter. The circuit (a) uses universal counter U_4 to measure and display the unknown capacitance in digital form. It covers a range of 1.0 pF to 0.2 F in two steps with a four-pole double-throw switch. The time interval τ (b) between the falling edges of A and B inputs is calibrated in terms of unknown value, C_x.

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 $75 for each item published.





Engineer's newsletter

Wanted: test sites for network protocols

Voluntary assistance from organizations with expertise in the design, implementation, and testing of computer network protocols is being sought by the Commerce Department's National Bureau of Standards. According to Robert P. Blanc, who should be contacted for further information at (301) 921-3817, the NBS Institute for Computer Sciences and Technology (ICST) is working with the International Standards Organization (ISO) and the American National Standards Institute (ANSI) **to develop international standards for computer network protocols based on the architecture of the ISO's Reference Model for Open Systems Interconnection.** Because of the obvious economic benefits achievable from this standardization, ICST wants to test implementations of the future standard network protocols on a widespread basis. To do this, ICST will make available the documentation for the transport and session protocols, including formal specifications, implementations in the C language, and preliminary test plans. Organizations providing assistance will implement the specifications on their own systems and connect to the ICST network protocol laboratory through an X.25-based network or other agreed-upon type of connection.

Is your earth station working?

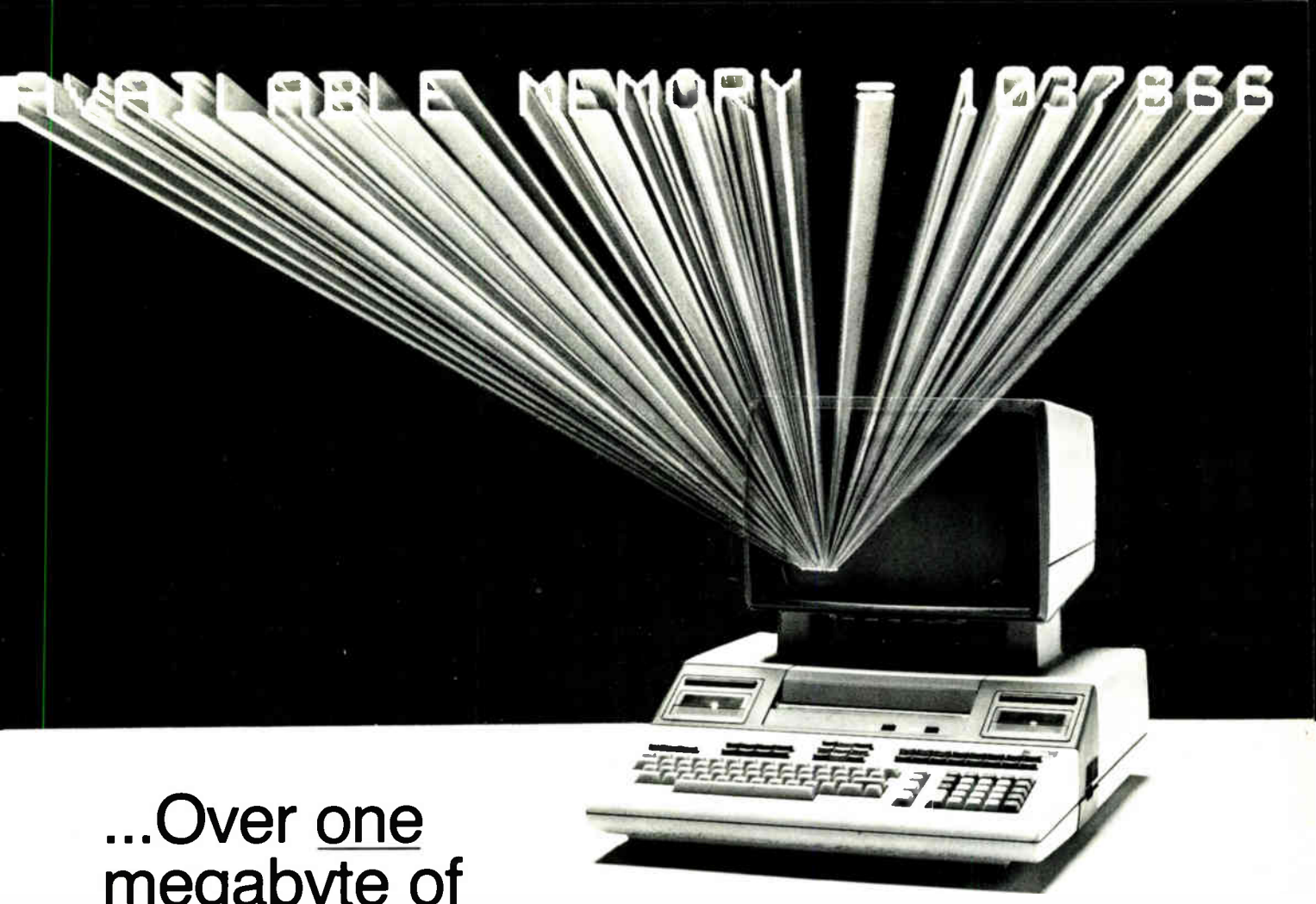
Though digital technology is the wave of the future for satellite communications, most existing systems are analog. So it's no surprise that the latest standard from the International Electrotechnical Commission (IEC Publication 510-3-1) is concerned with the performance of satellite earth stations used to transmit the frequency-division–multiplexed signals of telephones or black and white and color television. It contains **general methods of measurement specific to combinations of two or more earth-station subsystems.**

The object of testing combinations of subsystems is to approach actual operating conditions as closely as practicable. For some combinations however, this is not possible because of their size, cost, or the stage of their development at the time of testing. But even in these cases, the standard points out, these limitations can be overcome by calculation from appropriate measurements. Publication 510-3-1 is available for 15 Swiss francs from 1, rue de Varembé, 1211 Geneva 20, Switzerland.

Checksums take up less time and space

John G. Fletcher of the Lawrence Livermore Laboratory of the University of California in Livermore, Calif., has pointed out that the popular cyclic-redundancy checks used for error detection in serial data communications can sometimes be replaced by integer arithmetic checksum techniques. The checksum is "a bit weaker at detection," Fletcher says, but notes that "when both ends of a channel implement the redundancy check in software or firmware, as in **the fairly common case of two minicomputers or microcomputers communicating over a simple 1-byte-at-a-time asynchronous channel,** a redundancy check using decimal and not the commonly used binary arithmetic would seem preferable because of increased speed and reduced storage requirements." Fletcher has implemented a 1's complement checksum for Scull, a link-level communications protocol that is employed by the Octopus computer network installed at Lawrence Livermore.

-Harvey J. Hindin



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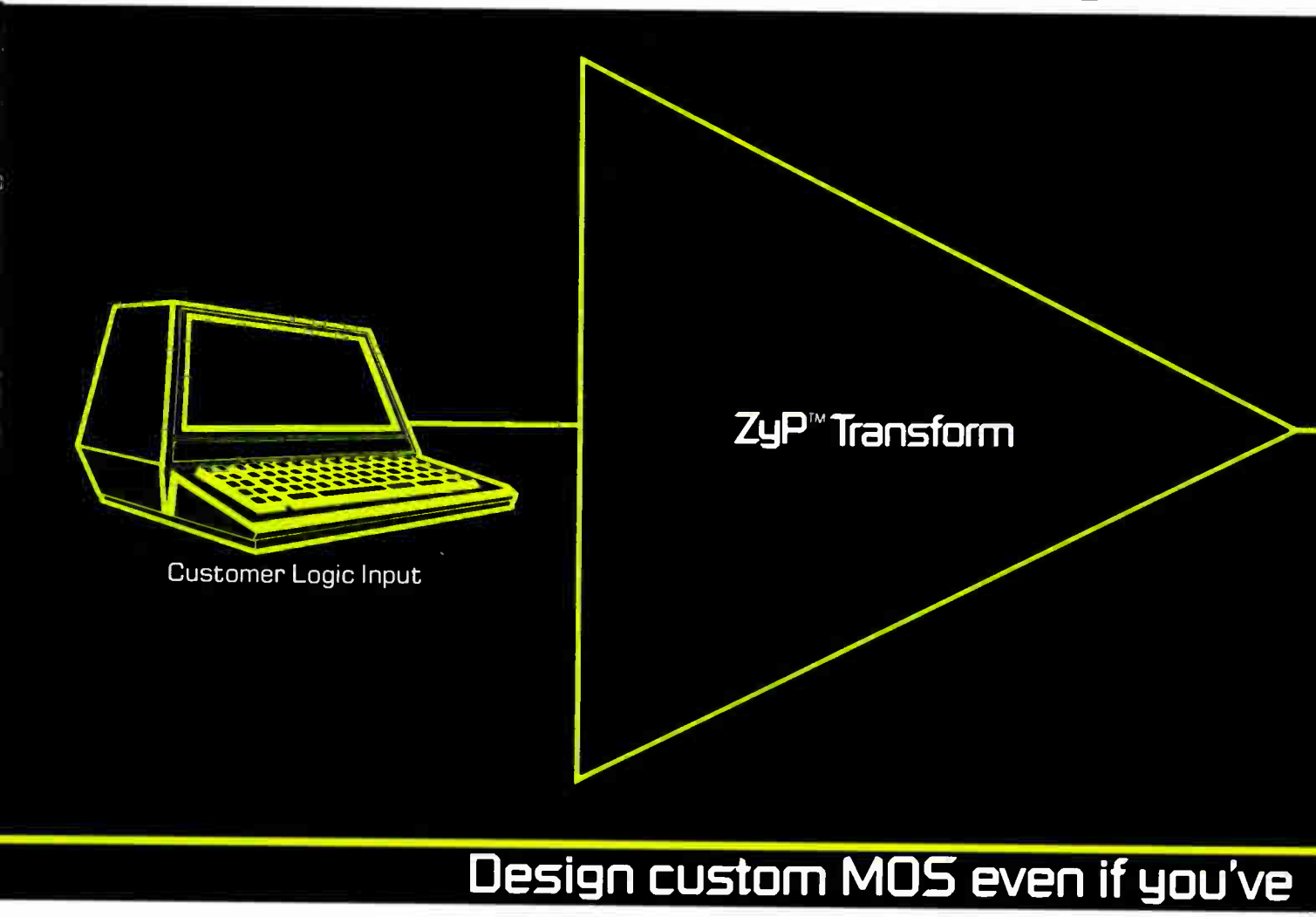

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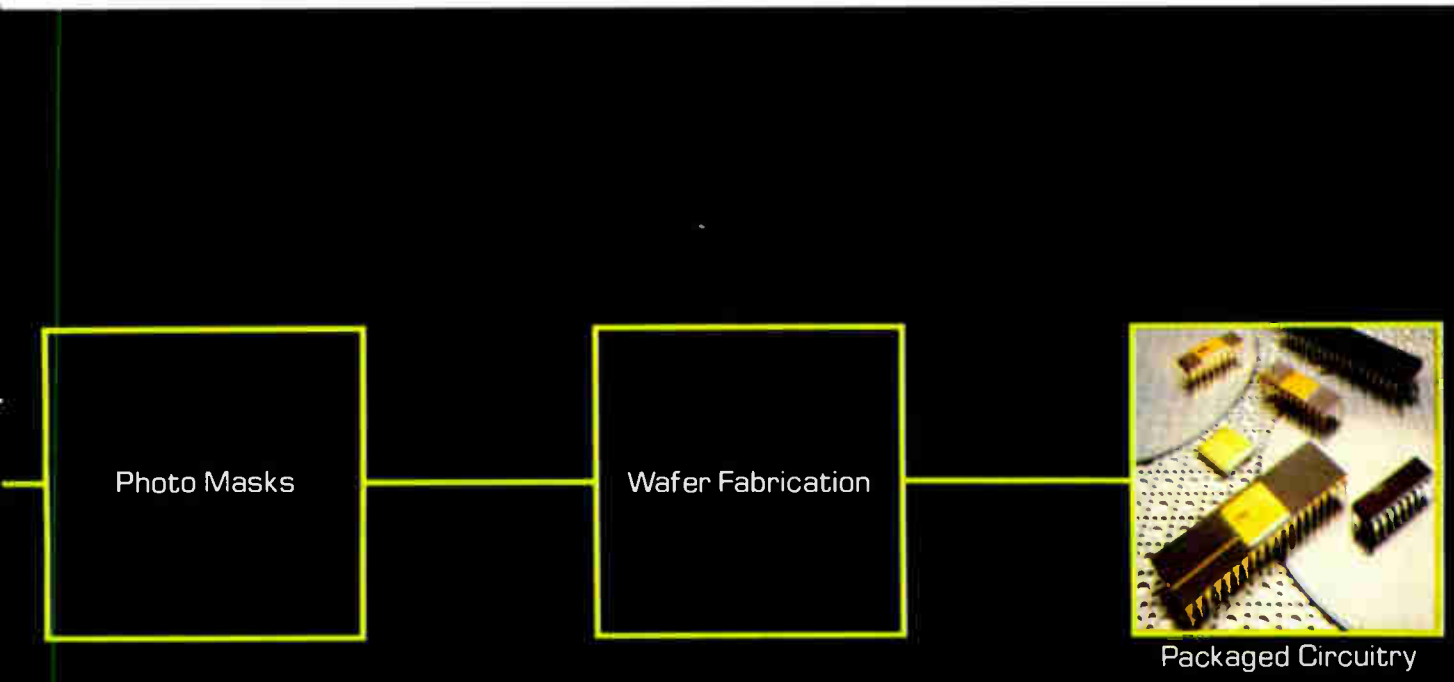

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The list of M146805 features is long. It's hard to know where to start and which to mention. Flexibility derived from a choice among several MCUs is very important. Two ROM versions, 1K and 2K, plus an expandable-bus MPU are available now. A CMOS PIA and Real-Time Clock also are available, and all five devices offer the option of leadless chip-carrier packaging.

Family processors have master and power-on reset, on-chip oscillators, programmable timers with prescaler, maskable interrupts, ten addressing modes, single-instruction bit manipulation and nested subroutines.

		MC146805E2	MC146805F2	MC146805G2
TECHNOLOGY		CMOS		
PROCESSOR	Bits	8 Bits		
	Instruction Set	Control Optimization of MC6800		
	Registers	2 General Purpose and 3 Special Registers		
	Addressing Mode	10 Addressing Modes		
	Basic Inst. Types	61 Basic Inst. Types		
	Total Instructions	209 Total Instructions		
	μs per Avg. Inst.	3.9 to 4.0 μs/Average Instructions (1 MHz)		
	Subroutines	29 Levels	13 Levels	29 Levels
MEMORY	Mask ROM	—	1K	2K
	RAM Bytes	112	64	112
I/O PINS	Inputs	—	4	—
	Program Bidirect	16	16	32
	I/O Drive Capability	LSTTL	LSTTL	16-LSTTL 12-2 mA, 4-LEO
PACKAGE SIZE		40 Pin	28 Pin	40 Pin
EXPANSION BUS		8K Addr.	—	—
SPECIAL FUNCTION I/O	High Current Drive	10 mA, 4 Pins	—	—
	Serial I/O	Shift Register I/O with Bit Manipulation Instructions		
TIMER	Prescale Bits	7 Prescaler Bits		
	Counter Bits	8-Bit Counter		
	Timer Functions	One Timer Function at a Time		
INTERRUPTS	Timer Interrupts		Timer Interrupt	
	External IRQ	1	1	1
DEVELOPMENT SUPPORT	IC's	EPROM and ROM-less Versions		
	Dev. System	EXORset™, EXORciser™ and Emulator Modules		
	Emulation	User System Emulator		
	Assembler	Macro Assembler		
SPECIAL CAPABILITIES	Self-Check	—	Yes	Yes
	External Bus	Yes	—	—
POWER REQUIREMENTS	Full Spd. Oper.	35 mW	10 mW	15 mW
	Wait Mode	5 mW	4 mW	4 mW
	Stop Mode	25 μW	25 μW	25 μW

M146805 emulators provide tailored CMOS development tools for every processor in the family, and the CMOS M146805 Family software is HMOS compatible. Family peripherals are HMOS compatible too.

Value, finally, is the bottom line, and we don't believe there is a design option that will give you better, more cost-effective value. Motorola's CMOS quality and reliability have been recognized around the world for years, and M6800-type architecture has been widely praised. RCA is now an alternate source for the M146805 Family.

Peripherals add value.

Additional value is provided by a pair of multiplexed-bus peripherals and the MCM1465516 2K x 8 mask-programmable CMOS ROM.

The MC146818 Real-Time Clock is a complete time-of-day clock with alarm and one-hundred year calendar, plus a programmable interrupt and square-wave generator. It has 50 bytes of low-power static RAM on-chip, and interfaces with 1 MHz processor buses.

Twenty-four I/O pins of the MC146823 Parallel Interface are organized into three bidirectional ports. It includes complete control handshake, output pulse, four interrupt inputs and 16 registers addressed as memory locations.

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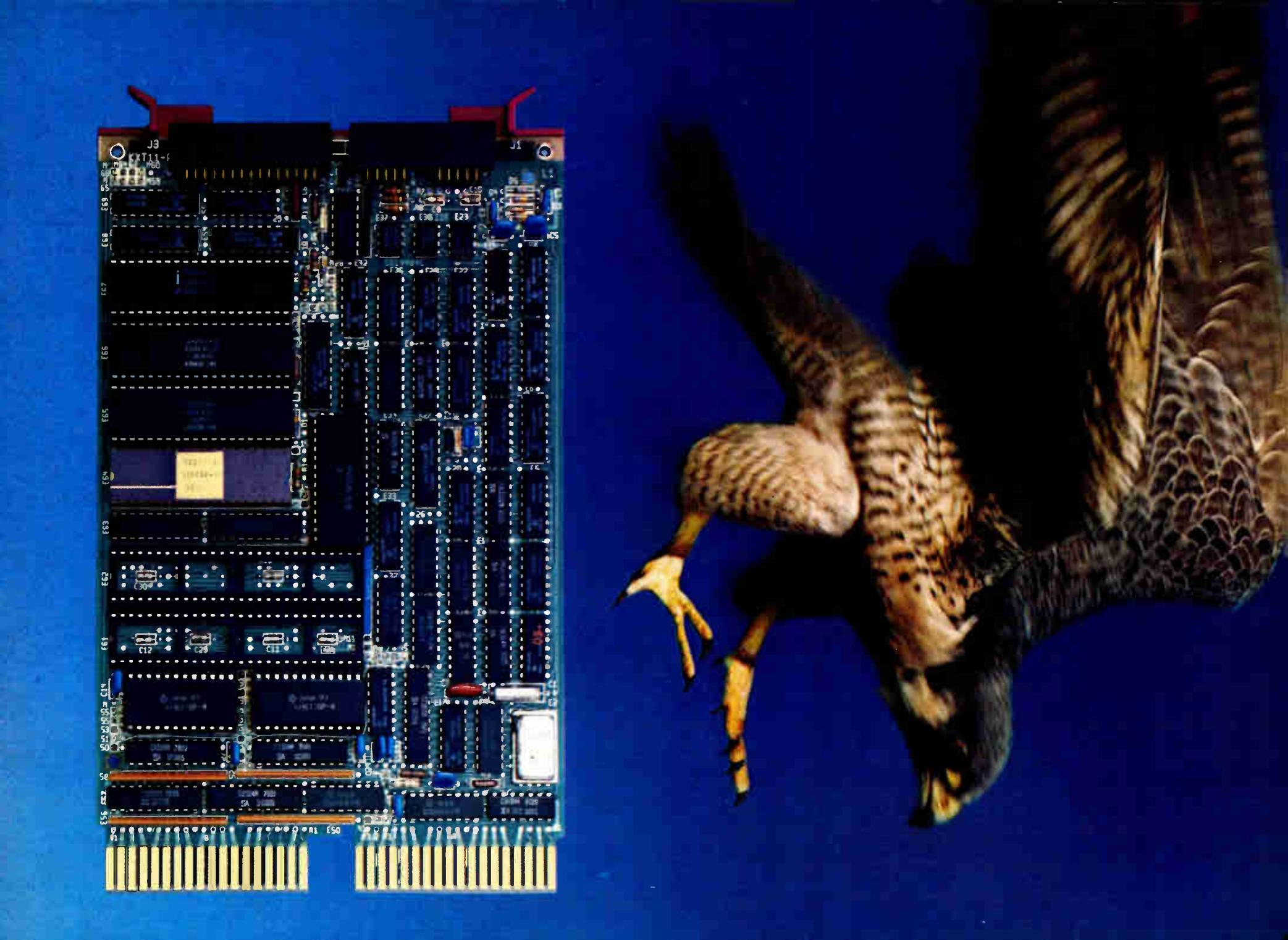

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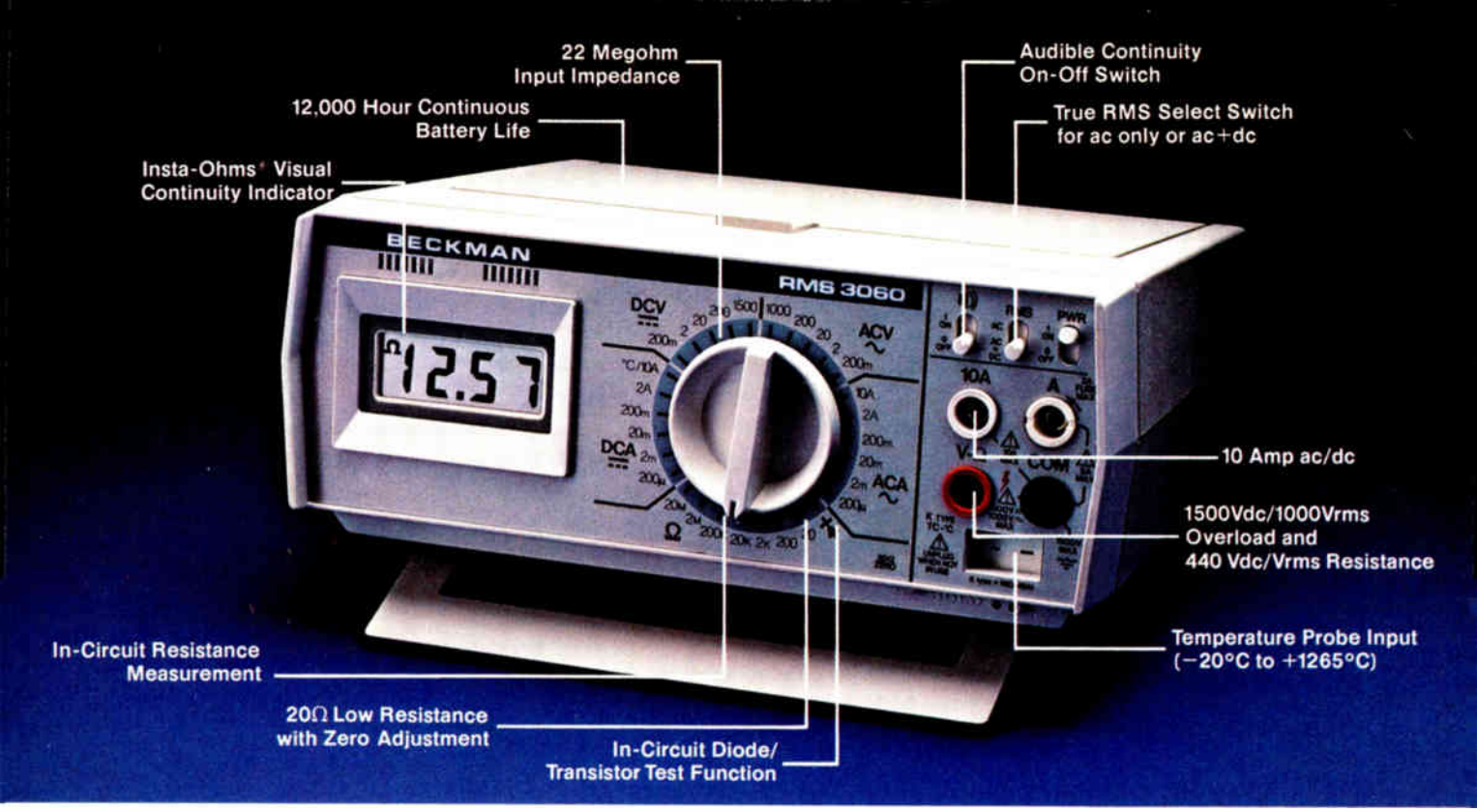

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Convenient storage and multiple viewing angles are featured in the new line of Beckman bench/portable DMMs.

BECKMAN

Circle 162 on reader service card

Analog acquisition system is complete

High-speed analog data-acquisition front ends are integrated in system supporting 50,000-sample/s remote or local input to PDP-11

by Larry Waller, Los Angeles bureau

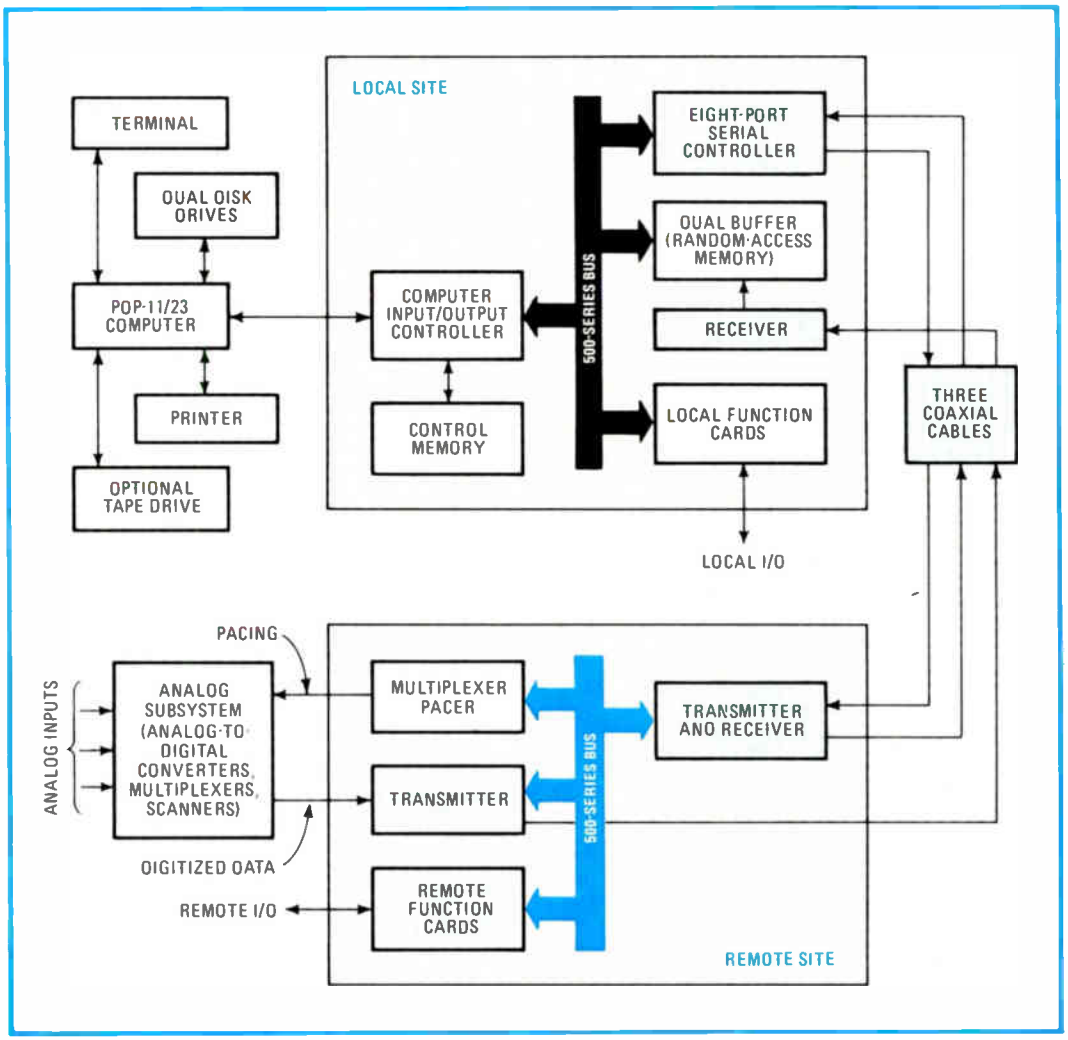
A small California company looks to be first off the pad with a product targeting what many call a neglected market niche: stand-alone systems that take data all the way from analog sensing through real-time digital processing. Neff Instrument Corp.'s 720 data-acquisition system offers a turnkey answer. By building on its own established analog data subsystems, Neff holds the price to about $120,000 in a typical configuration.

The firm zeroed in on the niche in the course of supplying its analog front ends to users with the technical resources to put them into custom networks. "But they want entire systems that don't eat up so much engineering staff time," explains James T. Barber, marketing manager. No such solution exists at present: a user must either do it himself or go to a custom system integrator. This is expensive and often unsatisfactory, Barber points out.

What stopped Neff from jumping sooner into the system business was a common hurdle: a minicomputer at the right price and with workable operating software. But last year, says Barber, "the Digital Equipment Corp. PDP-11/23 came along with the RSX-11M operating software—and that put us on the road."

To get peak performance, the DEC computer had to be smoothly married to Neff's fast subsystem. Neff's approach is through a buffered controller that performs direct-memory-access transfers from one half of a dual buffer while the second half is being loaded.

Neff designers picked fast subsys-



Remote or local. A complete 720 analog data-acquisition system with remote sensing is shown. A local-only system omits the tinted portions: the pacer connects to the remaining bus, and data goes directly to the buffer.

New products

tems and peripherals, attaining data rates supporting a throughput of 50,000 samples/s using magnetic-tape storage and 20,000 samples/s to disk. The 720 has up to 1,024 data channels and operates at up to the full 50,000 samples/s at 12-, 14-, or 15-bit resolution. With the Neff series 100 analog front end, each channel has gain and bandwidth that can be individually set, and 20 parameters are displayed.

Other Neff systems used are the series 500 bus-structured input/output interface and a buffered controller. The equipment is mounted in a two-bay cabinet, with 256-K bytes of MOS memory, dual 10.4-megabyte RL02 disk drives, a VT100 cathode-ray-tube terminal, a programmable real-time clock, and an LA120 180-character/s printer. All peripherals are supplied by DEC except for the optional magnetic-tape drive, which is from Kennedy Corp.

Neff software is aimed at making the system user-friendly and requires familiarity only with a high-level computer language. It provides as standard such fundamental functions as conversion to engineering units, limit checks, real-time monitoring, and summary printout. The system's automatic calibration operates down to the analog-input level.

Remote sensing. The 720 can be configured with either local or remote analog subsystems (see diagram). In systems with remote input, one of the two bays is installed with the PDP-11/23 computer, and the other is located at the sensing site.

The first 720 will be delivered in the spring to a utility company, which will employ it as a monitor for a plant start-up. Another will go to a chemical firm for rocket-propellant testing. The production rate is now one system per month, but it is expected to double later in the year. The company already is well along in preparing individual application packages for special requirements. Written in Fortran IV, these will grow to be an extensive library, available to all customers.

Neff Instrument Corp., 700 South Myrtle Ave., Monrovia, Calif. 91016. Phone (213) 357-2281 [339]

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Universe 68 leapfrogs the 16-bit minis.

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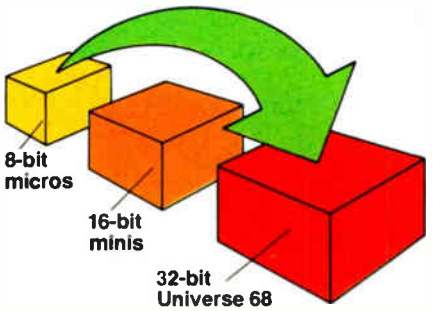


Jumping over outmoded 16-bit architecture

Built around the Motorola 68000 microprocessor, the Universe 68 system is a 32-bit supermicro that leapfrogs conventional 16-bit minicomputer technology. It has directly addressable, non-segmented address space of 16 million bytes, compared to the 64-kbyte limitation imposed by 16-bit architectures.

That means greater functionality per dollar, increased program development efficiency, and power to tackle demanding new applications.

The Universe 68/10 computer system

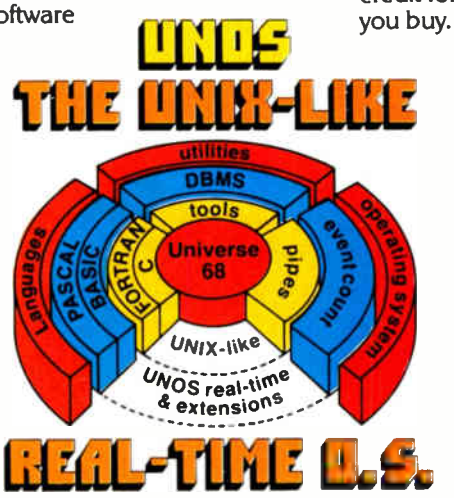
Outhopping supermini prices

The Universe 68 gives you 32-bit performance at micro prices – –while the big frogs in the minicomputer pond are still offering 32-bit technology only in expensive "superminis." A Universe 68/10 with 32-bit processor, 256 kbytes of memory, floppy disk, and Winchester disk sells for under $20,000. Order ten, and the unit price drops to $16,860, including system software.

Springing past conventional system software

UNOS, our UNIX-like operating system, is part of the new generation of more flexible, easier to use software written in the high-level systems programming language C. To help OEMs develop products faster and less expensively, it incorporates UNIX features (such as "pipes," I/O redirection, and hierarchical files), plus portability that conventional systems software can't match.

To its UNIX-like base, which supports FORTRAN and C languages, UNOS adds PASCAL and BASIC, an expanded data base management system (DBMS), and an array of run-time oriented, real-time transaction processing capabilities, including a highly sophisticated "Eventcount" process synchronization mechanism. These extensions can be the key to implementing real-time and information systems applications.



Croaking obsolete business practices

OEMs often find computer suppliers tough to deal with. Bundled hardware and software limit flexibility in configuring systems, while proprietary busses and assembly-language software can lock you in to one vendor.

We're out to change all that by offering OEMs a choice. You can buy complete systems from us, and just add application software. Or buy some components from us, and go elsewhere for others. You can even buy UNOS from us and run it on someone else's hardware. And by building the Universe 68 computer around standard, non-proprietary technology like VERSAbus, SASI bus, and the 68000, we've made second-sourcing easy.

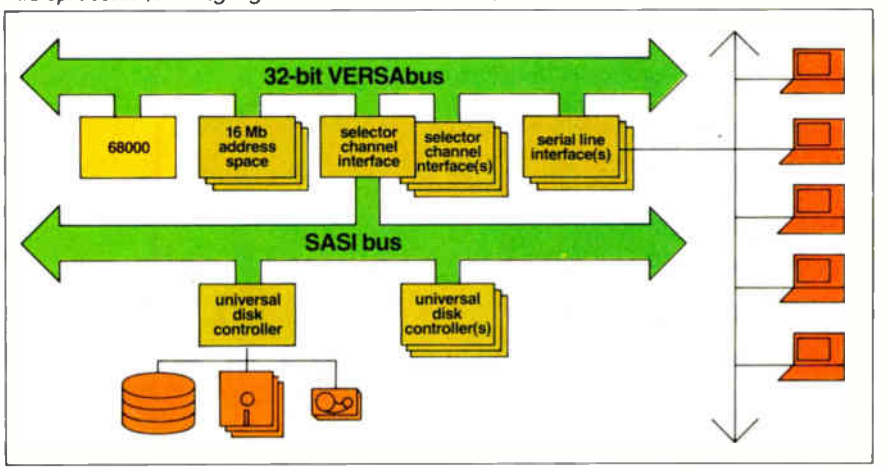
We've also introduced a more sensible approach to discounts. We give you discount credit for everything you buy. Our software discounts are based on how many licenses you buy, not in one year, but over *twenty* years. And they cut deep – all the way to 98%. We think this honestly reflects our costs: software development costs are almost entirely loaded at the front end, and support costs fall quickly once an OEM has gained experience.

Swallowing up the competition

If you need 32-bit power at a micro price and you can't wait for the minicomputer giants, you should know more about the Universe 68 computer and UNOS. For full information, call or write Charles River Data Systems, 4 Tech Circle, Natick, MA 01760, (617) 655-1800.

With the price/performance story we have to tell, we're ready to make a megasplash in the minipond.

The Universe 68 system takes advantage of standard building blocks, such as the 68000 microprocessor, 20-megabyte-bandwidth VERSAbus, and SASI bus.



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S-100 boards support Ada and CP/M

Dual-processor board set uses Z80A and 68000 microprocessors to accommodate 8-bit applications and Telesoft Ada compiler

by James B. Brinton, Boston bureau manager

Cooking up the Delphi-100 may have been second nature for Digicomp Research Corp. The firm has been a military contractor long enough to realize the value of an inexpensive computer system capable of supporting the Defense Department's standard language, Ada.

Using the Ada compiler from Telesoft Inc. of San Diego, Calif., the firm is making the Delphi system available in a variety of packaged configurations as well as a board set priced at $1,995. That price may make Delphi the least expensive Ada implementation around. In addition, the system is the only Ada support currently available for the IEEE-696 S-100 bus, according to Digicomp.

Delphi is a dual-processor system: its Ada support is offered through a Motorola 68000 microprocessor, and compatibility with 8-bit CP/M software is achieved with a Z80A coprocessor. The system's basic speed should be fairly high since the 68000 is clocked at 10 MHz and the Z80A at 4 MHz.

The 68000 addresses up to 16 megabytes, taking advantage of the system's 16-bit data bus and standard direct memory access. The Z80 profits from Delphi's memory-mapping subsystem, which allows it to access up to 1 megabyte of paged memory. This should make many disk fetches unnecessary and thus the Z80 should be a good deal faster than typical Z80 systems.

In packaged form the Delphi has two double-sided, double-density 8-in. floppy disks yielding a total of 2.4 megabytes of mass storage. Hard-disk systems are available with from 40 to 160 megabytes of storage. Delphi's standard main memory is 256-K bytes of complementary-MOS random-access memory; more memory is available in 256-K-byte modules.

Input/output facilities include four serial ports, each individually selectable for either RS-232-C or synchronous operation. In addition, there is a 24-bit parallel I/O port. The system also supports 16 levels of vectored interrupts. A real-time clock with battery backup is offered as an option.

The operating system is Telesoft's ROS, a single-user multitasking operating system featuring a user-programmable shell, file redirection, pipelines, and macro commands. With ROS, Delphi supports both Telesoft Ada and Pascal.

The Ada compiler is almost complete, omitting only a few complex operations. Work is under way at Telesoft on a complete Ada to be delivered later in 1982. For now, the compiler checks syntax for the full Ada language and generates code for all but a few operations.

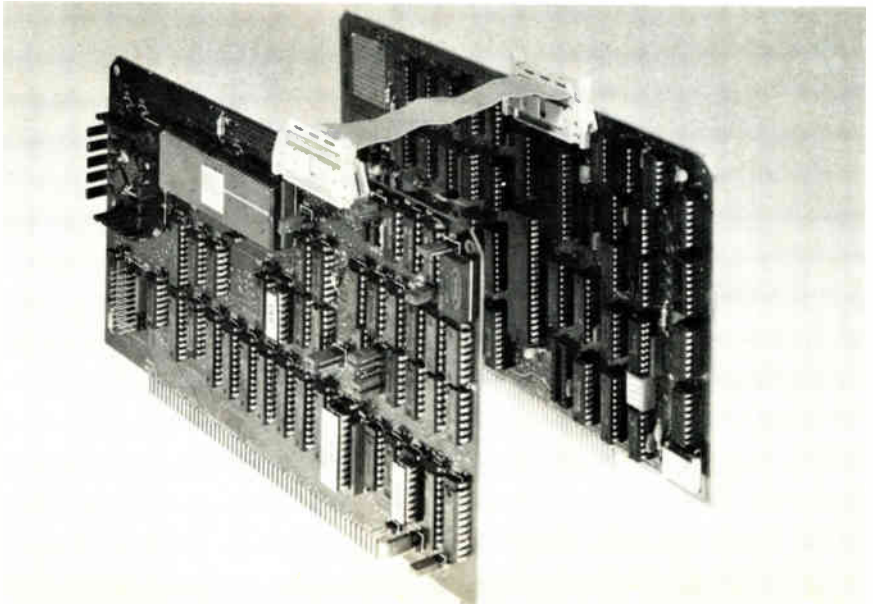
Pascal on Delphi is said to conform closely with the proposed International Standards Organization standard. It has separate extensions for compilation, multitasking, string handling, random-access disk I/O, and physical I/O.

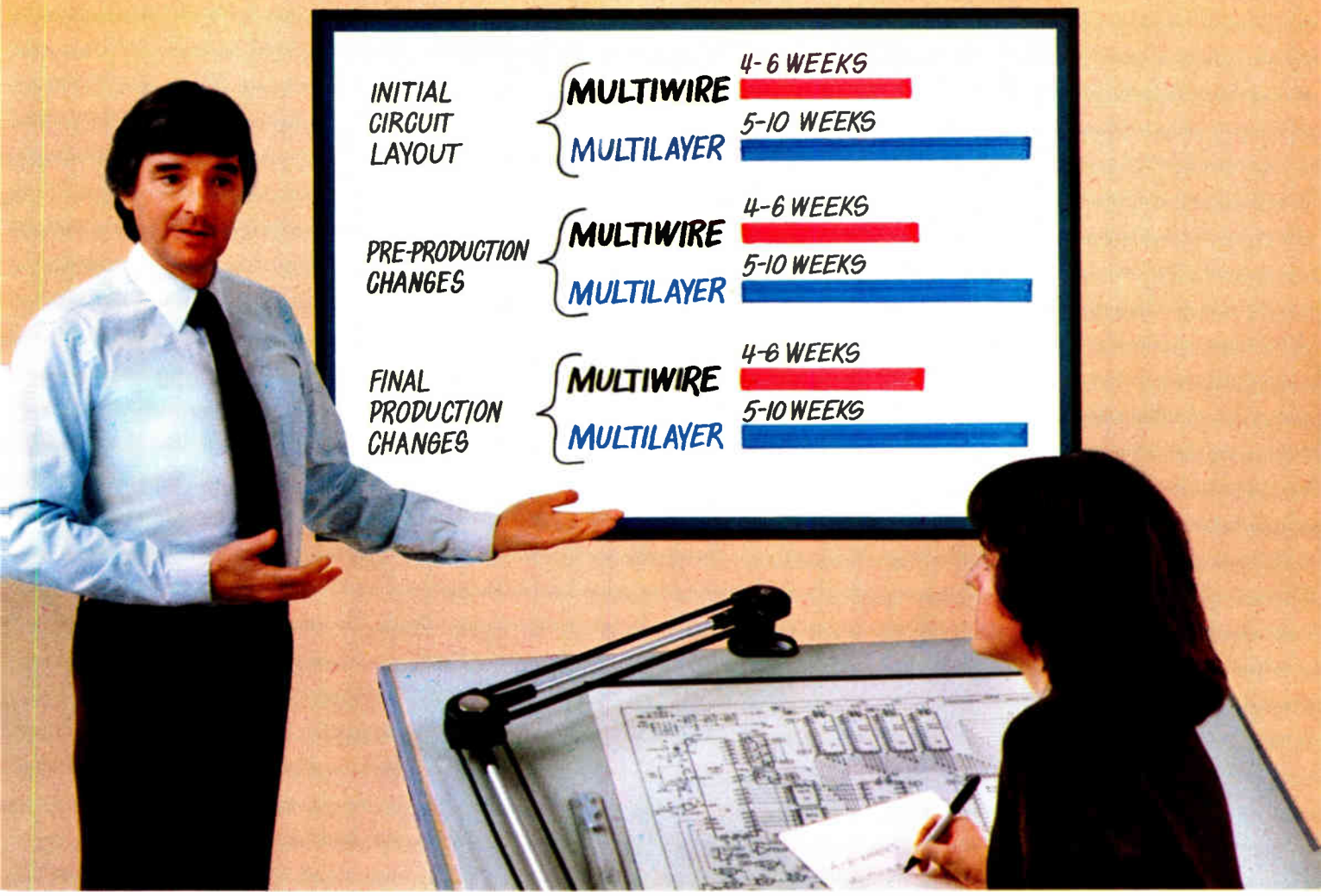
In addition, through the CP/M operating system, Delphi's Z80A supports 8080- and Z80-compatible software. The Z80 makes it less necessary to tailor systems or applications. The Z80 not only makes Delphi easier and faster to use, but in some cases can act as a window into Ada applications where existing equipment is 8-bit–compatible. Users are expected to use this feature to get a faster start with Ada.

Pricing varies with configuration, ranging from $1,995 for a dual-processor board set to upwards of $10,600 for a packaged system with central-processing-unit boards, I/O controllers, 256-K bytes of memory, and two 8-in. floppy-disk drives. Systems with more disk and main memory are available. A 256-K-byte memory board costs $1,395.

Delivery takes two weeks.

Digicomp Research Corp., Terrace Hill, Ithaca, N. Y. 14850. Phone (607) 273-5900 [338]





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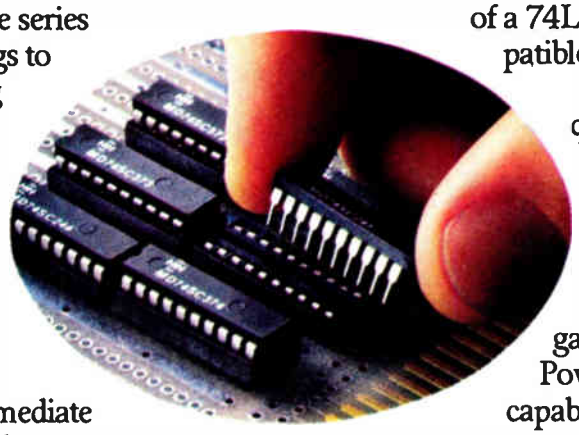

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MD 74 SC 245 Octal Transceiver
MD 74 SC 373 Octal Transparent Latch
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MD 74 SC 533 Octal Inverted Output, Transparent Latch
MD 74 SC 534 Octal Inverted Output, D-Type Flip Flop
MD 74 SC 540 Octal Buffer
MD 74 SC 541 Octal Buffer
MD 74 SC 545 Octal Inverted Output, Transceiver
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Computers & peripherals

CAD stations have two 68000s each

One microprocessor serves the display, the second peripherals, communications

Many recently introduced work stations for computer-aided design boast a local microprocessor that reduces the work load of the host computer system and shortens reaction times. California Computer Products Inc.'s latest line of graphics work stations takes this idea one step further: each station has two microprocessors to share the chores.

The three models in the Vistagraphic 4000 display-system family are aimed at the CAD market's midsection, moving down from the firm's traditional high-end CAD products. The 4000 line, which includes black and white and color models covering a range of display resolutions, are the first to be designed and built at the Nashua, N. H., facility of Sanders Associates Inc. since it bought CalComp in 1980. Marketing and support for the CAD stations are being handled by the California subsidiary.

One 68000 microprocessor performs display processing in each of the three subsystems, and a second 68000 is responsible for controlling peripherals. The approach makes possible very fast display updating—response times "are in the millisecond range, so the user sees no gaps in the display," says Matthew Reiner, a Sanders marketing manager.

The graphics processor works in conjunction with a three-tiered memory. One segment of the dual-image memory stores the image that is currently on the screen while the next image is built up in the remaining part of memory. The third memory section holds a list of graphics commands that have been downloaded from the host.

Random-access memory comes in capacities from 128-K bytes to 4 megabytes. Graphics capabilities include area filling and generation of characters, circles, and vectors.

The peripheral processor handles communications with the user and host and controls the peripherals. A keyboard with 32 programmable keys is the only standard peripheral, but data-entry options include a joystick, a 4000-series data tablet with light pen, a trackball for precise cursor positioning, and a "force stick," an item similar to a joystick but costlier. It provides fast pressure-activated proportional cursor control.

Other options include copiers for hard output of color or monochromatic images, a standard pen-type plotter, an electrostatic plotter-printer, and a digitizer. All three models have 19-in.-diagonal cathode-ray tubes. The color versions offer a 4,096-color palette and display up to 256 of those colors at a time. The model 4200 features 640-by-512–picture-element resolution. The 4300's resolution is 1,024 by 768 pixels, and the 4400 (shown) offers 1,024 by 1,024 pixels.

The line uses CalComp's VistaDOS operating system, which facilitates program development and permits real-time interactive graphics processing. Device-handling, file-management, input/output, debugging, and memory management routines are included in VistaDOS.

Prices for the 4200 begin at $6,965 for the monochrome version and $9,450 for a color unit, both in lots of 50. Delivery will take 60 days.

California Computer Products Inc., 2411 West La Palma Ave., Anaheim, Calif. 92801 [361]

Engine searches 2 megabytes in 1 s

Content-addressing data-base system can hunt for a word at specific point in paragraph

A data-base engine designed to search for a specified word in information stored on high-speed disk drives has been built using standard TTL and is being offered to integrators of word-processing systems by its developer, Textarcana. It is also available for demonstration to makers of large data-base systems.

The system has been tested at a throughput rate of 2 megabytes/s, and its inventor, Tim Skinner, is confident that it can easily handle rates around 3 megabytes/s. With some fine tuning, he adds, the engine could search through files at up to 8 megabytes/s.

Skinner's prototype is currently a two-board system, but he says the machine can be reduced to a single 9-by-18-in. board. "This is really designed to be incorporated into an existing system," states Skinner, a lawyer with data-processing experience. "It would be up to the user how he wants to integrate it into the total system." Skinner plans to license his product to original-equipment manufacturers; he estimates its cost to the system integrator as under $1,000, but very much depen-

New direct-connect MODEM Microboard.

Auto-dial, auto-answer RCA MODEM Microboard adds data communications to your board-level computer system.

You don't need a separate modem when you use the new CMOS Microboard MODEM with your board-level computer system.

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FCC-approved for direct connect to phone lines, the CDP18S653 provides auto-originate and auto-answer modes for unattended operation. Other features include:

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- Touch-tone or pulse dialing
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Because our MODEM Microboard offers you the CMOS benefits of low power and -40° C to +85° C operation, it is the ideal solution for gathering data at remote locations.

And the MODEM is supported by our large and growing family of CMOS Microboard products and development systems.

So if you want to turn your phone into a data communications center, pick it up right now and call (800) 526-3862.

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Just connect "Old Reliable's" MODEM Microboard to your phone line, and you're ready to transmit and receive data.

dent upon the approach taken.

The data-base engine is made entirely of hardwired logic, which gives it the speed necessary to accommodate the new breed of fast disk drive now appearing on the market. The system is able to find terms (words or characters) in data bases by location within the text as well as content.

For example, the system could locate all occurrences of the name "Smith," or it could be instructed to pinpoint "Smith" only if it appears at the end of a sentence or paragraph. It is not restricted in the length of words it hunts for.

The machine can monitor data ports or the disk bus of a host system. Using an 8-bit (or narrower) bus and the valid-data signal from the host, the engine uses status lines to inform the host that a search has been performed. This feature allows a host to drive a number of these engines concurrently.

One application for the Textarcana machine is in legal data-base systems, since it can handle both structured and unstructured data files. Skinner also believes the engine would be useful in large word-processing systems.

Textarcana, 780 Yale Rd., Boulder, Colo., 80303 [402]

5¼-in. Winchester drives have 51.6-megabyte capacity

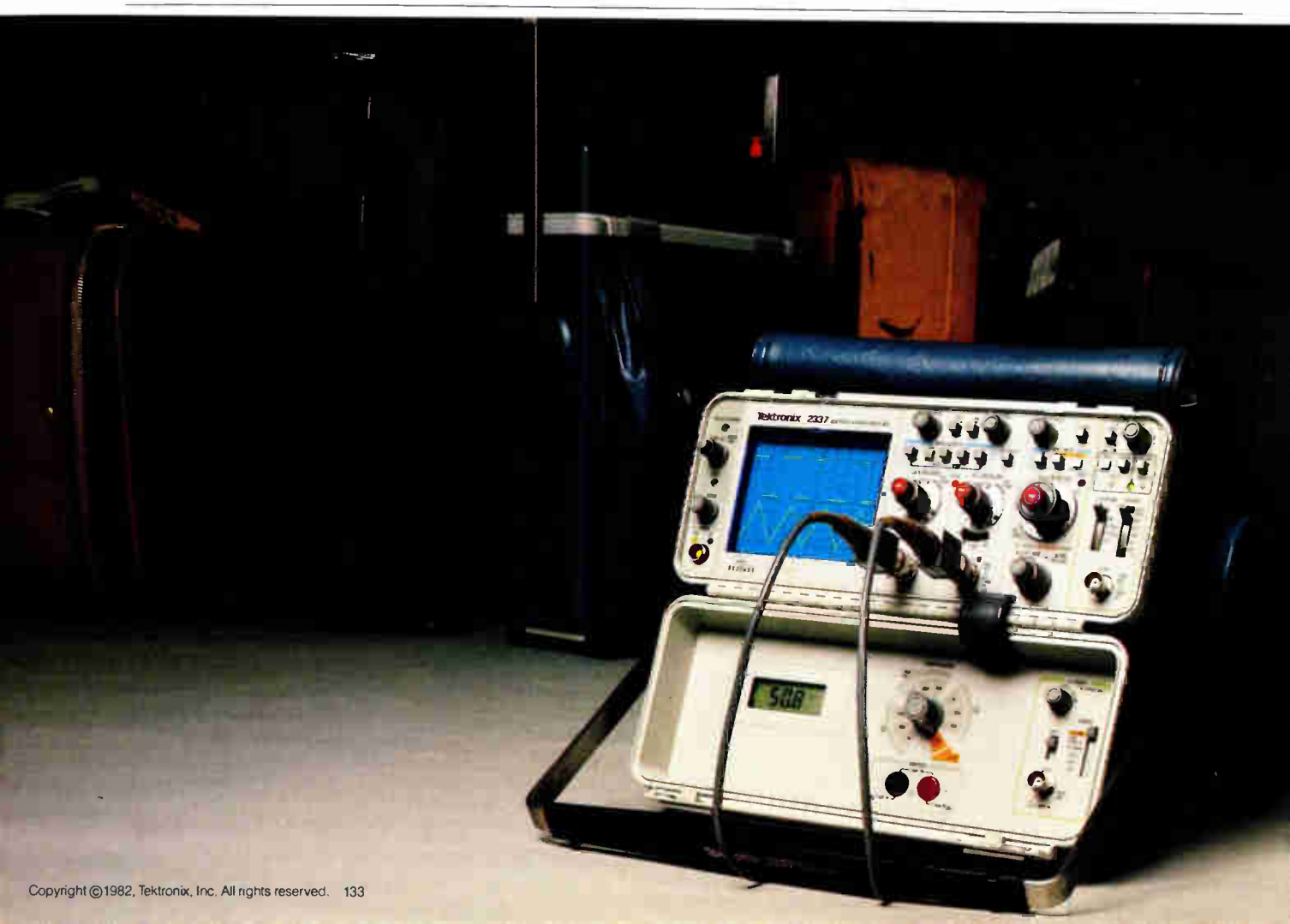
A series of eight 5¼-in. Winchester disk drives with storage capacities ranging from 7.8 to 51.6 megabytes will be introduced in evaluation quantities in June, with production quantities to follow in the fourth quarter. The ET5510, -20, -30, and -40 transfer data at 5 Mb/s and have one to four platters, respectively, with each platter storing 7.8 megabytes of unformatted data. The ET5810, -20, -30, and -40 transfer data at 8.2 Mb/s and, with 12.9 megabytes of unformatted storage per platter, store up to 51.6 megabytes of data unformatted and 40.3 megabytes formatted.

The two-sided drives access one track in 6 ms and have a maximum access time of 150 ms. They are powered by 5 or 12 V dc and are compatible with Shugart Associates and Seagate Technology devices. The 55XX series of drives starts at less than $875 and the 58XX series begins at under $975.

Evotech, 1220 Page Ave., Fremont, Calif. 94538. Phone (415) 490-3100 [362]

Graphics terminals have large screen, low price

The Visual 500 and 550 are two low-cost graphics terminals that emulate the Tektronix 4010 and run on popular graphics software like Plot 10, Disspla, Tell-A-Graf, Sas/Graph, and DI 3000/Grafmaker. In



addition, these terminals have a large 14-in. screen comprising 768 by 585 picture elements.

Graphics capabilities of the Visual 500 and 550 include vector and rectangle drawing, point plotting, and pattern filling. Both of these raster-scan terminals operate in an alphanumeric mode, display up to 80 characters on 33 lines, and incorporate separate alphanumeric and graphics display memories.

In the alphanumeric mode, the 500 emulates popular terminals like the VT52 and the ADM-3A. The block-mode 550 terminal provides full editing features and complies with ANSI X3.64 standards. Both terminals have an RS-232-C port for a printer.

Available this month, the 500 lists for $2,495 and the 550 for $2,695. Quantity discounts are available.

Visual Technology Inc., 540 Main St., Tewksbury, Mass. 01876. Phone (617) 851-5000 [363]

20-lb portable terminal prints on plain paper

Designed for the on-the-go professional, the Correspondent is a 20-lb portable terminal that is capable of printing 132 columns on plain paper. It also can communicate with a distant computer through an acoustic coupler or an integral RS-232-C interface.

The terminal prints 9-by-9–dot-matrix characters and has a full 128-character upper- and lower-case set. Included bit-map graphics capabilities have a 132-by-72-dot/in. resolution. Users are able to select print widths, spacing, bit rates, and parity through the keyboard.

There are four configurations of the Correspondent: one with both an acoustic coupler and integral modem, one with just the direct-connection modem, another with just the coupler, and a model without either modem or coupler.

With a carrying case that has sufficient room for the cord, paper, and small accessories, the Correspondent starts at $1,995. First deliveries are scheduled for the summer.

Digital Equipment Corp., Maynard, Mass. 01754. Phone (617) 897-5111 [364]

CAD/CAM system adds color to IBM mainframes

The model 2100 CAD-Colorgraphics system combines the advantages of color in computer-aided–de-

New products

sign and –manufacturing systems with the data-base integration of mainframe computers. Designed to replace present monochrome systems for International Business Machines Corp. mainframes, the modular and expandable 2100 system consists of four configurable units.

The 2120 on-line control unit emulates the monochrome IBM 3250 graphics display system to the host and incorporates new functions by expanding IBM protocols. Existing IBM 3250 system software and application programs can therefore operate on this system with little or no modification. The control unit connects to up to 16 display stations and allows operation with IBM 360, 370, and 3000- and 4300-series host computers.

The 2140 remote graphics controller allows operation up to 8,200 ft from the 2120 control unit and will drive up to four display generators with two work stations for each generator. The IAS model 2160 graphics display generator has up to 1,280 by 1,024 picture elements and a palette of 64 colors, 16 of which can be displayed on the screen at once.

Each 2100 system costs $69,950 for a control unit, display generator, monitor, keyboards, and light pen. Delivery takes 90 days.

International Applied Systems, 175 East Dana St., Mountain View, Calif. 94041. Phone (415) 962-9414 [365]

Jet printer for OEMs offers economical operation

The model 2712 OEM ink jet printer is a quiet and low-cost nonimpact printer. When printing bidirectionally at a maximum speed of 270 characters/s it makes less than 50 dBA of noise. It has a 12-by-9-dot mosaic formed by 12 ink jets, which use black, hygroscopic fast-drying ink.

The ink jet head is rated for a life of greater than 10 billion characters. In addition, full graphics are provided in two modes—a bit-image mode as used in most serial printers and a raster-scan mode as used in most line and page printers.

Besides downloadable character sets, selectable character sizes, and proportional spacing, the model 2712 printer also features a parallel or serial interface with a 9,600-b/s capability and a microprocessor board with 2-K bytes of random-access memory for user data storage.

In 100-unit quantities, the printer is priced at $1,730 and is available immediately.

Siemens Corp., OEM Data Products Division, 2911 Dow Ave., Tustin, Calif. 92680 [367]

Desk blotter simplifies computer access

Dressed as a desk blotter, the Image Data Tablet System gives keyboard-shy executives direct access to the company computer through hand-

written entries, sketches, drawings, and an alphanumeric touch table for mathematical problems, calculations, teletypewriter, and user-selectable programming functions.

The system can take a form up to 11.75 in. square and enter it as it is filled out into a host computer or its own optional microprocessor. A printer can produce an identical copy of the entry. The system is available with a document manager that provides continual on-line activity and a concentrator that allows for the use of up to 11 tablets in one system.

This multitask data entry system can be used, for example, by engineers as a computer-aided design tool for power-distribution planning,

Is your field service pipeline draining off your profits?

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The PC board pipeline.

It takes them in. It spits them out. In the process, it picks up exorbitant shipping costs, wastes valuable time, and causes unnecessarily high inventories.

The result is a big drain on potential profits.

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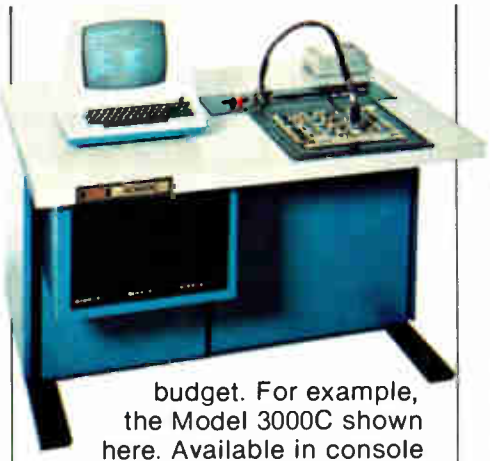
Most users have reported total equipment and related investment payback from their Fairchild-Testline units in less than one year. Many with dollars to spare.

There is a Fairchild-Testline system for every need and



budget. For example, the Model 3000C shown here. Available in console plus space-saving half-rack and full-rack configurations, it is capable of testing DTL, RTL, CMOS, TTL, and if specially ordered, ECL logic — at the rate of 10 IC's per minute.

And you don't need an expensive, highly experienced technician to operate this or any other Fairchild-Testline unit. Simple to implement programs can put an unskilled operator on-stream in no time. You can be testing your PC boards within a week of receiving equipment.

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traffic control, street planning, and statistical analysis and by supervisors and managers for payroll, inventory, building-site records, and shop-floor recording. It sells at a base price of $3,910 with deliveries taking 30 to 45 days.

Total Technical Services Inc., 341 Cobalt Way, Suite 308, Sunnyvale, Calif. 94086. Phone (408) 733-5211 [366]

Computer in a briefcase packs a big punch

A portable computer with two processors, 256-K bytes of 64-K random-access memory, 256-K bytes of magnetic-bubble memory, a 4¾-by-3½-in. amber electroluminescent bit-mapped flat-panel display, a switchable 1,200 or 300-b/s modem, and lots of software support sounds as if it could be difficult to carry. However, Grid Systems Corp., packed all

this into a product that fits into half a briefcase.

The 9¼-lb Compass Computer, which integrates an Intel 16-bit 8086 and 8087 number-crunching coprocessor, has enough peripheral devices to be a very effective stand-alone computer and is also a personal work station designed to provide business professionals with easy access to their company's entire range of computer- and information-system resources.

Software initially available will include five languages—Intel's Pascal, C, PL/M, and Fortran, and Grid's Basic (MicroSoft-compatible), five business applications (a relational file manager, a spreadsheet planning program, a graphics package, a word processor, and a critical-path project-management system), and terminal emulators for

Which personal computer can make you better at what you do best?

PERSONAL COMPUTER COMPARATIVE ANALYSIS			
	IBM PC	Apple III	HP-87
MAXIMUM MEMORY	256 K	256 K	544 K
SOFTWARE SELECTIONS	VisiCalc® Data Communications Word Processing CP/M® 86	VisiCalc® III Data Communications Word Processing Data Base Mgt. Business Graphics CP/M® Library Apple II Library	VisiCalc® PLUS Data Communications Word Processing Data Base Mgt. Graphics Presentations Statistics (3 pkgs.) Financial Decisions Linear Programming Math AC Circuit Analysis Waveform Analysis CP/M® Library Series 80 Users' Library
EASE OF USE			
Programmable Soft Keys	10	0	14
Error Messages	73	38	107
Built-in Disc Operating System	No	No	Yes
Built-in Screen Graphics	No	Yes	Yes
RELIABILITY			
Self Diagnostics	Yes	No	Yes
Operating Temperature	61-90°F	No figures available	32-133°F

THE BIGGEST MEMORY I'VE EVER HEARD OF.

MY KIND OF SOFTWARE.

SURE LOOKS EASY.

For you, choosing a personal computer means making an intelligent decision.

And isn't that what you do best?

The first step in your decision-making process is analysis. You look at all the numbers, and all the facts, before you leap. So you don't want a computer that's going to run short on memory. Not when you can have the HP-87 and a memory that expands to over half a million bytes.

Hewlett-Packard will make sure you don't run short on analytical software, either. For example, our VisiCalc® PLUS will let you turn up to 16,000 cells of data into bar graphs, pie charts or whatever you need to present your results graphically. And our CP/M® module gives you access to the expanding world of CP/M software.

We call it HP-Easy. Turn on the HP-87, and it's ready to go. The ROM-based operating system puts our built-in, enhanced BASIC to work for you. Instantly. The HP-87 has built-in commands and editing keys that eliminate complicated keystroke sequences. Whether you're generating a complex graph, writing a program or correcting errors.

And interfacing peripherals is as easy as putting a plug into a socket. That's the kind of craftsmanship that's putting all our Series 80 computers on the map. We're building power, friendliness and reliability into every one of them. From our portable partner, the HP-85, to the high-powered HP-87.

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Introducing the new HP-87. It's very good at what you do.

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6/2/02

New products

most IBM terminals and the standard Teletype. The Compass Computer will be available from Grid beginning in September at a single-unit list price of $8,150.

Grid Systems Corp., 2535 Garcia Ave., Mountain View, Calif. Phone (415) 961-6873 [368]

Q-bus controller emulates DEC devices

The WDC11 multifunction Q-bus controller contained on a single dual-width card lets popular independent and floppy-disk drives emulate a variety of Digital Equipment Corp. devices. Through its bipolar microcontroller and firmware housed in read-only memory, the controller serves three functions at once: with Winchester disk drives it emulates DEC's RK05 or RL01/2 hard disks, and with floppy-disk drives it emulates DEC's RX02 floppy disk.

The logical organization of the WDC11 is based on the 8X300 bipolar control chip, which provides the speed needed to handle high data rates. Currently, devices supported by the WDC11 include the Quantum Q2000 and Shugart Associates SA1000 8-in. Winchester drives, Computer Memories CM5000 and Seagate Technology ST506 5¼-in. Winchester drives, and the Shugart SA800, SA850, and Tandon TM100-4 floppy-disk drives. The WDC11 sells for $2,000 each.

The manufacturer also supports DEC's 22-bit addressing LSI-11 Q-Bus and board with the Q-22 product line of card cages, memory cards, and mass-storage controllers. These supports are designed for original-equipment manufacturers and for end users as complete systems. The firm also offers the EB11, which isolates, through banks of miniature switches, each data and control line that makes up the Q-bus. The Q-22 products range in price from $350 to $13,500, and the EB11 sells for $250.

Andromeda Systems Inc., 9000 Eton Ave., Canoga Park, Calif. 91304. Phone (213) 709-7600 [369]

Until now, if you wanted a high performance array processor, you had only one choice.

You had to buy the expensive high performance array processor even if you didn't need half its capabilities. But now, there's CDA's MSP-3000 floating point array processor. It offers the flexibility and performance you need, at a price you can live with.

Our MSP-3000 consists of fewer boards than the other high performance processor, and is much smaller. Best of all, it expands to a full 2 Mb of memory, and uses half as much power.

CDA's MSP-3000 is easily configured to meet your particular high speed applications.

For more information on the MSP-3000 and our broad line of input, array and display processors, circle the reader service number or call. We'll tell you how you can get just the processing performance you need.

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TELEX: 92-2521

Circle 185 on reader service card

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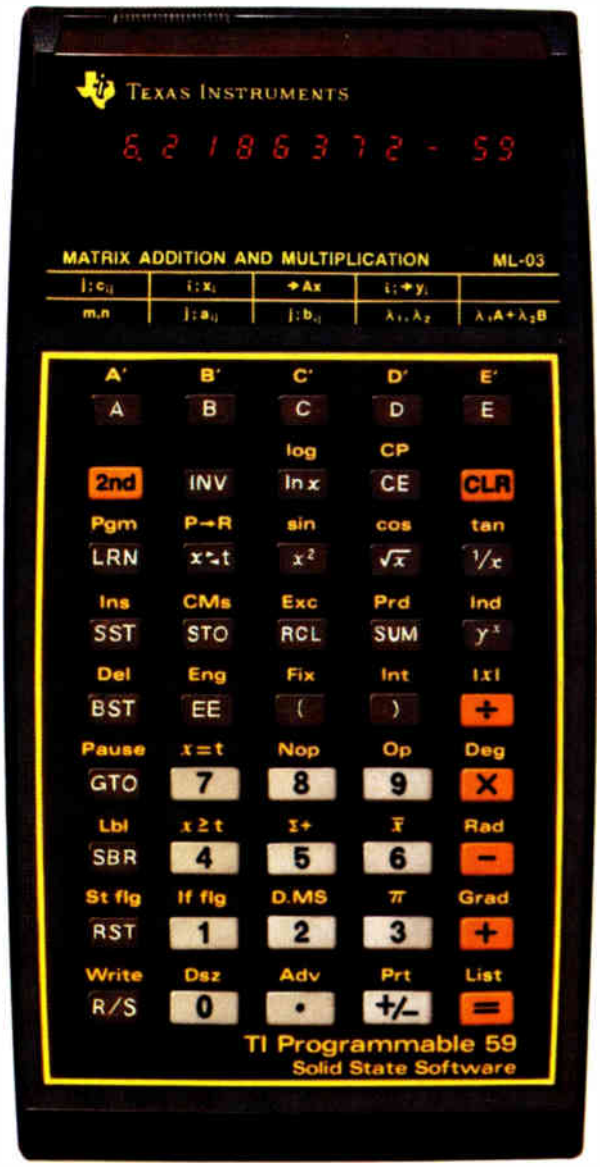
The Facts: Sure you could buy the other programmable calculator. But it wouldn't come close to the TI-59 Programmable. Look at the facts.

The TI-59 has 660 more program steps (960 total), 37 more program memories (100 total), and 3 more internal digits computed (13 total) than its closest competitor. Which is not really close at all, is it? And those aren't even all the facts. Because when you buy a TI-59, you get extras.



Like a built-in mag card reader, Solid State Software,™ rechargeable batteries and an AC adaptor. The closest competitor charges you extra for these extras.

Which leaves him far behind, doesn't it?

And there's one more fact you should know. All these features are built around the popular algebraic operating system (AOS).

So based on these facts alone, the TI-59 Programmable is a better buy. More features. More functions. More extras. More calculator. For less money.

And that's more than just fact. That's value.

then, $80 in free software makes it a great buy!

The Free Software: If all the facts on the other page haven't convinced you to rush out and buy a TI-59 right now, this will. Buy a TI-59 Programmable between Feb. 1, 1982 and June 15, 1982 and get 2 free modules worth $80.* That's right. You can choose from our wide selection of modules including Applied Statistics, Electrical Engineering and Business Decisions. Get the two you want and it won't cost you a thing.

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It's all pretty convincing isn't it? So go to your nearest Texas Instruments Dealer today, ask about the TI-59 and TI-58C Programmable and get a good buy. Then send in this coupon and make it a great one.

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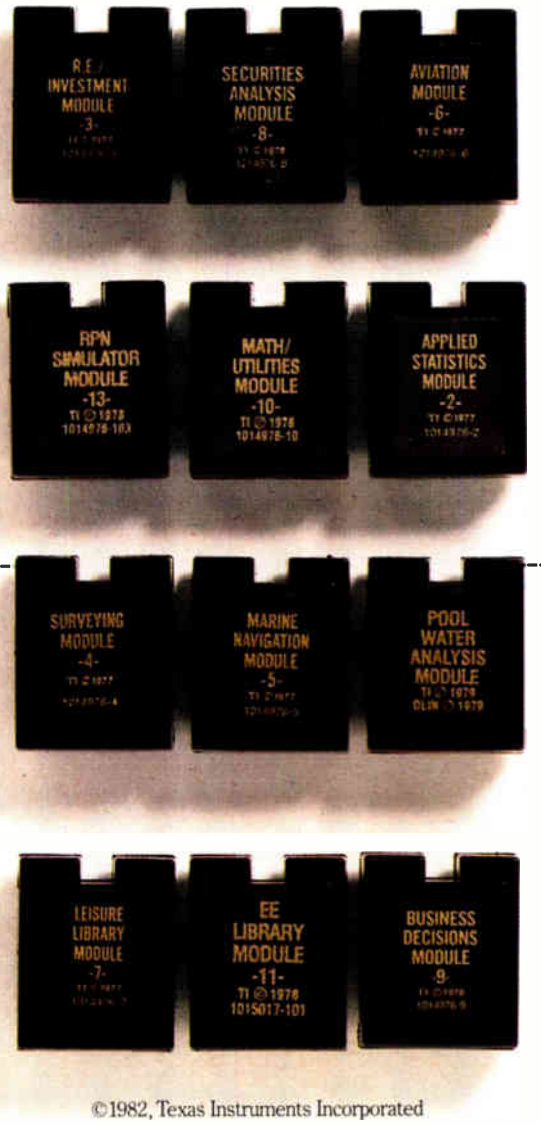

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Please allow 30 days for delivery. Offer void where prohibited. Offer good in U.S. only. TI reserves the right to substitute modules.

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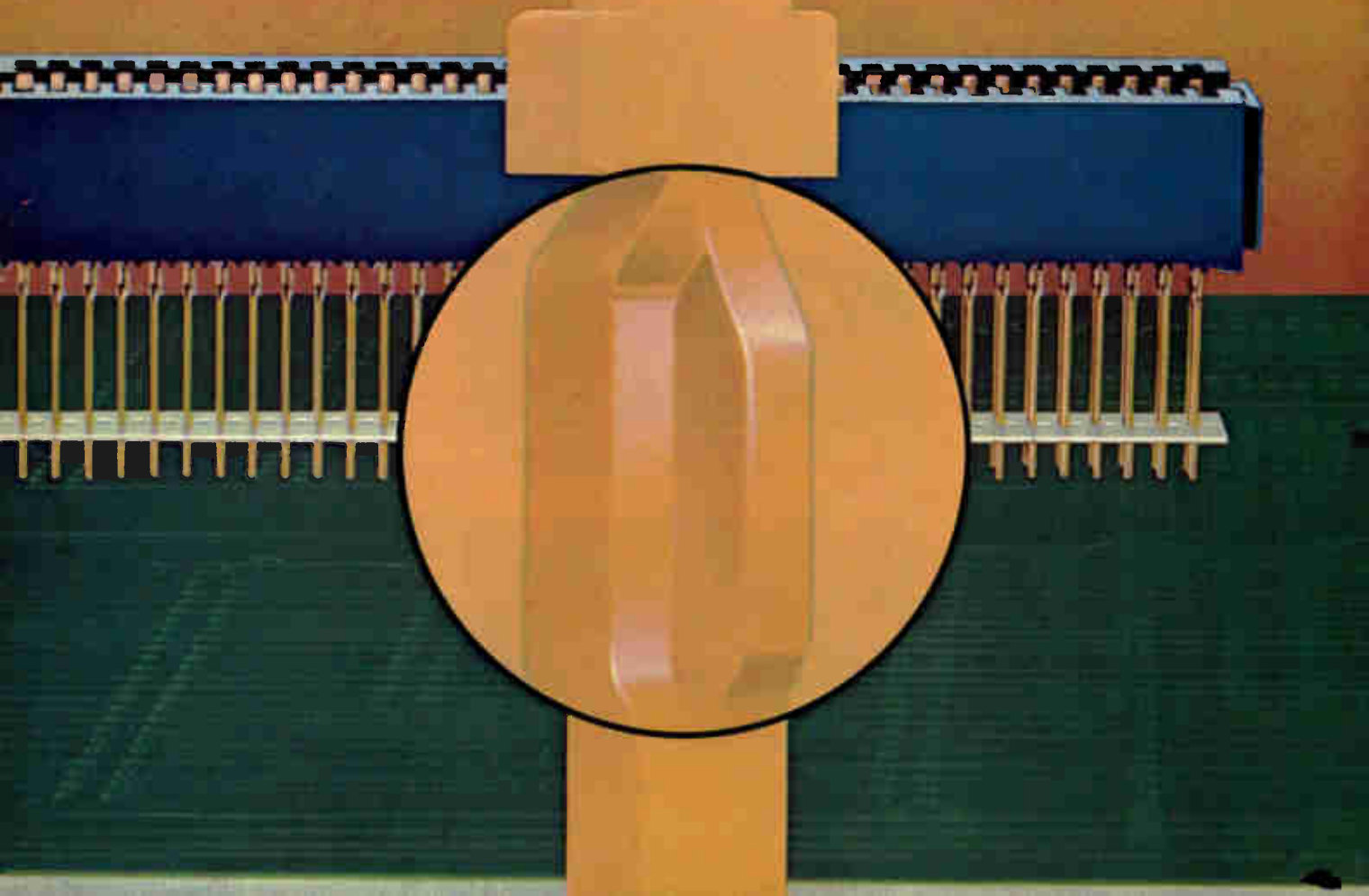
Yet the solderless advantage is only part of its story. Our compliant pin also prevents costly plated-through hole damage. It's forgiving enough to relax hole tolerances—and yet assure a gas-tight fit, every time. You can replace damaged pins a number of times, too, without losing any performance.

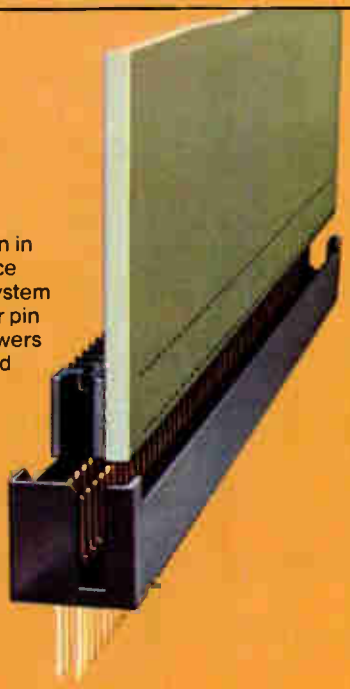
There's more. You can apply every one of these different AMP connectors with one basic production machine—across the board.



AMP Facts

New one-piece distribution tap with compliant pin for power I/Os.

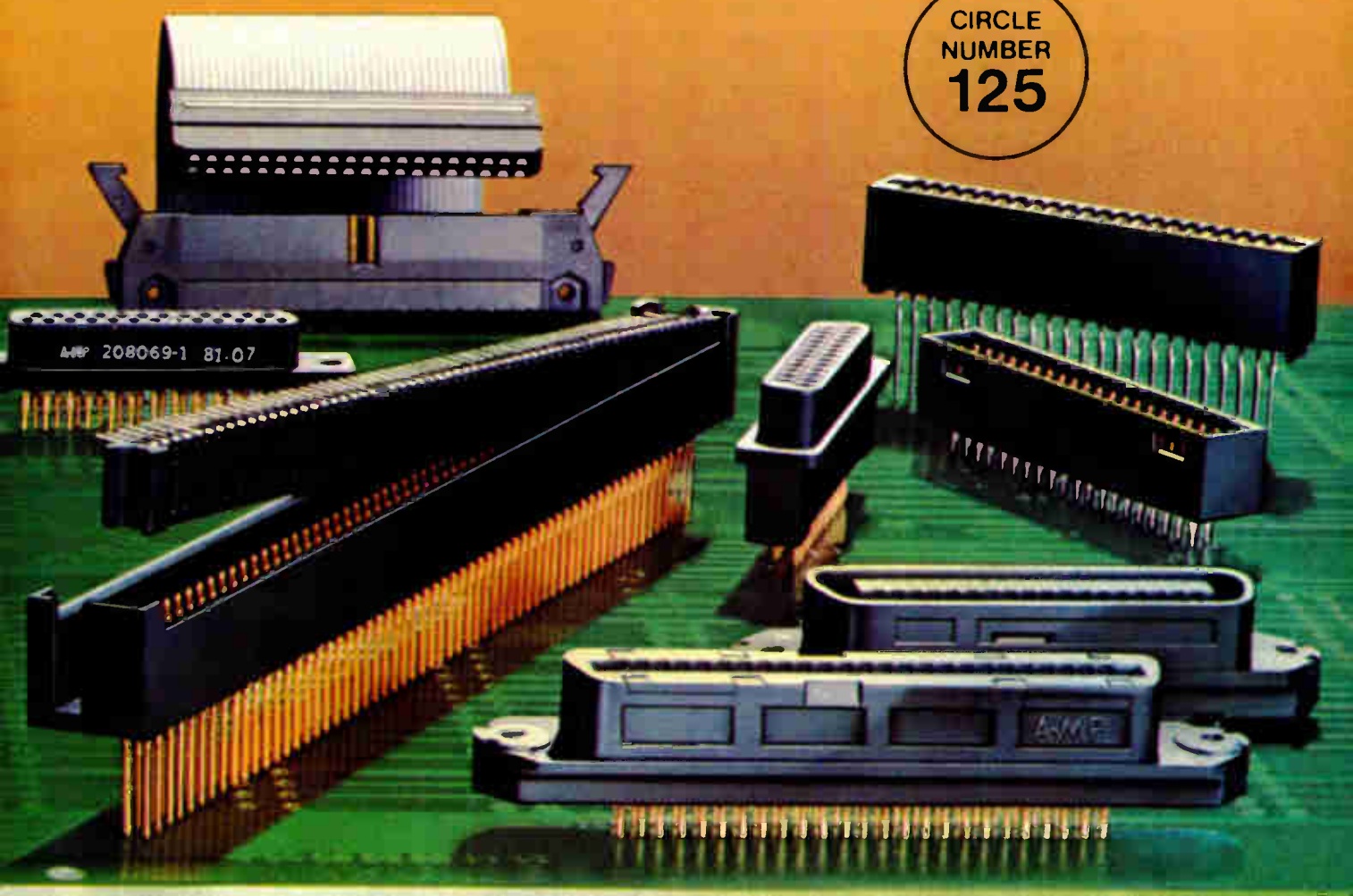
Compliant pin in new two-piece connector system allows higher pin count and lowers daughter card rejects.



To eliminate solder and get more information, call the AMP ACTION PIN Desk at (717) 780-8400.
AMP Incorporated, Harrisburg, PA 17105.

AMP means productivity.

CIRCLE NUMBER 125



Instruments

Series 80 takes on op amps, codecs

Packages debut with optional function generator, IEEE-488 interface, audio digitizer

Operational amplifiers and telecommunications devices like codecs can now be checked out by Fairchild Test Systems's recently launched general-purpose series 80 analog test system, thanks to the availability of two new application packages. Also announced as options are an IEEE-488–bus interface, an audio digitizer, and a programmable function generator.

The telecommunications package mixes the digital and analog functions necessary to test codecs with or without on-chip filters, as well as subscriber-line interface circuits. Resource boards offer programmable clock and timing circuits, synchronization between digital and analog functions, and analog stimulus, response, and reference circuits. The digital drivers and receivers operate at about 20 MHz for a safe speed margin above the required rates. Also included is a test adapter suitable for both wafer- and package-level testing, whether manual or with automatic handling.

With the package, the series 80 can check codecs for gain tracking, absolute gain, idle-channel noise, signal-to-distortion ratio, power-supply rejection, crosstalk, frequency response, and asynchronous operation. The system also verifies adherence to the companding law used by the codec—both U. S. μ-law and the A-law as specified by the International Consultative Committee for Telegraphy and Telephony for European use are supported. The entire telecommunications package is priced at around $50,000.

The package for testing operational amplifiers, not to mention instrumentation amplifiers and comparators, consists of one board and a test adapter. The device under test may be in a single, dual, or quad configuration; multiple amplifiers are tested in parallel to keep throughput high.

Slew rate can be measured by the system up to a 50-V/μs maximum. The gain-bandwidth product of the tested op amp is also determined, and a long list of dc tests can be performed. These include input offset voltage and bias current, gain, voltage and current output, power-supply and common-mode rejection, input-voltage breakdown, and power-supply current use.

The op amp package uses 12-bit analog-to-digital conversion to make the tests, but the system's 16-bit converters can be switched into action if greater resolution is required. This package is priced at about $6,500.

The $6,000 IEEE-488–bus interface for the series 80 is programmed with statements in the high-level Analog Factor language, allowing bus-compatible instruments to be operated from device programs. The $8,500 audio digitizer samples at 100 kHz with 14-bit resolution and thus is able to digitize signals as high in frequency as 50 kHz.

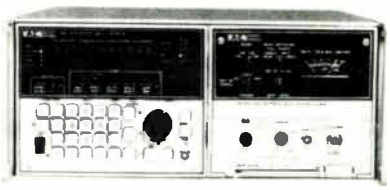
The series 80 programmable function generator puts out sine and square waves, ramps, and other single-valued time functions with an output bandwidth of up to 200 kHz. It has a local buffer capacity of 4-K 16-bit words and a digital-to-analog converter with 15-bit resolution (plus sign). Frequency accuracy is within 0.05%. Output is 20 V peak to peak, maximum, with 18-mV resolution and 50-Ω impedance. The function generator is $7,500.

The options and application packages can be delivered in 120 days.

Fairchild Test Systems Group, 1601 Technology Dr., San Jose, Calif. 95115. Phone (408) 998-0123 [351]

Direct decimal synthesizer has good noise performance

The fast-switching 384M synthesized signal generator operates between 1 MHz and 2 GHz and has good noise performance for automatic-testing and frequency-agile applications. Alternative plug-in units can



drop the lower frequency limit to 10 kHz or double the upper frequency limit to 4 GHz.

The instrument uses a direct decimal system. In addition, it has an accuracy of ±20 Hz without degrading signal purity. Frequencies can be

A Golden Opportunity.

The Blue Plate Special In South Carolina.

South Carolina's smaller communities represent a golden opportunity for new and growing industries. An opportunity supported by a stable, dependable work force and a Technical Education system that for years has been training workers at little or no cost to industry.

In our continuing efforts to make certain our work force is prepared, not only for today's jobs but for tomorrow's as well, we've added special Resource Centers for advanced machine tool, robotics, computer and micro-electronics, and a fleet of mobile units to our job training system.

We also have a team of plant location professionals available 24 hours a day, to help contribute to profitable plant locations. They, along with state and local leaders, have worked for years to make more than 50 communities ideal site locations which meet rigid requirements established by our State Development Board.

Add to this South Carolina's high productivity and low work stoppage rates...the lowest in America...and you soon realize that while golden opportunities are rare, there are a few left. South Carolina is one of them.

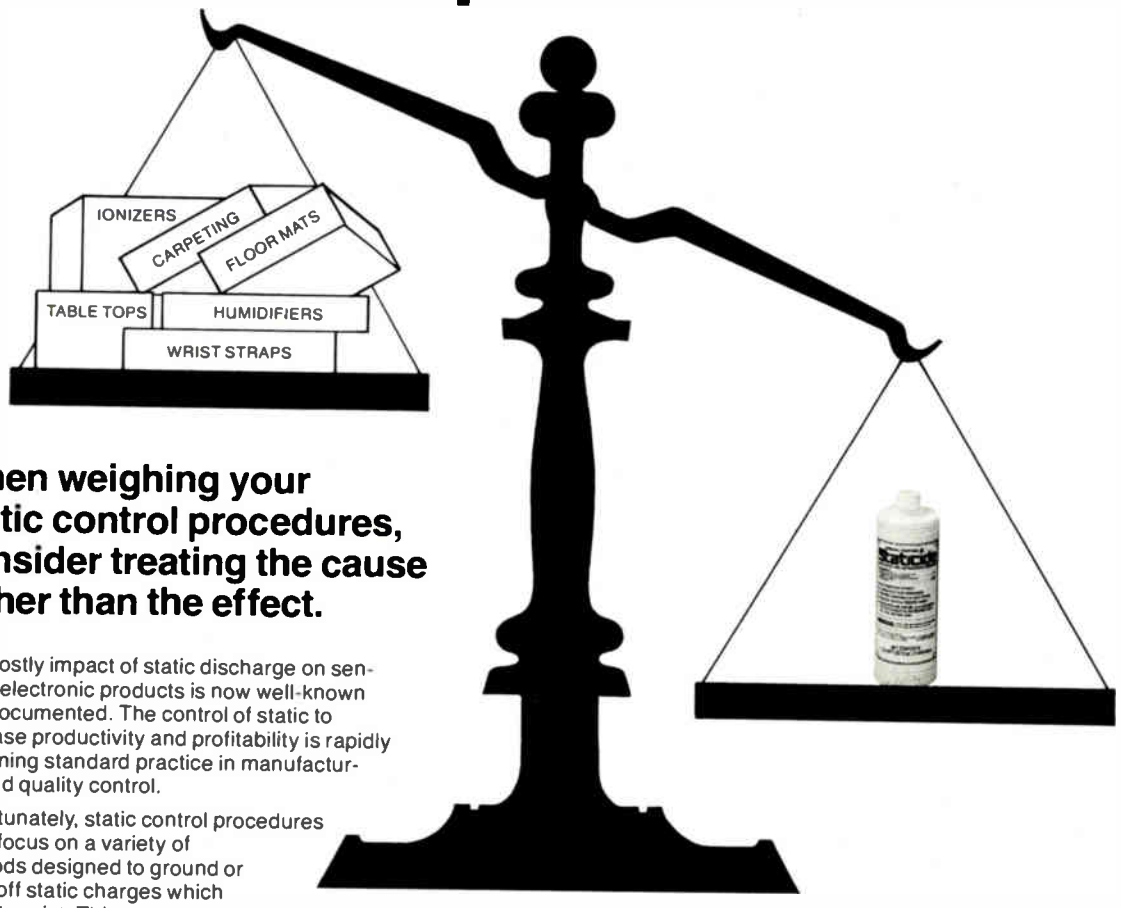
South Carolina

Toll Free 1-800-845-1802

For assistance or more information, call us toll free or write to
The South Carolina State Development Board, P.O. Box 927, Suite 202R, Columbia, S.C. 29202.

Circle 191 on reader service card

An ounce of static prevention...



When weighing your static control procedures, consider treating the cause rather than the effect.

The costly impact of static discharge on sensitive electronic products is now well-known and documented. The control of static to increase productivity and profitability is rapidly becoming standard practice in manufacturing and quality control.

Unfortunately, static control procedures often focus on a variety of methods designed to ground or drain off static charges which already exist. This approach usually requires a variety of costly devices and materials, plus the constant search for new and better ones. However, there is an alternative—a proven, economical approach to static control which minimizes static generation *before it becomes harmful.*

A long-term solution, by the established static control experts —ACL Incorporated.

The most effective product for dealing with the long-term prevention of static build-up is STATICIDE® brand antistatic solution, produced by ACL Incorporated. STATICIDE can be easily applied on most environmental surfaces, thus minimizing static generation at its source. STATICIDE provides total environmental static control by treating the *cause* of static rather than its symptoms.

Unlike any other static control substance, STATICIDE provides all these unique features:

- Meets static decay criteria and surface resistivity requirements of military and medical specifications
- EPA registered (in its ready-to-use form) as an antistatic and bacteriostatic compound
- Effective at relative humidities below 15%
- Effective on all materials: textiles, plastics, tile, glass, metal, printed surfaces, wood, etc.
- Can be mixed with virtually any solvent
- Is long-lasting, easy to apply and economical to use
- Non-toxic, non-flammable, safe to use
- Non-staining, completely biodegradable

For over 30 years, ACL has been committed to solving the most difficult industrial problems related to static electricity, through the production of STATICIDE, as well as instruments for the detection, measurement, and analysis of static charges. ACL is also internationally known for its consulting services, from materials design to complete facility evaluation and implementation of static control programs.

Tip the static control scales in your favor... Call on ACL!

Contact us for the name of your nearest international or domestic distributor.

acl incorporated Specialists in Static Control

1960 East Devon Ave., Elk Grove Village, IL 60007 • (312) 981-9212, TELEX: 4330251

192 Circle 192 on reader service card

switched rapidly—in less than 20 μs—without any overshoot or settling problems.

Spurious levels are better than −74 dBc for the 1- to 2- GHz range and improve in the lower frequency ranges to −100 dBc for the 1- to 100-MHz range. In the 2- to 4-GHz doubled range, spurious outputs are below −68 dBc, and all harmonics and subharmonics are below −38 dBc. Output of incorrect signals is prevented should faults occur.

The instrument is programmable using either a IEEE-488 bus or TTL parallel entry. The 384M is priced at $38,500 with delivery 26 weeks after receipt of order.

Eaton Corp., Electronic Instrumentation Division, 2070 Fifth Ave., Ronkonkoma, N. Y. 11779. Phone (516) 588-3600 [353]

Plug-in card turns an Apple into an analyzer

Just by sliding the A2-1 peripheral card into an Apple II computer, a user may create a logic analyzer that can analyze TTL-compatible MOS and TTL circuits. Three ribbon

cables connect 32 input and 16 output probes to the card.

The A2-1 differs from the usual expensive type of logic analyzer in that it provides a clock signal to the circuit under test rather than using the system clock. It can step through states until a critical point and then freeze the circuit's clock while changes are made to stimuli or display parameters.

Software for the system displays input signals as columns of 1s and 0s

New products

on the screen. Up to 16 inputs may be used for a trigger pattern. In addition, routines are provided in Basic, Pascal, and assembly language to help the user write custom programs. The card sells for $400 with delivery taking 30 days after receipt of an order.

Kanel Corp., 1025 Reynolds Rd. B202, Johnson City, N. Y. 13790 [354]

Unit generates transients to IEEE specifications

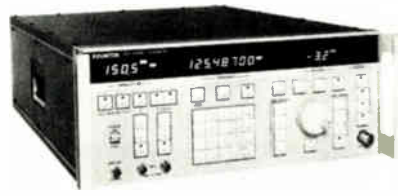
A surge and transient generator priced under $10,000 is capable of producing waveforms recommended by Category A of IEEE STD 587-1980 for testing ac-powered equipment. The model 711 A/F measures only 8¾ by 17½ by 23 in. and has provisions for a variety of plug-in accessories and alternative networks.

It is fully expandable to perform Category B testing. Add-ons include surge voltage and current monitors, couplers and filters that permit surge testing on live ac lines, and automatic repetitive control. Delivery takes 30 to 60 days.

KeyTek Instrument Corp., 12 Cambridge St., Burlington, Mass. 01803. Phone (617) 272-5170 [356]

Programmable generator reaches 1.08 GHz

The 1021, a programmable frequency- and amplitude-modulated signal generator, has a frequency range of



150 kHz to 1.08 GHz. The generator has radio-frequency output levels of +19 to −146.9 dBm below 540 MHz and +16 to −146.9 dBm above 540 MHz. At 30% am, the total harmonic distortion is less than 1% over a dc to 50 kHz bandwidth, and for fm, THD is typically 0.05% at up to 100-kHz deviation at a 1-kHz modulation rate over a 5-Hz to 200-kHz bandwidth.

A variable-frequency internal-modulation source with externally available output is programmable in both frequency and level. A fast-sweep mode, suitable for scope display, has narrow, medium, and wide ranges. Sweeps can be set to any frequency segment within the instrument's frequency range.

Full IEEE-488 capability, with listen and talk modes and free-format number entry are provided on the $15,950 unit. Delivery takes 12 weeks.

Boonton Electronics Corp., P. O. Box 122, Parsippany, N. J. 07054. Phone (201) 887-5110 [355]

Programmable calibrator has resolutions to 0.01 μV, 1 μA

The AN3200 dc programmable voltage and current calibrator has an accuracy of 10 ppm for applications requiring resolutions of 0.01 μV or 1 μA, settling times of 1 ms, and ranges of ±0.1 μV to ±100 V or ±1 μA to ±100 mA.

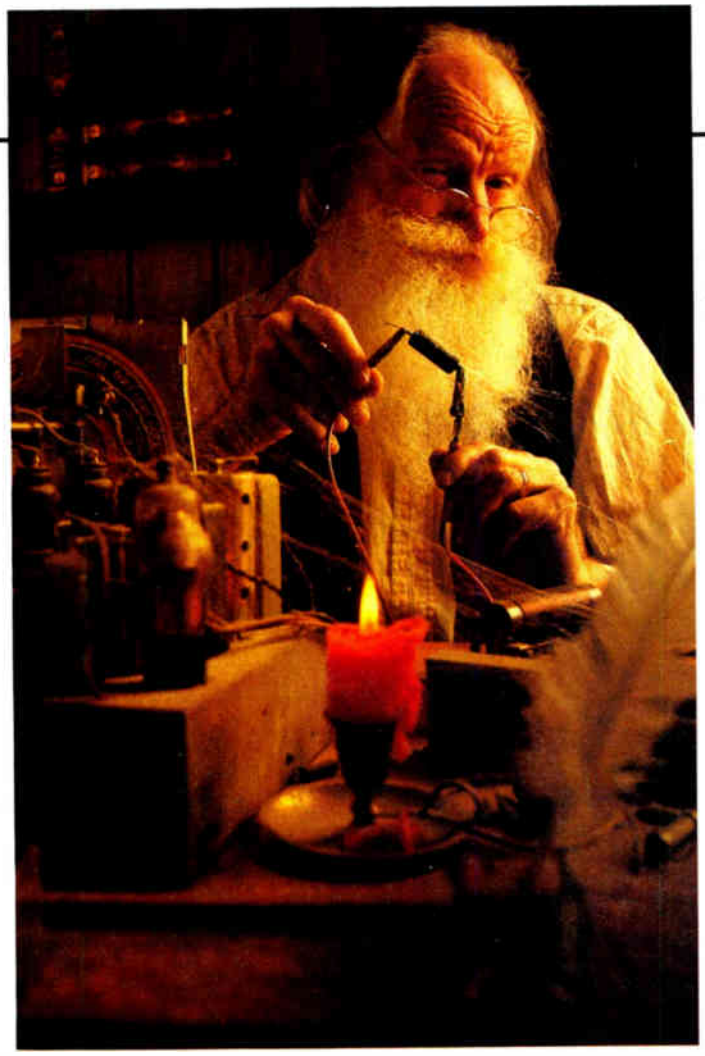
In manual mode, six dial controls set the digitally displayed output, plus polarity and automatic decimal-point positioning. Also, each dial has full borrow and carry capacity, allowing the operator to control significant decades by turning one dial.

The unit provides full protection of the circuit under test by returning the output to zero whenever the operator changes polarity, range, or function. In addition, all outputs float with respect to ground and guard; the common-mode capability is up to 1,000 V guard to case, and a separate guard terminal is provided.

Options on the $2,195 instrument, which is available now, include a ±1,000-V output range for $495 and an IEEE-488 interface for $295. Delivery is from stock.

Analogic Corp., Audubon Road, Wakefield, Mass. 01880. Phone (617) 246-0300 [357]

Congratulations... You Now Own A Priceless Relic



First came manual balance bridges for testing passive components. Very cumbersome, but they were the best bridges of their time.

Then digital instruments made their appearance. What a relief. No more knob twisting. All of a sudden, manual balance bridges became obsolete.

Now, step into the next generation of impedance test instruments with the VideoBridge from ESI.

Monitor test conditions at a glance.

As impedance test instruments evolved, they became more versatile. With the capability of programming test levels and test frequencies, parts could be tested under simulated working conditions. But all this flexibility made it hard to know what test conditions you programmed.

This is where the VideoBridge really shines. The conditions you program are displayed right at the top of the screen. Whether you are bin sorting or reading component values, the test conditions are displayed along with the test results! You'll have confidence that you're testing a part the way you intended.

Set up is a snap

Set up is made even easier with the 2110 version of the VideoBridge. Just store your test parameters on the 2110's micro-cassette tape. All your operators have to do is key in the test number and hit the load button. What could be easier?

That's only part of the VideoBridge story. To learn more, just give us a call, toll free. A better way of testing passive components is waiting for you at ESI.

ESI's VideoBridge® makes all other impedance bridges antique!

The leading edge in LRC testing

Electro Scientific Industries, Inc.

800 547-1863

Circle 195 on reader service card

DON'T SOLVE HALF YOUR CARD TEST AND REPAIR PROBLEM!

Use the new Marconi 80X with Computer Aided Repair option: It's the total solution. Up to 4096 test channels without multiplexing. Dual fixtures for higher throughput. CAR* to instantly identify faults in color.

Marconi's new in-circuit card test System 80X with the Computer Aided Repair station option is the most productive ATE system introduced in many a year. It's both sophisticated and easy to use.

The Marconi System 80 In-Circuit Test Systems for more productivity at less cost.

Usually our System 80 ATE units with a CAR station cost less than competitive test systems alone. Without the CAR option, which can be added later, System 80's offer outstanding performance at a substantially lower price than comparable test systems.

For instance, System 80 and 80X dual fixture systems allow one test system to completely test different circuit cards at two positions. Through time-sharing of testing and card handling, productivity can be 60% to 80% greater than competitive single fixture test systems. Add CAR and you're looking at over twice the productivity of competitive systems for about the same price!

Better software, better hardware.

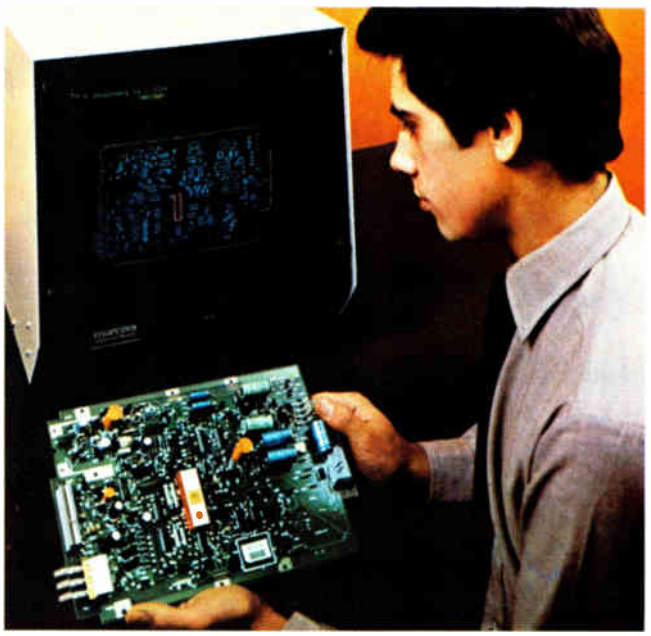
Customer benchmark comparisons have independently proven the superiority of Marconi's System 80 in-circuit technology in software, analog testing and digital testing. Let us discuss with you how these advantages will translate into increased productivity and lower cost in your plant.

The CAR Option. "How come nobody thought of it sooner?"

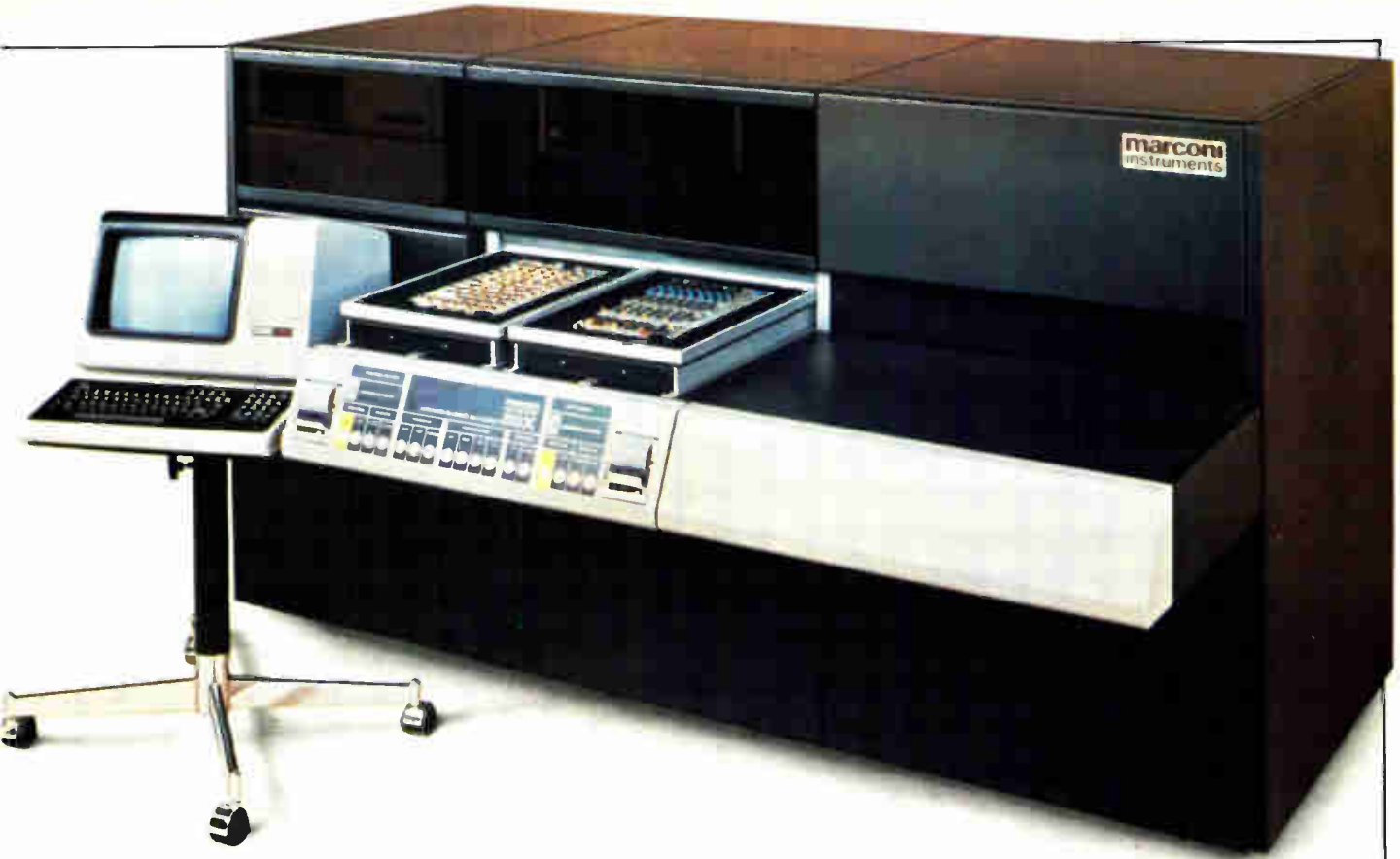
That's what a leading periodical editor said recently. Until now no one applied automation to the circuit card repair operation. Accompanied by a fault ticket, bad cards were simply sent to a manual rework and repair station. Then, in a process taking some 10 to 100 times as long as the card test time, they were reworked.

No more! Marconi's Computer Aided Repair Station, "CAR" for short, changes that forever. CAR, operating integrally with the Marconi System 80/80X In-Circuit Test Systems, uses new developments in software and a color graphic video terminal to instantaneously locate both component and trace faults. And, in a flash, bring them up on the screen in a contrasting color.

CAR is on-line and available now from Marconi, the largest international manufacturer of in-circuit card testers and a part of the $8 billion GEC-Marconi complex.

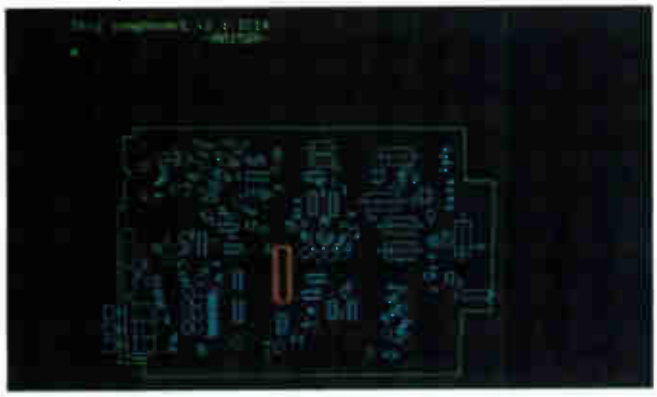


CAR station option



Marconi, first again.

Other systems tackle only the test half of your problem. But Marconi can help you automate both halves of your circuit card test and repair/rework operations with System 80/80X and CAR.



Component side of PC board showing faulty component in red

Trace side of PC board showing fault where contrasting colored traces meet

It's the complete solution to higher productivity and lower costs in circuit card manufacturing.

And no wonder. Marconi pioneered in circuit card testing when we delivered our first ICT in 1967. Now with more than 14 years experience and hundreds of installations, we're proving once again our mettle as the industry innovator. CAR takes your repair and rework operation out of the horse and buggy age.

Arrange a "hands on" demo.

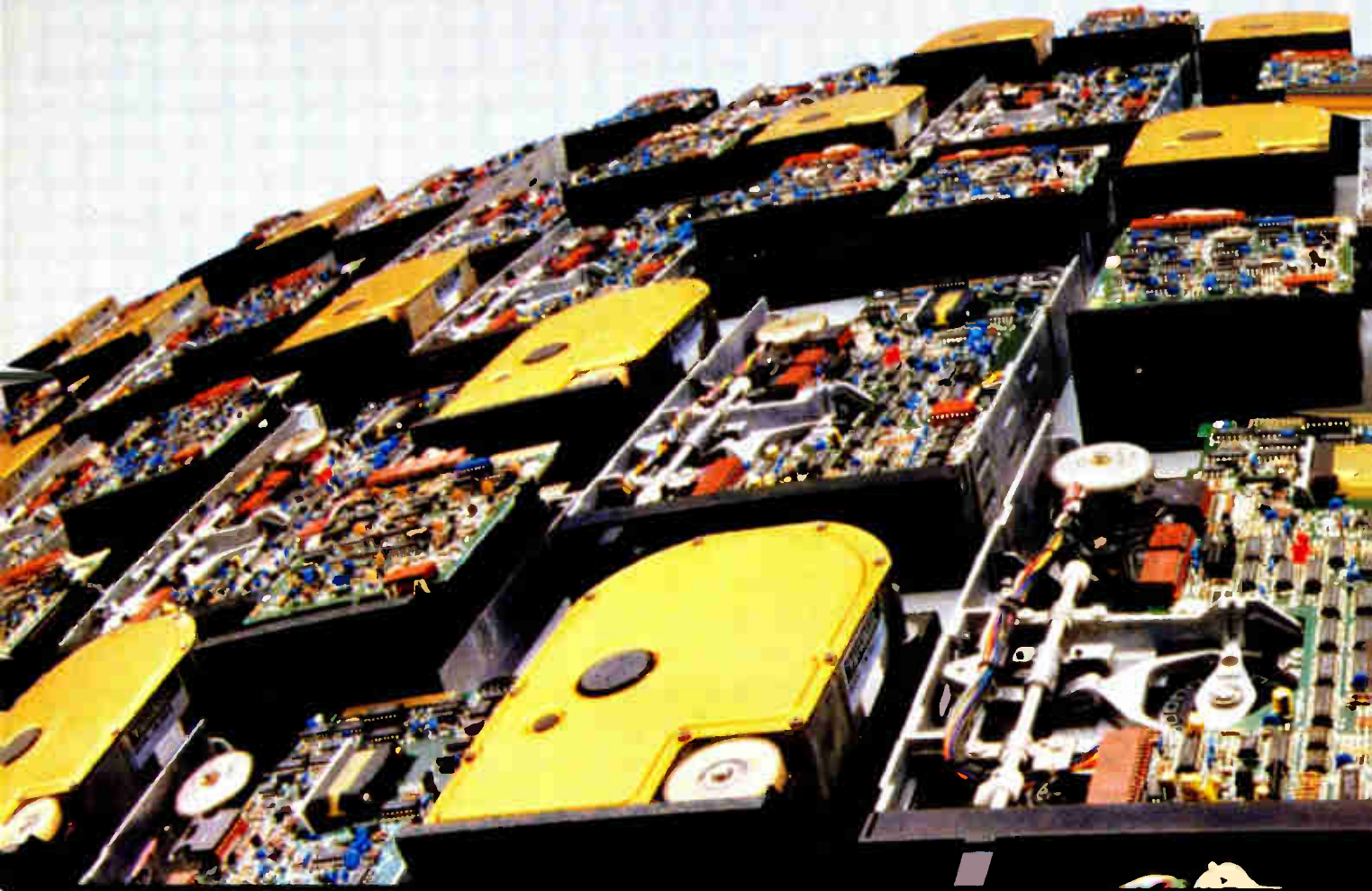
We cordially invite you to arrange a demo in either our East or West Coast ATE centers. And when you come, bring along one of your troubled boards. Let us show you how much you could save going the Marconi way. For more data address Marconi ATE Div., P.O. Box 60279, Sunnyvale, CA 94088. Phone 408-745-7561. TWX 910-379-0001. Outside the U.S. & Canada, address Marconi Instruments, Ltd., Longacres, St. Albans, Herts., England AL4 OJN. Phone (0727) 59292. Telex 23350.

*CAR is a trademark of Marconi Electronics, Inc

marconi instruments

Circle 197 on reader service card

LAST YEAR
SMALL DRIVES THAN A
FRANKLY, WE WERE DIS



Tandon Corporation. 20320 Prairie. Chatsworth, CA 91311. (213) 993-6644 Regional Sales Offices: Woburn, MA (617) 938-1916 • Plano, TX (214) 423-6260

WE SHIPPED MORE NYONE IN THE WORLD.

APPOINTED.

Because we could have shipped a whole lot more. In 1981, we shipped more 5¼" floppies, high-capacity 5¼" Winchesters, and 8" half-size floppies than anyone has ever shipped in a single year. And that's good.

But that represents only 35% of our total manufacturing capacity. So this year, we're looking for a lot more customers.

We already supply disk drives to the biggest names in the business. And for good reason: we've demonstrated that we can consistently deliver high volumes of reliable, precision-engineered drives.

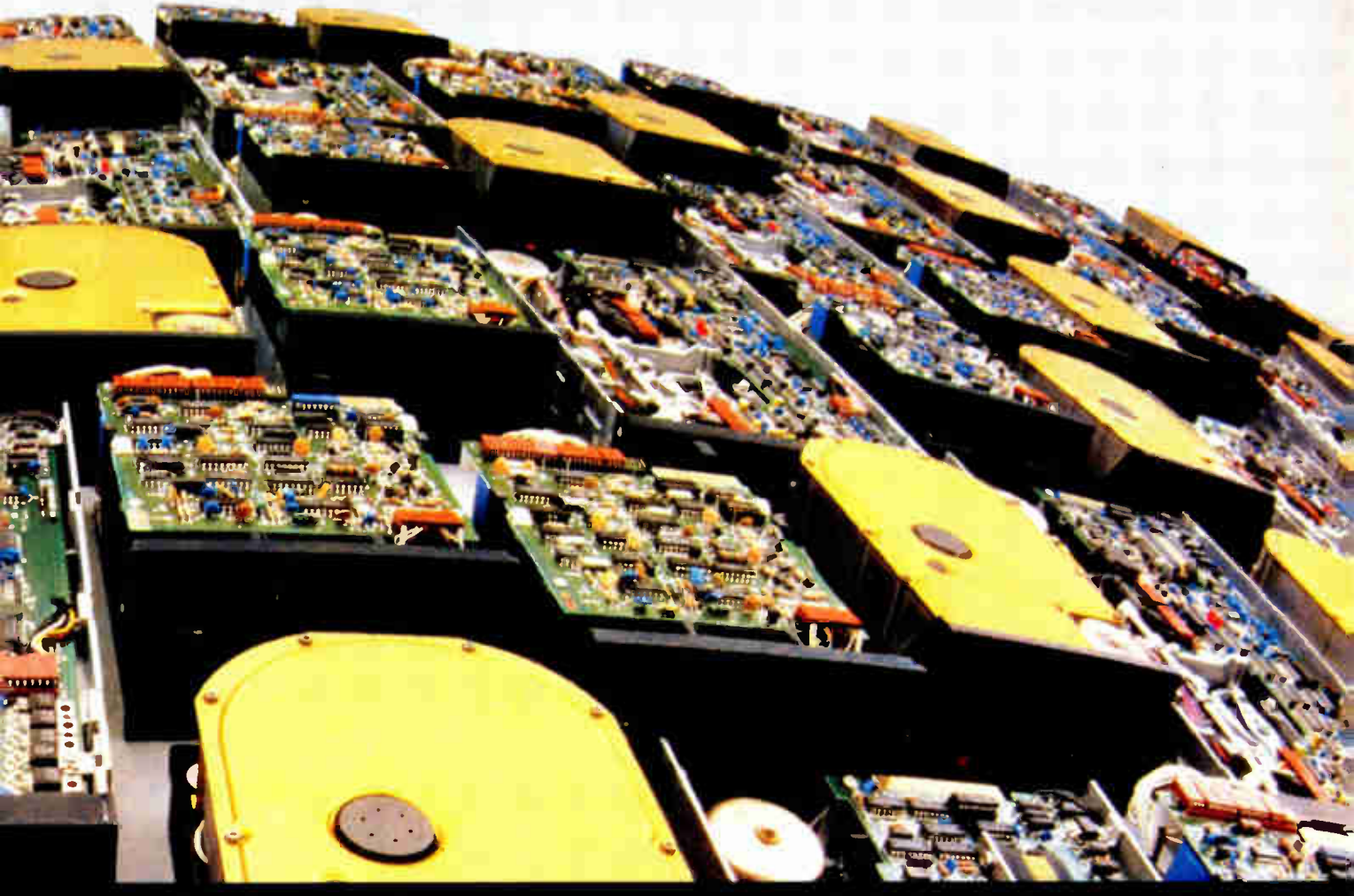
We're a multinational corporation, with more than 350,000 square feet of manufacturing and office space. And we intend to keep our capacity 50% greater than our shipment level. So we can always deliver the goods.

Over the last three years, we've shipped a million drives. And become the fifth fastest growing company in the U.S. This year, we expect to ship our second million. And then some. Maybe then we'll be satisfied. Until 1983.

For information contact your nearest Tandon office or your local Kierulff or Hall-Mark distributor.

Tandon

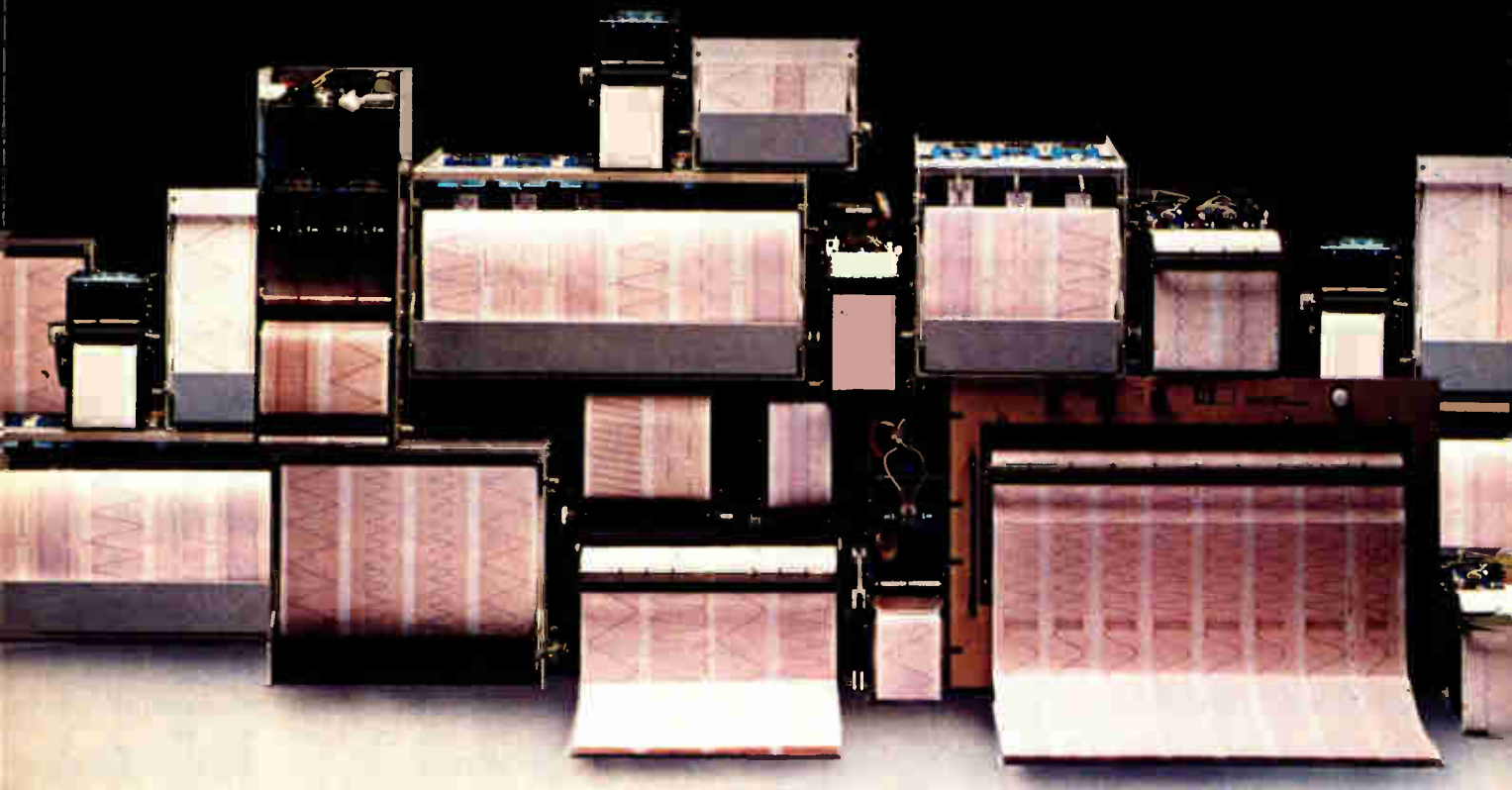
THE MOST SUCCESSFUL DISK DRIVE COMPANY YOU EVER HEARD OF.



• Atlanta, GA (404) 396-0493 • Addison, IL (312) 530-7401 • Newport Beach, CA (714) 675-2928 • Sunnyvale, CA (408) 745-6303 • Frankfurt, West Germany (0611) 392081-85, Telex 411547

Circle 199 on reader service card

There's an Astro-Med OEM recorder for every medical, scientific and industrial application.



For high-speed OEM graphic recorders that your equipment deserves, talk to Astro-Med first. Our extensive product line contains the model that will match your most exacting requirements. Knife edge or point writing. Low-cost thermal writing, of course. Roll-type or Z-fold chart handling. Fast snap-in or cartridge loading. Configurations of all types. The specific number of channels you need. And much more.

Take accuracy, for example. Astro-Med introduced and perfected position feedback galvanometer technology in the OEM field. Position feedback galvanometers, which increase accuracy to 99.5%, are *standard* on all of our recorders.

Writing quality is another significant Astro-Med achievement. We pushed the state of the art forward dramatically with our development of a practically indestructible knife edge stylus more than 10 years ago. More recently, our success in thick film technology led to the development of our superb instant writing stylus for Z-fold recorders (U.S. Pat. No. 4,168,505).

Our wide range of chart speeds, electronically selected, are unmatched in the recording field. Thermal printers and event markers are standard options. All Astro-Med recorders are produced in their entirety at our ultra-modern plant in West Warwick, R.I.

No wonder Astro-Med is the world leader in the design, manufacture, and sales of OEM graphic recorders. No wonder it makes sense to talk to us first when the subject is OEM recorders.

ASTRO-MED DIVISION
ATLAN-TOL INDUSTRIES, INC.

Atlan-Tol Industrial Park, West Warwick, Rhode Island 02893
Telephone (401) 828-4000 TWX No. 710-382-6409

Astro-Med End User and Custom Recorders

Z-1000 General-Purpose Single-Channel Recorder

Dash II Two-Channel Field Recorder with Internal Battery

Dash IV Field Recorder with Automatic Time and Date Printing

Custom Recorders Tailored to Your Private-Label Requirements

Circle 202 on reader service card

trol programs in Basic rather than in the system's currently available Fortran IV langauge.

Lab-Datax, which is based on DEC's LSI-11 series microprocessors and RT-11 operating system, loses no speed under DTBasic and continues sampling analog data up to its rated speed of 135 kHz. The amount of directly addressable workspace, at 25-K bytes or more, remains about the same as the amount for Fortran IV users. DTBasic also permits both single- and double-precision arithmetic functions, performed to 7 or 17 significant digits, respectively.

DTBasic users have direct access to the system's RT-11 operating system and can implement language extensions by adding Macro-11 callable subroutines. The language package supports chaining and overlay operations and also a wide range of Data Translation's analog and digital input/output boards, a real-time programmable clock, and DEC's VT125 color-graphics terminal. DTBasic will license for approximately $1,500. Delivery takes one week after receipt of order.

Data Translation Inc., 100 Locke Dr., Marlboro, Mass. 10752. Phone (617) 481-3700 [399]

Graphics packages run on full HP 3000 line

Users of the HP 3000 computers can obtain a full range of interactive graphics capabilities, including color, three dimensionality, and a graphics data structure, from the DI-3000 and Grafmaker. Both packages support the full line of HP 3000 computers, and both are machine-independent.

Written in the American National Standards Institute's Fortran IV, DI-3000 is an integrated system of 160 user-callable graphics subroutines developed in accordance with the 1979 CORE system defined by the Graphics Standards Committee of the Association for Computing Machinery's Special Interest Group on Computer Graphics. HP display devices currently being supported include the 2623, 2647, and 2648 raster display terminals and the 7220, 7221, and 7580A pen plotters.

Grafmaker, which operates in conjunction with DI-3000, is a package of user-callable subroutines for high-level data presentation in the form of, for example, line and bar graphs and pie charts. A perpetual license for DI-3000 starts at $8,000, and a license for Grafmaker begins at $4,000. Both are available for immediate delivery.

Precision Visuals Inc., 250 Arapahoe, Boulder, Colo. 80302. Phone (303) 449-0806 [393]

Subset compiles Ada for systems under CP/M

Such features of the full Ada language as loops, integer, and floating-point formats, as well as console printer and disk input/output, are supported by SuperSoft's Ada compiler subset. A fully validated version of the complete Ada language is expected by the end of the year.

This native-code, fully recursive, two-pass compiler requires 48-K bytes of memory and the CP/M operating system. The subset is currently available for systems using the Z80, 8080, and 8086/8088 microprocessors and is offered in a variety of CP/M formats. The compiler sells for $250, the documentation $20.

SuperSoft Inc., P. O. Box 1628, Champaign, Ill. 61820. Phone (217) 359-2112 [395]

Pascal development system compiles modules separately

A Pascal Development System, built on Whitesmiths Ltd.'s C compiler and libraries, provides a complete and portable software environment for Pascal programming on VAX-11, PDP-11, LSI-11, 68000, 8080, and Z80 computers.

The full Pascal language is supported with conventional extensions to permit separate compilation of modules. Code produced by the compilers is highly optimized and runs faster than Pascal interpreters. Both native compilers and cross compilers are available, running under VMS, Unix V6, Unix V7, Unix 32V, Idris-R11, RSX-11M, RT-11, IAS, RSTE-E, and CP/M, among others. All versions have provisions for generating code that can be placed in read-only memory.

Users also receive Whitesmiths' Portable Pascal library, Portable C library, and C language, which together include approximately 100 functions implementing controlled storage allocation, formatted input and output, math functions, and string manipulation.

Single binary licenses for the VAX-11, PDP-11, 68000, 8080 and Z80 native Pascal Development Systems cost $950 each, and any Pascal Cross Development System license sells for $1,550. All are available now.

Whitesmiths Ltd., P. O. Box 1132 Ansonia Station, N. Y., N. Y., 10023. Phone (212) 799-1200 [394]

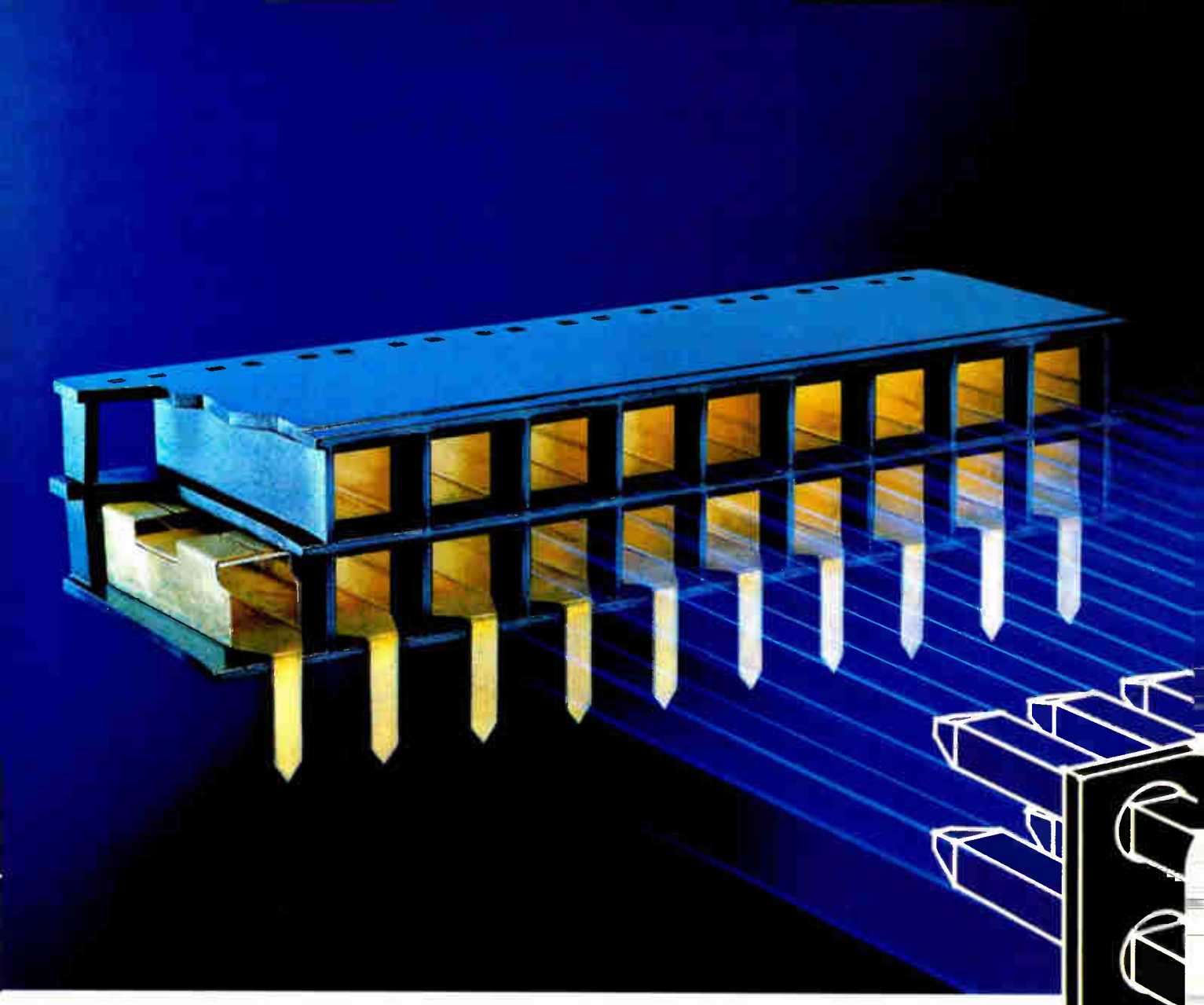
Color-graphics package determines best format

Rainbow is a color-graphics facility that runs on a variety of peripherals like the Tektronix TEK4027, Chromatics CG3999, and HP-7220 plotter. The package includes decision routines that automatically select the best format for displaying the output from Seed, the manufacturer's data-base management system.

As a result, the user need not be concerned with scales, labels, colors, or even the type of graph. However, if the user wishes to change Rainbow's decision routines, he or she can do so by means of a menu facility. The claim is that all this gives users more time to analyze data.

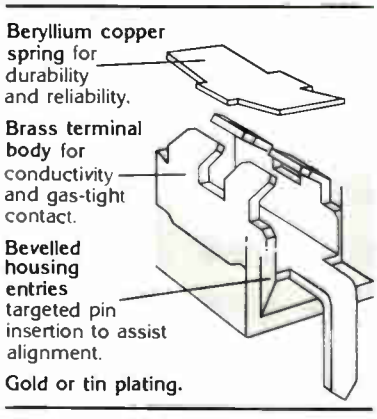
Rainbow is priced from $6,000 to run on a PDP-11 to $15,000 on a Control Data Corp. unit. It costs $10,000 when provided for Digital Equipment Corp.'s VAX. It is available immediately.

International Data Base Systems Inc., 2300 Walnut St., Philadelphia, Pa. 19103. Phone (215) 568-2424 [398]



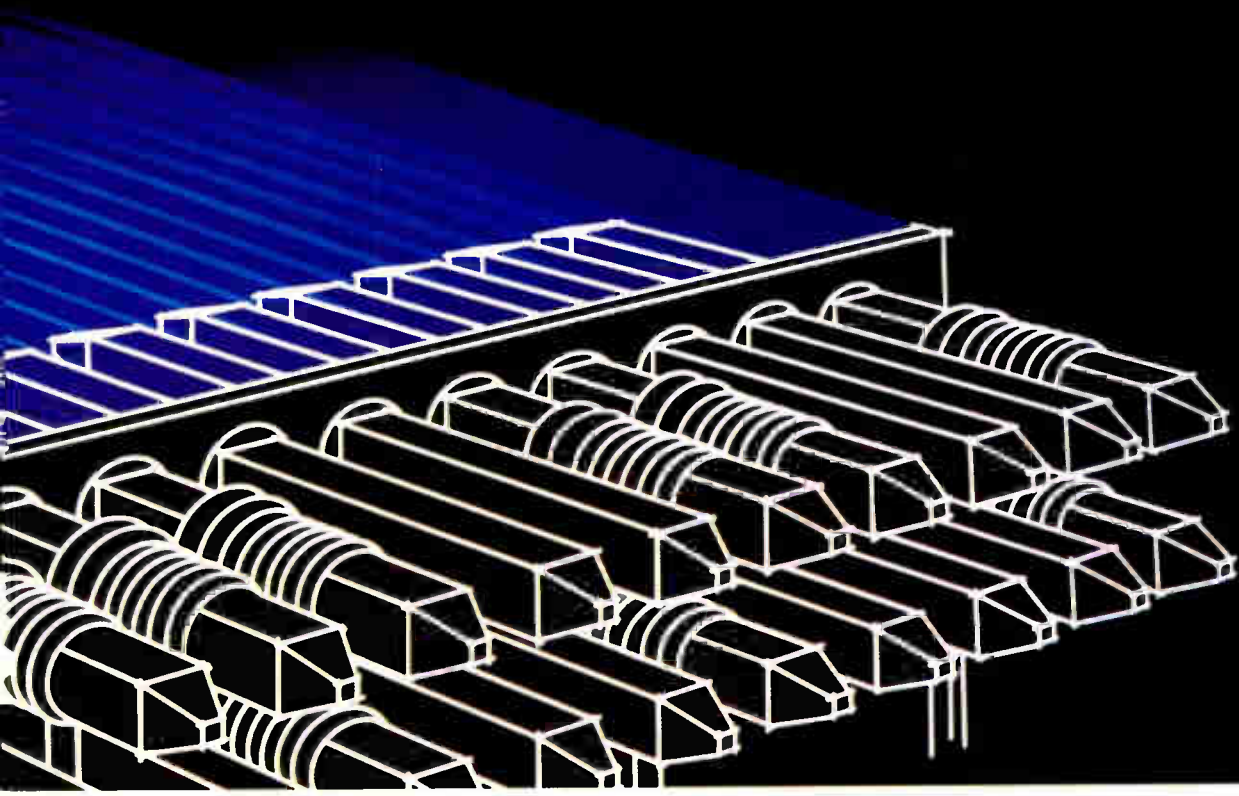
Only Berg's card connectors are made with the patented 2-piece dual-metal "PV"™ receptacle for low contact resistance, lasting retention and exceptional cycle life.

The secret is in the spring. Most female receptacles are stamped from a single strip of metal. The "PV" receptacle is unique: a brass body combined with a heat-treated beryllium copper spring (see the drawing).



Constant mechanical pressure is exerted on the pins by this all-important spring. And that pressure remains . . . even after repeated cycling. The spring also will absorb stress from a misaligned insertion and continues to apply strong, perpendicular retention force

Berg "PV" Card Connectors Make Solid Contact. Over and Over Again.



to the inserted 0.64mm (0.025") square pin.

Excellent electrical conductivity is achieved by the receptacle's high normal force. It creates a wiping action that cleans the contact surface of oxides during insertion and withdrawal. Berg "PV" card connectors come in selectively loaded single and double rows. So you pay only for the positions you need. They conform to MIL C-55302-127/128 and are available for delivery in only 4 to 6 weeks.

Find out more about the Berg "PV" card connector and the entire BergCon system that solves the majority of board-to-board, board-to-wire and wire-to-wire interconnection problems.

For details, call us for Bulletin 700 at 800-233-1450. (In PA. 717-975-2000)
The Du Pont Company, Berg Electronics, Camp Hill, PA 17011.

An electronics company.

DU PONT
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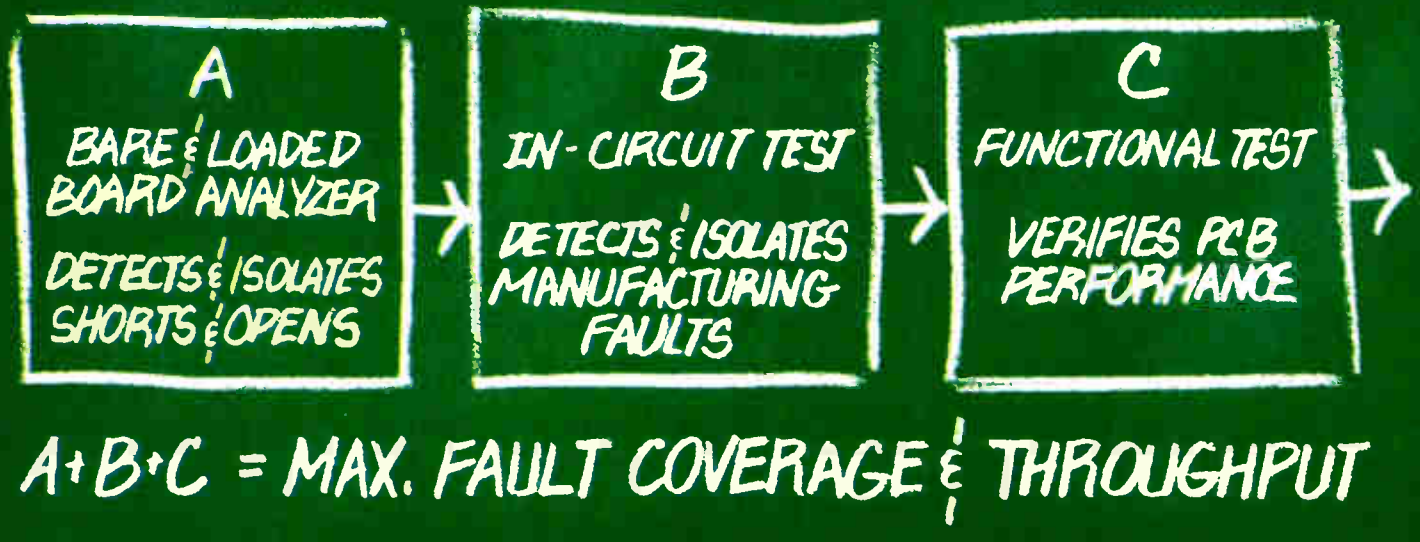
The key to greater PCB

The right test strategy



Only Fairchild

Fairchild can maximize your ATE investment every step of the way.

Keeping pace with today's high-volume production requirements is no longer simply a matter of which ATE system works best. It's a matter of which ATE *systems* work best within an overall test strategy.

Today, fitting the right test equipment into the right test sequence is the only way to increase your PCB throughput while maximizing your ATE investment. From incoming inspection, through manufacturing fault testing, and finally to comprehensive performance testing, there's a Fairchild test system specifically designed to do the job faster, more efficiently, and far more economically.

The Series 40/4400. The cost-effective system for shorts and opens.

The Fairchild 4400 is a low-cost, high-volume tester designed to find those faults that can account for up to 50% of your PCB failures. Its high-speed test sequence isolates and identifies shorts and opens in seconds. The 4400 offers a capacity of over 4000 test points, Selflearn™ programming, and it's the only tester in its class that provides PINCHECK™ software to verify good contact between fixture pins and PC board nodes. The 4400 can be effectively used on bare PCBs at incoming inspection and on loaded boards after wave soldering.

The Series 30/333. The hybrid in-circuit tester for your most complex PCBs.

Fairchild's new Series 30/333 In-Circuit Tester is the most advanced system ever developed for isolating manufacturing faults on large, complex, analog, digital and hybrid PCBs. With Fairchild's unique 256-pin FASTTEST™ capability, dynamic LSI and VLSI ICs can be functionally exercised with parallel patterns at speeds programmable to 2MHz. And the 333 can fully test mixed logic boards such as ECL/TTL. It offers a full 2,207 digital test point capability—each point with its own driver—and an analog test section of 959 points. With such innovative design features as FAULTS™ automatic program generation, automatic fixture wir-

production throughput:

The right test equipment

SERIES 40/4400 SERIES 30/333 SERIES 70/76

gives you both.

ing program, and an advanced Testing Diagnostic Center for isolating "problem" faults, the 333 provides unmatched PCB test comprehension.

The Series 70/76. The universal solution to functional board test problems.

Fairchild's 70/76 Functional Hybrid Test System is designed to ensure that every PCB is performance-verified. It tests boards for component-to-component interaction, isolating your otherwise undetectable dynamic failures.

Its automatic Live Data Compression option can handle LSI and VLSI ICs at full speed. And an optional Flo-Tracer™ isolates faults to the component level at high speed, which can save you diagnostic time.

The Series 70/76 has proved itself from military depot testing to the production test floors of computer and telecommunications equipment manufacturers.

From fixturing to field service, Fairchild gives you more.

Fairchild can provide the right test systems and the right test strategy, as well as a variety of advantages simply not available from anyone else in the industry.

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Circle 207 on reader service card

Microcomputers & systems

Versatile system burns all PROMs

12-socket programmer has interfaces for IEEE-488 bus, floppy-disk–drive systems

All currently available erasable programmable read-only memories and electrically erasable PROMs can be programmed in the 28-pin sockets of the Z-1200 and Z-2400 gang programmers. They are designed to program, test, and verify PROMs up to 128-K (16-K by 8 bits) in size and can handle either 12 at a time or 36, with the addition of two Z-120 gang programming slaves.

The Z-1200 has a 16-K-byte random-access memory for data, data-RAM editing facilities, and two RS-232-C serial input/output ports. Device type, transmission rates, and functions can be selected at the system's keypad or via a remote terminal or computer. Self-diagnostics perform tests on data RAM, the unit's processor, I/O, and other system logic, and a built-in voltmeter checks all analog voltages. Self-calibration is performed using a dummy load in one socket: the unit adjusts its digital-to-analog converters against a built-in reference, which can be monitored externally.

The system prompts the operator in English on its display. When PROMs are to be verified or programmed, the Z-1200 tests for devices correctly inserted in each socket and for bad devices that draw excessive current, indicating faults with light-emitting diodes next to the sockets in question.

Data RAM may be loaded from a master PROM or via one of the ports, and the user may specify which portions of the data are to be loaded into which locations in the PROMs. Four sets of three PROMs can be loaded simultaneously with different programs on the Z-1200 and each of the connected Z-120 slaves.

The Z-1200, which carries a $3,475 price tag, is compatible with the Z-100 universal slave. This unit, with plug-in programming electronics, can be used to program complementary-MOS E-PROMs, nonstandard bipolar PROMs, programmable array logic, and other programmable devices.

The Z-2400, priced at $4,975, is similar to the Z-1200 but has an IEEE-488 interface, 64-K bytes of data RAM, and an interface for the firm's Z-105 and Z-108 5¼- and 8-in. dual floppy-disk–drive systems. It also has an 8-bit bidirectional port with four control lines, making it possible for the user to program and test PROM sets installed on external memory cards.

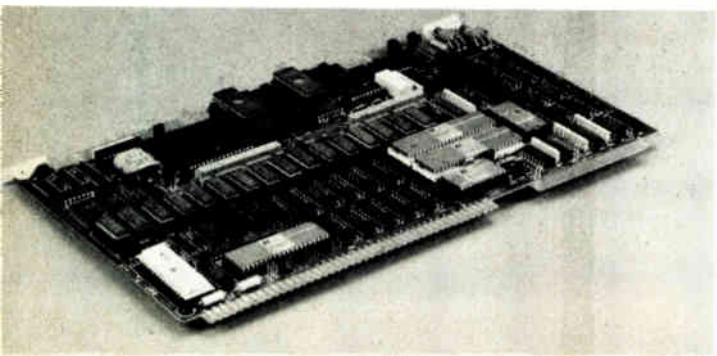
The 12-socket Z-120 gang programming slave sells for $1,350; $2,025 buys a Z-108 8-in. dual floppy-disk–drive system. The Z-1200 will be available the first week of May, and the Z-2400 and disk systems are slated for July delivery.

Sunrise Electronics, 524 South Vermont Ave., Glendora, Calif. 91740. Phone (213) 963-8775 [403]

Board lets user evaluate 16000

Multibus-compatible card carries sockets for upcoming 16000-family peripherals

To aid designers in evaluating the NS16000 family of 16-bit microprocessors, slave processors, and support circuits, National Semiconductor Corp. has introduced a development board. The DB16000, which is Multibus-compatible, contains the NS16032 central processing unit, support circuits, memory, and several input/output interface devices. There is also a monitor program residing in on-board programmable read-only memory.



Cross-development software packages are available that allow the DB16000 to be used with National's Starplex II development system or with Digital Equipment Corp.'s VAX computers running under the VMS operating system. The board can alternatively be used with an RS-232-C–compatible terminal.

Aided by a cross-support package called NSX16, programmers can compile or assemble NS16032 programs and then download them over a serial link to the DB16000 board to be executed. High-level symbolic debugging is then possible with the DGB16 source-level symbolic debugger, which is part of the NSX16 package.

The board contains 32-K bytes of random-access memory, expandable to 128-K bytes by using 64-K chips instead of the 16-K chips supplied. It also has 8-K bytes of PROM, expandable to 16-K bytes. Included are 24 programmable parallel I/O lines and connectors for two BLX expansion modules for additional I/O capability. The evaluation board's supply

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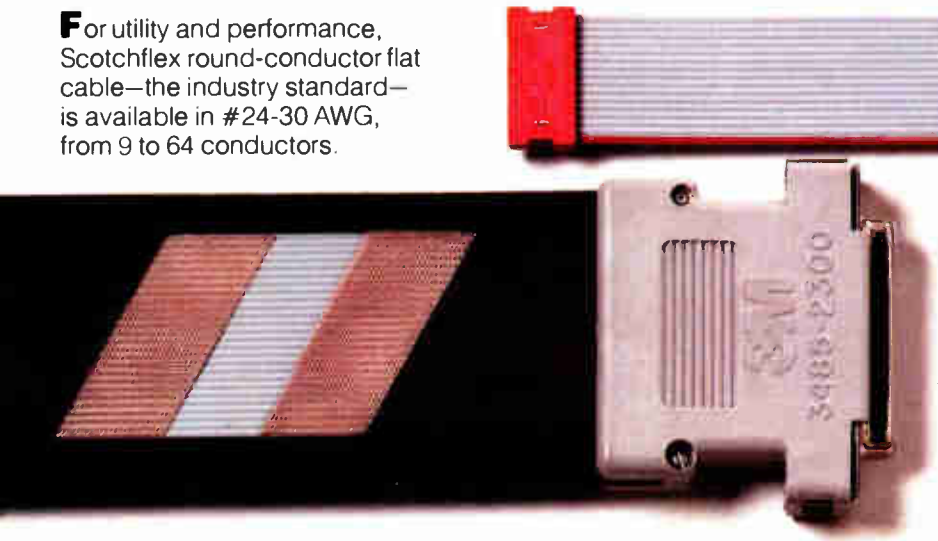

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requirements are +5 and ±12 V.

Available 8 to 12 weeks after receipt of order for $1,895, the DB16000 board contains sockets for the NS16081 floating-point processor, the NS16082 memory management unit, and the NS16202 interrupt controller, which will be available by the fourth quarter.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051. Phone (408) 737-4429 [404]

Networks for Multibus, IBM Personal Computer bow

Adding to its network product family, Destek has unveiled two interface boards—one for the IBM Personal Computer and the other for Multibus-based systems. Four different models of both networking boards will be available: baseband, broadband, fiber-optic, and telephone line through a modem.

The Desnet/IBM-PC board uses the High-level Data-Link Control and Carrier-Sense Multiple-Access network protocols. It requires only one slot and will be priced at under $1,000 for the baseband version.

The Desnet/Multibus board meets the physical and electrical specifications of the IEEE-P796 standard. It will function as an intelligent single-board network controller in any Multibus system. It uses the same protocols as the IBM Personal Computer version. Additionally, it will work as a bus master in a multiple-master environment. The Desnet/Multibus baseband version will sell for under $2,000.

Quantity discounts will be available on both, and shipments will begin 90 days after receipt of order.

The Destek Group, 1923 Landings Dr., Mountain View, Calif., 94043. Phone (415) 968-4593 [372]

Small box houses three-user microcomputer system

A desktop cabinet measuring only 13.5 by 16 by 6 in. and weighing 25 lb houses all the components needed to assemble a three-user microcomputer system. The buyer simply adds up to three terminals.

Two series 5 systems are currently available. The series 5-15D, which has two 5¼-in. floppy-disk drives storing 1 megabyte each, sells for $3,990. The 5-5D includes a 5-megabyte 5¼-in. Winchester disk drive backed up by a 1-megabyte floppy-disk drive and sells for $6,990.

Both systems feature a 4-MHz Z80 microprocessor with 196-K bytes of random-access memory (three blocks of 48-K bytes and a fourth block of 48-K bytes reserved for utility and operating system programs); double-density, double-sided floppy-disk drives; four serial RS-232-C input/output ports; and a parallel port. Each system can be upgraded with an additional 5-megabyte Winchester disk drive. Both systems are compatible with CP/M, MP/M, and Oasis. The units are available now.

Altos Computer Systems, 2360 Bering Dr., San Jose, Calif. 95131. Phone (408) 946-6700 [373]

Unit puts Multibus systems on Ethernet local network

Implementing the Xerox-Intel-DEC Ethernet version 1.0 specification, the NI3010, an intelligent Multibus Ethernet communications controller, contains on a single board all the data-communications logic required for interfacing Multibus-based systems with the Ethernet local network.

Targeted for use in 68000-, Z8000-, and 8086-based systems, the board performs the specified data link layer and physical channel functions that permit up to 1,024 stations to communicate at 10 Mb/s over distances to 2,500 m on a shared coaxial cable.

The board has a 16-K-byte receive first-in, first-out buffer that shields the Multibus system from the unpredictable arrival times characteristic of network traffic. For transmission, the board uses a 2-K-byte FIFO buff-

er from which all frame retransmissions are made. Data transfers at rates in excess of 1 megabyte/s between the controller and the host system are performed by an on-board direct-memory-access controller. Diagnostic features include power-up self-tests and three-level data loopback tests. The NI3010 is available now for $2,990.

Interlan Inc., 160 Turnpike Rd., Chelmsford, Mass. 01824. Phone (617) 256-5888 [376]

Board does time-keeping for Wang 2200 computers

Abilities the Wang 2200 computers never before had, like clock functions, calendar management, and software protection, are now obtainable with the RTC 2200. An enhanced version of the board, the RTC 2200P, further adds two serial and one parallel printer ports.

The clock section of the board will report the time of day in a 24-hour format, besides serving as a stopwatch, count-down timer, and alarm clock. The calendar section of the RTC 2200 retains both the system date and the user date.

The RTC 2200 will report the time and date information in either binary-coded–decimal or ASCII code and system and user date information in the American abbreviated and expanded, the international abbreviated and expanded, as well as the longhand, Julian, and absolute days formats.

Using the calendar functions, the board provides two levels of license security for the supplier of the system's software. On the first level, the RTC 2200 board will retain an eight-digit license date permanently in a nonvolatile memory and will automatically set a flag when the current date exceeds this license date. The flag is used to lock out users who have failed to renew their license. On the second level, the unit retains a serial number that is compared with that of the software license. The application software will not be allowed to execute if serial numbers do not match or if the RTC

2200 has been removed.

In single quantities the RTC 2200 sells for $595 and the RTC 2200P for $895. Supplied free to purchasers is RTC Basic, a Wang Basic-compatible language that has additional commands to make use of the real-time clock and the second level of software security.

Computer Concepts Corp., 8001 W. 63rd St., Shawnee Mission, Kansas 66202. Phone (913) 677-4000 [377]

Software development system offers multitasking capability

As the software development member of Millennium's 9500 development system and in-circuit emulator family, the 9520 works on its own or in conjunction with Millennium's 9508 microsystem emulator for developing systems based on 8-bit microprocessors or the 9516 microsystem integration station for developing systems based on 8- and 16-bit microprocessors.

The 9520's hardware includes a Z80A-based microcomputer system with 64-K bytes of dynamic random-access memory, expandable to 112-K bytes. Software includes a Pascal compiler with a linking loader for the Z80, 8080, or 8085, as well as cross assemblers with linking loaders for the 8080 and -85; the 8048, -49, -41, -21, and -35; the 6800 and -02; the 6801 and -03; the Z80A, Z8000, 8086, and 8088. In addition, the system has a multitasking capability with which users can manage as many as three separate functions simultaneously.

The 9520 software development system lists for $4,995 and is available 60 days after receipt of order.

Millennium Systems, 19050 Pruneridge Ave., Cupertino, Calif. 95014. Phone (408) 996-9109 [374]

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		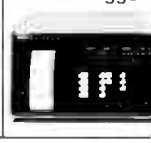

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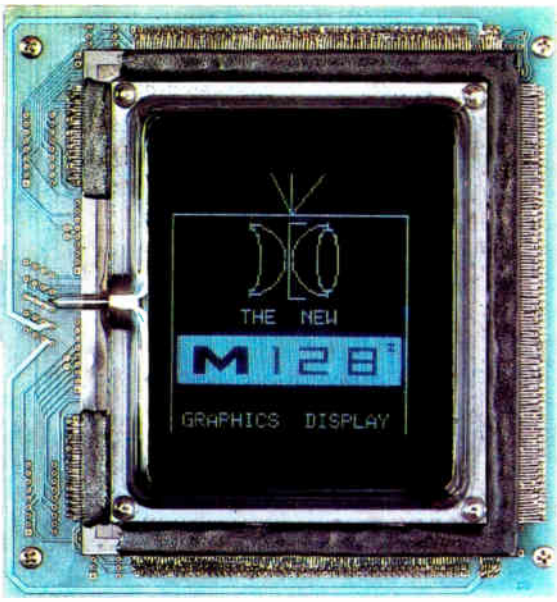

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DECO offers the latest in display technology. Close dot spacing and Vacuum Fluorescent technology make the display bright, sharp and highly readable even in daylight with proper filtering. Each dot is independently addressable allowing formation of almost any character or shape the mind can imagine! Graphs, charts, ideograms, waveforms and more can all be displayed. Even reverse video is possible. Complete drive, interface, control logic, refresh and buffer electronics are on board. Only +5 VDC is required to power the unit.

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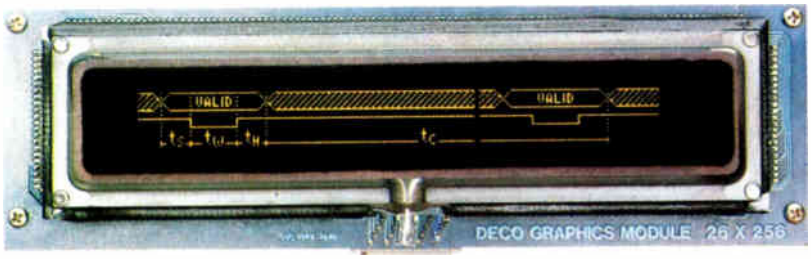
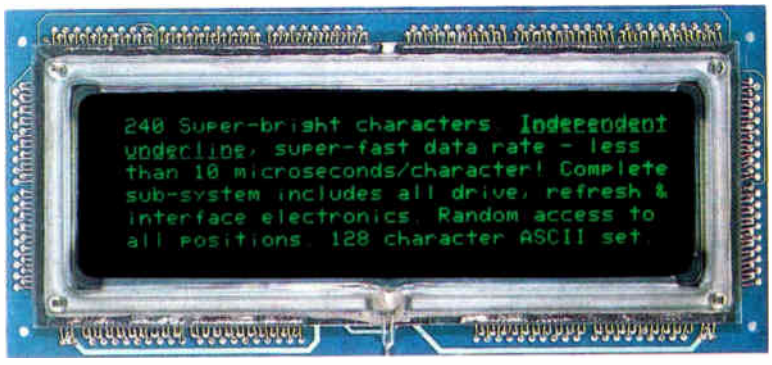
M128² Thin profile and low voltage made the M128² an ideal alternative to CRT in many applications.

Alphanumeric Displays are specified by engineers all over the world. The bright vacuum fluorescent characters are **highly readable** and filter from natural blue-green to blue, green, aqua, amber and red. VF tube technology offers high **reliability** and tube MTTF up to 100,000 hours. Low Power requirements (as low as 65 milliwatts/character) are well below the dissipation of LED or gas discharge displays. DECO's displays are **self-contained ready to use subsystems.** They are microprocessor controlled with all drive, refresh, interface, control logic and buffer circuitry on board. Some units have user programmable character generators. All models have on board power conversion circuitry. Just input +5 VDC and a 7-bit ASCII signal and you're in business!



M26 x 256 is ideal in many foreign language or mixed character size applications. Intermix graphics and alphanumerics at user option.

DECO'S SINGLE LINERS come in a wide range of sizes from 10 to 40 character positions and 5mm to 9mm character height. 14 segment, 5x7 and even 5x12 matrices available.



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Circle 213 on reader service card

Industrial

Thermocouple unit has ASCII output

Digital panel meters use microprocessor for scaling, correction, and calibration

Riding the bandwagon toward greater local intelligence in monitoring, measurement, and control systems, members of Analog Devices Inc.'s AD2050/2051 series of thermocouple meters are the first in their class to operate under microprocessor control, according to the firm. An internal 8-bit Fairchild 3870 microprocessor ensures stable performance by automatically performing all gain and offset error correction, cold-junction compensation, and thermocouple output linearization. Using self-calibration constants stored in memory, the 3870 automatically calibrates and scales each thermocouple measurement in degrees Celsius or Fahrenheit.

Easy interfacing. The 3870 also controls timing and counting functions in the AD2050/2051's conversion of analog inputs into digital form and puts out temperature data in standard 7-bit ASCII-character serial format at a rate selectable by the user. The ASCII output helps the AD2050/2051 meters interface more gracefully with printers, terminals, and other computer peripherals than do most conventional digital panel meters offering output in binary-coded–decimal form.

The AD2050 and AD2051 accept analog signals from six standard thermocouple types: J, K, T, E, S, and R. The AD2050 is programmed at the factory with a direct, dedicated interface, and the AD2051 is a universal unit that the user can adapt by switch programming. Both meters are single-channel, 3½-digit units, capable of measuring temperatures from −265° to +1,999°F, or from −165° to +1,760°C, with a resolution of 1° on either scale. Range temperature coefficient is a maximum of ±60 ppm/°C and ±25 ppm/°C typically.

The AD2050/2051 series comes in three versions with differing power requirements: 120 V ac, 240 V ac, or +7.5 to +15 V dc. The ac models provide protection against common-mode voltages of up to 1,400 V peak between the input and power-line ground. Input also is protected against up to 300 V peak in the case of a thermocouple short to an ac line. The common-mode rejection ratio in the AD2050/2051 is greater than 130 dB with a 250-Ω source imbalance in ac versions (dc to 60 Hz). Normal-mode rejection is over 80 dB. Maximum cold-junction compensation error is ±0.5°C over the full rated operating temperature range of +10° to +40°C.

Output options on the AD2050/2051 include an interface for an isolated 4-to-20-mA serial loop for remote data-acquisition applications, plus a 12-bit analog output linearized to within 1 mV/°C or F for driving analog instruments such as recorders. The AD2050/2051 mounts in a process-control or data-logging system's front panel and come in a case measuring 3.78 by 1.89 by 5.13 in. Its display uses 0.56-in.-high seven-segment light-emitting diodes.

In lots of one to four units, the AD2050 is priced at $230 and the AD2051 at $295 each; in hundreds, the units sell for $161 and $206.50, respectively. Delivery takes about four to six weeks.

Analog Devices Inc., Route 1 Industrial Park, P. O. Box 280, Norwood, Mass. 02062. Phone (617) 329-4700 [381]

Intelligent controller monitors 32 digital, 16 analog inputs

For as little as $1,500, users can obtain Cinch Pac, a single-board distributed measurement and control system complete with on-board intelligence, diagnostics, and power supply for local control in hostile environments.

Each Cinch Pac accommodates 32 digital and 16 analog input data points with 14-bit analog-to-digital accuracy. Standard multi-unit clusters can handle up to 6,000 points/s. A networking scheme makes conversation possible with over 100 other Cinch Pacs or with another vendor's network through a gateway.

Cinch Pac has its own on-board Intel 8051 microcomputer and can respond to alarm conditions and report the conditions without having to poll a host computer.

Both preprogrammed and user-programmable versions of Cinch Pac are obtainable. Either is available for rack mounting, as a board only, or in a NEMA-12 enclosure. Shipment will begin in early July.

Control Logic, 10 Tech Circle, Natick, Mass. 01760. Phone (617) 655-1170 [382]

Strap-on sensor simplifies boiler reset installations

With the introduction of a strap-on temperature sensor, contractors can now retrofit boiler reset controls with ease.

Dubbed the C7031K, the sensor is mounted externally on the boiler discharge water pipe and does not have to be drained, refilled, and vented as an immersion-well–mounted sensor would have to be. The Honeywell Energy Products Center claims that, by resetting boiler water temperature as outdoor air temperature changes, it can reduce heating bills by as much as 20%.

Systems without a reset control are subject to wide water-temperature swings due to frequent on-off cycling of the burner and circulator.

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Circle 215 on reader service card

New products

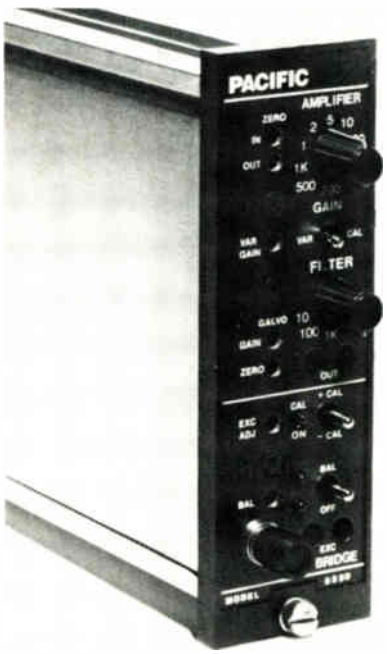
With the C7031K, lower supply water temperatures during mild weather cause the circulator to run longer, resulting in a more comfortable water temperature range. In addition, by maintaining lower supply water temperatures during mild weather, the sensor encourages less on-off cycling of the burner and circulator and should enjoy a long life.

The C7031K senses hydronic-boiler water-discharge temperatures from −40° to 240°F and is used with the W902A and W903A electronic temperature reset controllers. It is priced at $46 to $70 and is available from stock.

Honeywell Inc., 10400 Yellow Circle Dr., Minnetonka, Minn. 55343. Phone (612) 931-4396 [383]

Transducer amplifier includes balancing system

Used with strain-gage and resistive-bridge transducers, the transducer amplifier model 8250 supplies computer-automated excitation, balance, and calibration. It amplifies and filters the transducer output for data acquisition systems and analog and digital recorders. Normally, large multichannel systems are available with manual balancing, which is a



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Circle 217 on reader service card

tedious and time-consuming task. The 8250 reduces balance time to seconds for an entire system, regardless of its number of channels.

The 8250's balance system utilizes a separate isolated power source to offset the input of the differential amplifier. Automatic balance is digitally implemented using a 12-bit monolithic digital-to-analog converter, which provides a 0.25% resolution. Transducer conditioning includes constant voltage excitation variable from 0.1 to 15 V and built-in completion for partial bridges.

The instrumentation amplifier has a 120-dB common-mode rejection ratio, 5-μV stability, and 0.01% linearity for gains of 1 to 2,500. Bandwidth is 100 kHz with a switch-selectable data filter for bandwidth limiting. The unit also supplies three independent outputs: 10 V full scale for data systems, 1 V root mean square full scale for tape recorders, and an adjustable 1-to-10-V output with full-scale zero offset for analog recorders. The unit can be plugged into the company's 8200 series of mainframes and is compatible with other 8200 modules.

The base price for the 8250 is $1,070. Delivery in small quantities is from stock.

Pacific Instruments Inc., 2355 Whitman Rd., Concord, Calif. 94518. Phone (415) 827-9010 [387]

Transducer series extends range to 0 to 2 lb/in.^{2}

The introduction of the LX06002D and LX06002G, National Semiconductor's additions to its family of temperature-compensated monolithic pressure transducers, extends the pressure range down to between 0 and 2 lb/in.^{2} (0 to 55 in. of water). These devices incorporate a sensitive pressure-sensing element giving them a 20 mV-lb/in.^{2} output that varies linearly with pressure.

Available in gage, differential, and compact printed-circuit board–compatible packages, the transducers feature a ratiometric output for compatibility with ana-

Our delicate sense of timing helped this bird keep a very important date.

Space travel. Where a fraction of a second can make the difference between success or failure. That's why so many NASA & DOD "birds" get their precise sense of timing from Frequency Electronics' Cesium Beam Frequency Standards and Oscillators. They offer a level of reliability and accuracy that just can't be duplicated.

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TWX 510-223-0418.

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Circle 219 on reader service card

New products

log-to-digital converters, factory-calibrated offset and span for ease of field service, and a operating temperature range of −40° to +125°C. The units are temperature-compensated over their entire operating range and designed for barometric, flow-measurement, and industrial applications.

Samples of the LX06002D and LX06002G are available now. Delivery of production quantities is scheduled for April. In high volume, the transducers are priced under $10.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051. Phone (408) 737-5000 [384]

Four I/O modules mate with the LSI-11 bus

Digital Equipment Corp.'s Microcomputer Group has developed four input/output modules for use with the LSI-11 bus employed in Digital's LSI-11, -11/2, and -11/23 and Falcon SBC-11/12 microcomputers. The modules are a four-channel analog output, 16-channel analog input, 16-channel analog input with two-channel analog output, and a real-time clock.

The modules can be used as built-in components for system developers or end users who wish to integrate a microcomputer system into a larger assembly, such as instrumentation or process-control equipment. The analog inputs make available either 16 single-ended or 8 differential channels. The analog outputs employ 12-bit digital-to-analog converters, and the real-time clock module supplies five time bases: 100 Hz; 1, 10, and 100 kHz; and 1 MHz.

The 16-channel analog input module, designated ADV11-C, is priced at $1,095. The analog module with 16 input and two output channels, the AXV11-C, sells for $1,295. The AAV11-AC four-channel analog output board and the KWV11-C real-time clock both cost $895. All modules will be available 30 days after receipt of order.

Digital Equipment Corp., Maynard, Mass. 01754. Phone (617) 568-5312 [385]

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C-202

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Standard Fluorescents			
12	4' F40/RS	_____	_____
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My energy rate is $0.___ per kilowatt hour. 116
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Circle 222 on reader service card

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Our new ideas have a way of sweeping the market. In just a few years, TeleVideo has come from nowhere to become the No. 1 independent in CRT terminals. The reason: we offer exceptional quality, reliability and usability at a price no one can beat. (In fact, we use the same high quality modules, from keyboards to monitors, throughout the entire line.)

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Circle 223 on reader service card

Components

Large matrix LCD supports graphics

32-row, 80-column module uses 16:1 multiplexing, displays up to 64 characters

A large 32-row-by-80-column liquid-crystal-display module, developed by UCE Inc. on a dare from a regular customer, will come to market in early June. The IDA 3280, which employs 1-in-16 multiplexing, is targeted at industrial programmers, medical and electronic instrumentation, computer terminals, and electronic games.

The LCD is designed for both alphanumeric and graphics output. Four complementary-MOS 7227 LCD driver chips from Nippon Electric Co., which are compatible with most microprocessors, generate up to four rows of 16 ASCII characters on the display, using a five-by-seven-dot matrix for each.

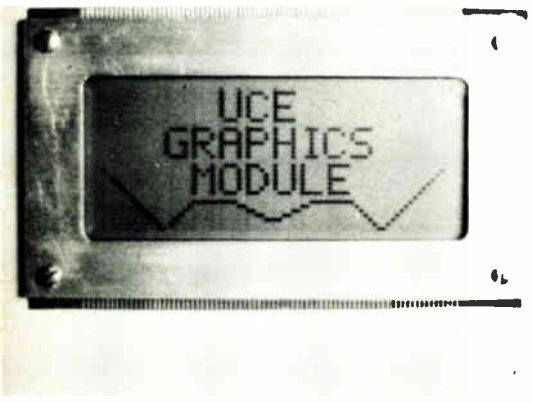
Additional length. The module has a 1.5-by-3.75-in. active display area and measures 6 by 9 by 1 in. Its length can be increased in increments of 40 columns: a module as large as 32 rows by 280 columns is available from the firm.

Operating from a single 5-V power supply, the module uses 0.5 mA/cm² of display area and has high visibility in ambient light (contrast ratio is typically 5:1). It has a 90° maximum viewing range; typically this figure is 60°. The user can specify any two viewing quadrants as those yielding maximum visibility.

A built-in temperature-compensation circuit helps the device achieve a −10°-to-70°C operating range. The typical rating is 0° to 50°C.

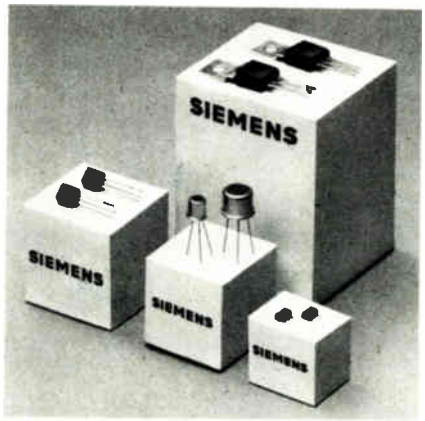
Single units for evaluation will sell for $345 each, but in production quantities, the IDA 3280 matrix LCD will list for $98.

UCE Inc., 24 Fitch St., Norwalk, Conn. 06885. Phone (203) 838-7509 [341]



Small-signal transistors use power MOS technology

A line of small-signal transistors from Siemens uses the same n-channel MOS technology employed in the company's line of Sipmos power transistors but is designed to provide the smaller capacitances and faster switching times required by applications in communications, industrial measurement, and controllers for small motors.



The five package types, the SOT-89, TO-92, TO-39, TO-18, and TO-202, combine the advantages of a voltage-controlled component with fast switching times for a variety of configurations. The devices consist of multiple transistors connected in series or parallel, integrated on a single chip. They possess a minimum reverse-voltage rating of 200 V and drain currents ranging from 0.3 to 1.5 A. Rise and fall times for the devices are typically 15 ns.

In lots of 100, prices range from $0.66 to $1.36 each. The transistors are available from stock.

Siemens Corp., 186 Wood Ave. South Iselin, N. J. 08830. Phone (201) 494-1000 [344]

FETs have on-resistance as low as 0.055 Ω

Added to International Rectifier's power MOS field-effect transistor line is a series of power Hexfets registered with the Joint Electron Device Engineering Council that have drain-source voltage ratings from 60 to 500 V, drain current ratings from 4 to 38 A, and on-resistance as low as 0.055 Ω.

The 16 transistors in the series, sequentially numbered from 2N6755 through 2N6770, are housed in TO-3 packages. Eight devices, with ratings from 14 A, 100 V, 0.18 Ω to 4.5 A, 500 V, 1.5 Ω, will meet joint Army and Navy, JANTX, and JANTXV qualification tests according to MIL-STD-19500/542A. Four devices to be specified as JAN, JANTX, and JANTXV according to MIL-STD-19500/543A have specifications ranging from 38 A, 100 V, 0.055 Ω to 12 A, 500 V, 0.4 Ω.

The prices for the devices, available now, range from $6.29 to $57.31 in 1,000-piece quantities.

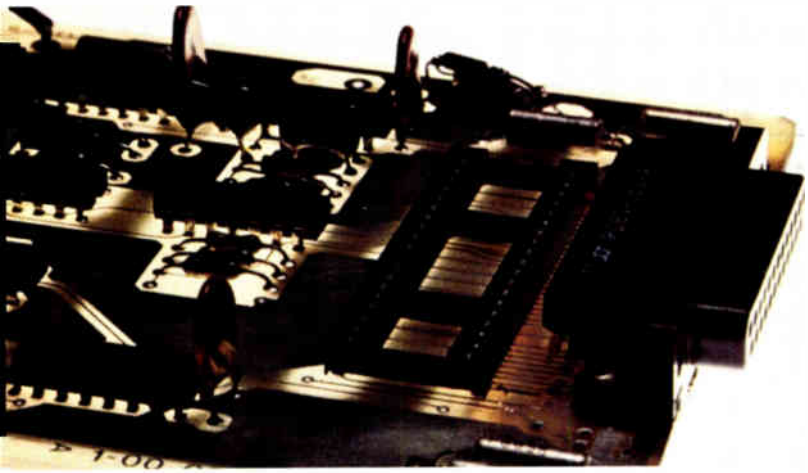
International Rectifier, 233 Kansas St., El Segundo, Calif. 90245. Phone (213) 772-2000 [345]

Electroluminescent displays can be read in sunlight

Two versions of an ac thin-film electroluminescent dot-matrix flat panel display have a 165° viewing angle and a brightness of 1,050 fL (root-mean-square) that lets them be read even in sunlight.

The displays, models TE 1x32 and 1x56, have an active display area of 2.6 by 2.6 cm. The 1x32 has 1,024 picture elements, each 0.457 mm square, and the 1x56 consists of 3,156 pixels, 0.305 mm on a side. The units demonstrate alphanumer-

Lose your shorts. Not your shirt.



Reduce the chances of short-circuiting and save money with the new Cannon® Mas/Ter™ family of all-plastic "straight" and "90°" D Subminiature connectors.

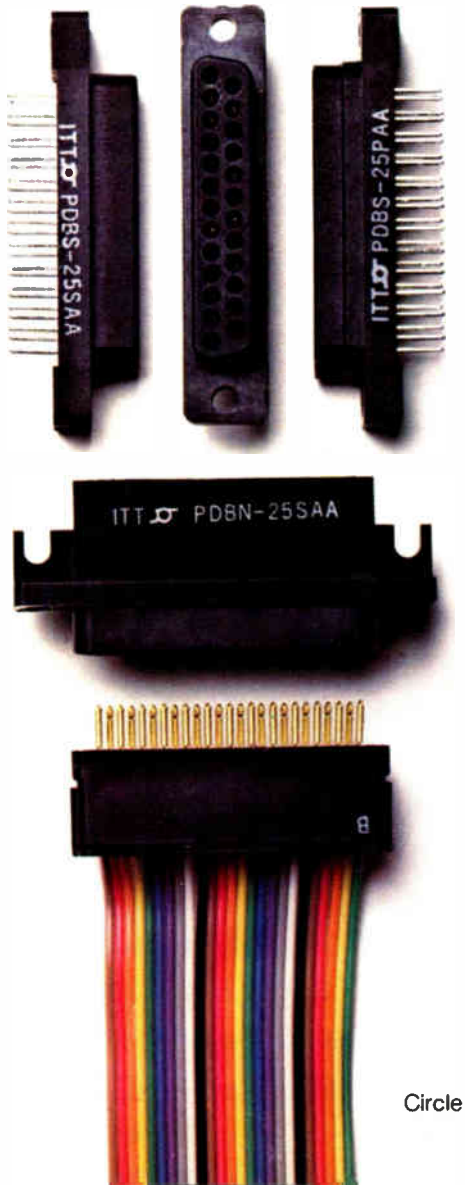
The secret is in the all-plastic construction. This allows for direct mounting on PC boards, reducing the chances of a short circuit, and at a lower cost. Plus, it's flame-retardant, UL-recognized and 94 V-O rated.

The simplicity of design in this product (it's all in one piece), plus the fact that it utilizes stamped contacts and high-volume insulator molding techniques, is another source of savings.

In addition, this new product line is fully intermateable with all Cannon D Subminiature series connectors and can be mated with I.D.C. (Insulation Displacement Contact) solder- or crimp-type contacts.

Also, coupling hardware is available for this product line with a 4-40 threaded bushing or female screw-lock stand-off, which saves you money on installation. While the closed-entry feature on the socket housing ensures positive pin-contact alignment.

All-Plastic D Sub Connectors.



We should also mention that the Mas/Ter 90° version comes in two footprints. Our shorter-length version utilizes less space on PC boards. Plus, they're both available with 9, 15, 25, 37 or 50 contact arrangements. And all versions satisfy all requirements for PC board applications.

So if you're looking for connectors for your computer or minicomputer, and want to save money and eliminate shorts, think plastic. Think ITT Cannon. And you won't come up short.

For literature, the name of your local Cannon distributor or other information, contact Rectangular Products Marketing Manager, ITT Cannon, a Division of International Telephone and Telegraph Corporation, 10550 Talbert Avenue, Fountain Valley, CA 92708. (714) 964-7400. In Europe, contact ITT Cannon Electric, Avenue Louise 250, B-1050 Brussels, Belgium. Phone: 02/640.36.00.

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New products

ic, graphic, scrolling, and real-time oscilloscope capabilities. They have an efficiency of greater than 2 lumens/W, a −100° to +100°C operating temperature range, and an operating life (to 70% of original brightness) in excess of 30,000 h.

Both displays operate from 12-v rechargeable, internal batteries. They have microprocessor routines derived from 8-K erasable programmable read-only memories and 4-K random-access memories. Included are input ports for analog and digital signals. Evaluation units are available from stock and are priced from $4,500 to $5,500.

Sigmatron Nova, 1901 Oak Terrace Lane, Thousand Oaks, Calif. 91320. Phone (805) 498-4504 [343]

Ladder networks come in 8- and 10-bit versions

Possessing a solid ceramic body, solder-coated leads with 0.100-in. spacing, and 14-, 16-, and 18-pin construction are the series 314 and 316 ceramic-metal resistor networks.

The 316LR8 and 316LO8 are 8-bit R-2R ladder networks for digital-to-analog and analog-to-digital converters with bipolar or complementary-MOS switches. Their tem-

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The Model 6100 is comparable to TEK's Model 465B and HP's 1742 but displays more traces (six compared with three), and offers more screen brightness, more flexibility, greater simplicity of operation and a two-year warranty that substantially reduces the second year cost of ownership. The Model 6100 also features an auto-dynamic focus circuit for clear, sharp pictures and a metal housing that minimizes RFI interference.

Now for the surprising news: Despite all the extra features, the 6100 costs less than either the TEK or HP scopes.

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Rugged and compact, the 6100 is completely modular. Like all KIK-scopes, the construction is on plug-in boards that are supported by a board swap-out program that assures fast maintenance turn-around and minimum down-time.

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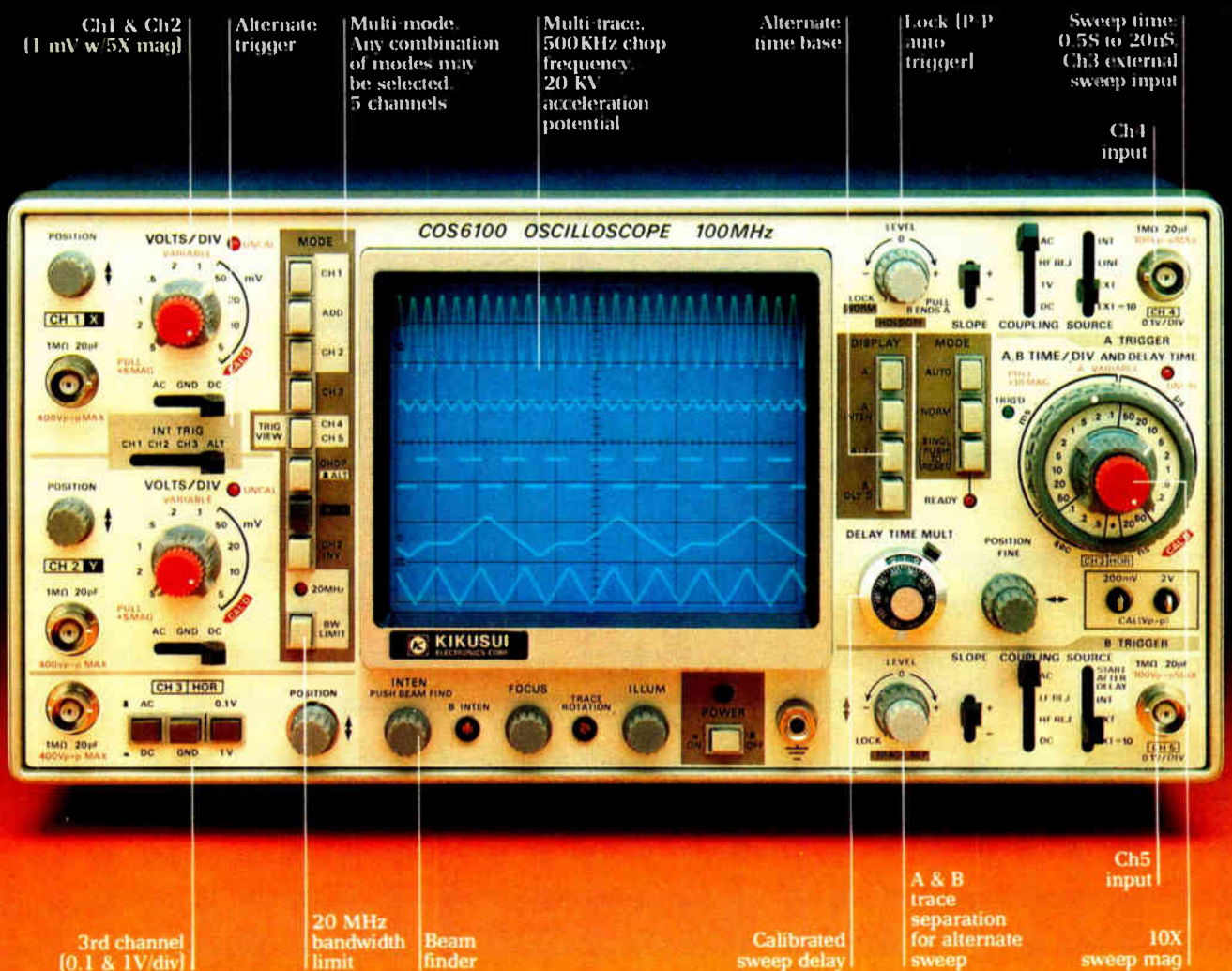

New products

perature coefficient of resistance is ±100 ppm/°C and their operating temperature range is 0° to +70°C. In this temperature range, the ladder networks' accuracy is ±½ least significant bit of full scale. The resistors come with resistance values of 25, 50, and 100 kΩ.

The members in the 314L10 series are 10-bit versions, identical to their 8-bit counterparts except in their ladder-network accuracy, which is ±1 LSB of full scale. The firm will customize networks to specific requirements. The 8-bit 316LR8 sells for $1.51 each in lots of 1,000. Delivery takes about five weeks.

Allen-Bradley, 1201 South Second St., Milwaukee, Wis. 53204. Phone (414) 671-2000 [346]

Unit automatically lights, dims rooms

The model ILC 1 automatic light control controls indoor lighting, especially in large warehouse areas, infrequently occupied corridors, school classrooms, and other places where lights are inadvertently left on when no one is present. It uses a passive infrared sensor that detects the presence of anyone who enters its field of view and automatically switches on the lights.

Specifically, the sensor looks for a moving infrared-radiating mass at a different temperature than that of the background temperature to trigger the lightswitch. The units can be set to shut off the lights from 4 minutes to one hour after the last movement has been detected.

Three sensors are available: a unit covering a broad 40-by-40-ft area, a 70-by-20-ft unit for medium-length hallways, and a 150-by-18-ft one for long corridors like those found in warehouses. The ILC-1 controls 110- and 277-V ac lighting, including fluorescent, incandescent, and high-intensity discharge. Prices range from $120 to $155 each, depending on the sensor chosen.

Colorado Electro-Optics Inc., 2200 Central Ave., Boulder, Colo. 80301. Phone (800) 525-0505 [347]

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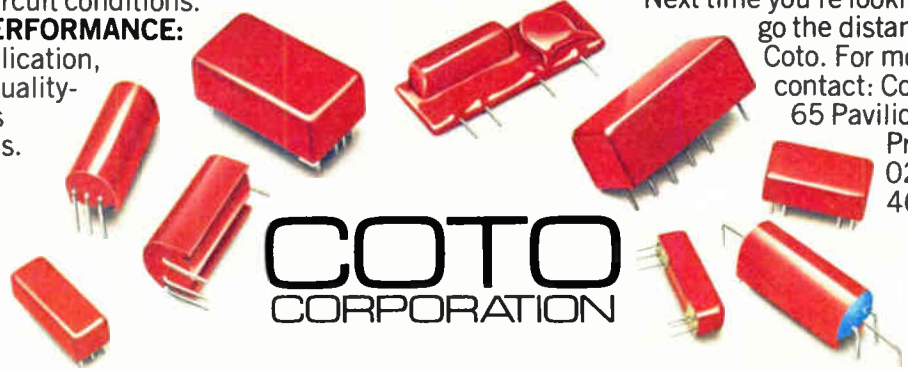

COTO CORPORATION

Circle 229 on reader service card

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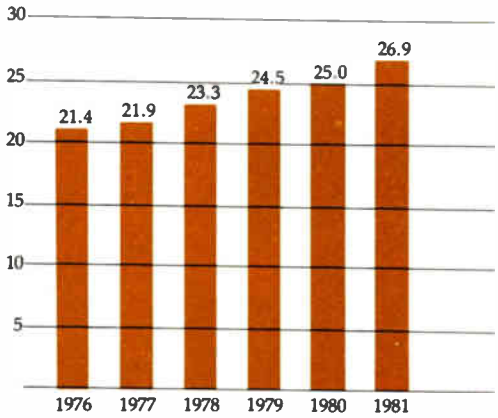
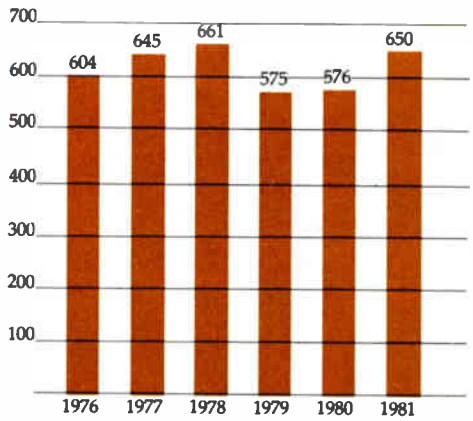
International Circulation (in thousands)



International Advertising Pages



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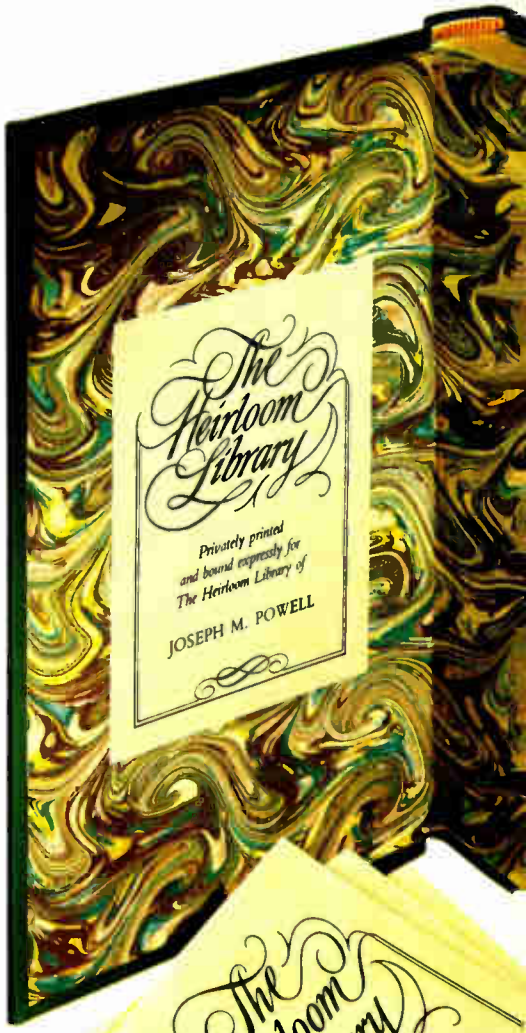

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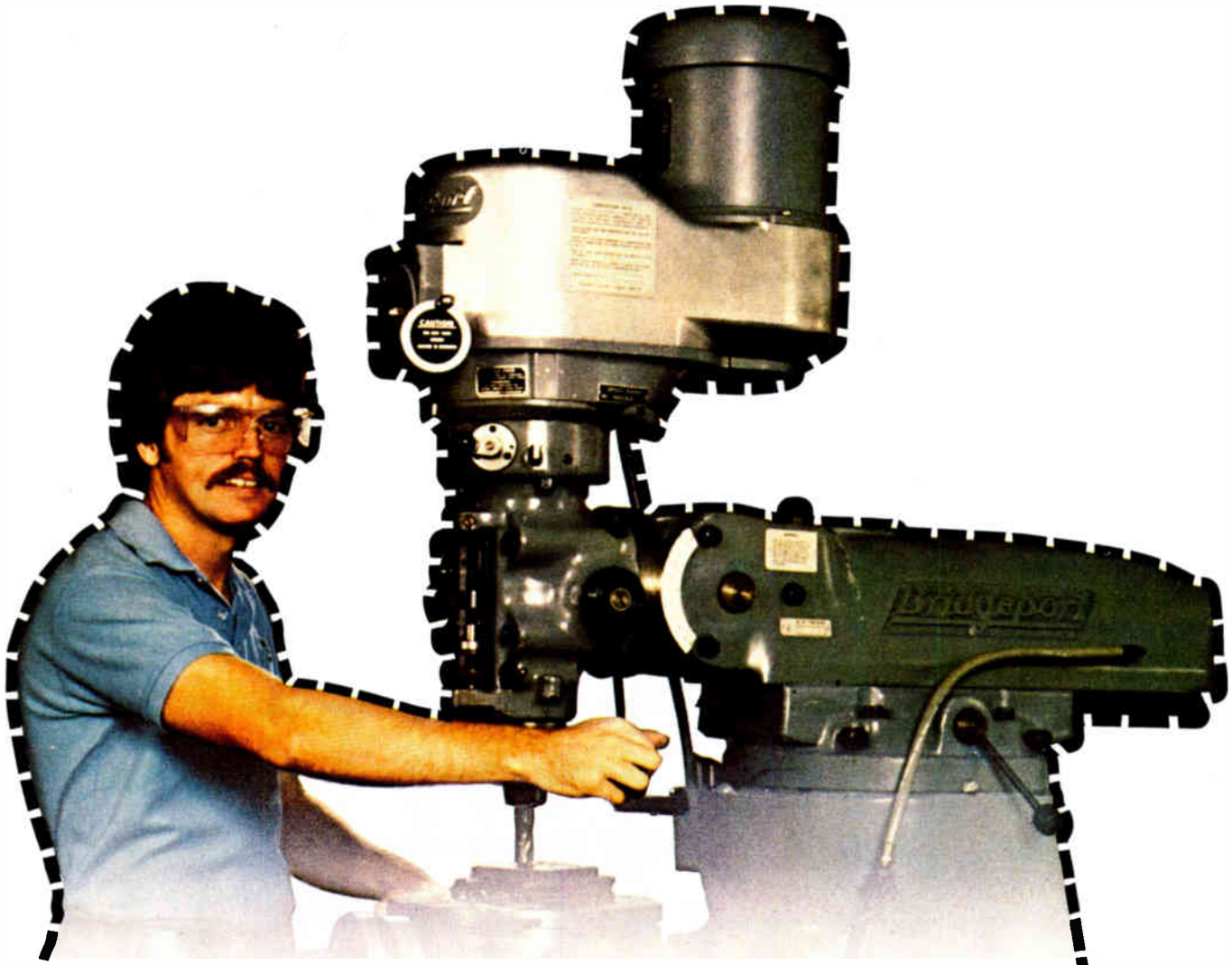

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Products Newsletter

5¼-in. floppy housings shrink by a third

The tendency of floppy-disk drive packages to shrink will also begin to squeeze 5¼-in. units in April. That is when Shugart Associates of Sunnyvale, Calif., begins shipping evaluation units of the SA200 reduced-height Minifloppy. **More than a third lower than standard 5¼-in. drives, the SA200 will cost $118 in lots of 5,000.** It is capable of single- or double-density recording, with either 125- or 250-K bytes of unformatted storage, respectively. Formatted storage is specified as either 81.7- or 163.8-K bytes. The SA200 transfers data at 125 or 250 kb/s, depending on density.

Byte-wide ROMs range from 16- to 64-K

A family of byte-wide read-only memory devices ranging in density from 16-K to 64-K is now available from NCR Corp. In 1,000-unit quantities, **prices range from $4.50 for the 2316-45, a 450-ns 16-K device, to $16 for the 2364-30, a 300-ns 2564-compatible 64-K part.** The Dayton, Ohio, firm promises four- to six-week turnaround time for prototypes and 10 to 12 weeks initially for production parts. Edge-triggered 200-ns and 250-ns versions of the 64-K part are set for May availability. A 128-K ROM is planned for later this year.

Controller juggles tape, floppy, and Winchester drives

As interfaces between storage devices and most popular microcomputers, Data Technology's Winifloppytape controller boards can juggle up to four 8-in. Winchester disk drives, one tape-cartridge backup, and, optionally one floppy-disk drive. Intended to simplify system integration, the Santa Clara, Calif., firm's **microprocessor-based boards accept commands and data transfers from the host over a bidirectional 8-bit data bus.** By using serial tracks in forward and reverse directions, all the controllers provide read or write backup data in a streaming mode without frequent starts or stops. Winifloppytape controllers sell for $1,100 each in quantities of 1,000. Delivery takes 30 days after receipt of order.

Portable units test Winchester drives

Winchester disk drives can now be tested in the field as well as on production lines with the portable QA 2000, models A-1 and A-2, which test 5¼- and 8-in. Winchesters, respectively. The 30-lb units from Qubex Associates, Santa Clara, Calif., **have two microprocessors dedicated to testing only, plus three microprocessors that handle operator interfacing,** allowing users to select from a menu of guided and prompted programs or to design their own tests. The self-checking instruments include a keyboard, a built-in printer, and a 5-in.-diagonal cathode-ray-tube display with a split-screen format for the continuous display of drive status and run-time error messages. The QA 2000 models A-1 and A-2 are priced at $10,950 each and are available now.

Spreadsheet uses IBM Personal Computer's color and graphics

Unveiled last week at the West Coast Computer Fair was the MS-DOS version of SuperCalc, a financial modeling package. **Dubbed SuperCache, the enhanced version comes with a 192-K-byte memory card (expandable to 192-K bytes)** so that it can make use of the graphics and color capabilities of the IBM Personal Computer. Packaged jointly by Sorcim Corp. of Santa Clara, Calif., and Vista Computer Co. of Santa Ana, Calif., SuperCache will retail for less than $800 in single quantities when it becomes available in the second quarter of this year.

SPECIAL REPORT: May 19

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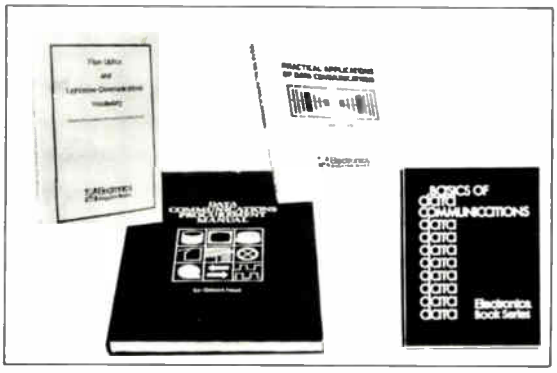

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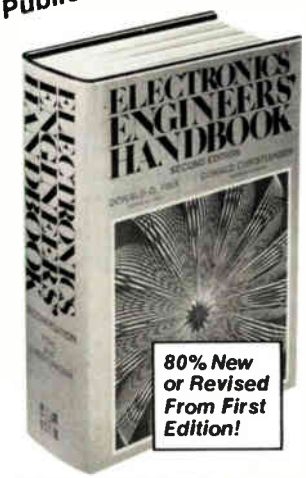

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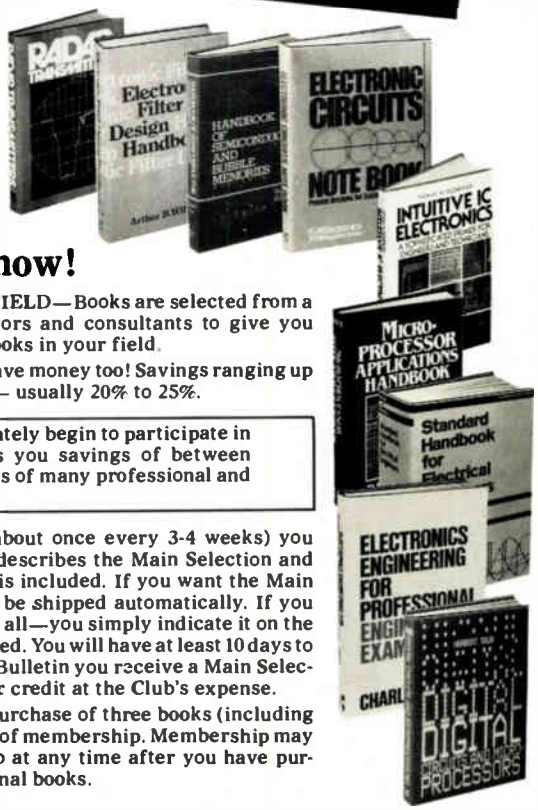

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Career outlook

Minorities gain ground

Efforts in the U.S. to increase the number of minority engineering students have been somewhat successful. The Engineering Manpower Commission of the American Association of Engineering Societies, quoting the National Science Foundation, says that members of minorities have climbed up to comprise 4% of the engineering profession from 1% in 1971 when an effort to increase minority representation was launched.

However, this figure is misleading because the most underrepresented minorities—blacks, Hispanics, and American Indians—make up only 1.8% of the engineering work force. In addition, 50% of them work in electrical engineering. These results were recently published in a study by the commission setting out the number of blacks, Hispanics, American Indians, Asians, and Pacific Islanders enrolled in undergraduate and graduate programs.

The commission goes on to say that of the nearly 60,000 graduates who received bachelor's degrees in engineering in 1981, 8.3% were members of minorities but only 4.7% were blacks, Hispanics, or American Indians. To achieve parity as measured on the basis of the 1980 census of the total college-age population of the U.S., states the commission's report, blacks would have to reach a total of 14.1% of the graduates, Hispanics 7.6%, and American Indians 3.5%.

Of all the minorities, blacks have perhaps fared the worst in making their way into engineering. The NSF's 1978 figures show that only 0.8% of the nation's engineers were black—and 92.8% of those were men. Electrical engineering is the field most favored by black engineers, 29% of whom work as EEs. That is far more than the second-place discipline, civil engineering, which attracts less than 10%.

Want to be EEs. As the table shows, the fall 1980 undergraduate engineering enrollment of blacks totaled more than 16,000 in U.S. schools, a 9% increase over the previous fall's total. Again, the EE degree was the most popular goal, with 28% of black students pursuing it. In all, four disciplines attracted 63% of the students, with mechanical-, civil-, and chemical-engineering disciplines following the EEs.

When the NSF surveyed Hispanic engineers in 1978, the nonresponse rate was high. However, says the manpower commission, Hispanics probably make up 1.4% of the engineer force and about 1.5% of the new engineers.

Excluding the 2,800 students enrolled at the University of Puerto Rico, Hispanics account for almost 2.5% of the students currently matriculating in engineering schools in the 50 states. That figure represents an increase of about 120% since 1975. Hispanic students also favor EE courses: in 1981, some 28% received bachelor's degrees in EE, with another 43% receiving degrees in mechanical, civil, and chemical engineering.

FALL 1980 ENROLLMENTS

Level	First year		4-year total		Masters		Doctorate	
	Hispanic	Black	Hispanic	Black	Hispanic	Black	Hispanic	Black
Aerospace	133	150	312	368	10	9	6	4
Automotive	–	–	2	2	–	–	–	–
Bioengineering	20	40	68	117	6	2	1	2
Computer	173	278	368	594	14	50	5	11
Electrical	1,140	1,640	3,333	4,526	98	123	22	33
Electronic	12	17	79	65	–	–	–	–
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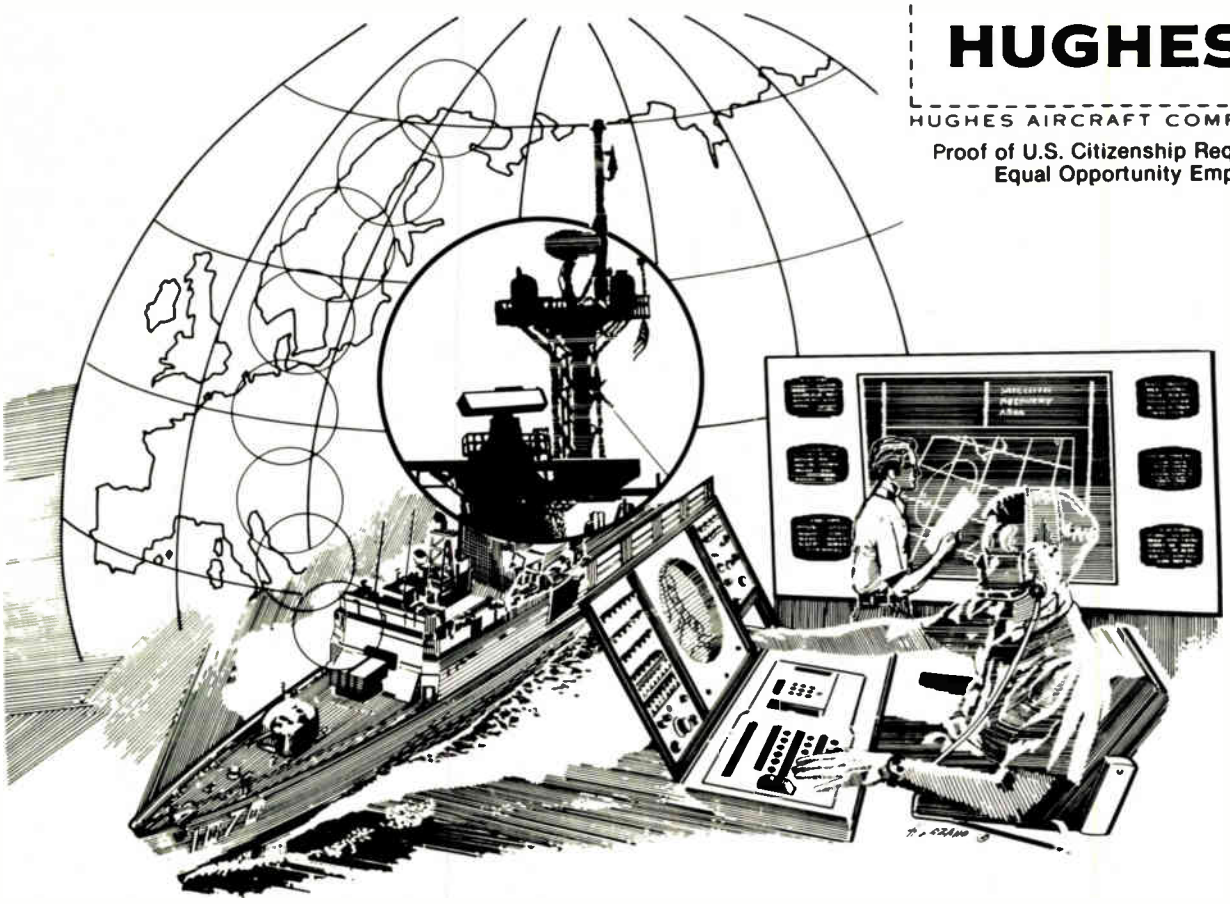

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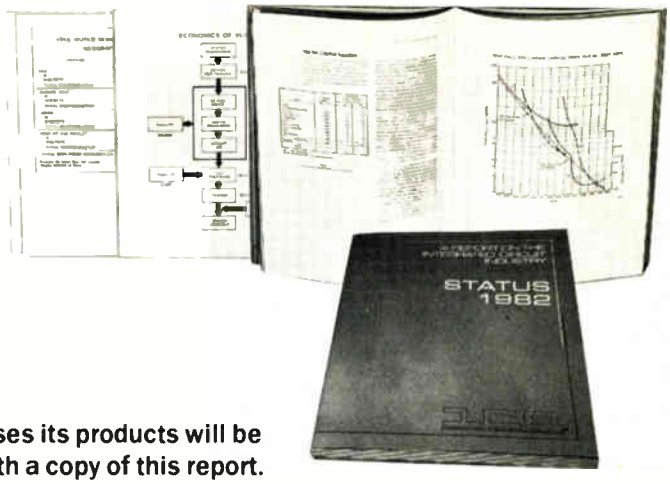

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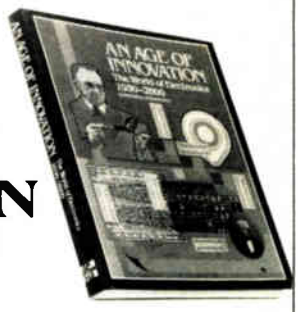

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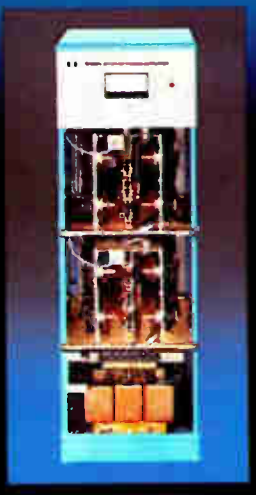

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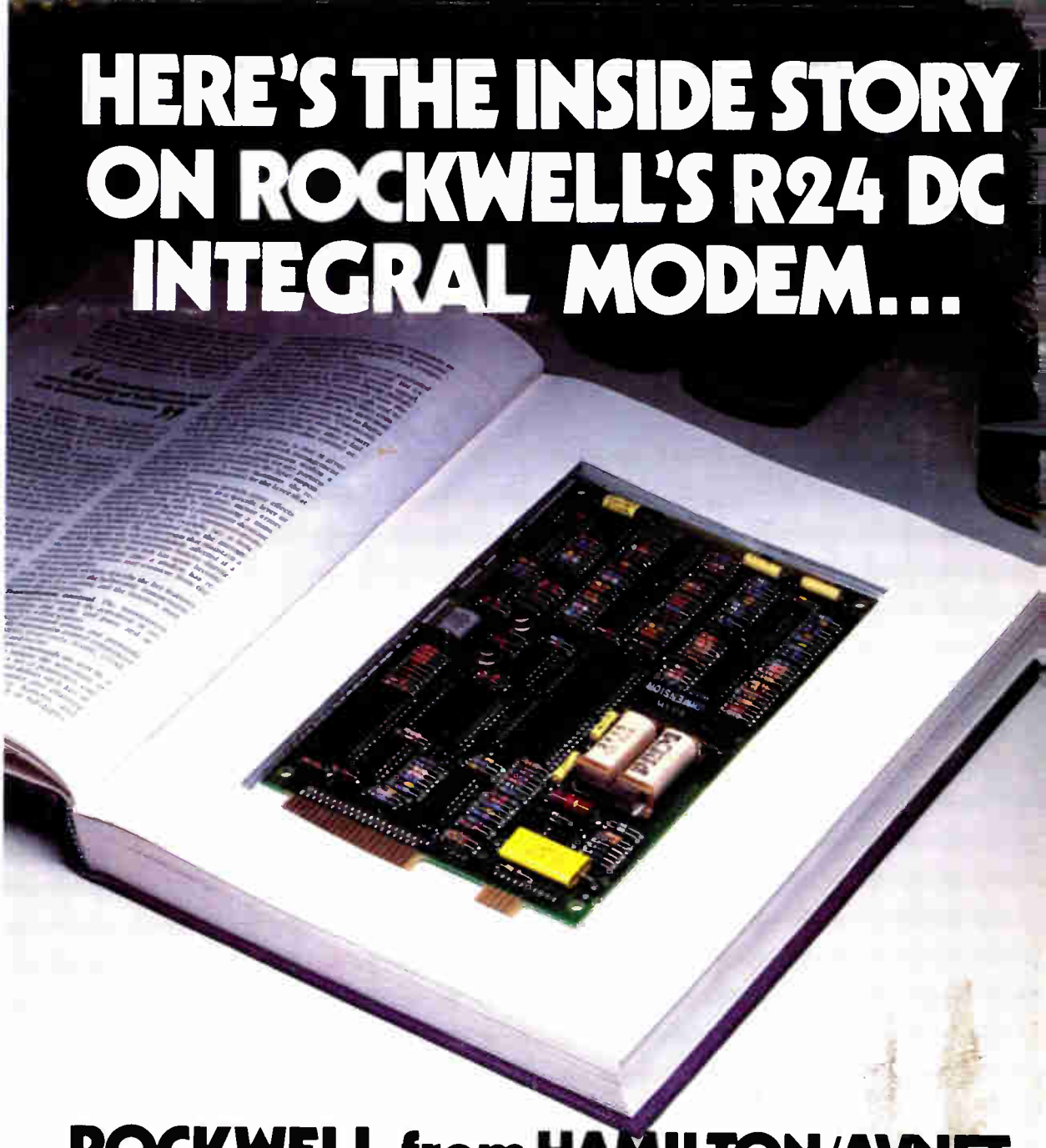

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