DECEMBER 6, 1979

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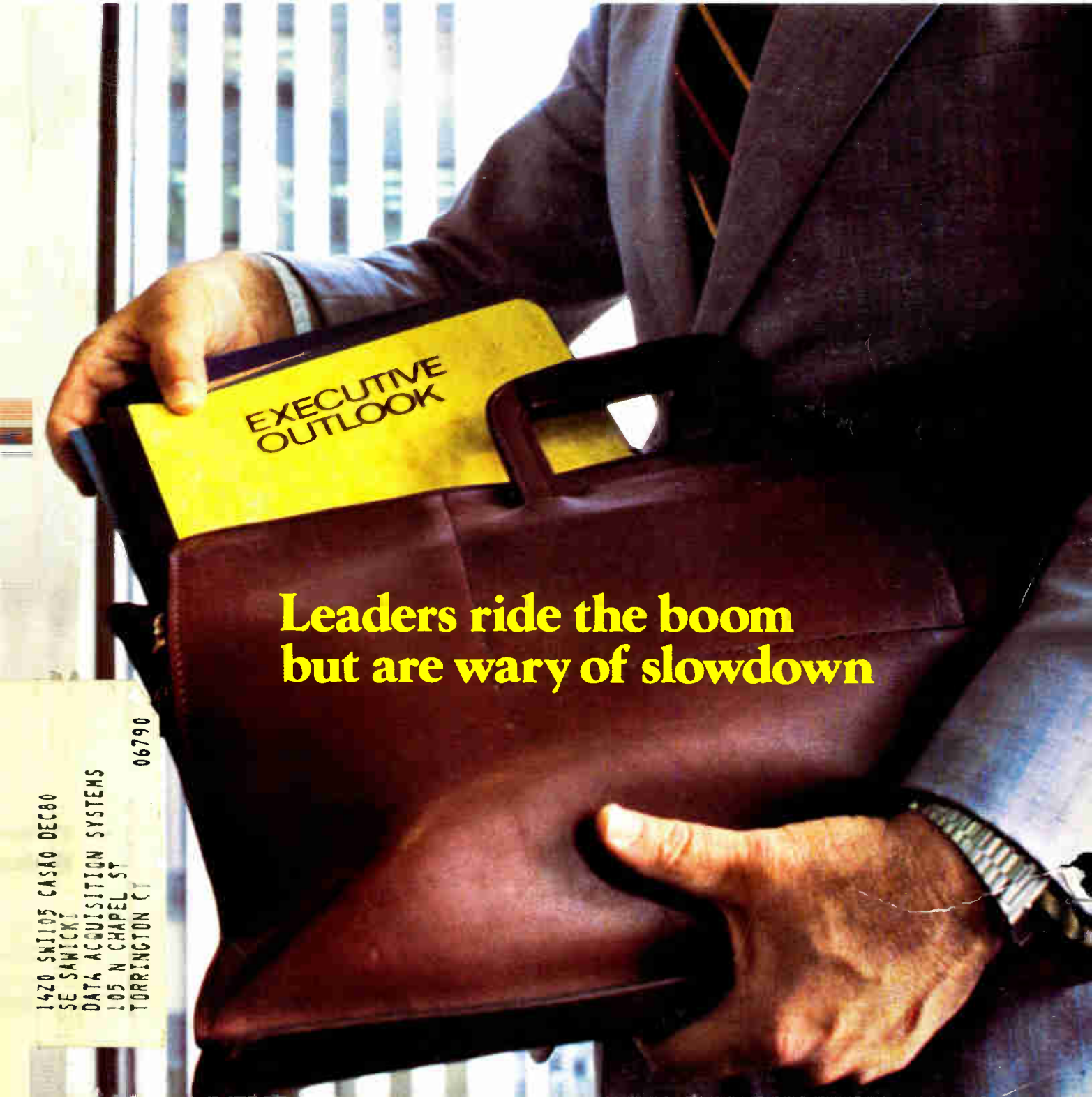
For distributors the outlook is cautious optimism/87

Scaled bipolar static RAMs fight off MOS/137

50 YEARS

Electronics

FOUR DOLLARS A McGRAW-HILL PUBLICATION



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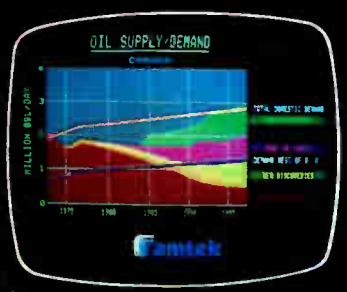

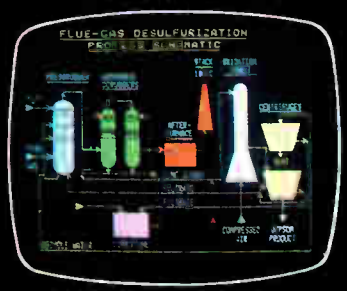

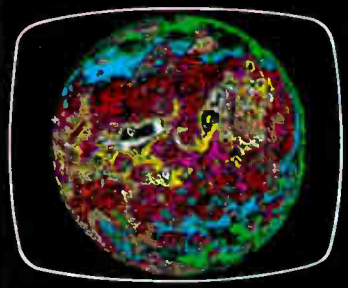

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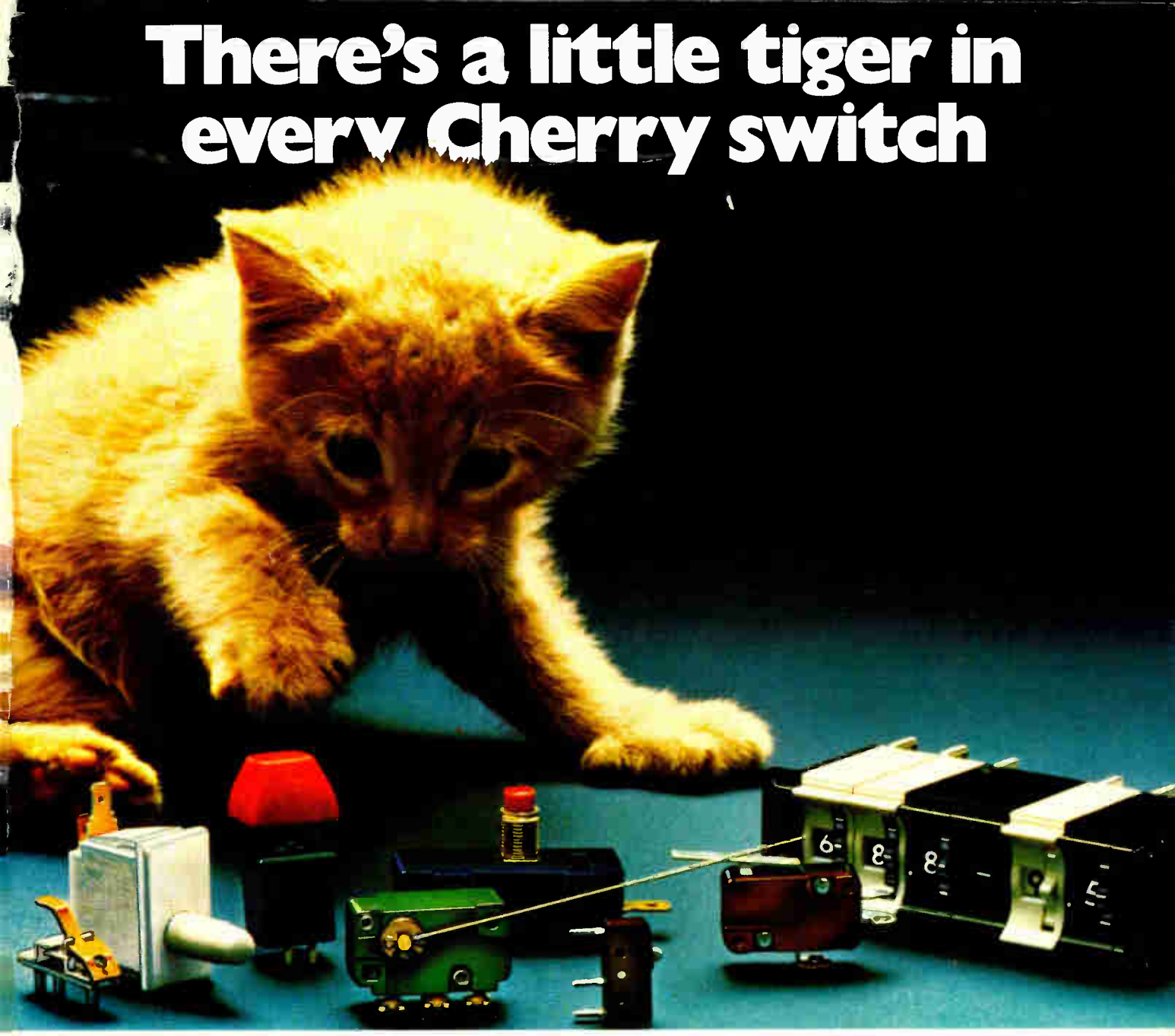

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Electronics
The International Magazine of Electronics Technology
Vol. 52, No. 25 • December 6, 1979

Highlights

Cover: Executives peer into mists of 1980, 111
The long-heralded recession has not yet hurt electronics manufacturers, nor do many think the industry vulnerable. But identical questions put to 23 top managers provoke widely varying responses.

Cover is by Art Director Fred Sklenar.

Show spotlights TV and toy developments, 96
Devices for tuning and filtering television signals and a system for infrared remote control of toys were described at the Fall Conference on Consumer Electronics held last month near Chicago.

Long strides in solid state seen at IEDM, 124
Highly productive research at home and abroad is making news at the International Electron Devices Meeting in Washington, D. C. From Japan, for instance, come details of a quadruply self-aligned MOS process that may soon yield a megabit random-access-memory chip.

Bipolar memory's dimensions dwindle, 137
Scaled-down bipolar memory is breaking the speed records again as improvements in the Isoplanar process help drive geometries downward.

. . . and in the next issue
A chip for interfacing packet-switching networks . . . higher-density Multiwire boards . . . real-time digital signal-processing techniques.

Electronics

Publisher's letter

We started doing an annual "Executive Outlook" in our Jan. 3, 1972, issue. It's interesting to look back and compare what electronics industries leaders said during this eight-year span with what they are saying in this year's report (p. 111).

In general, worries do not change much. For example, trade with Japan was a concern in 1972, except that at the time it was the U. S. television manufacturers who were feeling the pressure. It was not until the 1976 executive outlook that the semiconductor top brass sounded their alarms over Japanese competition for American markets.

Other familiar subjects came up in 1972. There was concern over the loss in momentum of the country's technological leadership, a worry that has intensified over the years. And company executives expressed a number of doubts about the handling of the economy by the Government, only then it was the Nixon Administration (remember Phase 1 and Phase 2).

By the beginning of 1974, a major concern in the executive suites was energy, yet another bit of *déjà vu*. Vying with energy that year was uncertainty about a possible recession expected some time in 1974–75. A year later, the recession turned out to have been a sharp downturn that had done much damage. There was some edginess about inventories and painful overcapacity in the semiconductor business.

What's bothering executives this year? It's a peculiar situation. True, some of the old standbys are mentioned—Japanese competition, inflation, Government economic policies, tight money, and taxes. But it seems that all hands are trying to solve the "case of the missing recession." Where is it? they keep asking.

If it happens, it will find the electronics industries prepared for it as never before. But what if it happens to others but not the electronics industries? By next year, we'll find out who's "recession-proof."

December 6 1979 Volume 52, Number 25 101,065 copies of this issue printed

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Readers' comments

Missing qualification

To the Editor: I call your attention to the following from the story on GenRad [*Electronics*, Nov. 8, p. 89]: "Eberstadt estimates that GenRad's earnings will grow at 46.5% compounded from 1974 through 1979, faster than any other company in the test and measurement industry. Teradyne Inc., in contrast, will reach only about 8.2% compounded for the same period, in Eberstadt's opinion."

From the reported net earnings for both companies, one comes up with compound growth rates of 17.5% and 11.1%, respectively, for the period 1974–79. The only way to approach a 46% growth rate for GR is to start at 1977 and take a two-year cut. But Teradyne's growth rate over the same period is 22% compounded, not 8.2%. Since 1976, Teradyne's growth rate works out to 46.6%. Since 1975, it's 109%. Where does the 8.2% come from?

Frederick T. Van Veen
Teradyne Inc.
Boston, Mass.

■ Electronics *erred in not qualifying the statement quoted. Everywhere in the paragraph where percent earnings appear, the correct term should have been "earnings per share." We regret the error.* —ED.

Not yet

To the Editor: In the Sept. 27 issue is a Washington newsletter item stating that the Canadian Communications Technology Satellite (CTS) would be shut down in October. This is incorrect. Although an October shutdown was once scheduled, CTS, or Hermes, as we refer to it, won't be shut down until January 1980, after demonstrations to the Australians of Canadian satellite technology. By then all planned experiments will be completed. The performance of the spacecraft's transponders is unchanged since launch; however, degraded telemetry signals have caused concern.

David Wright
Information Services
Department of Communications
Government of Canada

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News update

■ When Siemens AG became one of the first companies in Europe to introduce an electronic teletypewriter a few years ago, the reaction was not what technological leaders have come to expect. Drowning out the usual oohing and aahing were objections from labor union officials, who feared the new model 1000 would mean fewer manufacturing jobs. Being packed with integrated circuits, electronic teletypewriters are easy to assemble and have virtually no gears, levers, cam plates, or other parts that must be hand-assembled.

But the story has had a happy ending, both for the workers and for Siemens, because a new plant had to be built to manufacture the model 1000. That facility, in West Berlin, now employs 1,500 persons, some 400 more than were working there a year and a half ago, and is being supplied with parts from 1,500 outside vendors. In fact, there never were any layoffs. Because of the popularity of the new models and advance orders for it, production got off to a flying start in October 1976 and kept building. By May 1978 the plant had about 1,100 workers, and when sales really took off the other 400 were added. The upshot is that union attitudes are slowly changing.

For Siemens, the 1000 is becoming one of the most successful products in its arsenal of communications equipment. In the three years since production started [*Electronics*, March 4, 1976, p. 56], the Munich-based firm has turned out some 100,000 units. By comparison, it was 10 years before Siemens had made the same number of T100 machines, which were the electromechanical predecessors of the 1000.

Of those 100,000, some 55,000 were made in the past 12 months alone. The total output represents a value of well over half a billion dollars and has increased Siemens' share of the worldwide teletypewriter market to about 35%.

That is an impressive percentage in view of the competition that Siemens faces. Equally impressive is the fact that Siemens exports some 70% of its model 1000s to more than 80 countries. **-John Gosch**

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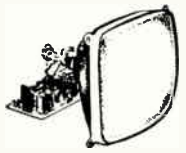

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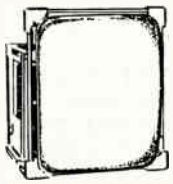

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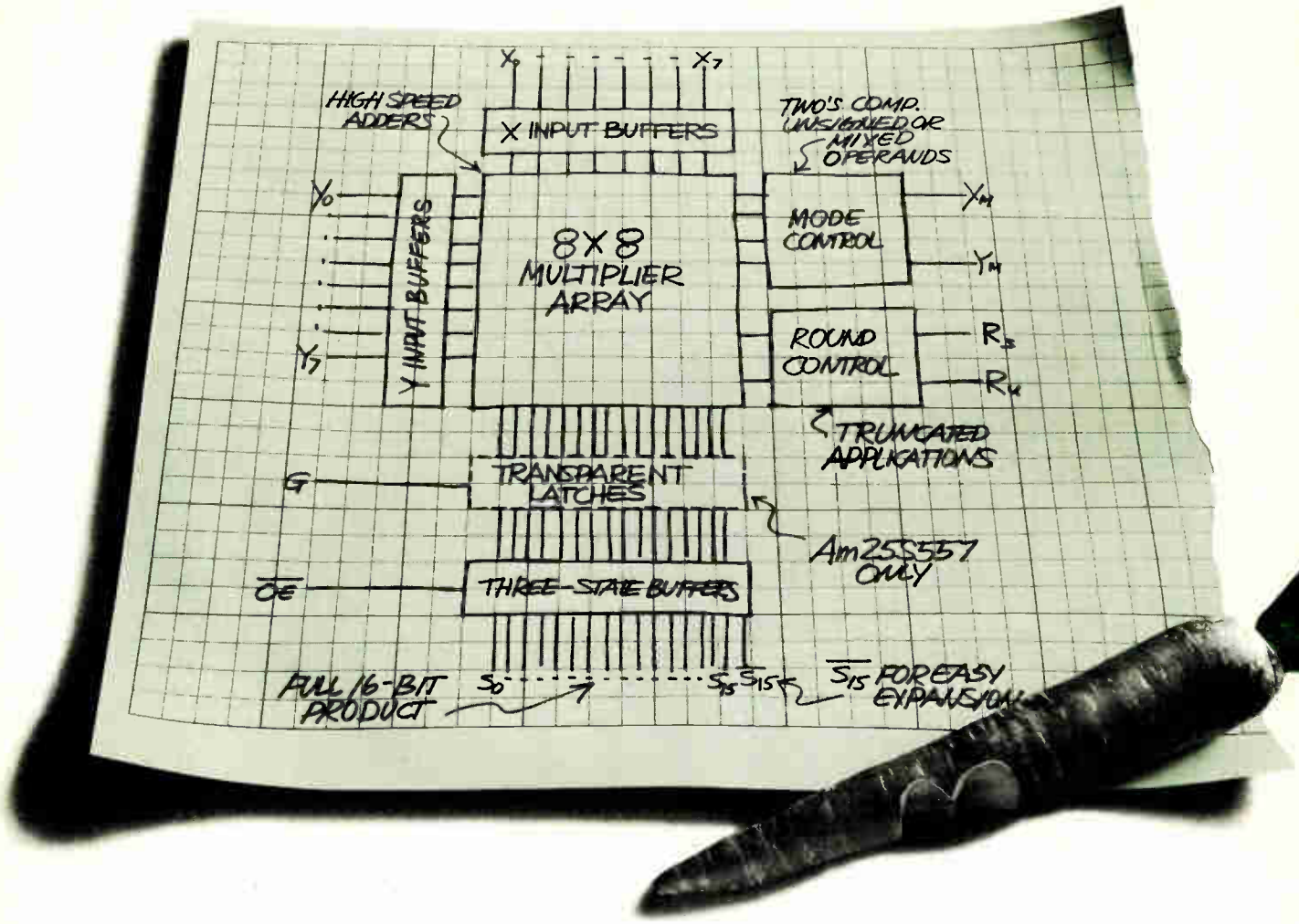

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Editorial

China: first come, first served

A funny thing seems to be happening to U. S. businessmen on their way to the China market: the Japanese are getting there first. That's the message from one American, John Ma, who recently returned from a five-week tour of the People's Republic of China.

Ma, speaking at the Institute of Electrical and Electronics Engineers' consumer electronics conference in Chicago, said that most foreign businessmen now in China are from Japan. As the Americans there worry about relations with Taiwan and other political matters, said Ma, the Japanese are busily hammering out trade understandings and agreements to exchange technology for Chinese raw materials. Though this is only one man's impression, it is not hard to imagine the energetic Japanese working hard to mine this vast and virtually untapped vein of raw materials in a country hungry for technology.

To be sure, American businessmen have been traveling to the newly opened nation, but what should be a steady flow has been more like a trickle: not enough of them take China seriously as a potentially gratifying market. They fail to take advantage of new laws there permitting foreign companies to make a profit in joint ventures and to take that profit out of the country. Also, Ma pointed out, they seem to ignore some tax-free benefits that have been provided.

Furthermore, U. S. industrialists, leery though they are of Chinese government policy, need not fear nationalization, said Ma, because the Chinese have learned that nationalized industries become obsolete in a few years.

Americans have been complaining about unfair advantages accorded by their Government to foreign competitors eager to capture slices of the domestic U. S. market. Now they have a chance to show what they can do with what amounts to a virgin market. If they fail, they will have no one to blame but themselves.

That's not a false alarm, folks

President Carter's ringing call to aid the cause of technological innovation—a call that has resulted in an increase in 1979 Federal budget obligations of a magnificent 0.002% [*Electronics*, Nov. 22, p. 24]—has been met with a variety of reactions. However, none is perhaps so shortsighted and parochial as the view holding that technologists have always become alarmed at any minor slowdown in innovation; this latest fuss, in short, is merely someone crying "Wolf!" This attitude insists that such slowdowns are normal.

Sadly, such thinking is not isolated. There are those who find it difficult in these times of galloping inflation, dwindling energy resources, and threatened economic slumps to get excited about technology, innovation, and the threat of foreign domination of American industry. But the incorrectness of that narrow outlook is manifest when considering the economy and the state of the nation as a whole. Robert J. Potter, International Harvester's senior vice president and chief technical officer, put it this way recently at an engineering conference: "We must exploit technology. In fact, without strong innovation, our companies and the United States will perish economically. . . . Modern innovations cannot be generated without strong technology. . . . Innovation is not just good for the profit of our companies, but for the basic well-being of our country."

Thus, to believe that the call for more aid and encouragement for technological innovation is merely the refrain of an old song is to shrug off the future of this nation.

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Circle 13 on reader service card

People

The Nobel laureates:

Cormack keeps his cool . . .

Cormack. The Tufts University professor began his CAT work in South Africa.

As Nobel Prize winners go, Allen M. Cormack, 55, is among the more relaxed and easygoing. He speaks about the prize for physiology that he shares with Englishman Godfrey Hounsfield in the low-keyed tones some reserve for out-of-town sports. He only grumbles good-naturedly about the press—"I don't expect to get any meaningful work done until after the ceremony," he says.

Cormack's work in the late 1960s laid a mathematical and experimental groundwork for today's computerized axial tomography equipment, or CAT scanners. He began working in that direction at the University of Capetown, South Africa, in 1956 when—though holding only a BSEE degree—he was asked to serve in a local hospital as a radiation health physicist. He was struck by the difficulty radiologists had computing the minimum effective dose of X radiation for cancer treatment.

This led to experiments with disks of wood embedded with aluminum plugs, to simulate bone within soft tissue. By 1963, despite his lack of a doctorate, he had assumed his present position as professor of physics at Tufts University, Medford, Mass., and in an experiment costing about $200 in machine-shop time and two days in the lab he had laid the groundwork for what would become the CAT scanner.

When the returns were in, Cormack saw that the experiment had developed an accurate map of the disk and its simulated bones. He published the results of his work and the background mathematics in the Journal of Applied Physics in 1963 and 1964, hoping that someone would pick up the technique and develop it. "And then there was a dead silence that lasted until 1970–71," says Cormack, "when I found that EMI was developing the CAT scanner."

Cormack feels no differently now than he did before the Nobel. Certainly his immediate career goals have not changed. "I'd like to work with some friends over at Harvard University's cyclotron, treating cancer with particle beams. It's potentially a much better treatment than X ray, since the lower-energy particles damage far less surrounding tissue." And the CAT scanner makes even these treatments more precise than they would be otherwise.

. . . as Hounsfield recalls a childhood on the farm

"I was brought up on a farm. I learnt a tremendous lot about engineering in my youth—tinkering with tractors and bikes and having time to think." That remark helps explain why Godfrey Hounsfield embarked on a career that was to lead to the development of a powerful new X-ray diagnostic aid—the computerized axial tomagraphic scanner—and to a 1979 Nobel Prize that the British technologist shares with Allan M. Cormack.

After leaving the farm, Hounsfield received an early training in electronics in wartime Britain before joining EMI Ltd. in 1951. He has been with EMI ever since, working in design and research. It was at EMI's Hayes facility outside London that, without any knowledge of Cormack's work, he developed the scanner now routinely used to provide slice-by-slice views of the body.

The work started, he says, when "I

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Circle 15 on reader service card

Hounsfield. From tinkering with tractors and bikes on the farm, to the CAT scanner.

was told to go away and think of something new. I had several projects on the boil at the time, but gradually this one bubbled to the top." His work in pattern recognition led him to a mathematical analysis of the amount of useful information that could be extracted from a straight-line scan through a three-dimensional object.

"I realized that it should be possible to reconstruct the contents of an enclosed box from a set of such scans. When I worked out the mathematics, it came out beautifully." He adds, "The idea of applying it to X rays only came later."

In the system developed and patented by EMI, the scans are generated by rotating the X-ray source and detector around the patient and by harnessing the computer to reconstruct a cross-sectional image. Today over 1,000 EMI scanners are in use worldwide.

Hounsfield, meanwhile, is still in harness exploring ways in which the computer's enormous computational powers can be employed to handle other tasks that are beyond the unaided human intellect.

Hounsfield is largely self-taught: his only degrees are six honorary university doctorates for his work on developing the scanner. One most important seat of learning, however, has never granted a degree. It is the small farm in England where he first learned to ask why and how things happen as they do. ☐

MEASUREMENT COMPUTATION news

product advances from Hewlett-Packard

DECEMBER 1979

Hewlett-Packard's new logic development system simplifies logic design, development, and analysis for all products built around a microcomputer. It can help move a design rapidly from definition to production with minimum cost and maximum design team performance.

HP-IB

New logic development system speeds and simplifies design of μP-based products

Hewlett-Packard's 64000 Logic Development System provides the capabilities you need to support your processor based products from definition to production. Using a hard-disc base and multistation architecture for a flexible, high performance operating system, the 64000 aids hardware and software designers in designing, debugging, and troubleshooting of microprocessor systems. Conventional software functions are combined with real-time emulation and transparent logic analysis for efficient and effective solutions to development problems. Currently, four microprocessors (Intel 8080, Intel 8085, Motorola 6800, and Zilog 280) are fully supported by the 64000, with relocating macro assemblers and emulators for emulation at operational speeds.

Tailor Your Logic Development System to Meet Your Needs

The HP 64000's modular architecture lets you begin with a basic system consisting of one development station, hard disc, and a printer. To this you can add up to six development stations sharing the

(continued on third page)

IN THIS ISSUE

An impressive new hardcopy partner for your system

HP-IB

A new, non-impact graphics printer, the HP 7310A, now offers impressive hardcopy flexibility for your computer-based computation and testing system in the office or laboratory. The first of a family of thermal printers from HP, the 7310A produces hardcopy of forms, text, and graphics—quietly and quickly. Designed for use as a peripheral for HP's 2640 Series Graphic and Alphanumeric Terminals, for the 9825 and 9835 Desktop Computers and for other HP computer systems, the 7310A Printer also accommodates a range of interfaces permitting it to be interfaced with computers and terminals not manufactured by Hewlett-Packard.

This versatile 7310A Graphics Printer offers these important capabilities:

- **High-quality graphics, text, and form printing.**
- **Fast printing for both text and graphics.** Print speed varies between 200 to 500 lines per minute, depending on print density and character set used.
- **High quality raster graphics.** 720 dot output in the horizontal direction, matches exactly the performance of HP's high-resolution 2647A and 2648A Graphics Terminals.
- **Fast hardcopy output.** As a result of its greater throughput speeds, the 7310A produces raster copies in less time than previously possible.
- **Forms printing.** The 7310A supports the optional HP 2640 series line drawing (forms) character set. Reverse printing (inverse video), underline, and bold face character enhancements provide a close matching with forms needs. Inverse and underline fields are printed just as they appear on the terminal screen. Blinking and half bright are printed in a special bold font to draw attention.
- **Automatic paper cutter and page stacker** permits page sizing to any length from 2 to 20 inches. Pages are printed, cut, and stacked for short term unattended operation.
- **Versatile interfacing.** Four interfaces are available: HP-IB (IEEE-488) for HP terminals and desktop computer systems, RS-232C/V.24 and RS-423A for remote printing on HP and non-HP computer systems, and 8-bit duplex for HP 2640 series alphanumeric terminals and OEM systems.

Whether you need printing, forms, graphics or all three, HP's 7310A Graphics Printer offers an impressive number of important features, speed and a range of interfaces.

- **Graphics directly from computers.** Graphics can be obtained directly from the computer using customer-written, raster conversion software which develops the "raster image" from X-Y coordinate information.
- **Easy-to-read text printing.** The combination of a proportional type face and programmable character size produce easily readable text.

  1) Proportional or fixed spaced 128-character ASCII text is easily accessed by program command or a rear panel switch. Twenty-four international language character sets are provided. Japanese Katakana and APL are also available.

  2) 9×15-dot matrix characters are printed with closely-spaced, thermal print head elements to produce high quality results.

  3) Programmable character height permits you to generate titles or footnotes in characters from 50% to 200% of normal character height.

Of course, the 7310A offers a full range of programmable printer control functions including tabs, margins, line spacing, page size, graphics image windowing and clipping commands.

- **Convenient table top physical dimensions.** The 7310A measures only 162×451×534 mm (6.38×17.75×21 in).

Check **B** *on the HP Reply Card for full product information.*

Move your design from definition to production with minimum cost

(continued from first page)

same disc and printer. All members of the design team have access to a common data base, thanks to the deep capacity and fast response speed of the hard disc. Designers will appreciate the directed syntax and soft keys that make the 64000 such a friendly system. It is easy to learn and use, allowing designers to concentrate on building the best possible product. As design needs change, more development stations or options can be added. Options include real-time emulators, up to 128 kilobytes of independent emulation memory, tape cartridge unit, integral PROM programmer and real-time logic analysis.

Sophisticated Design Tool

A state-of-the-art minicomputer with a high capacity disc drive provides the 64000's ease-of-use, speed, and depth for design projects, today and tomorrow.

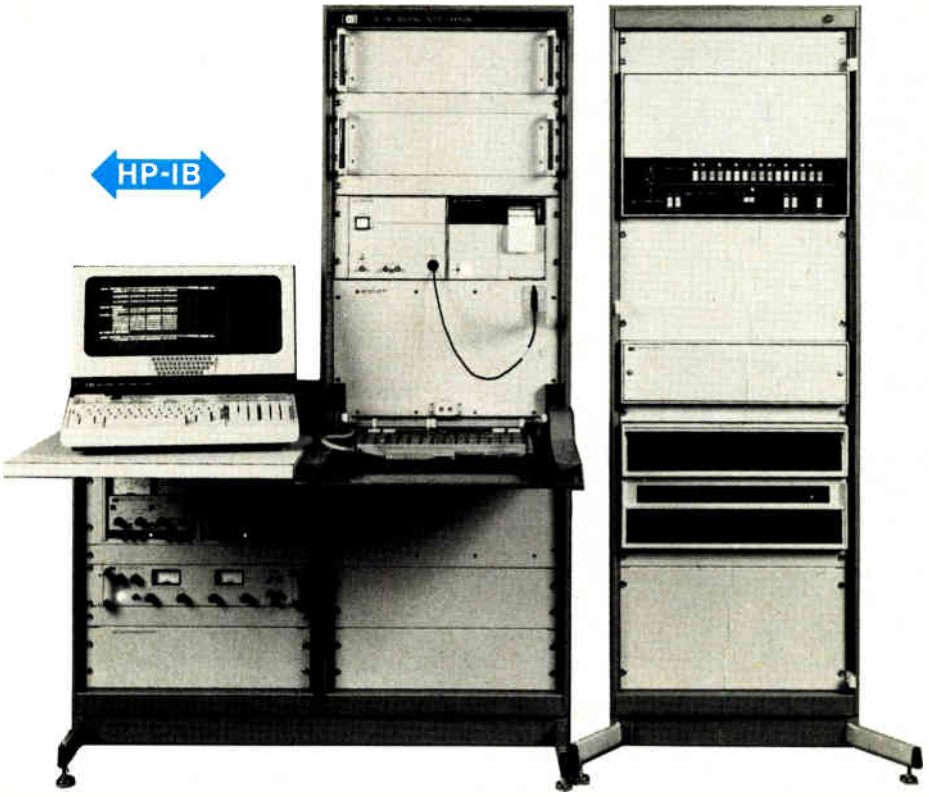
Important benefits include:

- INDEPENDENCE - Choose the best processor for your product.
- FLEXIBILITY - Expand the system as your needs grow.
- EFFICIENCY - Directed syntax and soft keys reduce the training time. Excellent text editor and operating system allow for quick and easy program development and system debugging.
- CONVENIENCE - Combine functions in each development station without using many peripherals.
- EFFECTIVENESS - Real-time emulation permits checks of designs at operational speeds during any stage of development.
- SERVICEABILITY - Comprehensive performance verification diagnostics and signature analysis.

Call your field engineer for assistance in choosing the optimal configuration of a Logic Development System for your design and development needs or check **C** *on the HP Reply Card for literature.*

CORRECTION:
In the September/October 1979 issue of Measurement/Computation News the price for the HP-41C printer was misquoted as $35. The correct price for the printer is $350.

Circuit test system allows concurrent production test and program development



The amount of logic on today's average PC board poses some difficult problems for production test. Board-test simulation is a technique that can minimize many of these problems and costs by modeling the circuit to be tested component-by-component and node by node in the test system computer. From this model, the system can calculate the correct response to any input pattern, plus predict failure modes and their responses.

This allows only those patterns which are necessary to help detect faults to be used as the test pattern stimulus. It also enables engineering to test designs before they're built and thus eliminate any problems before they reach production.

HP's answer to simulation and to the reduction of testing costs and time is DTS-70 Digital PC Board Test System. Consisting of the 9571A Test Station, the System 1000 computer and complete software package, the DTS-70 system can test your PCB's and isolate faulty components in only a few seconds.

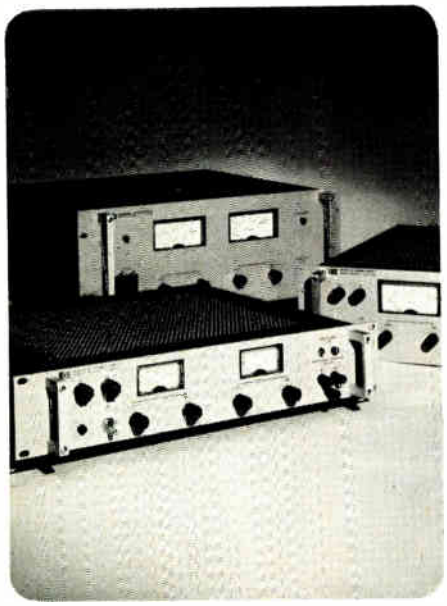
HP's DTS-70 is also an expandable system that grows with your production capacity. You can add up to three test stations without buying additional computing power. For more test software development capability, simply add an inexpensive CRT terminal to your basic system. A total of six software development terminals may be added without interfering with production testing.

In addition, the DTS-70 software is compatible with data base management software to keep track of data and help you better manage your production. For example, the system can give you reports such as specific board or component failure rates and modes.

Using HP's FASTRACE software, the DTS-70 also simplifies troubleshooting. It accesses faulty board models developed by the simulator and guides the operator in a quick series of probe tests to isolate faults. Unlike many simulator systems, the DTS-70 catches intermittent faults. Its zero delay capability allows it to detect races and hazards—a critical problem in logic circuit operation.

There are many other benefits to the DTS-70 in analog and hybrid circuit testing. Get all the details by checking **D** *on the HP Reply Card.*

High performance, low voltage dc power supplies



HP's fully protected low-voltage dc supplies come in power ratings from 120 to 2000 W.

If your system power requirements call for a dc supply with superior performance and the benefits of built-in overvoltage and overcurrent protection, take a close look at HP's family of low-voltage rack supplies.

These supplies boast load and line regulation of 0.02%, with less than 10 mV peak-to-peak ripple and noise, and full load efficiencies from 54% to 80%. Output voltage and maximum current limit are fully adjustable, while the overvoltage crowbar trip point can be independently set between approximately 10 and 110% of rated output voltage. Other advantages include automatic crossover between constant-voltage and constant-current modes, remote programming, and remote sensing.

Output Voltage Ratings

This power supply product line includes 12 models (6259B through 6274B) covering four output voltage ratings:

- 10 V at 50 or 100 A;
- 20 V at 10, 20, or 50 A;
- 40 V at 3, 5, 10, 30, or 50 A;
- 60 V at 3 or 15 A.

If you'd like to obtain complete information about HP's family of low-voltage power supply supplies, check **E** *on the HP Reply Card.*

New microwave frequency counter measures to 26.5 GHz with power and versatility

Simple keyboard control coupled with a microprocessor give HP's new Model 5343A Microwave Counter power and versatility not previously found in an instrument in this price range. High sensitivity over the 10 Hz to 26.5 GHz range makes the 5343A especially valuable for the newer satellite and terrestrial communications bands, and many K-band radar applications.

From the easy-to-use keyboard, the operator can define his or her own integer multiplication factor, M, to apply to the measurement and/or a frequency offset, B, to solve for $Y = MX \pm B$.

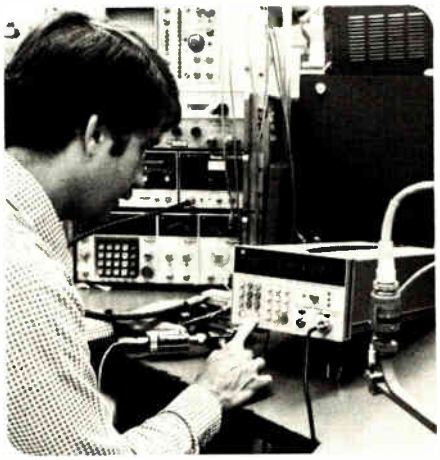
Guaranteed Sensitivity

The guaranteed sensitivity of the counter is: −33 dBm from 500 MHz to 12.4 GHz; −28 dBm, 12.4 GHz - 18 GHz; and −23 dBm, 18 GHz - 26.5 GHz. FM tolerance can be selected by a rear panel switch. When in the wide mode, the 5343A can tolerate up to 50 MHz peak-to-peak at worst case.

Any three consecutive digits on the display can be converted into an analog voltage output by adding the Digital-to-Analog Converter Option 004.

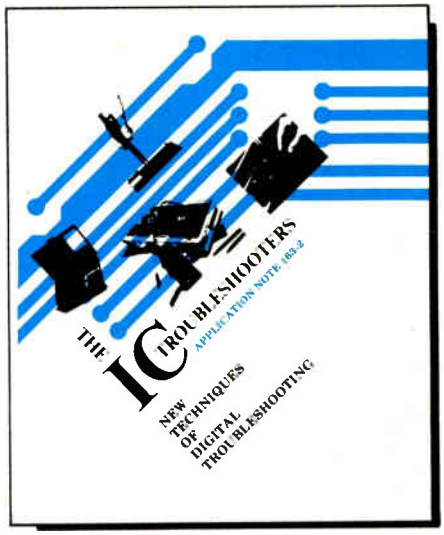
Adding HP-IB Option 011 permits remote programming of front and rear panel controls.

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



The high input sensitivity of the new 5343A counter makes it the outstanding measurement solution for all those low-level signals in R&D applications.

New Applications Note #163-2 stresses digital troubleshooting



Featuring information gathered from both customer and HP experiences in basic digital troubleshooting, a new HP Application Note now makes that valuable data available to you.

The note, #163-2, *New Techniques of Digital Troubleshooting*, contains 50 pages of material, including a brief section discussing HP's digital product line, and how the IC Troubleshooters fit in with our other products.

The troubleshooting tools discussed in the note are from HP's line of hand-held node and gate instruments, the IC Troubleshooters:

- 545A Logic Probe
- 546A Logic Pulser
- 547A Current Tracer
- 548A Logic Clip
- 10529A Logic Comparator

Current tracing techniques are thoroughly covered and provide you with all the tips we've discovered to help optimize use of the tracer for tough fault isolation tasks on three-state buses, solder bridges, supply-to-ground shorts, and more.

In addition to a section on how to use each of the troubleshooters, the note includes some actual examples of faults and the techniques employed to fix them, using stimulus-response testing in the digital domain.

Tutorial information on how current behaves in both TTL and CMOS families is also covered.

Obtain your complimentary copy by checking **G** *on the HP Reply Card.*

How to rack mount HP instruments

All the information a Hewlett-Packard customer needs to select and obtain the correct hardware in order to successfully rack mount most Hewlett-Packard instruments is now available from your local sales office. Included in two well-illustrated brochures, System I and System II, are descriptions and up-to-date specifications of the instrument rack mount options, as well as specific rack mount kit stock numbers for instruments already purchased.

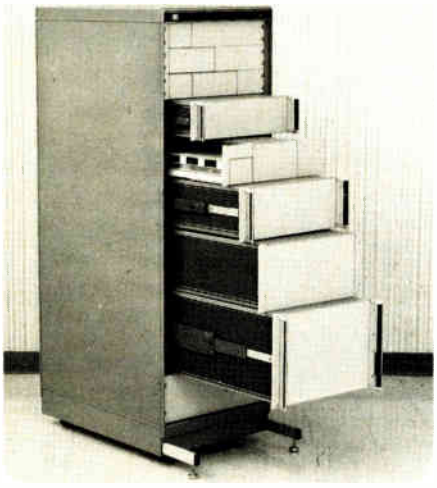
Both brochures also describe the two distinct and unique Hewlett-Packard cabinet styles, and how to correctly rack mount full and sub-modules. Included is also selection criteria for the appropriate instrument slides, instrument support shelves and other accessories.

The System I brochure covers Adapter Frames used to join sub-module instruments for full width rack mounting, Instrument Joining Kits, and Instrument Combining Cases.

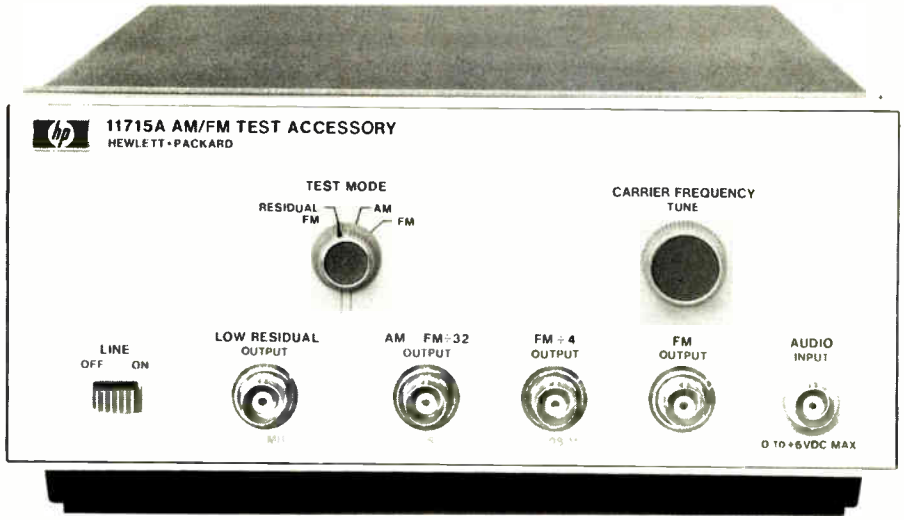
System II brochure covers accessories such as Lock Link Kits, Bail Handles, Cord Wrap Feet, as well as extensive descriptions on rack mounting.

A helpful feature of both brochures is a complete table of Rack Mounting flange dimensions conforming to the EIA standard specifications. This table includes dimensions in both English and metric to assist Hewlett-Packard customers in correctly mounting the equipment in rack cabinet systems. Miscellaneous other accessories are also described.

Get both brochures by checking **H** *on the HP Reply Card.*



New test source produces very high performance AM/FM signals



AM and FM modulated test signals with very high linearity and low distortion are available from the 11715A.

A new special purpose AM/FM test source, Model 11715A, achieves very high quality AM and FM modulation performance.

While intended primarily to be used in the calibration procedure for the HP 8901A Modulation Analyzer, the 11715A provides FM in the RF ranges 11 to 13.5 MHz, 88 to 108 MHz, and 352 to 432 MHz. FM distortion is <0.025% THD, with rates from dc up to 400 kHz, depending on band.

AM signals up to 99% depth and down to <0.05% total harmonic distortion are available in the 11 to 13.5 MHz range, with rates 20 Hz to 100 kHz. Finally a low residual carrier at 560 MHz has <3 Hz RMS residual FM.

By combining this test source and an 8901A Modulation Analyzer, excellent calibrated signals are available for broadcast stereo work.

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

New utility crystal detector for 10 MHz to 12.4 GHz

HP announces a successor to the widely-accepted Model 420A/B Economy Crystal Detectors. The new 420C offers improved performance in frequency response, higher sensitivity, and lower SWR.

Response is ±2 dB with SWR <2.0 over the entire band. Both negative and positive output polarities are available. Option 001 Matched Pairs can be specified for ±1 dB tracking.

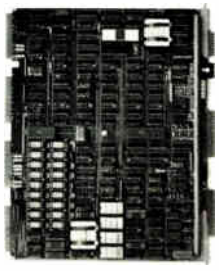
For full information, check **J** *on the HP Reply Card.*

Series 30: the new, lowest-priced member of the HP 3000 computer family

When you need immediate access to information, the new Series 30 can provide it with unprecedented economy. An entry level, general purpose computer, the Series 30 can operate as a stand-alone system or as a station in a distributed data processing network. It can simultaneously handle transaction processing, on-line program development, batch operations, and data communications in any of five high-level programming languages.

HP's proprietary silicon-on-sapphire (SOS) integrated circuit technology makes possible the small size and low power requirements of the Series 30—it is housed in a cabinet measuring only 61×91×46 cm (24×36×18 in.), and is accompanied by a disc drive and system console.

All communications are handled by the new Intelligent Network Processor (INP), an SOS-based computer in its own right. The INP offloads the communications management task from the CPU, permitting high levels of system performance concurrent with communications to other systems.



A computer in its own right, this INP handles all communications for the Series 30.

All members of the HP 3000 family use fully compatible systems software†, and application programs written on any HP 3000 system can be run on any other without reprogramming, recompiling, or relinking. Thus the Series 30 can prove its value in two significant ways: for the company purchasing its first computer, software developed for the Series 30 will remain valid when the system is expanded; for the company wishing to exchange information among a number of departments or manufacturing sites, the Series 30 is an economical station in a distributed systems network of HP 3000's.

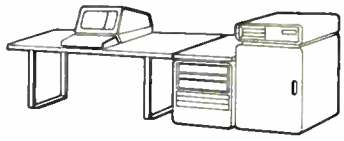
Obtain further details by checking **K** *on the HP Reply Card.*

†APL/3000 is available only on the Series III.

A family of compatible systems for distributed data processing

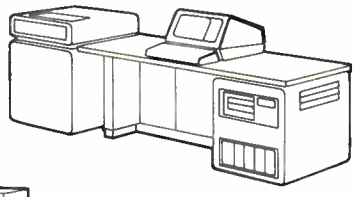
HP 3000 Series 30

The entry level Series 30 provides immediate information access at low cost, as a stand-alone system or as a station in a distributed data processing network.



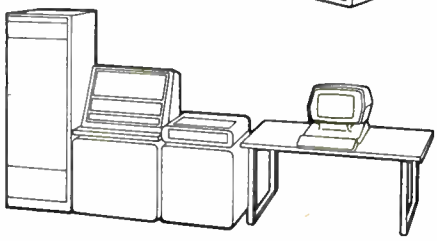
HP 3000 Series 33

The mid-range Series 33 offers an effective solution where several or possibly all of the functional areas of a business require efficient local information processing, with added capability for handling data communications lines.



HP 3000 Series III

The top of the line Series III performs well in several roles such as supplying computer power to a large number of users, or centrally controlling a network of HP 3000's.



HEWLETT-PACKARD COMPONENT NEWS

Attractive, low-cost 18-segment display for compact, low-power applications

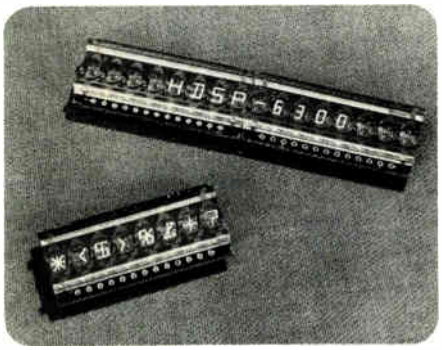
HP's new low-cost, solid-state, alphanumeric display is designed for compact, low-power applications.

An eight-character LED display, the HDSP-6300, has a 16-segment font plus centered decimal point and colon, offering complete 64-character ASCII capability. Its features make it attractive for use in mobile terminals, desktop calculators, hand-held instruments, and other products requiring low power, display compactness, and alphanumeric capability.

The red gallium arsenide phosphide LEDs are magnified by an internal lens to a character size of 3.56 mm (0.14 inch). This design results in enhanced character intensity and minimum power use. For example, characters drawing as little as 1 mA average current per segment can be read at a distance of 1.5 m (4.9 ft.)

The eight-character, dual in-line display package can be stacked end-to-end for applications that require additional characters. The package configurations permit mounting on PC boards or in standard IC sockets. Character spacing is five characters per 2.54 cm (1.0 inch).

Check **L** *on the HP Reply Card for complete details.*

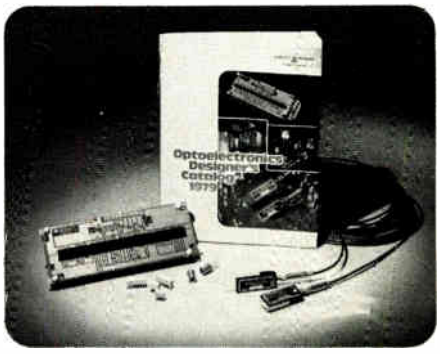


HDSP-6300, Hewlett-Packard's new low-cost, solid-state, alphanumeric display, is attractive for products requiring compact, low-power, monolithic LED characters.

New optoelectronic designer's catalog available

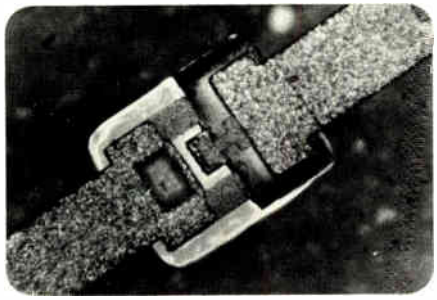
Intended for use as a source book in design situations, HP's new Optoelectronics Designer's Catalog includes the latest HP optoelectronic application notes as well as complete technical information about HP's optoelectronic products.

The 384-page catalog contains sections on fiber optics, solid state LED displays, solid state lamps, optocouplers, PIN photodiodes, and emitter/detectors. Photographs, package dimensions, features, operating characteristics, and performance graphs are all included to provide a complete description of HP optoelectronic components. Other catalog features are an alphanumeric parts



number index and an introductory capabilities section on each product line. *Obtain your free copy by checking* **M** *on the HP Reply Card.*

Mesa structure enhances beam lead PIN performance



The glass backfilling reduces parasitics and provides strength to the beam leads of this new rugged diode.

The thin **I** layer and mesa fabrication of the 10×30 mil beam lead package contribute to the low series resistance and fast recovery time of the new HPND-4001 beam lead PIN diode.

A typical series resistance of 1.8 Ω, a recovery time (switching time) of 3 ns, and an RC product of 0.13 ps make this device an excellent shunt switching element in microstrip and stripline circuits.

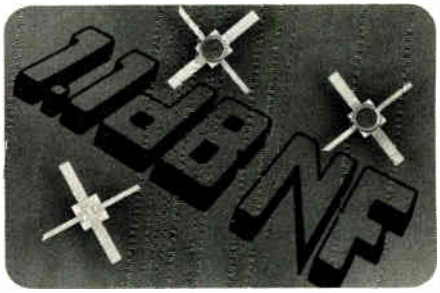
Check **N** *on the HP Reply Card and we will send you the technical data sheet and Application Note #971, "Beam Lead Mesa PIN in Shunt Applications."*

Low noise FET now in 100-mil package

With superior noise and gain performance over a wide dynamic range, the new 0.5 micrometer gate HFET-2202 GaAs Field Effect Transistor is well suited for land and satellite communication and radar applications.

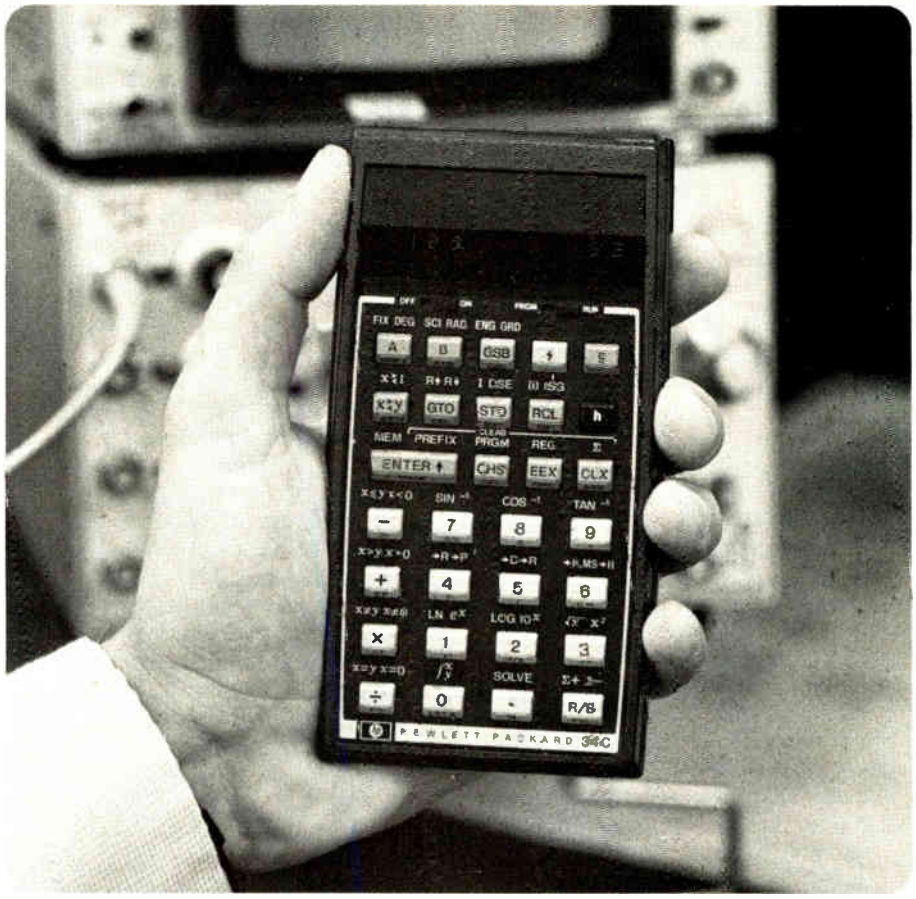
The device offers consistent operation from 2 to 12 GHz, with a typical noise figure of 1.1 dB and a 12.0 dB minimum associated gain at 4 GHz. Telecommunication applications in the 3.7 to 4.2 GHz range should look to the HFET-2202 for critical low noise front-end designs.

Check **O** *on the HP Reply Card for more information.*



For ease of design, the 0.5 micrometer gate FET comes in a rugged package for low noise figures applications at 4 GHz and up.

You asked for Continuous Memory in Series E... We didn't forget.



Last year, HP introduced Series E—designed to deliver professional quality and capability at very affordable prices. But some of you asked for more. Specifically, Continuous Memory, because with Continuous Memory you could store data and programs in your calculator even when it was turned off. Three new Series E models with Continuous Memory were developed to meet this need.

First we took the very popular HP-33E Scientific Programmable, and HP-38E Advanced Financial Programmable and added Continuous Memory to create the new HP-33C and HP-38C. Then we went a step further and developed the totally new HP-34C Advanced Continuous Memory Programmable.

Advanced Programming

The HP-34C offers you an impressive array of advanced programming features. There are up to 376 programmable keystrokes; label, line and indirect branching; E subroutine levels; indirect data storage; insert/delete editing; 4 flags, 12 labels; 2 user definable keys; and loop control to name a few.

Solve and Integrate

Also with the HP-34C are two important new function keys: Solve and Integrate. Solve finds real roots for an incredibly wide range of functions—comparable to today's best computer "root finders." Integrate, the process of computing the area of a function bounded by an upper and lower limit, has never been simple. Now, with the HP-34C, it's pushbutton easy. Also new with the HP-34C is the "gamma" function, an extension of n! that computes factorials for non-integers. These new function keys offer the sophistication of a computer but the ease of operation that must be experienced to be appreciated. Compare the HP-34C's new functions to any other solutions and see if you don't agree—HP's made another major contribution to technical problem solving.

Get full information about HP's new Continuous Memory in Series E; check **A** *on the HP Reply Card.*

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South-P.O. Box 10505, 450 Interstate North Pkwy., Atlanta, GA 30348, Ph. (404) 434-4000
Midwest-5201 Tollview Dr., Rolling Meadows, IL 60008, Ph. (312) 255-9800.
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MEASUREMENT COMPUTATION news
product advances from Hewlett-Packard

November/December 1979

New product information from
HEWLETT-PACKARD

Editor:
Bojana Fazarinc

Editorial Offices:
1507 Page Mill Road
Palo Alto, California, 94304 U.S.A.

HEWLETT PACKARD

PRICES

Following are U.S.A. domestic prices only:

HP-33C	$120.00
HP-34C	$150.00
HP-38C	$150.00
DTS-70	$95,000.00
420C	$110.00
Op. 001/unit	$20.00
HFET-2202 (Qty. 10-49)	$98.00
HP 3000 Series 30	$49,750.00
HPND-4001 (Qty. 10-99)	$14.40
5343A	$5,200.00
Op. 004	$250.00
Op. 011	$350.00
HDSP-6300 (Qty. 125)	$24.00
7310A	$4,950.00
11715A	$1,550.00
64000A full system	$125,000.00

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- Please contact me. (You will receive product information *and a follow-up* call from a Hewlett-Packard representative.

If both reply cards on this page have been used, contact your nearest HP field office or one of the regional offices listed on the preceding page. Or, write directly to the Hewlett-Packard Company, 1820 Embarcadero Road, Palo Alto, California, 94303, U.S.A.

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- ☐ ◯ E. 6259B-6274B dc Power supplies
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- ☐ ◯ H. Brochures for rack mounting HP instruments
- ☐ ◯ I. 11715A Test source
- ☐ ◯ J. 420C Economy crystal detector
- ☐ ◯ K. HP 3000 Series 30 computer system
- ☐ ◯ L. HDSP-6300 LED display
- ☐ ◯ M. Optoelectronic designers catalog
- ☐ ◯ N. HPND-4001 Beam lead PIN diode
- ☐ ◯ O. HFET-2202 GaAs FET

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MEASUREMENT COMPUTATION **news** Nov/Dec 1979

product advances from Hewlett-Packard

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Through Value Engineering, we look at your particular product needs to design a cost-effective solution to your problems. That means designing a keyboard that interfaces with your total system and meets your needs. Precisely.

It also means we can often lower your total system cost. For example, we might be able to incorporate into a keyboard several levels of codes that you had been paying for separately. And at a much higher cost.

Or maybe customize integrated circuits to provide you more logic for less money.

Besides giving you cost-efficiency, MICRO SWITCH keyboards out-feature practically every other in the industry.

You can choose LED or incandescent lighting. Tactile or linear feel. Sealed versions for military and industrial uses. Alternate or momentary action. Encoding techniques that'll meet any code requirement.

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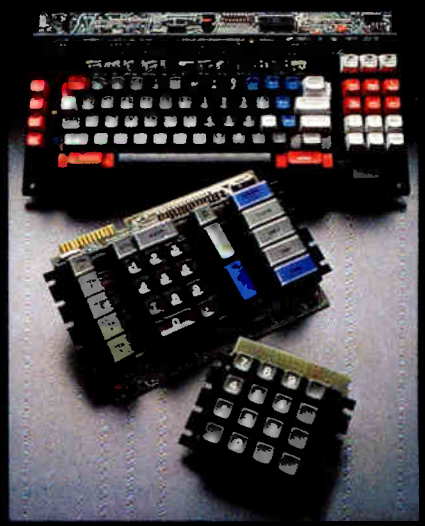
Standard, solid state Hall-effect technology throughout the line delivers reliability no mechanical keyboard can offer. Plus, we back up every keyboard we make with a 1% Acceptable Quality Level and a two-year warranty.

It all adds up to quality you can put your fingers on every time.

For more information, call 815/235-6600.

With MICRO SWITCH, you'll be paying for keyboards instead of mistakes.



MICRO SWITCH

FREEPORT, ILLINOIS 61032

A DIVISION OF HONEYWELL

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Circle 27 for data

8088: Twin Reality

Intel unveils the ultimate 8-bit CPU. Powerful. Practical. Beneath the surface, the heart of an 8086.

True beauty is never skin deep. Such is the case with our new 8088 microprocessor. On first impression, you'll see a powerful third generation CPU with the convenience and practicality of an 8-bit bus. Look closer and you'll discover the remarkable 16-bit internal architecture, megabyte addressability and advanced instruction set of our 8086.

The 8088 is both. Therein lies its ultimate beauty.

When we introduced the 8086 family more than 18 months ago we called it a new beginning, a microcomputer system architecture so advanced it would deliver a dramatic increase in system sophistication, performance and expandability. Now the 8088 delivers the same performance increase for 8-bit designs.

8088: Designed with reality in mind.

We built the 8088 to perform in the type of systems you're designing today and well into the future, too.

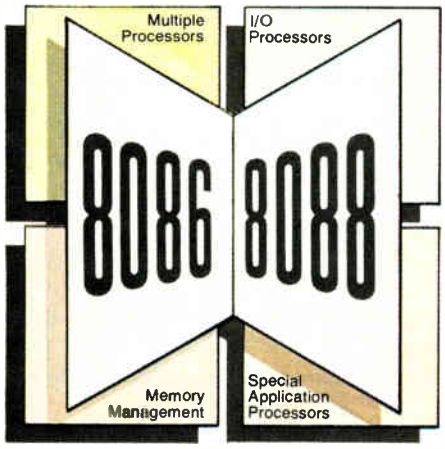
Advanced arithmetics, including 8- and 16-bit multiply and divide, boost computational thruput for your most complex mathematical and control applications. But the 8088 is much more than a superb number cruncher.

Its byte-wide orientation and extensive string-handling instructions give it unprecedented capabilities—block moves, string comparisons, data scans and translations—that make the 8088 the ideal CPU for your business-oriented applications as well.

The 8088 addresses up to a megabyte of memory, in 64K byte segments. Segmentation and efficient register utilization enabled us to build in the capability for such minicomputer-like features as instruction pre-fetch, re-entrant code, position independent code and dynamic relocation. And 64K I/O space and indirect I/O simplify programming even further.

Make your own reality.

Any way you look at it, the 8088 is a tantalizing prospect. If you are upgrading your 8080, 8085 or Z80 design, the basic 5MHz 8088 delivers two to five times



the performance, yet preserves your entire hardware investment. And with the CONV-86 code converter and PL-M/86 compiler, your software can be easily upgraded, too.

The 8088's 100% software compatibility with its 16-bit twin ensures the smoothest possible transition to any future 16-bit processor needs.

Its 16-bit internal architecture and elegant instruction set are super efficient for implementing high-level, block-structured languages such as Pascal or PL-M/86.

Etched into its HMOS* circuitry, the 8088 allows compatible interface to multiprocessing configurations with the 8086 and Intel's new generation of I/O processors, math processors, memory managers and distributed intelligence configurations.

For more space—and cost-sensitive applications, though, four other readily available Intel® bus multiplexed peripherals combine with the 8088 for a complete 8-bit system of unprecedented performance.

The future has arrived.

Because the 8088 shares the instruction set and object code of her more powerful sister, the same Intellec® development system and software package you use for 8086 program development fully support the 8088, too.

Put some true beauty into your new designs. You can order the 8088 support components and development system from your local Intel distributor, or with a single call to your Intel sales office. Or write: Intel Corporation, 3065 Bowers Avenue, Santa Clara, CA 95051. Or call (408) 987-8080.

*HMOS is a patented Intel process.

intel® delivers.

Europe: Intel International, Brussels, Belgium. Japan: Intel Japan, Tokyo. United States and Canadian distributors: Arrow Electronics, Alliance, Almac/Stroum, Component Specialties, Cramer, Hamilton/Avnet, Harvey, Industrial Components, Pioneer, Wyle/Elmar, Wyle/Liberty, L.A. Varah and Zentronics.

Circle No. 29 for information

Meetings

Computer Networking Symposium, IEEE Computer Society (Box 639, Silver Spring, Md. 20901) *et al.*, National Bureau of Standards, Gaithersburg, Md., Dec. 12.

Conference on Decision and Control, IEEE, Galt Ocean Mile Hotel, Fort Lauderdale, Fla., Dec. 12–14.

Winter Consumer Electronics Show, Electronic Industries Association, Convention Center, Hilton and Jockey Club Hotels, Las Vegas, Nev., Jan. 5–8.

Sixth Semiannual ATE Seminar and Exhibit and First Annual Test Instruments Conference, Benwill Publishing Corp. (1050 Commonwealth Ave., Boston, Mass. 02215), Convention Center, Pasadena, Calif., Jan. 7–10.

Second Design and Finishing of Printed Wiring and Hybrid Circuits Symposium, American Electroplaters' Society (1201 Louisiana Ave., Winter Park, Fla. 32789), San Francisco Hilton, Jan. 15–17.

TV Mex, the TV Microelectronics and Microprocessing Exhibition, and IDEA, the International Domestic Electrical Appliances Exhibition, Montbuild Ltd. (11 Manchester Sq., London W1M 5AB, England), National Exhibition Centre, Birmingham, England, Jan. 15–17.

VHSIC—A New Era in Electronics, American Institute of Aeronautics and Astronautics (Box 91295, Dept. VHSIC, Los Angeles, Calif. 90009), Hyatt Regency, Cambridge, Mass., Jan. 21–22.

Advanced Semiconductor Equipment Exposition, Associated Ad-Ventures Inc. (Suite V, 4546 El Camino Real, Los Altos, Calif. 94022), Convention Center, San Jose, Calif., Jan. 22–24.

Annual Reliability and Maintainability Symposium, American Society of Mechanical Engineers, IEEE *et al.* (for information, contact N. Kutner, Burroughs Corp., Burroughs Pl.–5F48, Detroit, Mich. 48232), San Francisco Hilton, Jan. 22–24.

Communication Networks '80, The Conference Co. (60 Austin St., Newton, Mass. 02160), Sheraton Washington, Washington, D. C., Jan. 28–30.

Fifth Topical Meeting, Integrated and Guided Wave Optics, Optic Society of America (200 L St. N. W., Washington, D. C. 20036) and IEEE, Hyatt–Lake Tahoe, Incline Village, Nev., Jan. 28–30.

11th International Symposium for Mini and Microcomputers, International Society for Mini and Microcomputers (P. O. Box 2481, Anaheim, Calif. 92804), Asilomar Conference Grounds, Pacific Grove, Calif., Jan. 30–Feb. 1.

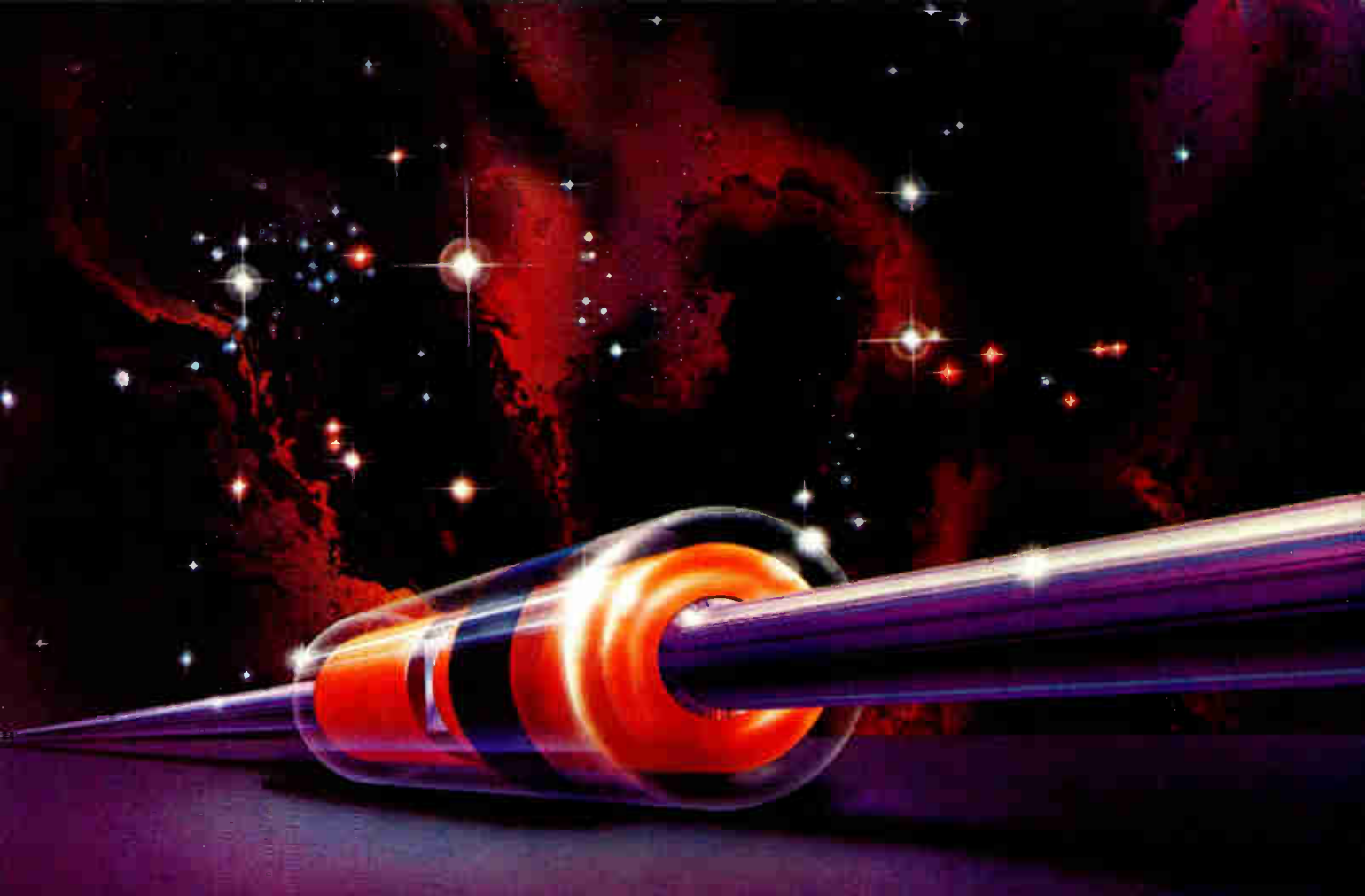
Annual Television Conference, Society of Motion Picture and Television Engineers (862 Scarsdale Ave., Scarsdale, N. Y. 10583), Sheraton Centre Hotel, Toronto, Feb. 1–2.

Eighth Semiannual Conference on Federal ADP Procurement: New Departures, American Institute of Industrial Engineers (P. O. Box 3727, Santa Monica, Calif. 90403), Shoreham Americana Hotel, Washington, D. C., Feb. 4–6.

The Automated Office, American Institute of Industrial Engineers, Computer and Information Systems Division (P. O. Box 3727, Santa Monica, Calif. 90403), Statler Hilton Hotel, New York, Jan. 28–30, and Twin Bridges Marriott Hotel, Washington, D. C., Feb. 11–13.

Word/Text Processing, American Institute of Industrial Engineers, Computer and Information Systems Division (P. O. Box 3727, Santa Monica, Calif. 90403), Ambassador West Hotel, Chicago, Feb. 20–22.

Third Conference on Laser and Electro-Optical Systems, IEEE, Optical Society of America (200 L St. N. W., Washington, D. C. 20036), *et al.*, Town and Country Hotel, San Diego, Calif., Feb. 26–28.



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Astronomical odds, but it hasn't happened by chance. When it comes to workmanship standards and rigid process control, we leave nothing to fate. We use no body paint that might mask microcracks or photoelectric effects. Individual glass seals and diode chips are 100% inspected for microcracks and other abnormalities, making R-Ohm diodes unfailingly reliable, even under the most severe conditions. Because our actual accumulated Field Failure Rate is only 1.2 electrical rejects in a billion, we've never had a lot rejected by a customer. Quality like that makes AQL standards obsolete. That's why the industry's most demanding OEM's have switched to R-Ohm. For immediate delivery of incredibly reliable industry-standard diodes, contact us today.

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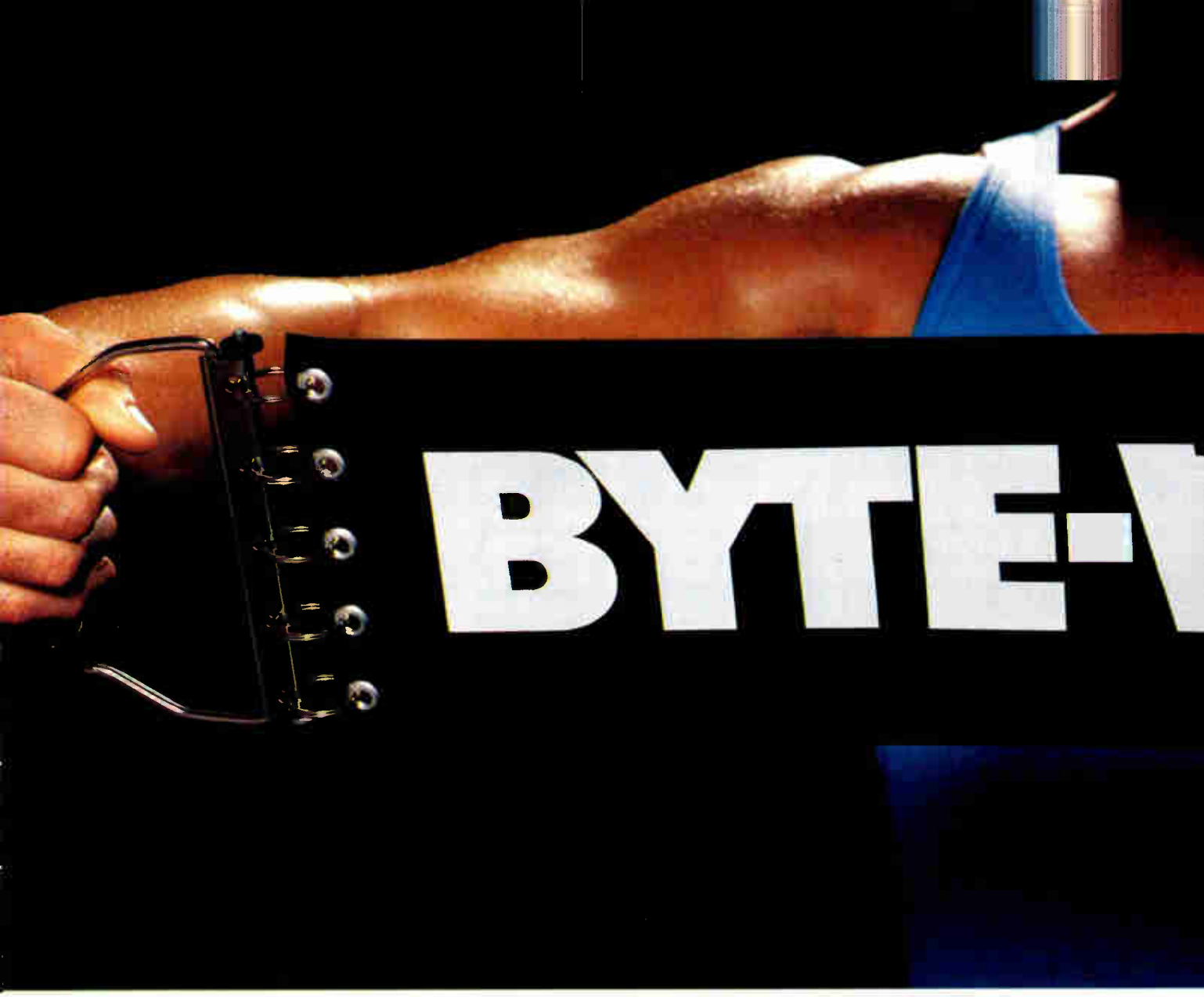

Stretch your memory for system flexibility.

Mostek's Byte-Wyde family features compatible RAMs, ROMs and EPROMs. Their common pinouts allow you to interchange all three and upgrade to next generation memories without redesign.

Byte-Wyde organization is consistently *n-words x 8-bits,* so these memories match byte-oriented microcomputers perfectly. And, Byte-Wyde performance meets the demands of the very latest microcomputers.

Simple system control functions on both our static and pseudostatic memories make interfacing easy. And our Byte-Wyde family offers state-of-the-art memory components as well as a logical package philosophy.

Mostek's Byte-Wyde memories includes RAMs, ROMs and EPROMs with density options ranging from 8K to 64K.

So, if you're designing with microcomputers, fill in and mail the attached coupon and we'll send you our Byte-Wyde Memory Design Guide.

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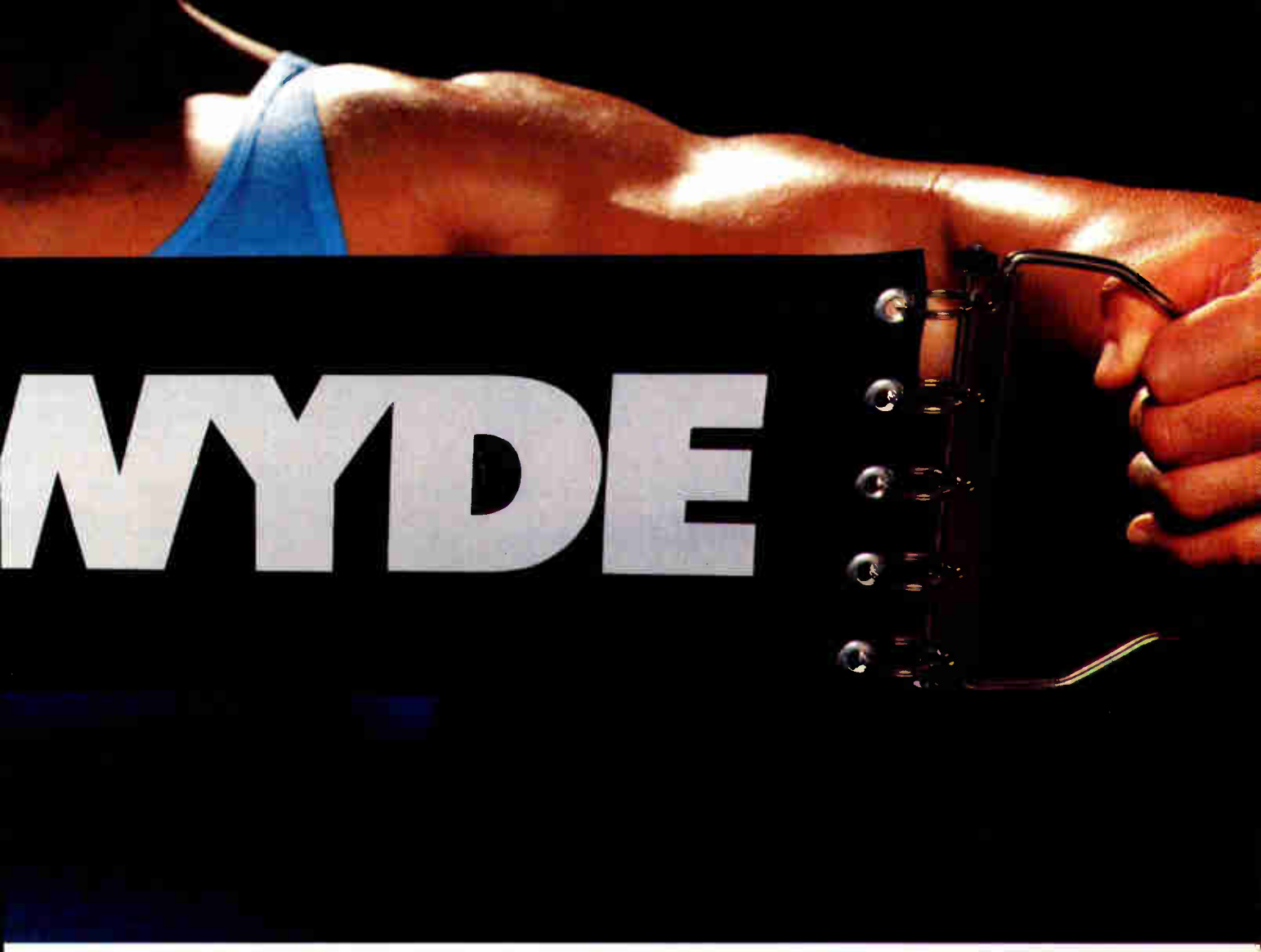

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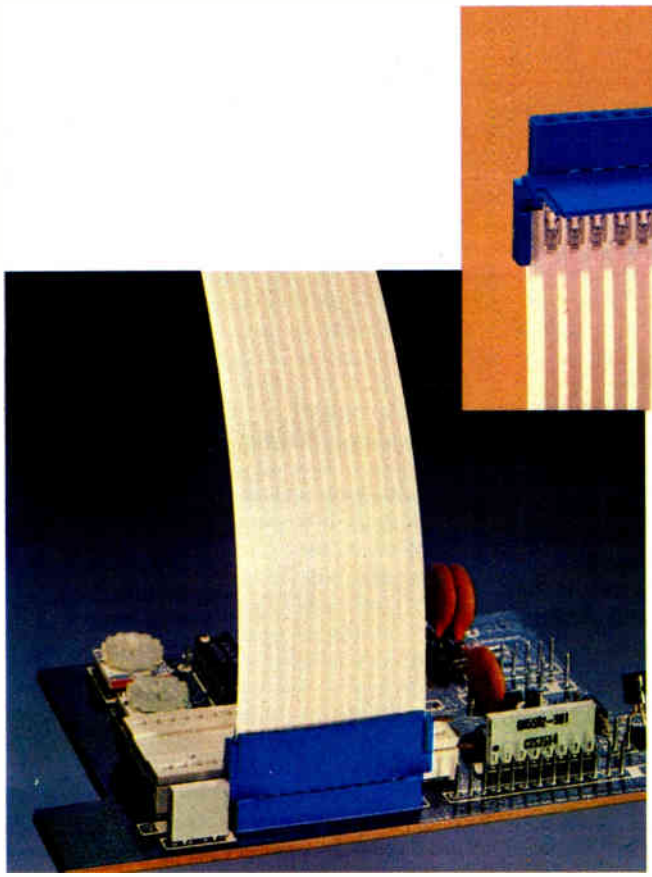
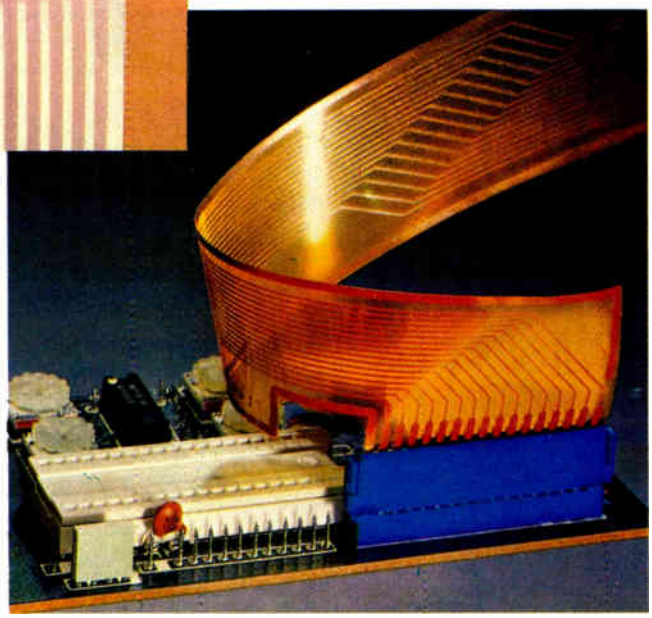
Circle 33 on reader service card

Berg's Clincher* connector mass terminates flat conductors quickly and reliably.



The "Clincher" on flat conductor, flat cable.



The "Clincher" on flat conductor, flex circuitry.

The "Clincher" is a superior connector system for flat conductor, flat cable or flex circuits. It offers high reliability and the lower applied cost of mass termination.

With the "Clincher," all of the flat conductors are terminated simultaneously, within 15 seconds. Cable stripping is not required. The "Clincher" system offers a substantial reduction in total installed cost over individually terminated conductors.

The "Clincher" design uses Berg's proprietary PV* receptacle, a connector of proven reliability for over a decade in data processing and telecommunications applications. The dual-metal construction of the "PV" provides a high normal force to assure highly reliable mechanical and electrical performance.

Berg's "Clincher" accepts a 1 to 2 oz. copper 0.062" wide cable. It is stackable on 0.100" centers in double-row configurations for dense packaging. The "Clincher" mates with 0.025" pins or standard Berg headers to form a complete interconnection system.

Rely on Berg for quality performance to meet your most demanding application needs. For a brochure describing the "Clincher" system, write or call:

The Du Pont Company, Berg Electronics Divison, New Cumberland, Pennsylvania 17070.
Telephone: (717) 938-6711.

DU PONT BERG ELECTRONICS

*Du Pont Trademark

Electronics newsletter

U. S.-Canadian compromise triples down-link capacity

Delegates to the 10-week World Administrative Radio Conference due to wind up in Geneva on Dec. 5 have worked out what U. S. and Canadian delegates describe as a "stunning" solution to their dispute over use of the 11.7-to-12.7-GHz band. That band is for down links for geostationary fixed-service and direct-broadcasting satellites in the Americas. Going into the conference, the U. S. wanted to allocate the bottom half of the band for fixed service and the top half for direct broadcast. The Canadians insisted on leaving the entire band open for both, with allocations of orbital positions to avoid interference. The solution, worked out with the help of several Latin American countries, **essentially divides the 100-MHz band down the middle,** allocating the bottom half for fixed service and the top for direct broadcasting, **but also permits direct broadcasting in which power limits do not exceed 53 dBW in the bottom half of the band and some fixed service in the top.** The net result is roughly three times as much capacity for both kinds of satellites.

Development system supports for processors, says Tektronix

Taking a cue from semiconductor manufacturers, who often announce a product before production begins in order to reserve space in highly competitive markets, Tektronix Inc. of Beaverton, Ore., is raising the curtain on its 1980 Microprocessor Development Lab (MDL) advances. The company claims its MDL 8002A, a universal system, is the first to support all four major 16-bit microprocessors. Already capable of supporting the Texas Instruments TMS9900, **the 8002A will have assemblers and prototype-debugging packages for the Intel 8086 and Zilog Z8000** by the second quarter of 1980 and for the Motorola 68000 by the third quarter. Programs will be downloaded from the MDL through a peripheral unit that permits real-time prototype analysis and in-circuit emulation of these 16-bit processors, in addition to 8-bit devices.

Pentagon expects export control update results in a year

The Defense Department expects significant results by October 1980 in its effort to update and possibly simplify technology export license regulations **by identifying and categorizing critical technologies,** according to William J. Perry, under secretary for research and engineering. The results will be the product of nine industry-named Critical Technology Export Groups and 13 Technology Task Groups comprising Federal agency specialists.

The seven export electronics groups involve: array processors; acoustic arrays; computer networks; high-energy lasers, large-scale integration production; infrared detection; and structures, materials, and processes. Nine of the 13 technology groups oriented toward electronics equipment deal with: avionics and navigation, computers, telecommunications, transportation, instrumentation, semiconductors and materials, components, photography, and military equipment and materials.

Technology transfer beyond U. S. control, OTA tells congress

The U. S. may be wasting its time trying to control the transfer to the Soviet Union of Western electronics and other civilian technologies that may also have military applications. That is a key conclusion of a 300-page analysis delivered at the end of November to Congress by its Office of Technology Assessment (OTA). Titled "Technology and East-West Trade," the report finds that such U. S. allies as Japan, West Germany, France, and Great Britian view the sale of technology as "primarily an

economic issue," **and do not share U. S. concerns over the political, military, and strategic implications of maintaining tight controls** over so-called dual-use technologies. Moreover, the report notes, there is little the U. S. can do to prevent Soviet acquisition of all Western civilian technology it can use militarily, since the U. S. is not the sole source.

14-bit s-to-d converter housed in one package

In a move away from complex hybrid circuits and toward a greater monolithic capability, ILC Data Device Corp. will be offering a 14-bit synchro-to-digital converter in a single package. A major supplier of military-grade converters, the Bohemia, N. Y., company currently offers the converter housed in two packages, with several dozen chips making up the multilayer hybrid circuits. **The new converter will have three customized monolithic chips bonded onto a single-layer substrate** and is scheduled for delivery early next year.

Microwave system that detects, treats tumors is tested

A microwave system capable of both detecting and treating tumors using microwave heating, or hyperthermia [*Electronics*, April 26, p. 88], has completed first tests at Norfolk General Hospital in Virginia. Developed by Kenneth L. Carr, senior vice president of Microwave Associates Inc., Burlington, Mass., the system may be the first to combine both detection and treatment capabilities. **Ultimately, cancers could be treated almost simultaneously with diagnosis.** The detection scheme also may be the first to take advantage of cancerous tissue's tendency to heat faster than healthy tissue when irradiated with microwave energy. A C-band radiometer is the system's sensor, and a 25-W variable-frequency solid-state microwave source is used to heat tissue, both for detection and treatment. In the recent tests, sponsored by the National Aeronautics and Space Administration, 14 patients were examined; a tumor that conventional diagnostic techniques had missed was detected in one.

Zenith, GE want in on disk market

Convinced that video disk players represent a larger market than video cassette recorders, Zenith Radio Corp., General Electric Co., and other U. S. television assemblers are not going to leave the market to RCA Corp.—which is scheduled to unveil its SelectaVision on Dec. 7—and Magnavox. **GE is now looking for design engineers to build prototypes, and Zenith vows to come out with its own unit soon, too.** Knowledgeable consumer electronics marketers predict that video disk player sales will exceed video cassette recorder sales within three to five years of national distribution. However, all sides concede that RCA's SelectaVision will be tough to beat because of its unique position: its access to software and the fact that it will also make its own disks.

Addenda

The first add-in memory system, a quarter-megabyte model, for Digital Equipment Corp.'s VAX 11/780 super minicomputer is coming next February from Mostek Corp. of Carrollton, Texas. . . . Japan's Sharp Corp. will start production next spring of the Zilog Z8000 and Z8.

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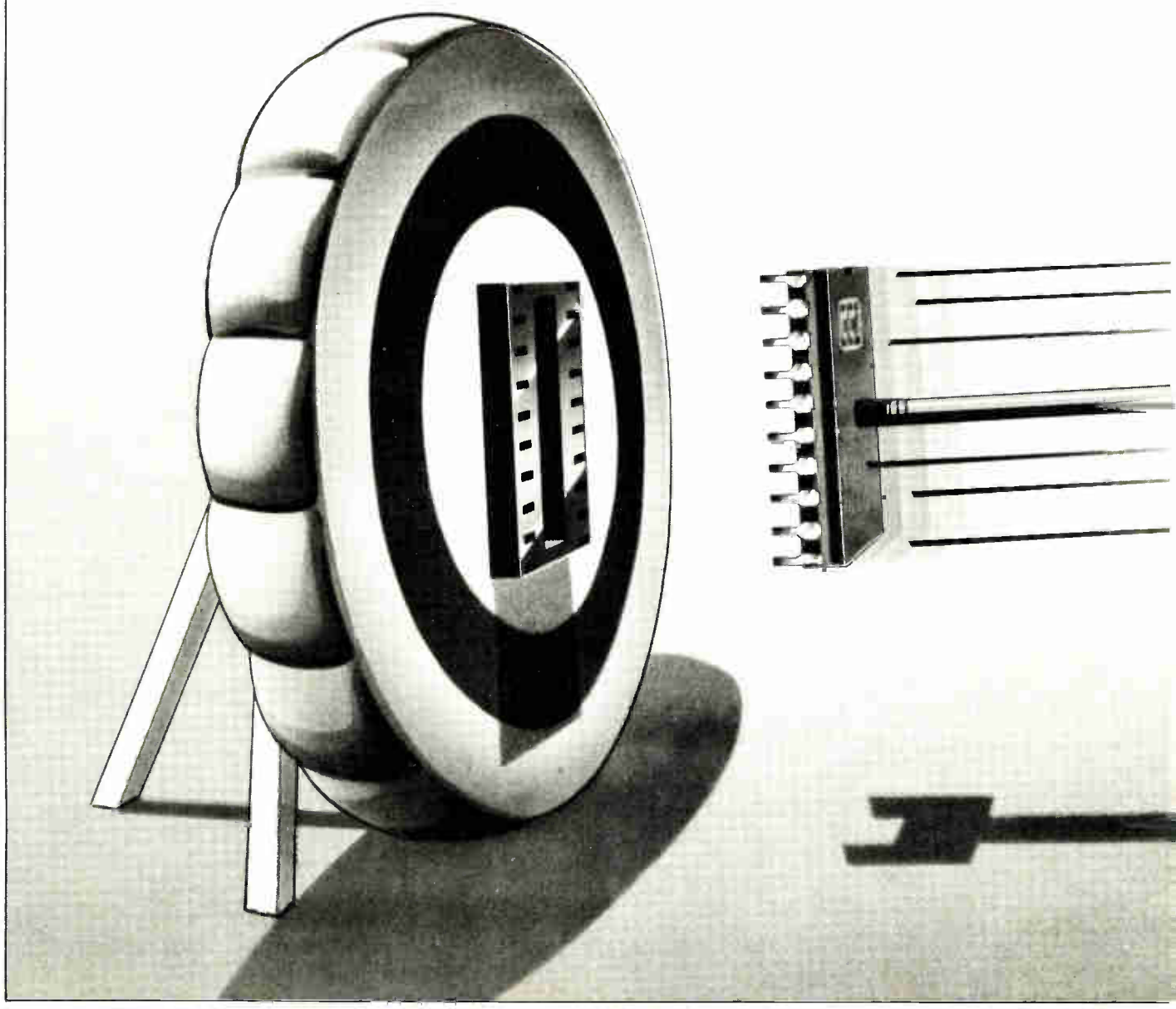

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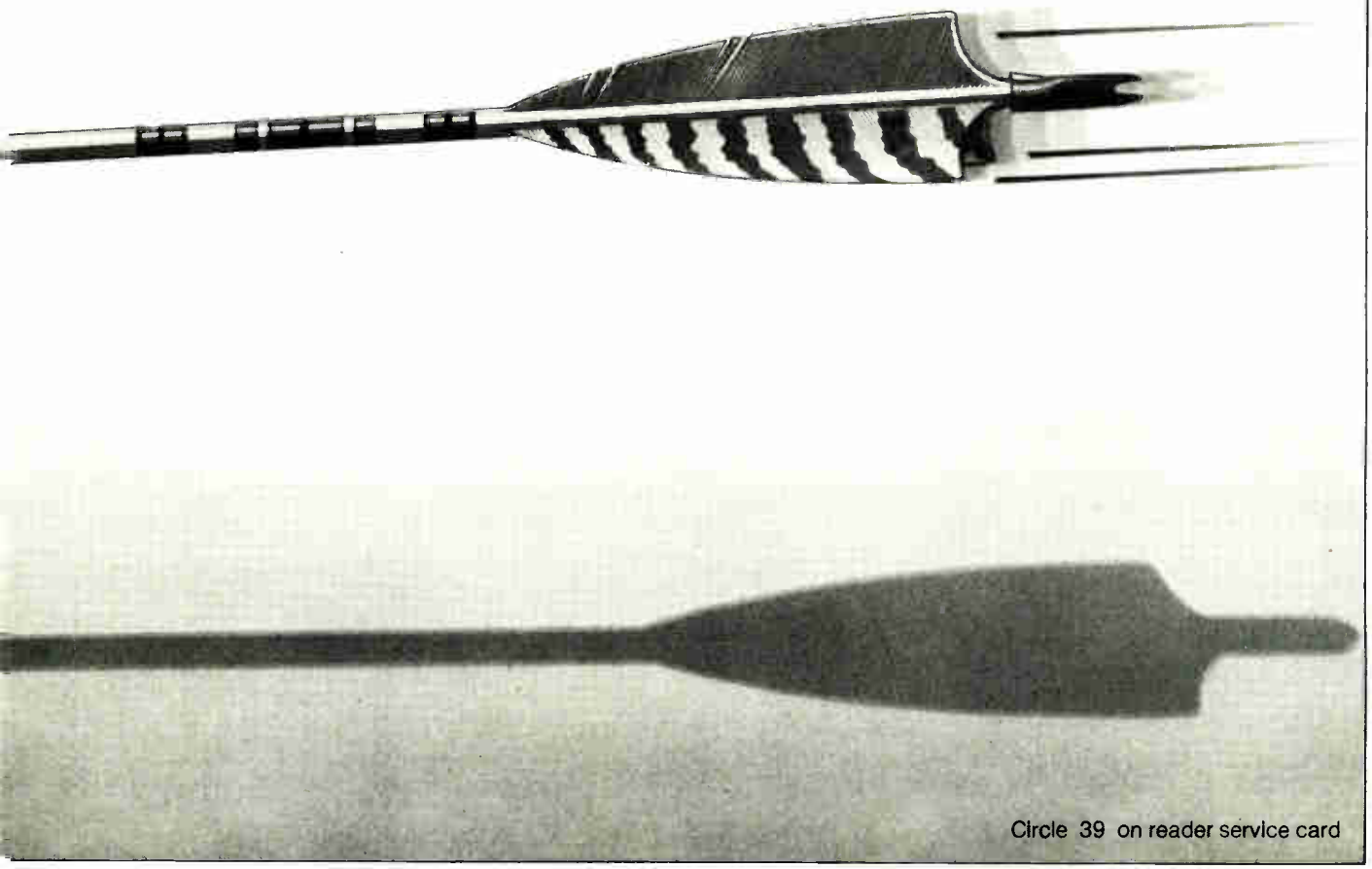

Circle 39 on reader service card

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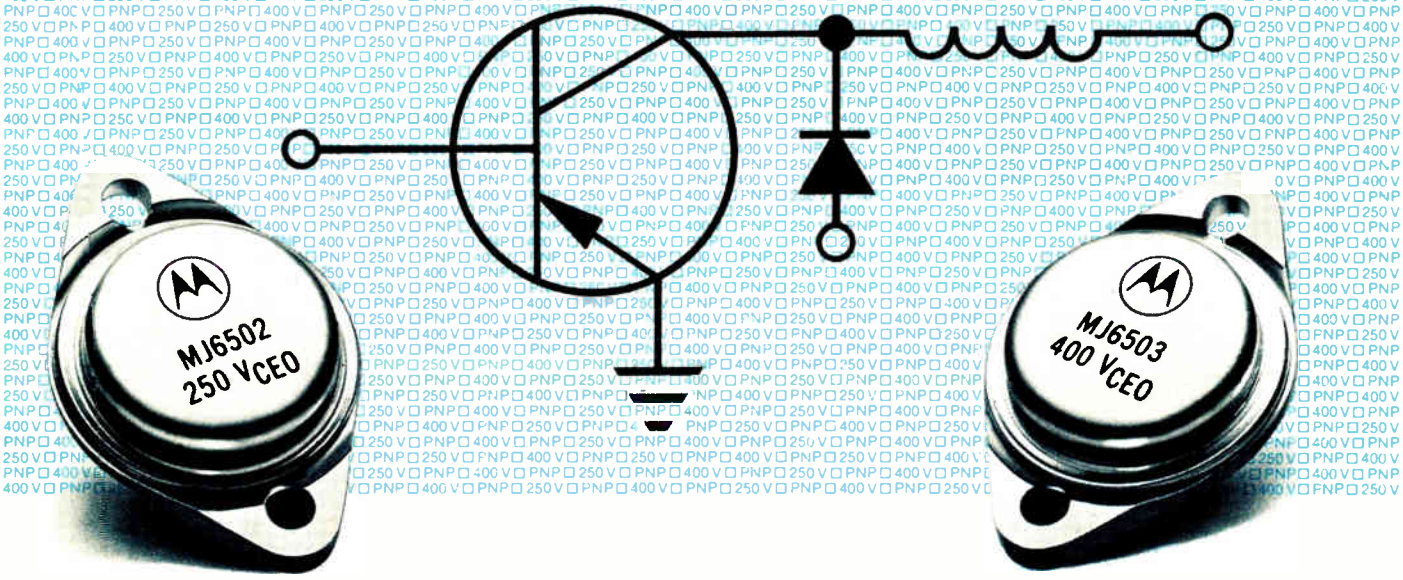

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U. S. trade unit sees bad omens for IC industry

by Ray Connolly, Washington bureau manager

New study shows Japan gains in sales and productivity, while Europeans buy into American high technology

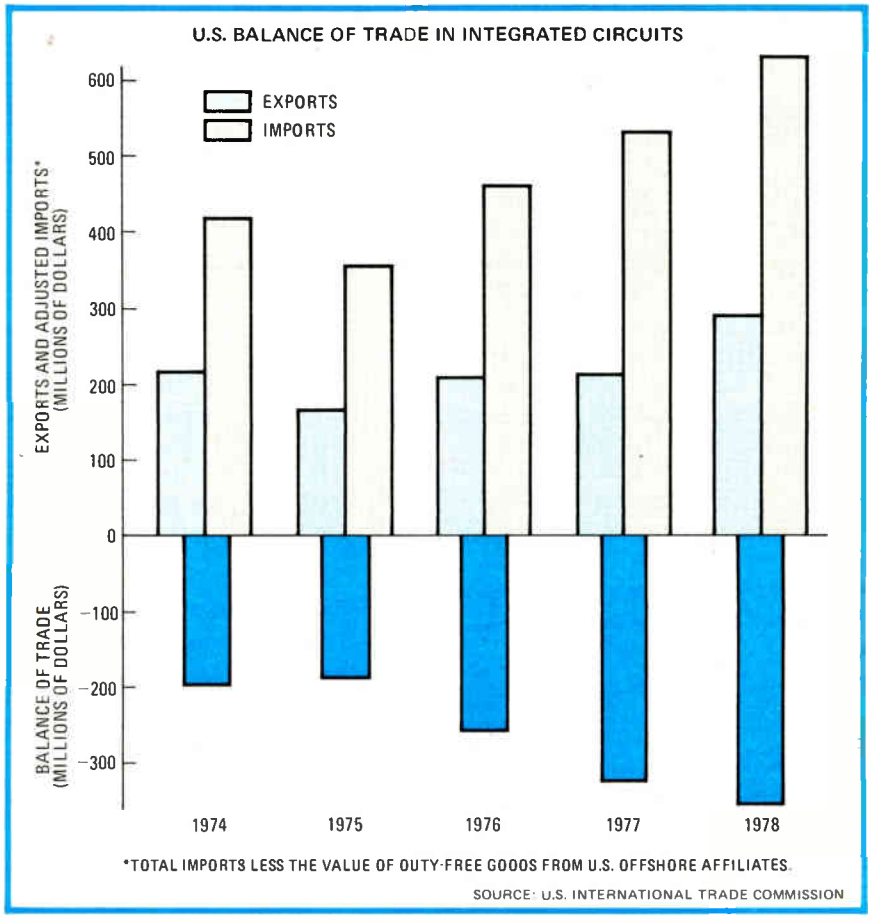
The U. S. integrated-circuits industry is now paying the price for underinvestment in new plant and equipment following the 1974–75 recession, when manufacturers failed to anticipate the market boom that followed. The price, an International Trade Commission (ITC) report to the Senate charges, is a declining share of the world export market, a steadily rising IC trade deficit in the domestic market, and increased foreign takeovers of capital-starved U. S. producers, coupled with a productivity level that appears to have fallen below that of Japan, its principal competitor.

"A modest restructuring" to come in the U. S. industry will include "the exit of some marginal small- and middle-size firms," as well as a drop in the number of new business entries in the face of stiffer capital requirements, the 10-month study concludes. Nevertheless, ITC's Nelson Hogge, a principal author of the report, sees no conflict between this bad news and the good portents that the U. S. industry will enjoy continued growth in absolute terms, world leadership in technological development and production, and steady profitability.

Hogge insists that the growth forecast is not incompatible with the stiffer competition facing the U. S. However, the Semiconductor Industry Association's counsel in Washington, Peter B. Archie, is equally firm in his insistence that the ITC's optimistic outlook is unsupported by the report's statistics.

Controversial. The Senate subcommittee on international finance, which has scheduled a Jan. 15 hearing on the 150-page report, acknowledged that "there is some controversy about the forecast." The hearing will address that issue and other aspects of the report with witnesses from the ITC, other trade experts from Government, the SIA, and other industry witnesses, says subcommittee staff member Robert Russell. The report, titled "Competitive Factors Influencing World Trade in Integrated Circuits," was requested last autumn by the subcommittees on international trade and on international finance. The trade subcommittee will not decide before January what action, if any, to take on the report, according to staff member David Foster.

What the ITC study's 72 tables and charts show are mostly bad signs



for the U. S. industry's world market domination. Using data assembled from a survey of U. S. and Japanese companies and Government agencies, plus publicly available information on the European Economic Community (which refused to participate), the study says:

- The U. S. share of the world's IC export market is steadily slipping, dropping from 91% of the $705 million market in 1974 to 79% of the $1.6 billion exported in 1978. Almost all of this loss was absorbed by Japan, the ITC says.
- The U. S. trade deficit in ICs is steadily growing (see bargraph, p. 41), from $196 million in 1974 to $349 million in 1978 after adjustment to eliminate duty-free imports under the U. S. Tariff Schedule. Sections cover partially processed U. S. products exported for further processing and then reimported and products assembled and processed offshore from U. S. parts. Imports subject to duty have risen at a far faster rate than exports in the five-year period.
- Foreign investment in American IC producers has risen in the decade since 1969 from the $285,000 used by Canada's Northern Telecom Ltd. to acquire 12.4% equity in Monolithic Memories to this year's $397 million takeover by France's Schlumberger Ltd. of Fairchild Camera and Instrument. All told, 19 U. S. companies have sold part or all of their equity to foreign companies for $584 million. "Foreign investment," the ITC says, "has been directed at high technology firms located in the area south of San Francisco," with most of the money coming from Western Europe. Japan's share of this total is only 3.17%, involving four transactions. The growing level of foreign investment is attributed by the ITC to "poor financial performance by certain U. S. producers and depressed conditions in the U. S. stock market" that limits capital availability.

Japanese IC producers have achieved a higher unit of output than the U. S. industry on the basis of aggregated investment in research, plants, and equipment, the ITC claims in one of its more controversial conclusions. When shipments and exports per employee were measured, the ITC states, Japan took the lead away from the U. S. in 1976–78 and that spread is widening. To achieve its nearly $3.7 billion in 1978 shipments, the U. S. industry invested 24%, or $897 million, in plants and equipment and spent 14%, or nearly $530 million, on research and development. Japan's more rapidly growing IC industry, operating on a much smaller base, reportedly had 1978 shipments of about $1.1 billion, according to sources familiar with the unedited version of the ITC report, which withheld the Japanese totals on the basis of confidentiality.

This figure would put Japan's $172 million invested in plant and equipment at about 16%, so shipments required only two thirds the investment needed for U. S. output. On the other hand, the Japanese R&D investment of $199 million for the year would represent 18% of shipments, a third better than the U. S. figure.

However, the SIA is challenging the ITC estimates of higher Japanese productivity. "Any significant disparity would be highly surprising, because manufacturing equipment and processes in both countries are identical," the SIA's executive director, Tom Hinkelman, comments. "The Japanese investment data should be verified."

Communications

Frequency synthesizer uses SOS process, integrates prescaler, switches in 50 μs

Moving its burgeoning silicon-on-sapphire program a step closer to commercial realization, Rockwell International Corp.'s Microelectronics division has developed an SOS frequency synthesizer. Such a chip benefits significantly from the combination of high speed and low power offered by complementary-MOS on a sapphire substrate.

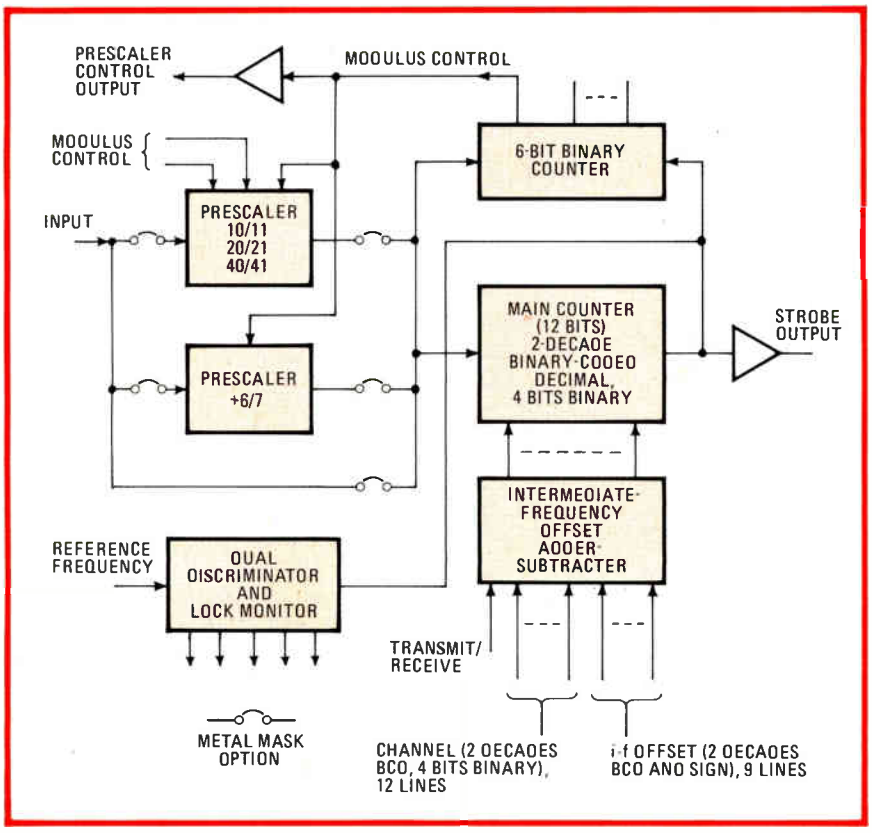
"A frequency synthesizer is a nice thing to do with C-MOS on sapphire because it requires front-end speed in the incoming signal going into a chip, and that's where SOS can really shine," says Ray Kjar, manager of SOS products for the Anaheim, Calif., division.

Plans. The new chip is intended for a wide range of applications in the very- to ultra-high-frequency regions, although at the moment outside sales are forbidden by sister division Collins Radio, which financed development. However, Rockwell does see significant market niches for this and other SOS devices developed for in-house use. Also, the company is pushing its SOS technology for increasingly dense devices [*Electronics*, June 7, p. 48].

The synthesizer has 3-micrometer channel lengths, operates at 120 megahertz, and typically dissipates 25 milliwatts. So far, a 7-volt power supply is required, says Kjar, but Rockwell is aiming at getting this down to the more standard 5 V, just as it is working to boost operating frequency up to 160 MHz or so. Power consumption drops with the operating frequency until leakage of 10 microwatts dominates at frequencies below 100 kilohertz.

Since much of the synthesizer's performance depends on what is required by the communications system in which it is used (in Collins' case, military radios for the Navy), it can be made as accurate as the on-chip frequency-reference standard dictates, with several kinds of outputs. The switching rate can be as fast as 50 microseconds, says Kjar. Getting to the higher uhf frequencies, where more avionic and commercial applications open up, "simply involves the choice of the appropriate prescaler," he says.

The importance of the Rockwell synthesizer as an advanced SOS development is noted by a researcher



Precious stuff. Rockwell's new frequency synthesizer on a chip uses silicon-on-sapphire technology and features a choice of two types of prescalers or none at all.

working with the technology at Hewlett-Packard Co. He terms the performance of 120 MHz at 25-mW dissipation and 50-μs microsecond switching "very significant."

On-chip prescaler. Particularly impressive is the fact that the synthesizer is capable of uhf operations with a prescaler integrated on chip, he says. Many applications outside Rockwell certainly can use the synthesizer, he confirms.

On the chip (see figure) are 1,500 transistors in an area 115 by 140 mils. All inputs and outputs are compatible with TTL and n-channel devices.

Word of this C-MOS-on-sapphire product has leaked out and already triggered requests to buy it, Rockwell says. It is thus an example of an SOS product with a market niche foreseen by the division, Kjar says.

The firm will avoid general microprocessor and memory products, where n-channel speed advances already negate SOS's advantage. The need to charge premium prices also would work against the technology here, he says.

Meanwhile, further work in C-MOS on sapphire at Rockwell's nearby Electronics Research Center is pushing device density in an advanced version of a Viterbi decoder. Whereas the original device had 8,188 transistors on a 124-by-184-mil die, the new one crams 33,000 transistors onto an area of 170 by 250 mils. **-Larry Waller**

Industrial

Control system uses multiple 8048s

Add another chip maker to the list of semiconductor houses offering systems for industrial markets. Intersil Inc. is launching its Remdacs—for remote data-acquisition and -control system—that makes liberal use of microcomputers to fit onto compact circuit boards, transmitting digital signals long distances over an inexpensive twisted-wire pair.

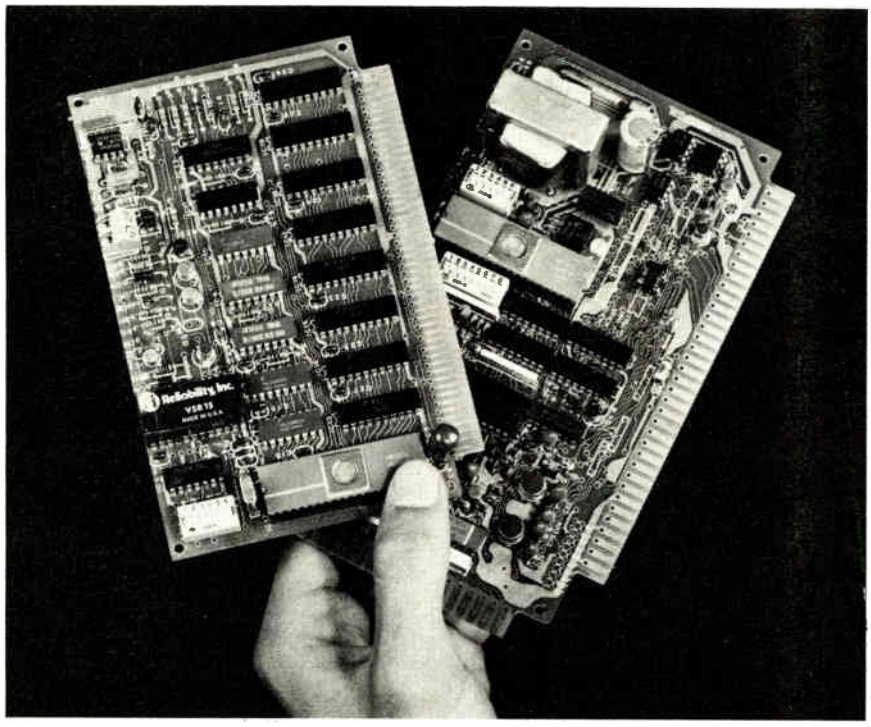
By putting an 8048 at each remote sensing station, Remdacs can handle voltage and temperature transducer inputs while supplying digital outputs to a central receiver/transmitter card. The receiver/transmitter incorporates its own 8048 for data-flow control to and from a central computer and for formatting messages of either 24- or 44-bit words to as many as 512 remote stations.

New business. With the demand for microprocessors and other integrated-circuit logic so strong, chip makers' diversification into such systems business may seem unnecessary. What they see coming fast is the day when even one-chip microcomputers are jelly-bean parts available from many vendors.

So the time is ripe to seek new markets, and systems business is the logical step up from chip vending. Intersil is far from the first to make the move; among the chip makers already in the industrial market are Intel, which offers the iCS 80 industrial controller [*Electronics*, March 1, p. 50]; Analog Devices with a large line of industrial controllers, including Macsym 20 [*Electronics*, Nov. 8, p. 40]; and Texas Instruments, which even offers a speech-synthesis module for manufacturers of industrial controllers [*Electronics*, Nov. 8, p. 44].

The Cupertino, Calif., firm is noted for its complementary-MOS parts, and it will replace the 8048 with its own C-MOS version when it becomes available. The first Intersil version coming in late spring, will be the 87C48 with an erasable programmable read-only memory, and Remdacs will use that part until the 80C48 comes on line in a year.

The Remdacs architecture employs remote distributed intelligence, unlike industrial systems from some other chip makers, because the company thinks it will be cheaper in the long run. With a microcomputer plus the necessary multiplexers and analog-to-digital converters and each remote station, the system can forgo the complex and expensive wiring and signal conditioning neces-



Handful. Intersil fits its new remote data-acquisition and -control system on compact cards; at left is the receiver/transmitter and at right is one of the remote stations.

sary to transmit analog inputs to a host central processing unit.

The remote microcomputers also relieve the host CPUs of many overhead tasks. Intersil sees typical applications as energy management systems for large buildings, process monitoring for a variety of industries, and test-bed instrumentation.

Remdacs actually consists of four types of boards: two types of remote stations, the receiver/transmitter, and an RS-232-C card when communication via a serial interconnection to the computer is preferred to a parallel one. A sample system, available now, consists of one of each type of board and costs $1,000.

One type of remote station handles voltage signals, either 16 single-ended inputs or 8 differential inputs, with one digital input/output channel. The other type handles one temperature input and has four digital I/O channels.

Dual protocol. The dual-length message format permits addressing of 256 remote stations with 24-bit words and 256 with 44-bit words. The transmission speed is user-selectable from 150 to 4,800 bauds.

The 24-bit word is intended for applications in which the amount of acquired data is small and the maximum system throughput is crucial. The 44-bit word is directed toward applications needing more data per message, with better integrity. It uses an 8-bit cyclic redundancy check in place of the shorter word's 4-bit checksum error check. The other 16 bits provide two more data bytes. **-Benjamin A. Mason**

Office automation

Software integrates many functions

Computer systems tying together more than one business function represent the leading edge of office-automation technology. A key example comes from Datapoint Corp., which is launching software that integrates word processing and electronic mail with data-processing and telecommunications-managment capabilities already part of the San Antonio company's systems.

Notable among software enhancements are a program that can search the data memory by content and one that integrates the management of data transfer and the telephone system. They are part of a package including new hardware [*Electronics*, Nov. 22, p. 34] unveiled at the annual meeting in New York last week. Datapoint has made its name as a maker of distributed data-processing equipment and sees its future as supplier of a range of products that can add up to a totally automated office.

Content-addressable. Likely to draw particular attention is the content-addressable access scheme, part of the word-processing package. Known as AIM, for associated index method, it allows files of up to 12.5 megabytes (about 65,000 documents) to be searched for all mention of free-format, user-specified key words, partial words, phrases, or sets of words.

"What we've developed here is an access technology that lets you call whatever you're filing nothing. But you can retrieve it by calling it anything," explains Jonathan Schmidt, vice president for advanced product development.

Such a system can save more time than traditional numbered indexing methods and can prevent loss of information due to misfiling. Similar capabilities using a hardware implementation have been under development by a number of computer companies, including International Computers Ltd. of the UK [*Electronics*, June 7, p. 73].

However, Datapoint may be the first to put content addressability into a commercially available product. AIM requires about a 10% software overhead, says Gerry Cullen, vice president of product marketing. The company is not disclosing details of the program, however.

Voice and data. As part of its new electronic message service, the company offers communication among terminals within an office. It also has integrated management of data transmission with its existing LDCS long-distance control system, which performs such functions as least-cost routing of telephone calls. One new benefit is the ability to queue low-

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Circle 45 on reader service card

Infrared gives the word

Infrared radiation is beginning to attract attention as a means of low-cost flexible data transfer between computers over short distances. Datapoint Corp. introduced new hardware last week that uses IR light to transmit data between computer networks in different buildings. LightLink, as the company calls it, may be the first commercially available IR data transfer. However, several companies have reported work on the concept, including IBM [*Electronics*, Sept. 28, 1978, p. 41].

LightLink will transfer data at 2.5 megabits per second using modulated, noncoherent IR radiation for line-of-sight transmission of digitized data between computer networks up to two miles apart. Each box houses spontaneous-emission diodes and avalanche-diode detectors necessary for full-duplex communication with only 1 milliwatt of output power.

When extreme atmospheric conditions cause intolerable transmission impairment, the system is programmed to shut down automatically until conditions improve, Datapoint officials point out. Additional circuitry for implementation of the National Bureau of Standards' data encryption standard is also available.

Using available components, data rates as high as 10 Mb/s are attainable with the LightLink technology, notes Vic Poor, senior vice president for research and development. Since the 2.5-Mb/s rate is sufficient for the company's attached-resource-computer (ARC) network, multiplexed channels are possible.

Priced at $24,750 per pair, LightLink was designed with an eye toward cutting the cost and inconvenience associated with other communication techniques. Unlike microwave transmission, no time-consuming licensing procedure is required to use an IR link, notes Poor. The high cost of laying an underground coaxial cable can also be avoided.

priority data messages for transmission over flat-rate voice lines during times of light use.

The foundation of Datapoint's integrated office is its attached-resource-computer (ARC) network architecture. This relies on a high-speed bus to link as many as 255 multifunction processors in a network sharing a data base, says Cullen. Word processing and electronic mail service may be licensed for $750 and $1,500 respectively, plus appropriate media charges. New hardware includes the light-link communication device (see "Infrared gives the word"). The office package is scheduled to be available in early February.

Buildup. As a pioneer in distributed data processing, the 11-year-old San Antonio, Texas, firm brought out one of the first intelligent terminals in 1970. That machine lead to its current line of multifunction business processors, which can be used on a stand-alone basis or as add-on units in the ARC network concept introduced in late 1977.

The company "certainly caught the crest of the wave in the distributed-processing area," says William Becklean, an analyst with Bache Halsey Stuart Shields Inc.'s technology group in Boston. Since 1975 sales have zoomed at an annual growth rate averaging nearly 50% from $47 million to $232 million in the fiscal year ending July 31.

Datapoint's new software is the latest, and among the most comprehensive, of recent office-automation product introductions. The most competitive product is Wang Laboratories Inc.'s Integrated Office Systems, introduced last summer, although Datapoint will also face IBM's complex of products, including the recently introduced 5520 and a variety of other competitors currently merging word and data processing [*Electronics*, July 19, p. 81].

Some observers criticize the Datapoint approach, arguing for a need for a more powerful processor. However, Vic Poor, senior vice president for research and development, dismisses such criticism, noting that ARC allows users to build a system that can operate at much faster speeds than most mainframes by simply adding processors. Each works like a partition in a mainframe, capable of running its own cycles without slowing down the overall calculation rate of the system.

Poor acknowledges that the largest partition that can run is limited to the largest amount of memory available on an individual Datapoint processor, which is currently 256 kilobytes. However, such a size suits almost all business applications, where the most important consideration is the very high transaction rates that an ARC system can deliver, Poor argues. **-Wesley R. Iversen**

Packaging & production

Polyimide insulator improves liftoff

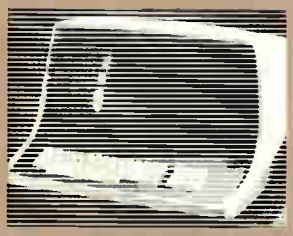
In the quest for ever finer metalization patterns for semiconductors, Hitachi Ltd. researchers have developed a new processing technique that employs a polyimide film as the liftoff layer. This approach permits deposition of the metals at high temperatures, significantly increasing yield, the researchers say.

Liftoff is a relatively new method which deposits a thin film of metal over the entire surface of a resist-covered wafer where a circuit pattern has been exposed. Then a solvent removes the unexposed resist and the metal above it.

Problem. While geometries in the low micrometer range result, the poor heat resistance of the resists used as the liftoff layer requires low-temperature deposition of the metalization layer. At these temperatures, adhesion of the metal to the wafer is a problem, say Yoshio Homma, Hisao Nozawa, and Seiki Harado of Hitachi's Central Research Laboratory in Tokyo.

What the trio has done is to use the Hitachi version of PIQ, or polyimide isoindroquinazolinedione, [*Electronics*, Feb. 16, 1978, p. 48] for the liftoff layer. Such polyimide resins can withstand temperatures

A computer is only as good as its software.



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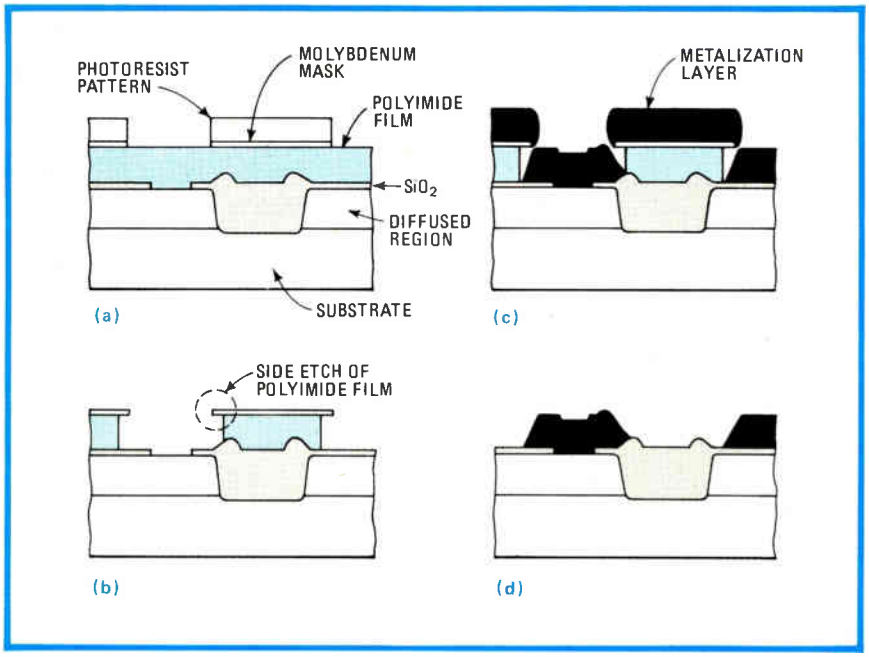

Lifting off. Hitachi's liftoff process uses a polyimide insulating film in place of the typical resist. Significantly higher processing temperatures are possible, thereby hiking yields.

up to about 350°C and are typically used as insulation for electric wires.

As described at this week's International Electron Devices Meeting in Washington, D. C., the new process begins by spin-casting a silicon wafer with a PIQ film. Then a layer of molybdenum is deposited on this liftoff layer and etched, as shown in part (a) of the figure.

Liftoff removal. After removal of the photoresist pattern, the next step is to remove the parts of the liftoff layer exposed during the etching. Removal is by reactive sputter etching, producing a precisely controlled side etch (b).

The effect of this side etch is to separate the metalization layer on the polyimide from the same layer on the substrate (c). The separation makes the liftoff step very stable, the researchers say.

Electron-beam evaporation deposits the metalization layer, composed of alloys like aluminum silicon or aluminum copper silicon. Then electrolysis removes the liftoff layer, the molybdenum mask, and the unwanted metal on top of them (d).

The Hitachi researchers say that they have fabricated devices with two levels of metalization using exposed via holes. Since the metal layer is not etched during liftoff, many different materials may be used for this layer without changing the process, they add.

The experimental devices fabricated include high-speed bipolar large-scale integrated circuits with speeds two to three times higher than those with conventional LSI. The packing density with this technique is twice that achieved with conventional chemical packaging, according to Hitachi. **-Jerry Lyman**

Military

Tacan transceiver transcends all others

The U. S. Air Force's new TRN-41 tactical air navigation transceiver weighs only about 120 pounds, breaks into packs for portability, survives parachute drops, and can run for hours or even days on its own battery. What makes this list of attributes so impressive is that other Tacan units weigh 500 to 1,000 lb, are hardly mobile without a truck or helicopter, rarely survive parachute drops, and need a motor-generator set to power them.

The TRN-41 owes its features to its solid-state design. Even its 100-watt, X-band transmitter is solid-state, using paralleled bipolar transistors, says James L. Twombly, product line director for navigational aids for the Montek division of E-Systems Inc. The West Salt Lake City division delivered the first units to the Air Force in mid-November.

Combat and cargo aircraft use Tacan's range and bearing data to plot their positions. Portable navigational aids like the TRN-41 are particularly useful because an enemy would probably begin hostilities by destroying permanent navigational aids.

The new transceiver "is built to come apart, in four major modules, for a total of seven circuit cards," Twombly says. Thus "it is field-maintainable." Built-in fault isolation also helps; the 13 most important functions are continually monitored and the status of each displayed on a small panel of light-emitting diodes. If a major flaw develops, the unit shuts itself down.

Small antenna. Getting rid of the tubes helps solve the size, weight, and power problems, but antenna design is equally important. It is an electrically short antenna of proprietary design, about 1 foot across rather than 3 ft. Despite the tricky design, the voltage standing-wave ratio has been held to less than 1.5, indicating a good match between antenna and transmitter.

The TRN-41 can serve as a sophisticated homing beacon as well as for area navigation. The range and bearing data it yields out to a range of 75 nautical miles are accurate to within ±1° in azimuth and ±1/10 nautical mile in range. Thus one can be dropped ahead of a forthcoming supply drop or be used to mark a helicopter landing zone with accuracy never before available, says Twombly.

A three-man team without prior training can assemble the TRN-41 and go on the air in 5 to 15 minutes, he says. If needed, it can be backpacked to a remote site as its three major subassemblies fit 40-lb packs.

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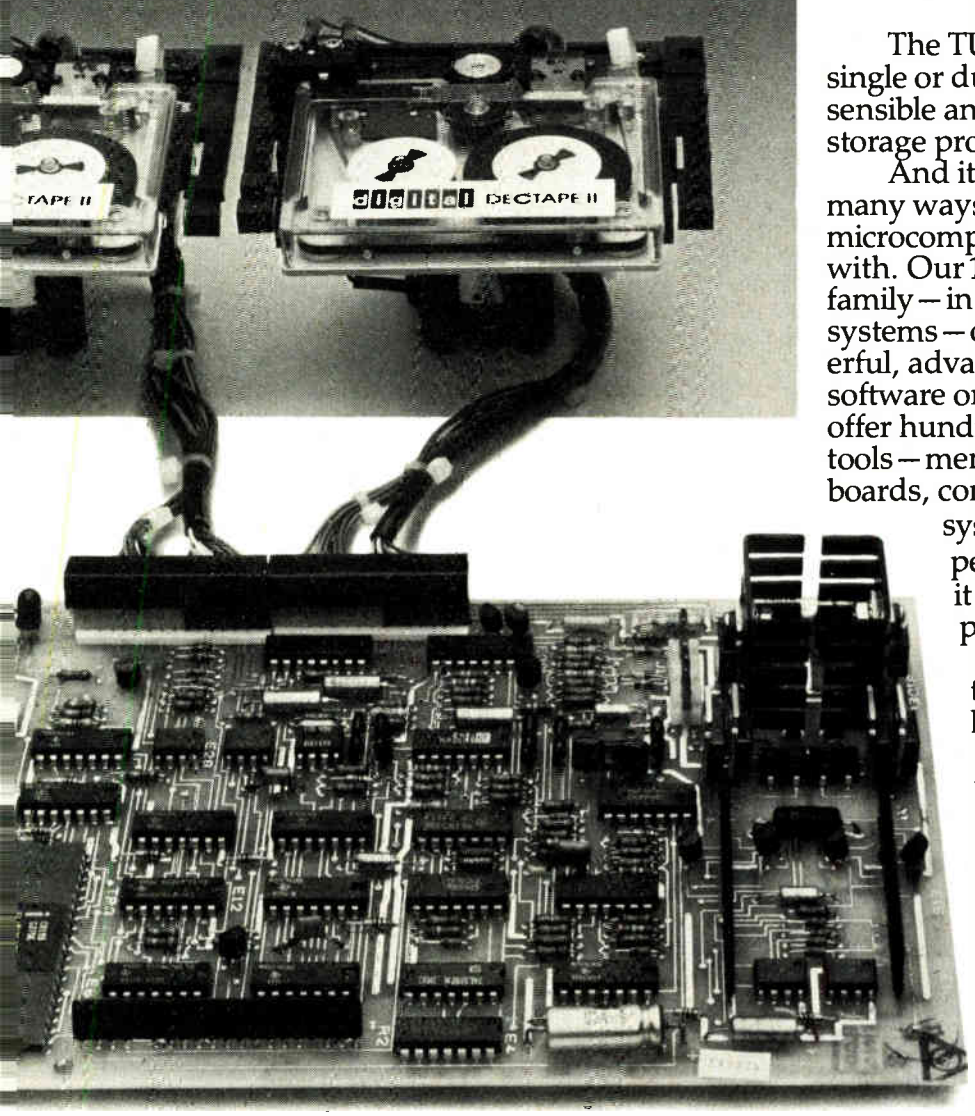

Digital's 512Kb TU58 cartridge tape subsystem. At $562 in 100's, it's priced like a tape device. But with random-access block addressing, and EIA serial interfacing, it's like no other tape drive on the market.

That's because the TU58's controller board has a built-in MPU that makes it think like a disk. It reads, writes and searches for data in blocks, instead of running serially through the whole tape like conventional systems. And the TU58's small size—the board measures just 5.2" x 10.4" (13.2 cm x 26.5 cm)—makes it easy to design into your product.

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Circle 49 on reader service card

News briefs

Navy to develop ultrasound minidetector
The Naval Research Laboratory, now developing fiber-optic ultrasound detectors for antisubmarine sonars, will employ that technology to help the Food and Drug Administration's Bureau of Radiological Health. It will design such a detector with a minimum frequency range of 1 to 10 megahertz that is small enough to be implanted in an anesthetized laboratory animal. The FDA bureau will use the acousto-optic detector in animals exposed to diagnostic ultrasound levels. "Existing piezoelectric detectors are impractical for this application, because they are too large to be implanted in tissue without altering the field near the detector," a spokesman for the bureau says.

Wafers for IR arrays getting larger
Three-inch-diameter crystals of mercury cadmium telluride have been produced at Honeywell Inc.'s Electro-Optics Center in Lexington, Mass. Researchers also report they achieved uniformity of composition within 0.1%. Previously, wafers of that uniformity were restricted to 2-in. diameters. The larger diameter, along with high uniformity, is crucial to the development of large-scale mosaic focal-point arrays for the next generation of infrared imaging systems.

National, DEC end dispute
National Semiconductor Corp., Santa Clara, Calif., and minicomputer manufacturer Digital Equipment Corp., Maynard, Mass., agreed to drop patent suits filed against each other last fall. The suits centered around National's plans to make and market a system 200 minicomputer that would be totally compatible with DEC's PDP-11/34 system. The agreement of the companies follows National's decision to shelve its system 200 computer program [*Electronics*, Oct. 11, p. 89]

Chu to head American Electronics Association
T. Z. Chu, chairman and president of Finnigan Corp., a Sunnyvale, Calif., producer of analytical instrumentation, has been elected chairman of the American Electronics Association for 1980. A director of the trade association for the past four years, he succeeds Noel J. Fenton, who is president of Acurex Corp.

Amdahl, Memorex merger off
Unable to agree on terms, the boards of directors of Memorex Corp. and Amdahl Corp. have decided to discontinue merger discussions that began last summer. Amdahl, a Sunnyvale, Calif., producer of IBM-compatible mainframe computers, proposed a stock exchange with Memorex, a producer of IBM-compatible computer peripherals in nearby Santa Clara. The companies say they will continue to cooperate with each other on specific transactions, as in the past.

Second source signs up for D-MOS products
Semi Process Inc. of Santa Clara, Calif., has entered a second-source agreement with Signetics Corp.'s Analog division in nearby Sunnyvale for D-MOS products. The "D" signifies a process that relies on diffusion, in addition to lithography, to determine channel length or active area of chips. The accord, which covers single and quad analog switches and dual-gate radio-frequency amplifiers and mixers, also allows Semi Process to develop new D-MOS products, which Signetics may make.

transceiver usually transmits navigational signals only when interrogated, turning itself off 30 seconds after interrogation ceases. To protect the three-man crew from enemy action, the unit's operation can be monitored through a built-in radio link that may be located as far as a mile away.

The first units were delivered to the 437th Military Airlift Wing, Charleston, S. C. According to the Air Force Electronic Systems division, Hanscom Air Force Base, Mass., which is the TRN-41 lead agency, deliveries will continue at three a month until 70 systems are delivered sometime in mid-1981. Of these, 30 will go to the Military Airlift Command and 40 will be used by the Air Force Communications Service to backstop existing Tacan systems. **-James B. Brinton**

Automotive

Panel sees 300% hike in electronics value

A study of trends likely to affect the auto industry and its suppliers in the 1980s is adding another voice to the chorus predicting a boom in the on-board automotive applications of electronic devices. A 300% increase in the value of automotive electronic components is predicted by a study just released by Arthur Andersen & Co., a large accounting firm.

A panel of decision-making technical executives and engineers who participated in the study predicts that 5% of the total cost of U. S.-produced vehicles in 1980 will be attributed to electronic components. By 1985, electronic devices will account for 10% of the cost and by 1990 for 15%, it predicts. [For related estimates, see *Electronics*, Aug. 30, p. 44 and Nov. 8, p. 94].

Pressures. Underlying this trend is pressure on car makers to boost fuel economy and reduce emissions. To accomplish these goals, such design changes on gasoline engines as closed-loop spark-timing control, programmed combustion, or even variable valve timing may reach the marketplace in significant numbers. All include electronic controls.

Since the study centered on the automotive industry rather than on electronics suppliers, it is vague on the nature of the controls. "It would be anything involved in the electronic system of the vehicle and would include central processing units, transducers, and entertainment systems," says David Cole, director of

NO. 3

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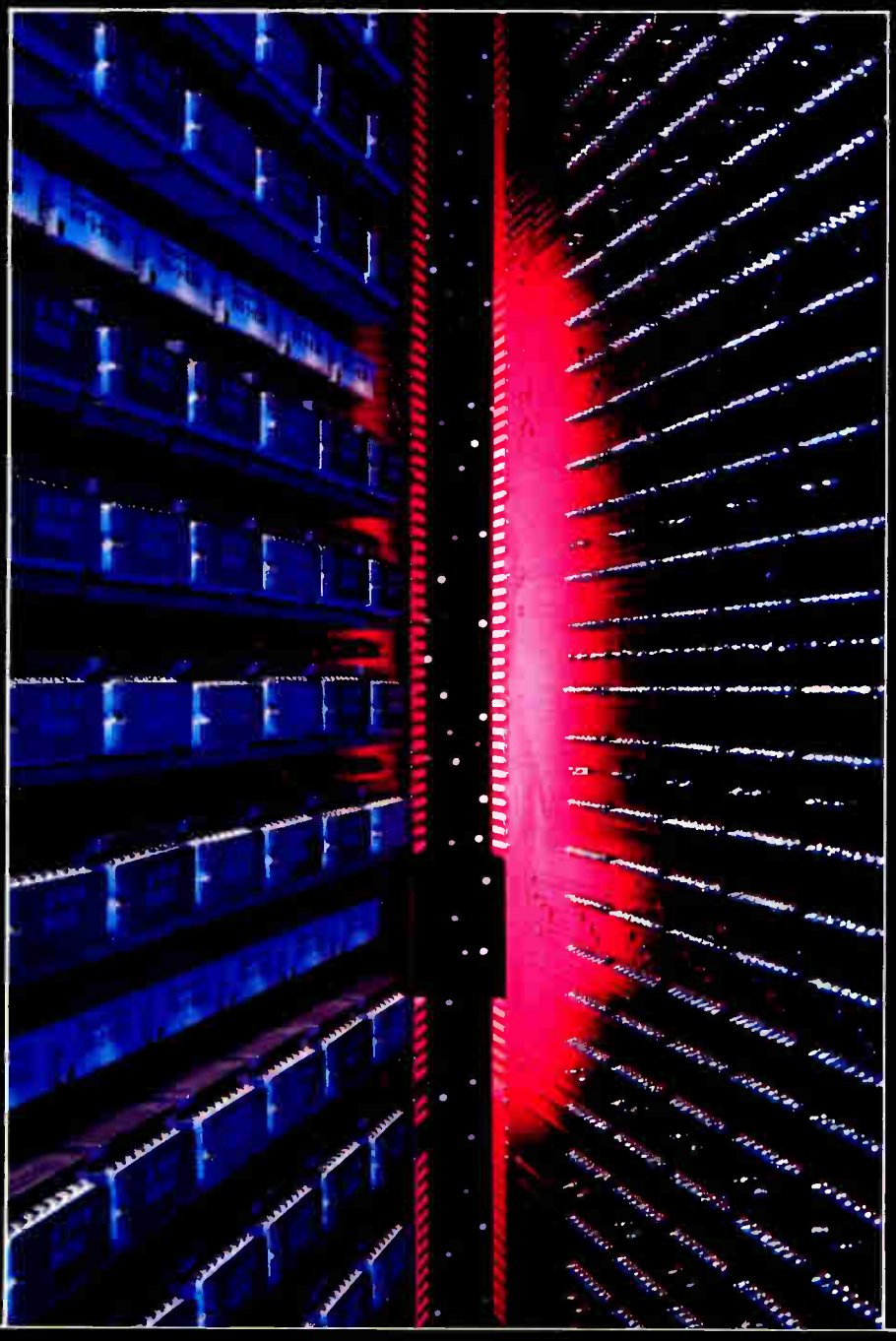

Low-cost, high-speed BIFETs in National service

MICRO-DAC D/A converters get you off the bus easy

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National Semiconductor invented BIFET technology back in 1975. And because of their low bias current and high-speed performance, these devices soon made themselves indispensable to the industry. Predictably, the competition copied National's BIFETs, and continue to imitate what National developed.

National, however, moves on. From invention to an 80-plus list of op amps, multiplexers, sample and holds, comparators, switches, and A/Ds. Their latest offering consists of three new low-cost, high-performance military temperature range op amps, designated the LF151A, LF151, and LF153.

The LF151A and LF151 singles. The LF151A and LF151 were designed to close the price/performance gap between National's LF156H mainstay and their top-of-the-line model LF156AH. Both of the new models come complete with a solid, dependable list of guarantees over the −55° to 125°C temperature range.

By way of illustration, the LF151A features a maximum input offset voltage of 2mV coupled with a maximum input offset voltage drift of less than 20μV/°C. In addition, the minimum slew rate is 10V/μsec, and the bandwidth is 3MHz minimum.

All these parameters are fully tested (including temperature drift), and are unconditionally guaranteed. That means there are no exceptions, qualifications, asterisks, or footnotes along with your product.

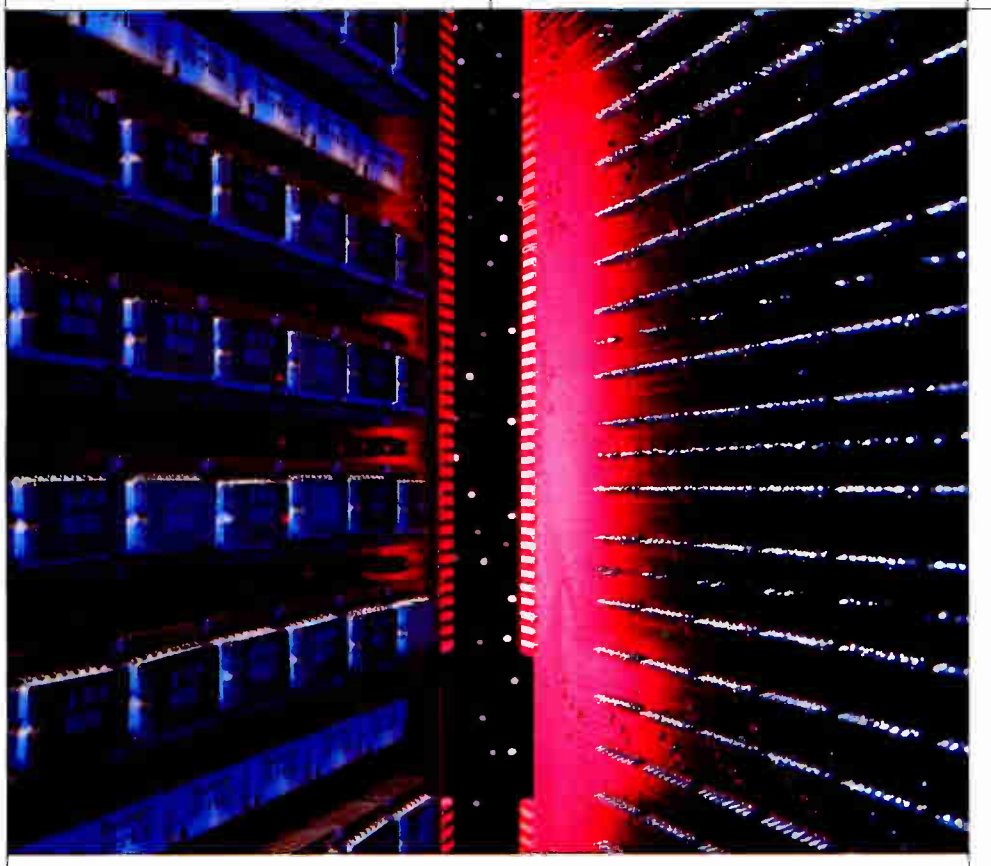
Two LF151's for the dual minded. If a dual op amp is what you're looking for, there's National's LF153, nothing more than two LF151's on the same die.

National guarantees that its input offset voltage will not exceed 7mV over the full military temperature range. You also get low bias current, high-speed, and a very capable and efficient pair of op amps in a practical-sized, single 8-pin package.

It is another sensible, timely solution from the people that invented the BIFET.

On top of everything, they're available now. In addition to the attractive features of these three new op amps, there are two more appealing aspects: all three are available now, for as low as $3.25 for the single, and $6.00 for the dual (100 unit price). For more information, simply call or write your local National distributor or sales engineer. They'll be more than happy to answer any questions you may have about BIFETs.

Or about anything else in the semiconductor-related industry, for that matter.



National tests memory components at the system level, so the customer doesn't have to.

In addition to the usual component level processing, MST™ ensures more reliable memory components through testing in a system environment.

Thanks to National's Memory System Test (MST) program, customers specifying MST can eliminate or greatly reduce their own board level testing.

That's because the MST manufacturing flow includes a lot of benefits. Such as correlated accelerated stress testing equivalent to 168 hours at 125°C; inherent stress integrity in the MST equipment, not found in conventional burn-in systems currently in use; and board-level environmental testing over the ambient temperature range of +25° to +70°C, as well as over all power supply limit combinations. These tests are performed in addition to National's usual final testing and QA component level processing.

This combination of board level and component level testing, with its multiple insertions, results in parts that are significantly better in quality and reliability.

Separating the good from the bad. The MST program has been developed by National over a four-year span, and investigated extensively in their engineering and production facilities. The system correlates fully with standard component test equipment, with some important improvements.

With standard equipment, certain devices could be intermittent failures, a certain card in a system environment may fail, or their failure simply may not be detected.

The MST system also detects units that experience one or more "soft errors" at any time during the many hours they are in the system test environment. This type of failure is usually detected during a board level system test.

Multiple test patterns, power supply margin tests, real time error logging, and hours of continuous testing over the operating temperature range in a card-level system help separate the good units from the bad.

Providing a real memory system environment. When National's customer specifies MST processing, he receives parts that have been tested in a true card-level system environment. MST is a memory system with built-in testing and diagnostic capabilities. And it makes use of memory storage cards operating in a temperature chamber.

The memory storage card is a multilayer printed circuit board holding 72 units. Each MST module holds 64 cards operating as a memory system in a temperature chamber. Which represents 4608 units operating under test simultaneously.

The bottom line is that National's MST processing is unique to the entire industry. And specifying MST may cost a little more, but it's worth a lot more.

New MICRO-DAC™ Series is the easiest way to get from D to A.

National's DAC 1000 is the first of a series of four quadrant multiplying D/A converters which easily interface to a μP.

The DAC1000 is the only microprocessor-compatible 10-bit DAC that is truly μP-compatible without the need for any support chips. In fact, it looks like a memory location or I/O port with all control functions right on the chip. So you get easy interface with any 8 or 16-bit data bus.

The "Best Straight Line" Myth. The competitions' linearity spec is based upon a "best straight line," which doesn't correspond to real world applications, and can mean several adjustments to find the "best straight line." The competitors benefit by shipping these lower accuracy devices. You lose.

With National's "end point" linearity spec only two adjustments are needed – Zero and Full Scale; set these, and the linearity specification is met. Thus, National's linearity specifications ease calibration of the system. In addition, where low reference voltage, or reference voltage changes are required, linearity is maintained even with a 10 to 1 reduction.

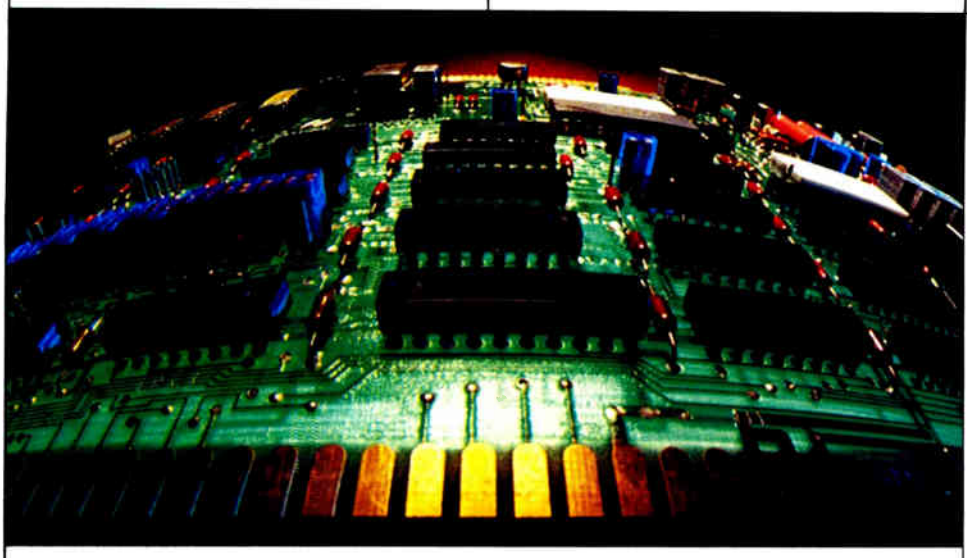
It fits into a lot of places and takes up a lot less space. The MICRO-DAC1000 Series is used primarily for building D/A conversion systems. But these DACs can also be used as building blocks for digitally controlled amplifiers, alternators, active filters, and even oscillators. They're also more flexible than any DACs around – 4 quadrant multiplying, double buffered, single supply operation from +5V to +15V, right or left justified data format, micro power operation (2mA max.), and output current mode setting time of 500ns.

In the 20 pin package they're only .3" wide compared to .6", so they're easily inserted and use a lot less space.

If you don't need μP interfacing, National's still got you covered. The DAC1020 and DAC1220 are 10 and 12-bit DACs without all the μP interfacing. And they still offer application flexibility along with improved linearity.

If you're already using AD7520, AD7521, AD7530, AD7531, or AD7533, National's DACs are direct replacements. They're also priced at least 30% lower and in some cases as much as 300% lower. These inexpensive DACs start at $4.00 at 100 pieces and because of National's volume capacity, no one can sell for less.

The MICRO-DAC Series opens up a whole new world for design engineers. Because National's D to A's are better from A to Z.



BLC-8737 simplifies MULTIBUS design.

The new BLC-8737 analog I/O board is the newest addition to National's already broad line of more than 75 MULTIBUS-compatible products. It provides easy interface to the real world of analog, thanks to its built-in intelligence that handles analog functions automatically.

The BLC-8737 eliminates the time formerly spent writing conversion routines, because it takes care of the complete analog conversion and scanning control. So you save substantial development costs, and get to the market quicker, too.

The board also comes with a warranty of a full 12 months – four times longer than the competition's. That's just one more reason why National's boards aren't just simpler, they're simply better.

Who and what are practical wizards?

Practical wizards are people with vision, vast knowledge, and a desire to help people through their work. They're not afraid to offer solutions that are new and different from anything that's been tried before.

They're people like Thomas Edison, the wizard of Menlo Park, also called the father of modern electronics. Edison was concerned with improving the human condition, and he attempted to do so with his insights into the workings of electronics. He was a visionary, true, but practicality was the hallmark of everything he did. And ultimately, it was that human practicality that made his accomplishments even more profound and far-reaching.

Just as Edison changed the world with his ideas, the practical wizards at National contribute their part through semiconductor technology. With their expertise, and level-headed, sensible approach to solving problems, they are the embodiment of "wizardry made practical."

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the University of Michigan's office for the Study of Automotive Transportation. He is one of four persons who compiled the forecast.

However, the key to closed-loop spark control is an on-board computer that reads the composition of the car's exhaust and sends signals to the ignition system, dictating spark timing, and to the carburetor to adjust the gas mixture. Microprocessors are a likely candidate for such a task; in fact, the panel expects fully 90% of 1990's car production will have them on board. **-David Whiteside, McGraw-Hill World News**

Computers

Peripheral makers look to thin-film heads

Stepping up the pace of development, makers of IBM-compatible computer equipment hope to overcome the lead the industry giant has built in disk drives that incorporate read/write heads made with thin-film technology. IBM recently shipped the first of these 3370 disk drives, and competitors are hurrying their entrants into the race, although hobbled by a dearth of information on the technology and performance of the front runner.

Among those looking to exploit the advantages offered by thin-film head technology [*Electronics*, June 21, p. 86] is Magnex Corp. The San Jose, Calif.–based affiliate of Exxon Enterprises Inc. is developing a 3370-type head that "won't necessarily use the exact same technology as IBM, but will meet the same form/fit/function parameters," says Joel Levine, director of marketing.

Integrated sliders. Using processes similar to those employed in fabricating integrated circuits, Magnex has developed what it calls the integrated slider, which combines the read/write head with the mechanism that carries it over the disk. The traditional ferrite heads and typical magnetic thin-film heads would be bonded onto separate bulky ceramic air-bearing sliders. Magnex deposits

hundreds of the heads' magnetic circuits onto a thick wafer, which is diced and machined to form hundreds of one-piece head-slider assemblies. The 0.25-inch thickness of the wafer becomes the length of the air-bearing slider, Levine explains. Thus the company can eliminate the critical manual operations of accurately bonding a transducer, or head, to the slider, he notes. What's more, the integrated slider assembly not only offers tighter tolerances and higher densities, but improved reliability and lower costs as well, he claims.

Shipments. Magnex intends to begin shipping initial production quantities during the second quarter of next year. "Our turn-around time will be fast if we've guessed it right," Levine says. "However, if IBM has thrown us a big curve, we will have to go back to the drawing board, and it will be about another six months before we could deliver a product."

Applied Magnetics Corp., Goleta, Calif., also plans to have a thin-film head, equal to or better in performance than the 3370, available shortly. "We expect to have a thin-film disk head device in pilot production in early 1980 with roughly four times the performance of a 3350 and what we estimate will be in excess of the 3370's performance," says Paul Frank, director of research and advanced technology at the Magnetic Head division. "If the market demands it, we will also satisfy the needs of those wanting 3370-equivalent performance in an identical head," he adds.

Which way? A major question is what type of magnetic coil to incorporate in the head: whether to go with a helical wind in which each turn wraps around the preceding one or with a spiral wind in which the turns are side by side in the same plane. Head performance is directly related to the number of windings and to their proximity to the disk surface.

With a helical design, as Applied Magnetics is using, there is insufficient room for many windings, but they are equally close to the disk. With the spiral design, there is room

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Circle 53 on reader service card

for many windings, but their distance from the surface varies along the plane.

Memorex Corp., Santa Clara, Calif., is working on both types of windings, as well as on a multilayer spiral that combines both approaches. "All have their merits and disadvantages, but the multilayer spiral approach seems to be the best of all worlds," says Frank J. Sordello, manager of the firm's Recording Technology Center. "However, its complexity is greater than that of the other two."

Sordello is not saying which coil design Memorex will adopt for a 3370-type product. Nor is he specifying which of several air-bearing sliders developed for the thin-film heads will be used. One is a standard 3350-type slider that flies about 20 micro-inches over the disk's surface. The firm also has developed a standard railed slider and a self-loading slider that fly 15 μin. and 10 μin., respectively, above the surface.

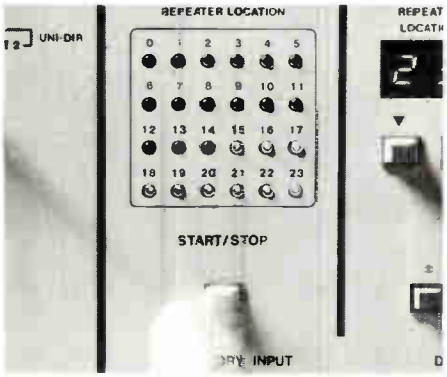
Two transducers. The prototype Memorex head has two magnetic transducers on one air-bearing slider, whereas conventional drives have one such read/write device per slider. In effect, then, the firm could offer two heads in a unit to speed access times. "We will be supplying volumes of thin-film heads by the fourth quarter of 1980," Sardello says.

Yet another supplier expecting to offer a disk drive equal in the performance to the 3370 is Microdata Corp., Irvine, Calif. Whether its offering will use thin-film technology or existing ferrite-head devices is uncertain.

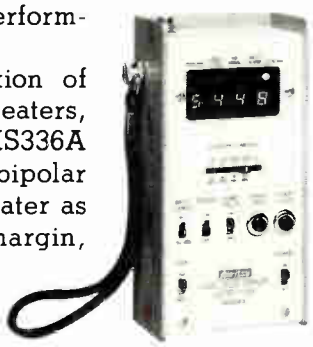
"The fastest response we could make would be if we went to a ferrite-head drive" that used 3350 technology but doubled 3350 density. "We then could have a product on the market within 12 months," says Bud Bleininger, vice president and general manager of Microdata's Original Equipment Manufacturer division. "If we go to 3370 technology, it would take a much longer period of time, perhaps 24 months, before we get a product to market," he points out. **-Bruce LeBoss**

NOW YOU CAN TEST UP TO 24 REPEATERS IN A SINGLE GLANCE.

With Anritsu's new PCM Line and Repeater Testers MS333A and MS336A, you don't have to wade through an ocean of knobs and meters to test or locate faulty repeaters. Digital-to-digital testing of up to 24 repeaters can be done at just a push of a button. A built-in micro-computer coupled to a 24 LED display provides automatic detection and visual indication of faulty or marginal performance repeaters.



In addition to automatic location of faulty or marginal performance repeaters, the MS333A (30 channels) and MS336A (24 channels) enables you to test bipolar violation errors in the line or repeater as well as current, voltage, density margin, crosstalk interference margin and insulation resistance of local repeaters. Anritsu also offers a repeater test receptacle option which enables you to test individual repeaters by direct insertion.



For on-site testing of local repeaters, Anritsu offers their new PCM Code Error Detectors MS334A (30 channels) and MS337A (24 channels). This lightweight portable unit is packed with all the features and performance you need to make counting bipolar errors a breeze.

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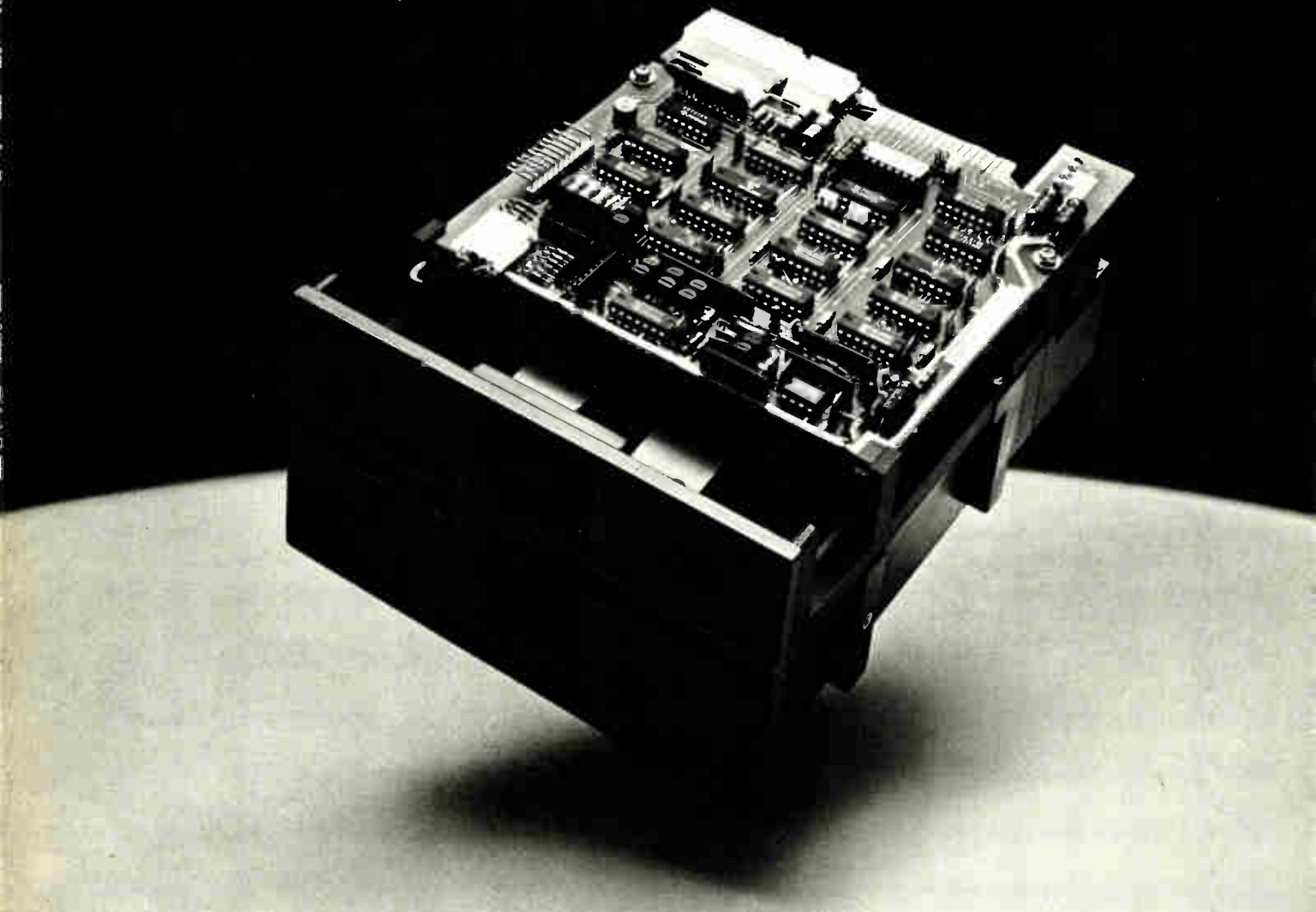
The FD-50A is designed to reduce the chances of data loss to a minimum. Write-protection circuitry allows you to protect valuable disks from accidental erasure. A door lock prevents inadvertent opening of the door while the disk is in use. And a precision stepper motor ensures accurate, reliable head positioning. FD-50A. The fast Mini Disk Drive from TEAC.



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Circle 56 on reader service card

Washington newsletter

Pentagon finds Soviet tactical radar superior . . .

New Soviet airborne tactical look-down/shoot-down radars tested earlier this year "are superior" to any system deployed by the U. S.," Under Secretary of Defense William J. Perry disclosed at November's end before a Senate subcommittee hearing on technology transfer. Perry's disclosure came as he told the senators how the USSR has benefited from sharply increasing military research and development spending during the regime of Chairman Leonid Brezhnev. **That increase has been from one half of American outlays to almost double today's $13 billion U. S. program,** Perry says. Russia's formerly inferior missile-guidance systems are now on a par with those of the U. S., he adds, and its spending on high-energy laser R&D—an area in which it had "no capability 10 years ago"—now stands at $1 billion annually, five times the U. S. level. However, the U. S. still retains the lead in large- and very large-scale integrated circuits, computers and software, and jet engines.

. . . as U. S. seeks 7% increase in R&D funds

In addition to reducing the transfer of critical U. S. technologies to Soviet Bloc nations, Perry says the four-point U. S. program to counter increased Russian military R&D includes a 7% real growth in annual outlays after inflation, increasing cooperative programs with European allies and Japan to eliminate redundant efforts and benefit from their $5 billion military R&D expenditures, and increasing Pentagon support of independent research and development programs that the Defense Department finds "crucial" despite congressional criticism.

FCC denies appeals opposing merger of GTE and Telenet

Unless Graphnet Systems Corp. or Tymnet Inc. goes to court—and there are rumblings that they might—the two competitors of Telenet Corp. have lost the battle to prevent acquisition of the packet-switched data services company by General Telephone & Electronics Corp. At the end of November the Federal Communications Commission rejected the pair's petitions to reconsider its approval of the GTE-Telenet merger. Moreover, the FCC left intact its June modifications of the merger plan, which had softened its earlier stance on the arms-length separation of GTE and Telenet. The companies must maintain separate books and marketing operations, but may share personnel with prior FCC approval, perform joint research and development except in software, and exchange proprietary information (provided it involves no customers). Three of the seven FCC commissioners still want the software R&D restriction removed, noting that it denies Telenet the opportunity to buy from its new GTE manufacturing affiliates such software-oriented modules as switches, multiplexers, modems, and customer terminals.

Launch of third RCA satellite for TV approved

RCA American Communications Inc. in New York has received approval for a Dec. 6 launch of its third domestic communications satellite, the $11.1 million Satcom F-3, for television transmission service. The Federal Communications Commission approval of the $20 million launching by the National Aeronautics and Space Administration of the 24-transponder satellite overrode a TV transmission company's petition to halt it, **pending an investigation of RCA Americom's sales and service practices.** Those charges, from Eastern Microwave Corp., Woburn, Mass., will be treated as a separate complaint, the FCC said, noting "there is an immediate need for Satcom F-3" that makes it in the public interest not to delay.

Washington commentary

Keeping America competitive in the '80s

If the integrated-circuits industry of the U. S. can find the $5.5 billion in investment capital it will need in 1988, its shipments that year could reach $22 billion. But that is a very big "if," since it assumes a relatively modest 18% annual growth rate in industry shipments from last year's $3.7 billion and a very high annual capital intensity ratio of investment to shipments of 25%. Nevertheless, that is the estimate put forth by the International Trade Commission in a 150-page study carried out for the Senate of the competitive factors influencing world trade in ICs (see p. 41).

An increasing number of Government and private economists are saying that 10-year growth projection will not be met by a domestic industry whose appeal to private investors and lenders is diminished by its high risk of technological obsolescence and relatively low profitability. Compounding that problem for the short term is the capital crunch in today's economy, where lenders can charge a U. S. manufacturer 10% more than his competitors in Japan may be charged by lenders there.

The rush offshore

For the U. S. to retain a diminished but still dominant role in the world marketplace, present economic trends make it likely that more IC companies will expand facilities offshore. Those smaller firms unable to go multinational or raise capital at home probably will succumb to the takeover offers of large European and other foreign manufacturers anxious to catch up to the U. S. technological lead. Others will simply license their technological birthright to foreign competitors, as some 60 did with Japan in the five years that ended in 1978. The number of small entrepreneurs entering the market, meanwhile, is expected to dwindle sharply as the costs of beginning a new IC venture put capital out of reach.

Integrated circuits then will be a truly international market made up of vertically integrated companies using much of their own IC output in their own end products, with relatively few independents. No one is willing to forecast what "maturity" will do to the pace of innovation, although many agree that present economic trends are leading toward an industry in which the rich will get still richer and the poor will disappear.

U. S. manufacturers already employ as many people producing ICs in foreign subsidiaries (65,152) as they do in domestic plants (66,426), according to 1978 data assembled in the International Trade Commission's survey. Significantly, it took four years for employment in domestic plants to recover from a 24% cutback in the 1975 recession and to catch up with and pass the 1974 level of 62,322 jobs, whereas jobs in foreign subsidiaries gained back their recession losses in two years. In other words, the net gain in the number of domestic IC workers between 1974 and 1978 is only 6%.

Japan's smaller IC industry, with 20,416 domestic jobs in 1978, expanded faster in the same five years, adding 27% more workers. How many more IC workers are employed offshore by Japan in subsidiaries in Korea, Malaysia, and elsewhere? The commission will not say, since Japanese participants in its survey submitted their data to it on a confidential basis.

But the statistics the commission has assembled in 72 tables on investment, production, and trade in integrated circuits in the U. S., the European Economic Community, and Japan can be worked over to reveal some interesting contrasts, particularly between the U. S. and Japan, which American manufacturers regard as their biggest future threat. Consider just one example: 35% of U. S. domestic IC output goes for computers, while 10% is for consumer products. In Japan, those numbers are reversed. In the context of 1978 U. S. shipments of $3.7 billion and Japan's estimated $1.1 billion, this means Japan uses more ICs in consumer products ($385 million) than the U. S. ($370 million), while Japan's IC development for the computer industry is barely beginning.

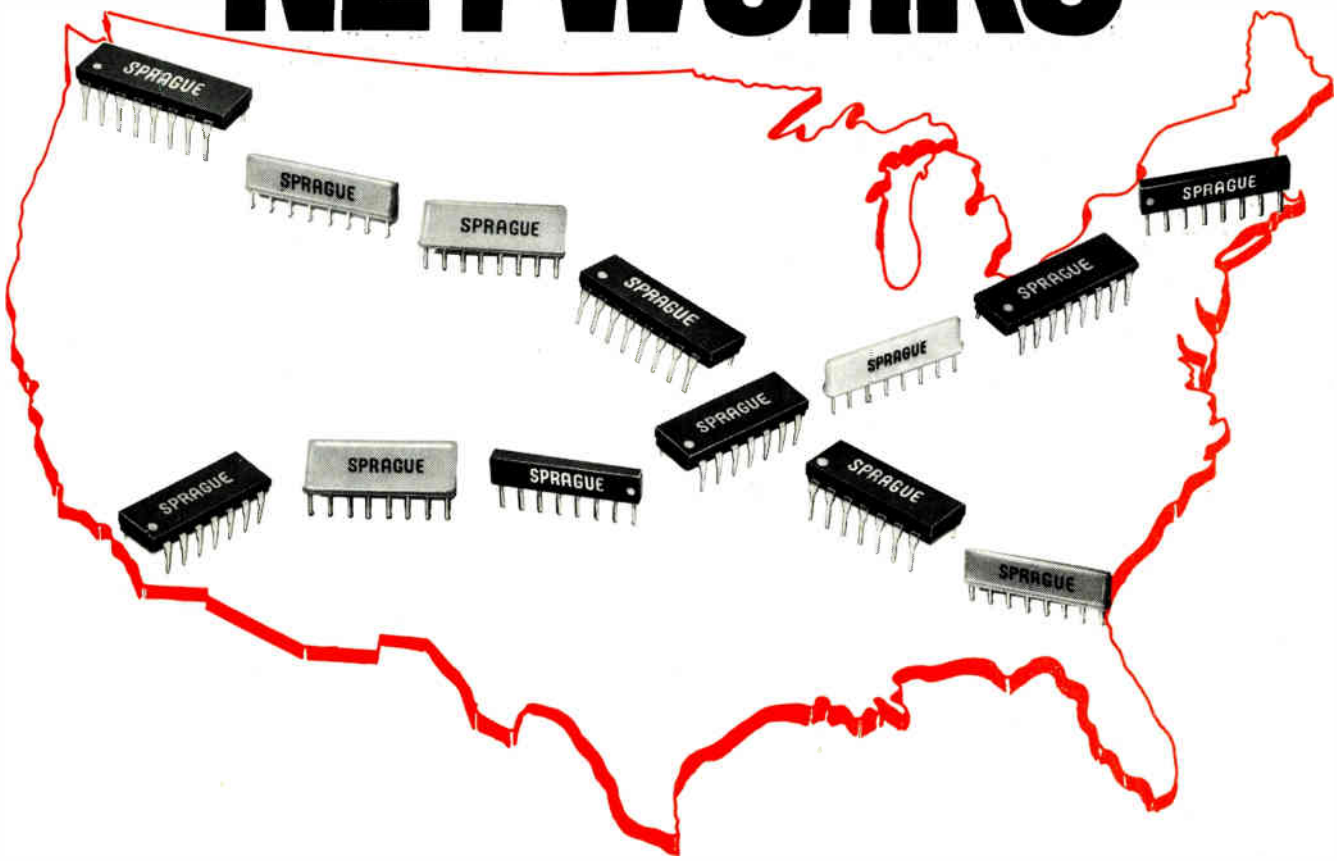
Needed economic incentives

There are many other such examples to be extracted from the commission's report and certainly better ones from the more complete number sets that have been provided to the Senate subcommittees on international trade and international finance.

Yet the general conclusions the Senate should draw from the study are the same: unless the U. S. integrated-circuits industry gets some fast congressional action on its requests for Federal tax credits to stimulate research and development, faster tax write-offs for equipment depreciation in a rapidly changing industry, and a reduction in the capital gains tax to encourage capital investment, the nation may be on the way to losing its world leadership of one more high-technology industry that has a lot of growth yet to come and was first made in the U. S. A. It seems Congress should want to keep it here.

-Ray Connolly

COAST-TO-COAST NETWORKS



Solve your resistor network delivery problems by calling your Sprague sales office or stocking distributor.

Sprague supplies the DIP and SIP resistor networks required by customers like you. This table, listing just a few of the more-popular devices, shows how Sprague cross-references with other well-known suppliers.

Description	Allen-Bradley	Beckman	CTS	SPRAGUE
Multiple Isolated 14 Pins, 7 Resistors	34B . . . 4 314B . . .	899-3-R . . .	760-3-R . . .	**914C . . . X2SR**
Multiple Isolated 16 Pins, 8 Resistors	36D . . . 4 316B . . .	898-3-R . . .	761-3-R . . .	**916C . . . X2SR**
Pull-up/Pull-down 14 Pins, 13 Resistors	34A . . . 4 314A . . .	899-1-R . . .	760-1-R . . .	**914C . . . X2PE**
Pull-up/Pull-down 16 Pins, 15 Resistors	36C . . . 4 316A . . .	898-1-R . . .	761-1-R . . .	**916C . . . X2PE**
Thevenin Terminator 14 Pins, 24 Resistors	34E 4 314E	899-5-R . . . / . . .	760-5-R . . . / . . .	**914C . . . X2TR**
Thevenin Terminator 16 Pins, 28 Resistors	36E 4 316E	898-5-R . . . / . . .	761-5-R . . . / . . .	**916C . . . X2TR**

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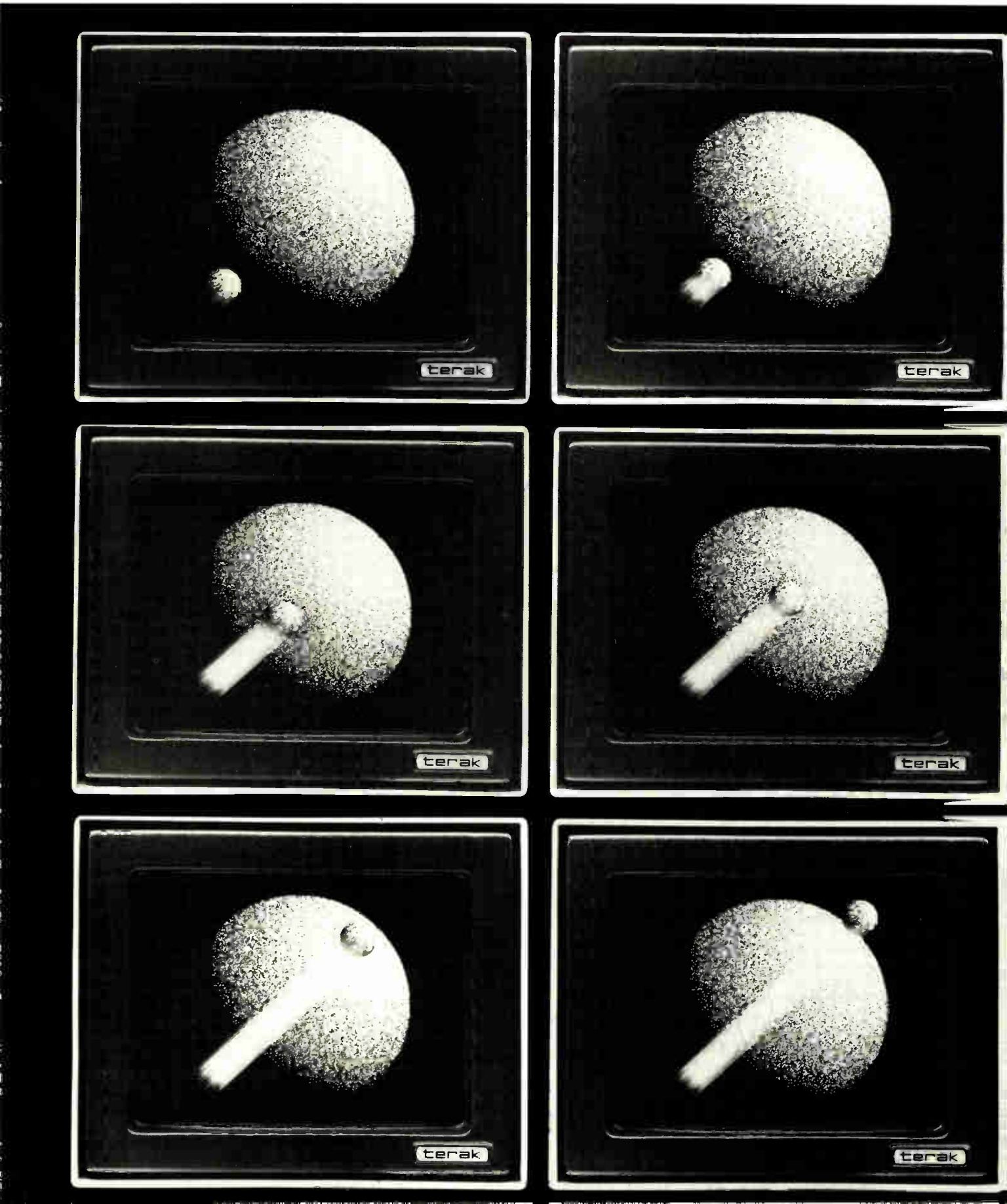
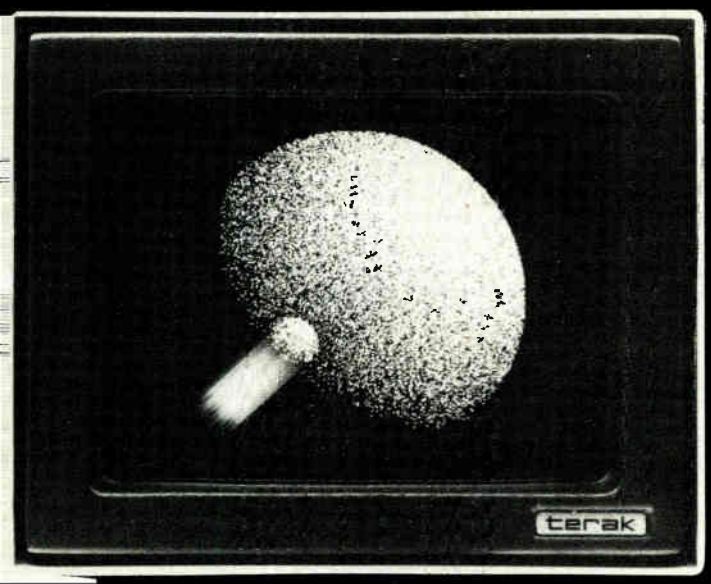
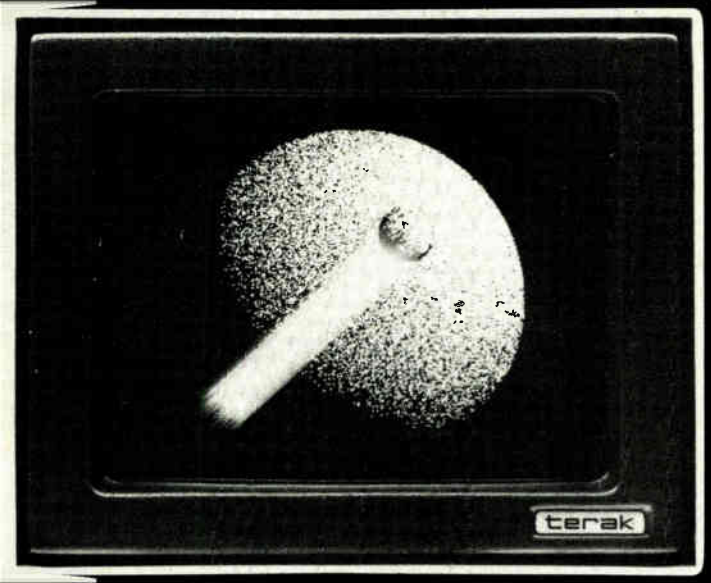
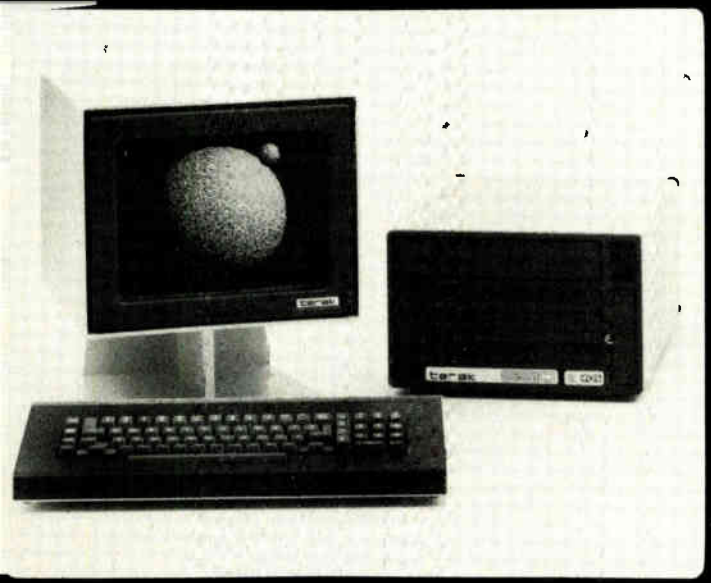


IN MOTION FOR $7,850.







These are actual unretouched photos.

Invest in a Terak 8510/a desk top graphics computer for only $7,850, and you'll get the performance of systems costing thousands of dollars more.

With DEC's powerful 16-bit LSI-11* microcomputer at its heart, Terak provides a medium resolution animation capability that, until now, could only be achieved through larger, more expensive systems.

It operates in either stand-alone or on-line environments, and it's totally compatible with DEC hardware and software.

An independently controlled 4K read/write memory allows the creation of unlimited character sets, so the Terak can display any language or symbol set required.

And there's more. A two-port memory structure means you can display text and animated graphics simultaneously.

But the best part is the software. Terak provides comprehensive, easy-to-use operating systems using UCSD PASCAL**, DEC RT-11*, BASIC, APL and FORTRAN IV languages.

So if you've got a limit on your budget but not your ideas, get a Terak. It's the best price performer in the business.

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Animation by Michael Smith
University of Utah
Computer Aided Instruction Group

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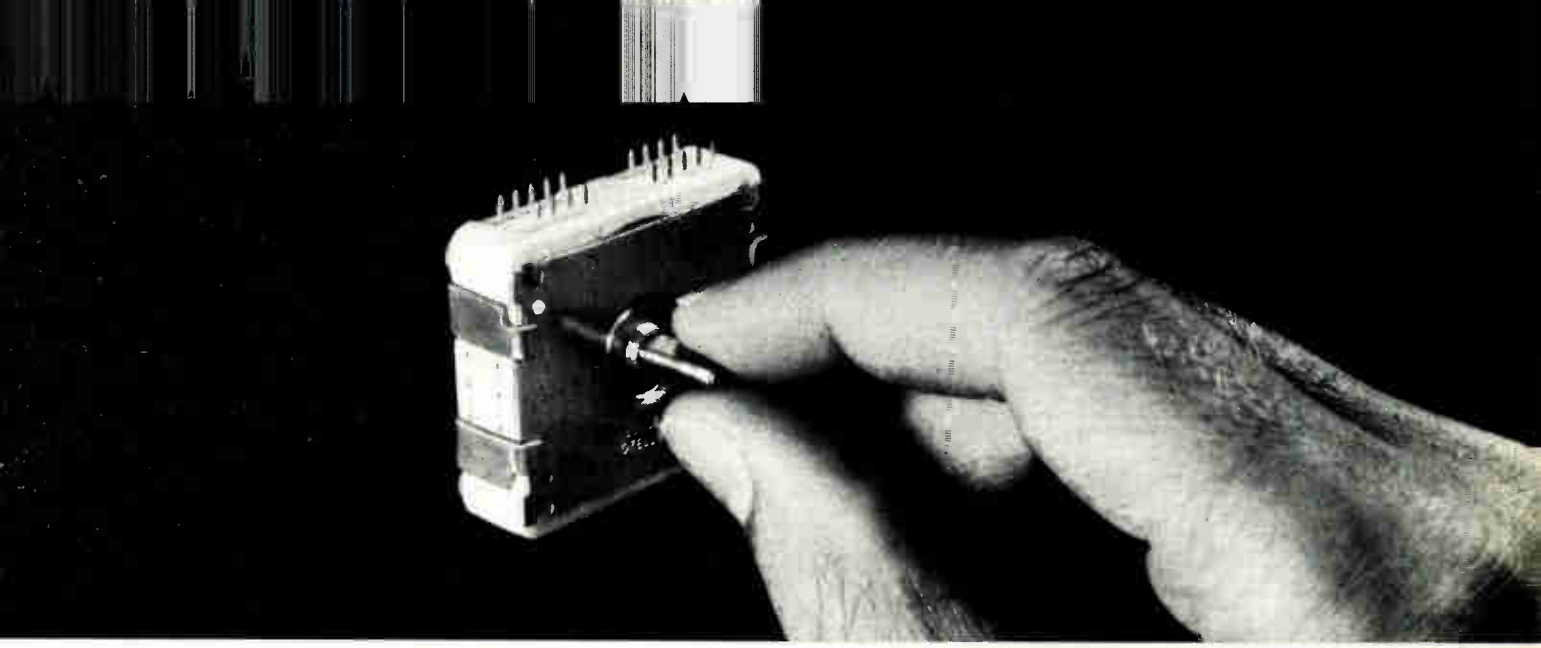
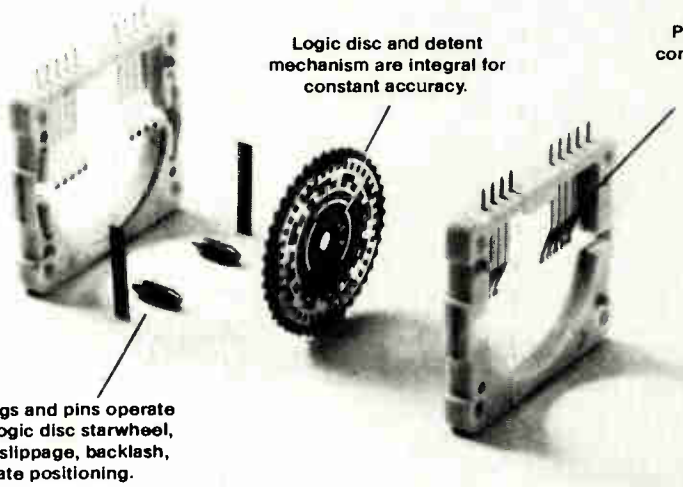


New twist on an old idea sets new accuracy standards in digital logic switching.



CTS Series 230 digital rotary switches assure accuracy in two important areas. First, contacts are insert molded securely in thermoset modules... not soldered or clipped in place. The one-piece molded design eliminates the mechanical shifting of contacts/terminations. And second, the detent mechanism is part of the logic disc for foolproof positioning.

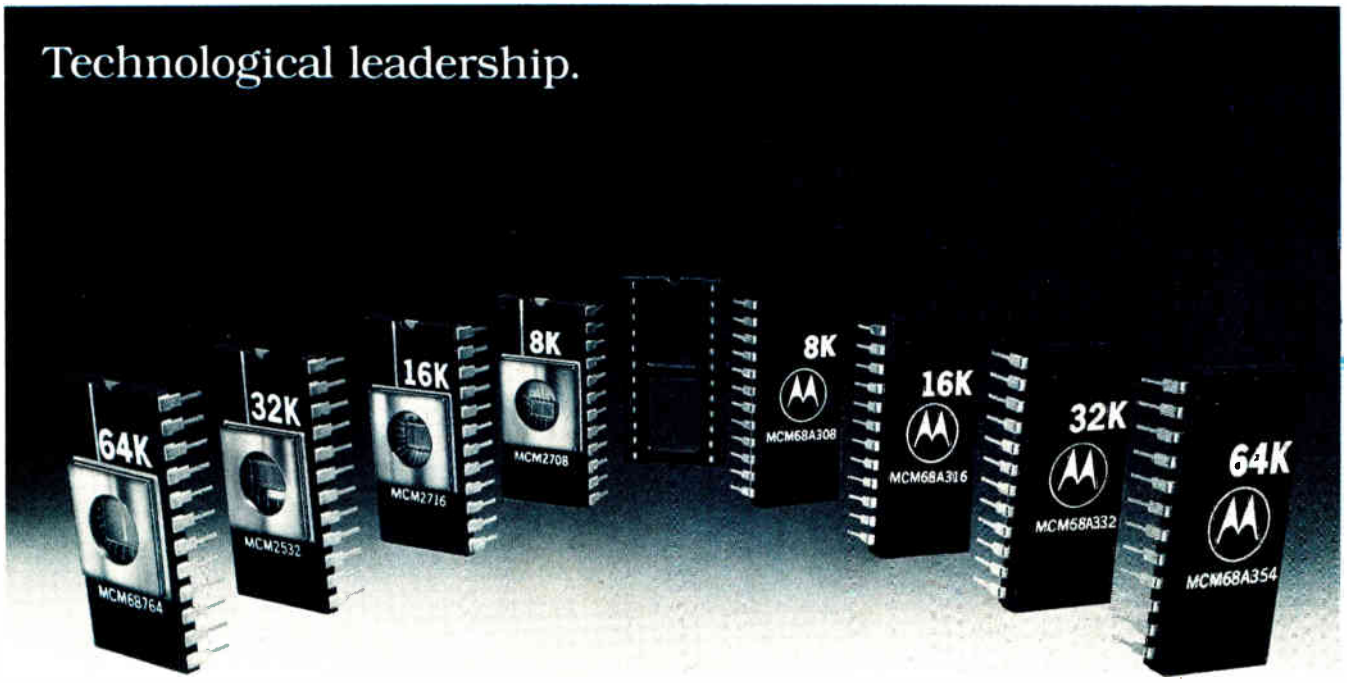
Engineering imagination is just about the only limiting factor in using this problem solving switch. 40 detent positions are standard, but up to 50 are optional. And units may be ganged to increase the number of functions. Logic disc codes are anything you can devise using a maximum 8 level truth table per switch section.

While one side of the logic disc is programmed for switching functions, the other side can have a 7 segment code to operate LED's or LCD's. And at a cost of about $2, a CTS digital logic switch may well be an answer in search of a problem.

For technical information, circle the Reader Number. Or **for a free 7 digit readout sample, write on your letterhead** and indicate the use you contemplate for a CTS digital logic switch. Write CTS of Elkhart, Inc., 1142 West Beardsley Avenue, Elkhart, IN 46514. (219) 295-3575.

CTS CORPORATION
ELKHART, INDIANA

Circle 63 on reader service card



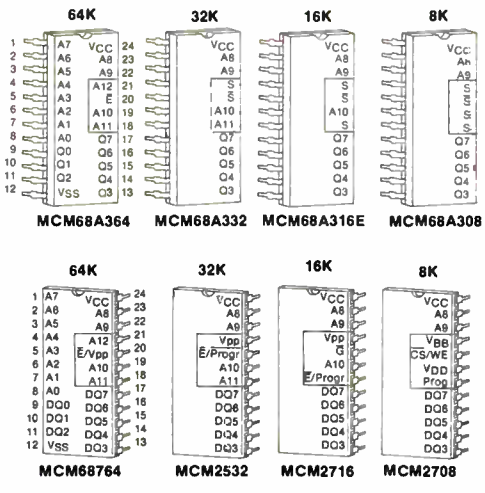
Plug-in compatibility is a natural with the first 24-pin 64K EPROM.

Motorola's MCM68764 is the first 64K EPROM to be directly compatible with 24-pin industry-standard ROMs and EPROMs.

It's also consistent with Motorola's concept of fully compatible EPROMs and ROMs from 8K to 64K. It's a natural.

Alternative concepts for 64K EPROMs have, up to now, been planned as 28-pin devices. But, what do you do with a 28-pin EPROM when you want to increase the capacity of an existing system full of 24-pin sockets? How do you convert a system from industry-standard 24-pin ROMs to EPROMs?

Motorola's pin-compatible ROMs and EPROMs.



Get the natural solution: the EPROM/ROM compatible 64K EPROM that drops right into your existing or new 24-pin sockets. Once again, Motorola has the innovative approach.

Motorola's complete EPROM/ROM plug-in compatible family.

The MCM68764 crowns our 24-pin EPROM series. Fourth quarter introduction of the MCM2532 32K EPROM gives Motorola the only total family of fully-compatible 24-pin ROMs and EPROMs from 8K to 64K. Motorola has been a ROM leader for years. We were one of the first to provide the full range of industry-standard pinout ROMs. Now, for the first time ever, you can match them with pin-compatible EPROMs.

All are TTL compatible, and the 16K, 32K, and 64K units operate from a single +5 V power supply.

The Motorola compatible EPROM/ROM family concept makes more sense for your system. Contact your Motorola sales office or distributor.

Motorola presents you with the memories and a broad range of additional leadership products for

Innovative systems through silicon.

MOTOROLA INC.

International newsletter

ITT microcomputer dissipates very little power

The ITT Semiconductors Group will come out early next year with a single-chip 4-bit complementary-MOS microcomputer whose dissipation of 45 μW in standby is claimed to be among the lowest power consumption ratings achieved for such a a device. **In operation, consumption is 135 μW.** The SAA 6001, developed at the group's headquarters company, Intermetall GmbH of Freiburg, is designed primarily for use in infrared remote-control systems for TV sets. It comes in a 60-pin plastic flatpack, operates off 3 V, and can drive an eight-digit liquid-crystal display without any interface circuitry. The chip itself measures 14 by 14 mm.

100-MHz tester due on market from Takeda

The fastest logic and memory tester around—it has clock rates of 100 MHz for emitter-coupled-logic devices with up to 384 pins—will be offered by Takeda Riken Industry Ltd. of Japan. The highest speed till now has been 40 MHz. Takeda's systems are similar to the prototypes it turned out for the Nippon Telegraph and Telephone Public Corp. [*Electronics*, Oct. 11, p. 45] and will sell for some $600,000 for a 64-channel setup to more than $3 million for one with 384 channels and a full failure memory.

The high-speed driver for ECL circuits has a transition time of 700 ps for an 0.8-V pulse. **The high-level driver for MOS devices has a transition time of 5 ns for an 8-V pulse,** lowering the maximum clock rate to 50 MHz. Two models are available: the T3370 system for memories only and the T3380 general-purpose tester.

Canon accepting orders for fast fine-line printer

Canon Inc. has started taking orders for an ultraviolet unity-magnification reflex projection unit that can print lines as narrow as 1.5 μm on silicon wafers. **Delivery in Japan is scheduled for next summer,** but the company has not yet decided when it will take orders for export. The initial commercial version will use an ultraviolet rather than a deep ultraviolet light source, like the original one built by Canon for Japan's Cooperative Laboratory [*Electronics*, April 26, p. 72], to keep the price reasonable, but a company spokesman says that it will announce a deep ultraviolet version within a year. The unit, which has **a throughput of 60 5-in. wafers an hour,** is available in two models. The MPA-500FA includes automatic mask alignment using a laser beam and is priced in Japan at roughly $320,000. The MPA-500F omits the laser alignment system and sells for $280,000. Canon will initially make five or six units per month.

French joining insiders in NATO re-equipment contest

Two French companies will be in for a slice of the $150 million to $200 million program to modernize the UK Air Defense Ground Environment system, whatever the outcome of the two-consortium contest. More significantly, the $1 million bidding phase will give the two, Thomson-CSF and Sintra, an inside position, along with American and British firms, in the bidding for the modernization of the North Atlantic Treaty Organization's entire ground radar air defense system by the end of the century. In July, only one consortium, Ukadge Systems Ltd., comprising the U. S.'s Hughes Aircraft Co., the Plessey Co., and the Marconi Co., bid for the UK part of the NATO network, but **political pressure from France led to the formation of a new consortium** made up of Westinghouse Electric Corp., Britain's International Computers Ltd., the Dutch Hollandse Signaalapparaten, and Sintra. Now Thomson is joining the Ukadge Systems consortium to complete the lineup. Tenders close in February 1980.

International newsletter

British develop highly stable crystal

A British company, Cathodeon Crystals Ltd. in Cambridge, claims to have overcome the tricky manufacturing problems associated with high-stability TTC-cut crystals and is offering production samples of its 10-MHz crystal. The production technology was developed under a Ministry of Defence contract, with support provided by Cambridge University in the X-ray crystallography techniques needed to slice the crystals. TTC-cut crystals have a flat temperature-frequency characteristic over an extremely wide temperature range, whereas conventional AT-cut crystals have a zero temperature-frequency characteristic at a narrow saddle point. Additionally, **TTC-cut crystals support a second, temperature-sensitive mode of oscillation (25 ppm/°C),** that can be used as a thermometer to control an oven or in conjunction with digital logic circuits to temperature-compensate the crystal. Hewlett-Packard Co. first proposed this technique to provide a super-stable frequency reference for its instrument requirements, and the University of Bath has developed a similar technique but using an AT-cut and a Y-cut crystal co-mounted [*Electronics*, Sept. 19, 1978, p. 67]. The new TTC-cut crystals are less sensitive to mechanical and thermal stress than conventional ones and offer superior aging.

Toshiba typewriter 'hears' 100,000 words by using syllables

An experimental voice-input typewriter developed by Toshiba Corp. can potentially type any one of the 100,000 to 200,000 Japanese words. It does this by recognizing the language's 68 basic syllables. In contrast, voice-input schemes that recognize discrete words are limited to a relatively short list. The scheme is said to be suitable to languages such as Finnish and Italian, with Spanish somewhat more difficult. It is not well suited to English, though, because of its irregularities and the number of syllables.

Toshiba says that a commercial product is perhaps two or three years off. **The present system gives a correct response to about 90% of the syllables spoken by a registered speaker.**

Fairchild gets its European act together

After a decade of half-hearted competition in much of Europe's semiconductor market, Fairchild Camera and Instrument Corp. now seems embarked on a course of consolidation and determined growth. With an 80-person sales force at its facility in Garching, near Munich, its subsidiary Fairchild Camera and Instrument (Deutschland) GmbH covers Central Europe, plus South Africa, Israel, Turkey, and the Eastern Bloc countries. Though its present share of Central Europe's semiconductor market is only slightly more than 4%, the company is shooting for 10% to 12% by 1985, **"by aiming our semiconductor products at growth markets such as the automobile, computer, and industrial electronics equipment sectors,"** says general manager Siegfried Mack.

Four-company team to develop TV satellites

A consortium of four aerospace and electronics companies is being formed to develop and operate TV-SAT, the Franco–West German direct-broadcasting television satellites [*Electronics*, Sept. 27, p. 98]. Although **the two West German partners, Messerschmitt-Bölkow-Blohm GmbH and AEG-Telefunken, will take the leadership role** for the two preoperational sister satellites, due to be launched in late 1983, all other tasks will be shared equally with the French companies, SNIAS (Société Nationale Industrielle Aérospatiale) and Thomson-CSF. Overall, MBB will coordinate work on the satellite platforms, Thomson work on the payloads.

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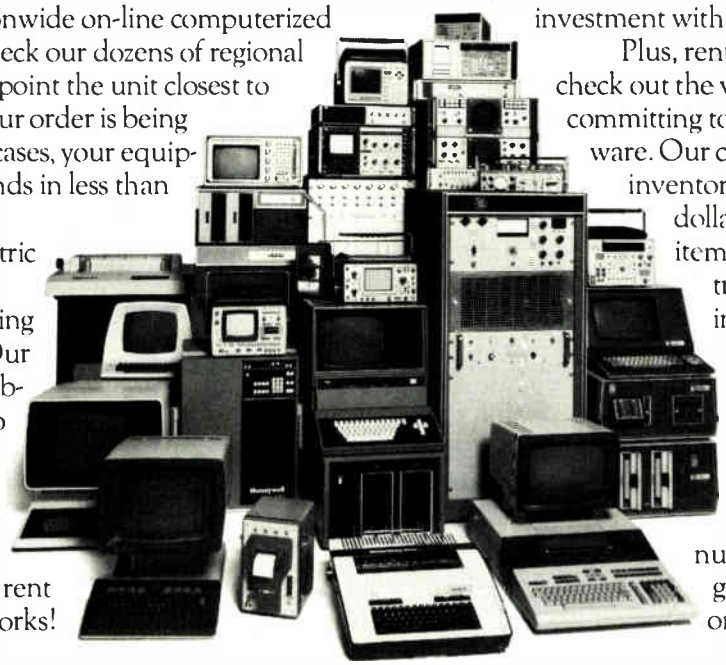

But renting from Leasametric means more than immediate possession. It's the one effective way to get the new equipment you need without going back to management for more money. There's no major capital investment with a Leasametric rental.

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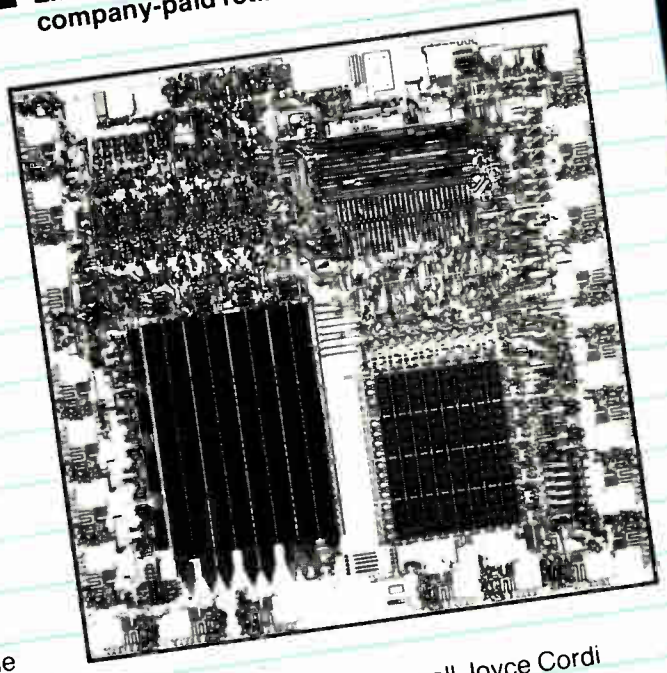

The Age of the Microcomputer

Our world is changing fast. Sophisticated electronic devices, in one form or another, are now found in virtually every household and industry—inside refrigerators, automobiles, traffic signals, industrial process controllers, and laboratory equipment—providing better communication and more efficient energy usage. No single invention has so radically influenced this evolving life style as the microcomputer.

We were first from the beginning and remain the world's leading supplier of microcomputer products. This commitment to maintain our technological leadership is now stronger than ever. Looking ahead, we see the advent of even more powerful, more useful, and more economical microcomputers.

To meet these challenges, we'll have an increasing demand for talented Field Applications and Field Sales Engineers in every major city in the United States and eastern Canada.

If you are an aggressive, innovative individual with a BSEE or equivalent, and at least 3 years of microcomputer systems design experience interested in exploring these opportunities, please call Joyce Cordi at (800) 821-2280, ext. 905. Previous electronics sales experience, technical project management experience and/or an MBA are desirable but not required. If you are unable to call, please send your resume to her attention, Intel Corporation, Dept. 49BD, P.O. Box 3078, Santa Clara, CA 95051.

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Power inverter achieves efficiency of over 90% even for low outputs

by Arthur Erikson, Managing Editor, International

Designed for households, 2-kVA prototype prefers electronically switched batteries to transformers

No one expects solar energy to supply a substantial part of the world's electrical power. But with the costs for oil-fired generating plants soaring to nearly unbearable levels, householders in sunny climes may well find one day that photovoltaics is a better buy for electricity.

When that happens, power inverters that transform direct current into conventional alternating current to run electrical appliances will be a must for practical home photovoltaic generation. And the more efficient the inverter, the more competitive photovoltaic power will be.

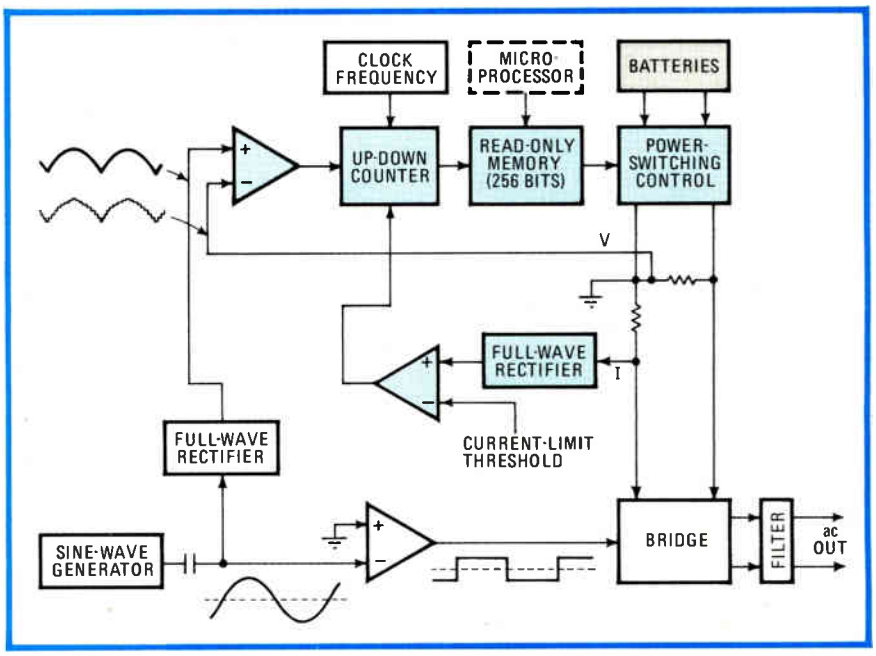
An inverter with extraordinary efficiency and designed for household use has been put together at Laboratoires d'Electronique et de Physique Appliquée (LEP), a research unit of the Philips group in Limeil-Brèvannes, outside of Paris. The 2-kilovolt-ampere prototype that LEP will present next week at the 68th French physics exhibition at the Porte de Versailles in Paris converts better than 93% of its input dc power into 220-volt, 50-hertz ac at full load. At an output of 0.1 kVA, efficiency still exceeds 90%. With no load connected to it, the inverter consumes a measly 5 watts.

Some commercial inverters now on the market operate at 90% efficiency at their nominal output. But when they are supplying lesser loads, their efficiency plummets, largely because of transformer losses that stay the same no matter what the load. For a household solar-panel supply, the round-the-clock efficiency of a conventional inverter is some 50%, figures Geert Jan Naaijer, who is credited on LEP's patent with inventing the new inverter.

Naaijer pared no-load losses to next to nothing by eschewing transformers. Instead, a bank of batteries is switched onto the load in sequence under electronic control to create a step waveform that closely approximates the sine wave of an ac supply. The switching is timed to hold harmonics to a low level, so that a simple filter can smooth the output.

In the prototype, funded in part by France's Commissariat à l'Energie Solaire, the basic scheme is implemented with eight 48-volt batteries. Associated with each is an electronic switch, basically two complementary low-voltage Darlington transistors shunted by power diodes to handle inductive currents. These switches feed battery power to a full-wave bridge, comprising four high-voltage Darlington transistor pairs, and the bridge is switched by the digital equivalent of a reference sine-wave generator to ensure the polarity reversal needed for an ac output. To isolate the control electronics from the power circuitry, the Darlingtons are controlled by optocouplers.

The concept is straightforward (see figure). A 256-bit read-only memory stores the switching sequences and feeds on and off signals to the optocouplers to generate the



Low losses. LEP substitutes batteries for the conventional transformer and switches them in sequence, controlled by feedback loop (color), to keep power inverter's losses under 10%.

step waveform. The inverter output that results is continuously compared with the rectified reference sine wave (whose instantaneous polarity also controls the bridge). Any difference between the two develops a control signal for an up-down counter clocked at about 10 kilohertz. The counter's output, in turn, determines the control signals that the ROM transmits to the optocouplers. Because of this loop, the inverter output follows the reference wave very closely.

Protected. To prevent overloads, the up-down counter also gets a priority signal that develops when the inverter's output current exceeds a preset threshold. In that case, the counter switches to the down mode and instructs the ROM to drive the output voltage toward zero.

Even more sophisticated control could be added, Naaijer notes, by adding a microprocessor to control the ROM. Further, he sees no reason why, since each switching element handles only a small fraction of the total output power, the prototype could not be scaled up to 10 kVA.

To isolate the solar-cell panels that would charge the batteries in a full-fledged working installation from the ac circuitry, Naaijer would split the batteries into two identical blocks. One block would be connected to the solar cells while the other powered the inverter. Although either block could run the inverter for several days, the two would be alternated daily to keep them charged equally.

Great Britain

Digital transmission equipment works with only two telephone wires

Looking toward the growth of digitally based services in telephony, GEC Telecommunications Ltd. has come up with prototype transmission equipment that packs a high-quality digital speech channel and a 16-kilobit-per-second data channel onto the existing two-wire analog telephone exchange link.

Down to two. Digital transmission ordinarily requires four wires (see "Two wires vs four"). To circumvent this requirement, GEC Telecommunications engineers, working with the parent firm's Hirst Research Laboratories, Wembley, have adopted half-duplex time-sharing so that each end talks in turn. The resulting system is capable of carrying up to 96 kb/s of information in both directions simultaneously. The digitally coded speech occupies 64 kb/s, synchronization 8 kb/s, and signaling and supervision another 8 kb/s, leaving an extra 16 kb/s to provide one or two additional data channels.

In volume production, a large-scale integrated version of this equipment would cost as little as $100 per line, according to R. A. Burden, manager of export sales for the company's telephone switching group. The subscribers' terminal equipment will be on three complementary-MOS LSI chips and could be incorporated into the telephone. Eventually, says D. J. Clothier, a development engineer on the project, "the electronics could shrink to one LSI chip incorporating both a codec and control logic." A wall-box multiplexer is provided for data services such as facsimile or viewdata.

In LSI form, the exchange equipment will occupy one double Eurocard with eight lines per card when connecting to a digital exchange. For an analog exchange, there would be one line per board.

The Coventry company is not rushing its prototype into manufacture because it is awaiting a CCITT international standard for two-line half-duplex digital transmission systems. In the interim, it bases its system on the CCITT standard for digitally encoded speech of 64 kb/s, with one digital sample contained in each 125-microsecond frame.

Slavery. To resolve any conflict should both ends try to start transmitting simultaneously, the telephone receiver acts as a slave to the exchange equipment. For an incoming call, the exchange originates transmission and evokes an initial response from the phone in the usual way. For an outgoing call, the phone transmits a message to alert the exchange, after which it reverts to the slave mode and awaits the first transmission from the exchange.

Each 12-bit data word is transmitted as a 256-kb/s burst. However, because of transmission delays, the system can be used only on links up to about 2.2 kilometers long. That is

Two wires vs four

With digital exchanges spreading into the world's telephone networks, equipment manufacturers are turning their attention to ways of bringing the new services based on digital electronics to the local subscriber. As it stands, the existing two-wire network linking subscriber to local exchange is inadequate for the task. Designed for analog speech, it combines two-way transmission, power feed, and signaling by the use of hybrid transformer techniques. In digital transmission systems, though, separate sending and receiving channels are generally required, leading to a four-wire arrangement.

New subscribers can be connected with four-wire cable, but it would be expensive to provide present users with such links. So telecommunications authorities and telephone companies are faced with the problem of piping advanced new services into people's homes over the existing network. Equipment to accomplish this will be of enormous importance, according to R. A. Burden, manager of export sales for GEC Telecommunications Ltd.'s telephone switching group, Coventry, for it will allow telecommunications authorities to preserve their investment in local telephone cable networks as digital technology is extended to the periphery of the system. **-K. S.**

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sufficient to cover more than 60% of subscriber loops in the UK. For longer lengths, two-wire links can be fed to a remote concentrator and a standard four-wire pulse-code-modulated link.

Others, too, are developing such systems. The British Post Office, for one, which is working with GEC on its gear, has a complementary system with a greater data-channel capacity. **-Kevin Smith**

Japan

Digital loop controller series take modular approach for wide applicability

Japanese users of industrial controllers will channel at least 60% of their spending toward direct digital controllers in 1985, according to Masahiro Shimizu, president of Hokushin Electric Works Ltd., Tokyo. His company is now jockeying for a leading position in this market as it puts the finishing touches on three series of modular controllers, designed for 1 or a maximum of 8 and 14 loops, respectively, that it will announce early next year.

These series are aimed at applications for which the company's present 900/TX system, based on Digital Equipment Corp.'s LSI-11/2 and designed for 16 to 48 loops or multiples thereof, is not economical.

One-loop controllers provide the highest possible reliability for critical loops, an argument advanced by other companies, including Toshiba Corp. [*Electronics*, Aug. 2, p. 72]. They are also suitable for some applications like cascade control that require two analog controllers.

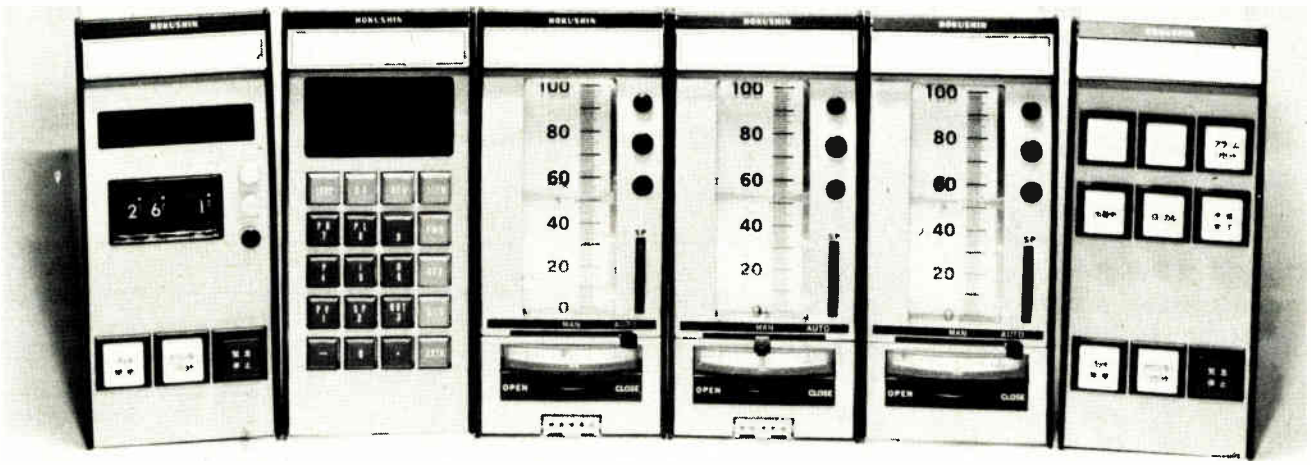
Eight-loop controllers have been developed by other firms, including Toshiba (again) and Yokogawa Electric Works Ltd., but Hokushin says that the loops are too few for many chemical batch processes, even though the number is excellent for most steel industry processes. Hokushin therefore developed the 14-loop series for minimum cost per loop in chemical processes requiring more than 8 loops. The 2 apparently missing loops (from an even binary 16) leave capacity for the moderately complex sequence control often needed in modern control systems.

Hokushin's one-loop controller will be priced in the $1,900-to-$2,100 range, which is about 10% to 20% below the price of Toshiba's controller. The capacity of its read-only memory is somewhat smaller, limiting the number of algorithms, and there will be a few applications for which the Toshiba unit is suitable that the Hokushin controller cannot handle, but Hokushin is betting that it has selected a more attractive tradeoff.

Moving up. An 8-loop system will be priced at about $16,000, about 10% less than the Toshiba system, which would be its main competitor. The firm says that its new products will really shine when up to 14 loops are required, because the price is only $24,000 to $27,000. With the Toshiba system, two 8-loop systems are necessary, so the savings would be as much as 25%.

Hokushin calls its new line Homac, for Hokushin Microcomputer-based Advanced Control system, series 300, 500, and 700. It has kept hardware costs low by choosing popular, inexpensive microprocessor components and by reusing the same hardware and software for different functions in the system.

Thus the single-loop controller is based on an Intel 8085 processor with 6 kilobytes of ROM and 1.25 kilobytes of random-access memory. It includes the same indicators and controls on its front panel traditionally used on analog controllers, with which it is interchangeable. On its side panel, visible when the unit is pulled forward, are a calculatorlike



In control. Hokushin's line of digital controllers includes (from left to right) a communications interface station, an 8- or 14-loop controller, a 1-loop unit or a loop module for individual loops in a multiple-loop configuration (three shown), and a sequence module.

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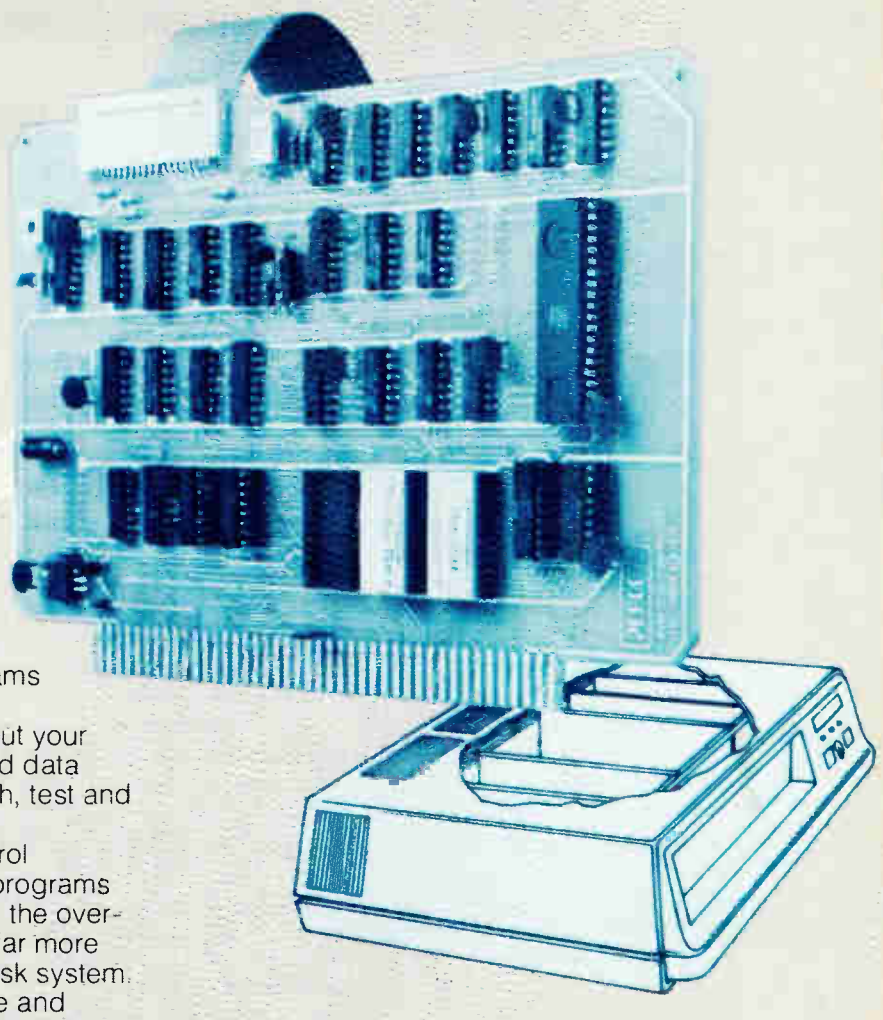

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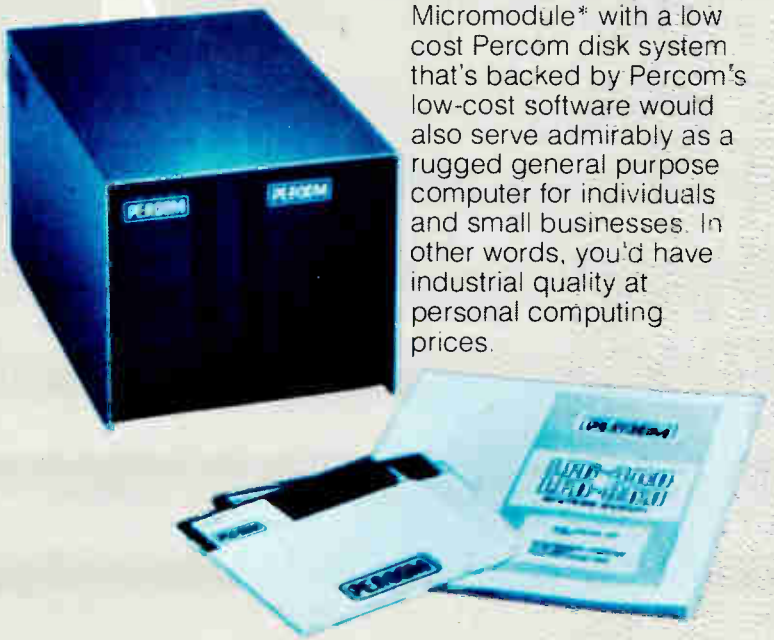

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keyboard and an eight-digit light-emitting-diode display for entering programs, for checking auxiliary loops, and for maintenance.

The 14-loop controller is based on an 8086 with 14 kilobytes of ROM and 8 kilobytes of RAM; the 8-loop controller is similar with somewhat less ROM and RAM. Both also have a calculatorlike keyboard and an LED display—in these cases, 16 digits—on their front panel.

Monitoring. The status of individual loops in multiloop setups is controlled by loop modules that are similar to the single-loop controller except that the ROM capacity is reduced to 2 kilobytes and the RAM capacity to 256 bytes and the keyboard and display are eliminated. The processor in these modules handles the input and output signals, including control of analog-to-digital and digital-to-analog conversion.

Also included in the line is a sequence module and a communications interface station, each built around an 8085 processor. The former provides 12 illuminated switches to enter operator's commands, indicate input/output status, and provide I/O contacts to and from such components as limit switches and electromagnetic valves.

The latter acts as a store and forward interface between the 7,800-bit/second bus that connects to the single-loop and multiloop controllers and an RS-232-C asynchronous data path to the supervisory computer system (if one is used). It also interrogates each instrument every 2 seconds and activates an alarm if it detects a failure.

Programming. Like the earlier Toshiba units, Hokushin's controllers include a menu of control algorithms that are used as subroutines. But rather than writing the user's program in a programmable ROM, Hokushin writes them in a complementary-MOS RAM, which is backed up by a battery to prevent the loss of its contents during a power failure. Program loading can be done through the instruments' keyboard and display, but program loaders with magnetic-tape cassettes will be used for convenience.

The controllers, like most others, operate from a 24-volt dc line, which is standard in control environments, and include a dc-to-dc converter to transform the voltage into the 5 V required by the microprocessor. Backup for the C-MOS RAM is 4 V, obtained from a 12-V storage battery, which Hokushin engineers say is normally available at control installations; an internal lithium battery is optional. **-Charles Cohen**

Israel

Rotary encoder's low price extends availability of electronic control for lathes

An optoelectronic digital measuring system recently developed for manually operated lathes may offer an alternative to similar but high-priced devices now on the market. The unit, from a small, new Israeli company, VMW Ltd. in Holon, is an enclosed incremental rotary encoder with a digital readout.

Present systems for achieving a measure of electronic control over manually operated lathes consist of a linear encoder mounted on the lathe and hooked up to a digital readout nearby. About a foot long, the linear encoder takes up valuable space on the lathe and is expensive, primarily because of the code-bearing chromium-plated scale.

Since the most basic model of the linear encoder costs some $1,000, only a small percentage of lathes are rigged with them. Operations or shops that deal with very limited or individual runs, for which automatically programmed lathes are unnecessary, have therefore had to rely on manual operation, which can be inefficient and inaccurate.

The new way. A year and a half in development, the rotary encoder is located behind the handle of the shaft that controls the movement of the lathe's cutting edge. It replaces the dial, with which all lathes are fitted, that mechanically measures the cutting edge's progress.

The principle of the rotary encoder is the same as that of the linear device: an optical disk senses the angle through which the shaft turns and relays this information to the readout. Since the feed screw's angle of rotation is precisely related to its linear motion, the angle measurement indicates the position of the cutting edge.

Easing up. With this device, the lathe operator no longer has to continually perform mental gymnastics or stop to check with his micrometer. Now he has only one measurement to make of the initial part diameter. Then he simply presets his result on the digital readout. The part diameter will be displayed accurately to within 5 micrometers. Besides saving time, the use of the rotary encoder considerably reduces the chance of errors by the operator.

The encoder, 25 millimeters wide and 85 mm in diameter, operates from 0 to 6,000 revolutions per minute. It fits any linear displacement of the tool support from 0 to 999.99 mm, or to an optional 9,999.9 mm. Resolution is one order higher than that of the lathe (usually 0.01 to 0.005 mm), but the device may be made with higher resolution. Options include a binary-coded-decimal output, metric or inch readout, and battery backup.

By fabricating the linear encoder as a shaft-angle encoder attached to the lathe's feed screw, VMW has come up with a system that, it claims, can be produced for $250. With this sort of production price, it may even prove attractive to shops with old lathes that would not otherwise be worth fitting out with any sort of electronic control.

The rotary encoder can also be connected to milling machines, jig bores, and grinders. It is currently being tested for use by Koor Industries Ltd., Israel's largest industrial conglomerate. **-Arthur Kemelman, McGraw-Hill World News**

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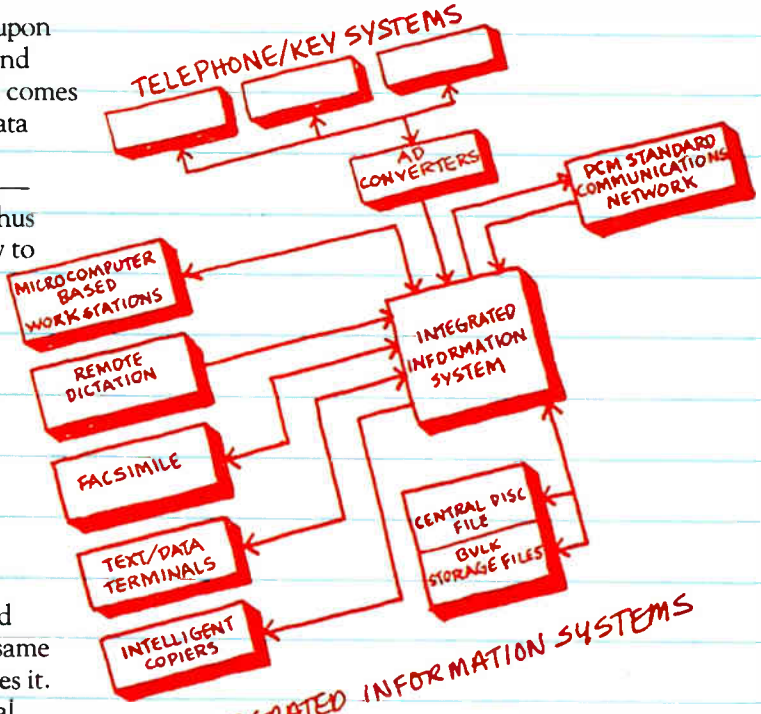
The microcomputer—invented by Intel in 1971—has been the key component that's made possible distributed processing networks, with central computers linked to remote "smart" terminals, printers and local processors.

Today, the biggest obstacle to the growth of such networks is the cumbersome analog-based



transmission system. One alternative —already in use—is to use satellites to bypass the traditional transmission system. To compete, the telecommunications industry will have to convert to the high speed, wide bandwidth of digital transmission. And, ultimately, "telecomputerization" will require the extension of digital standards to the subscriber station.

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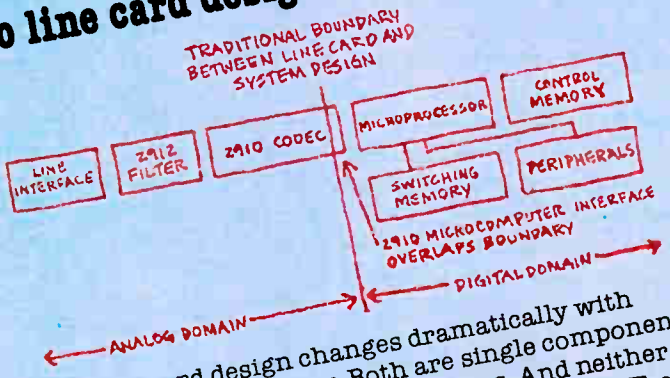

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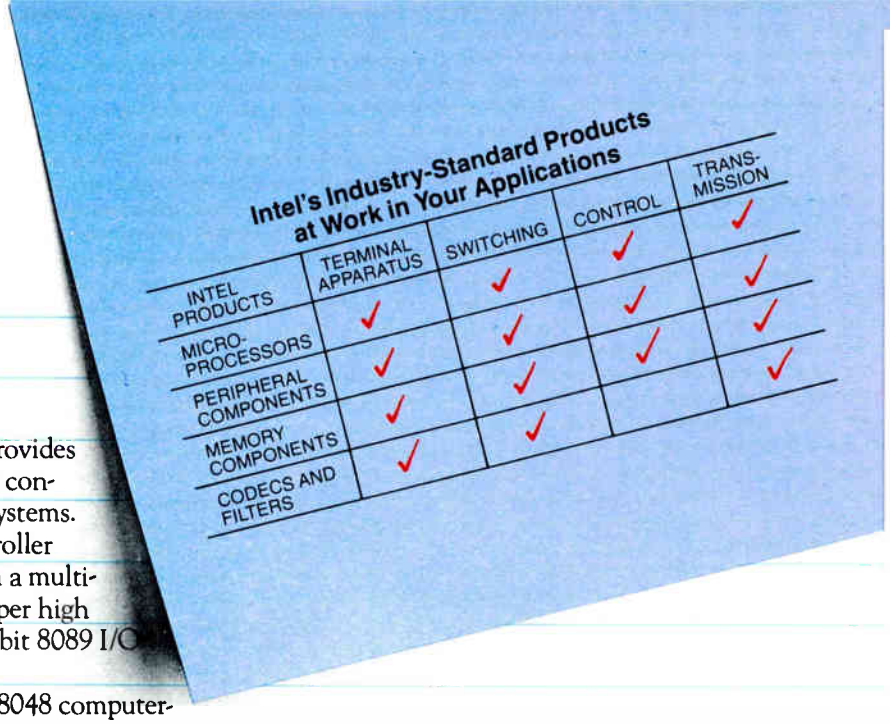

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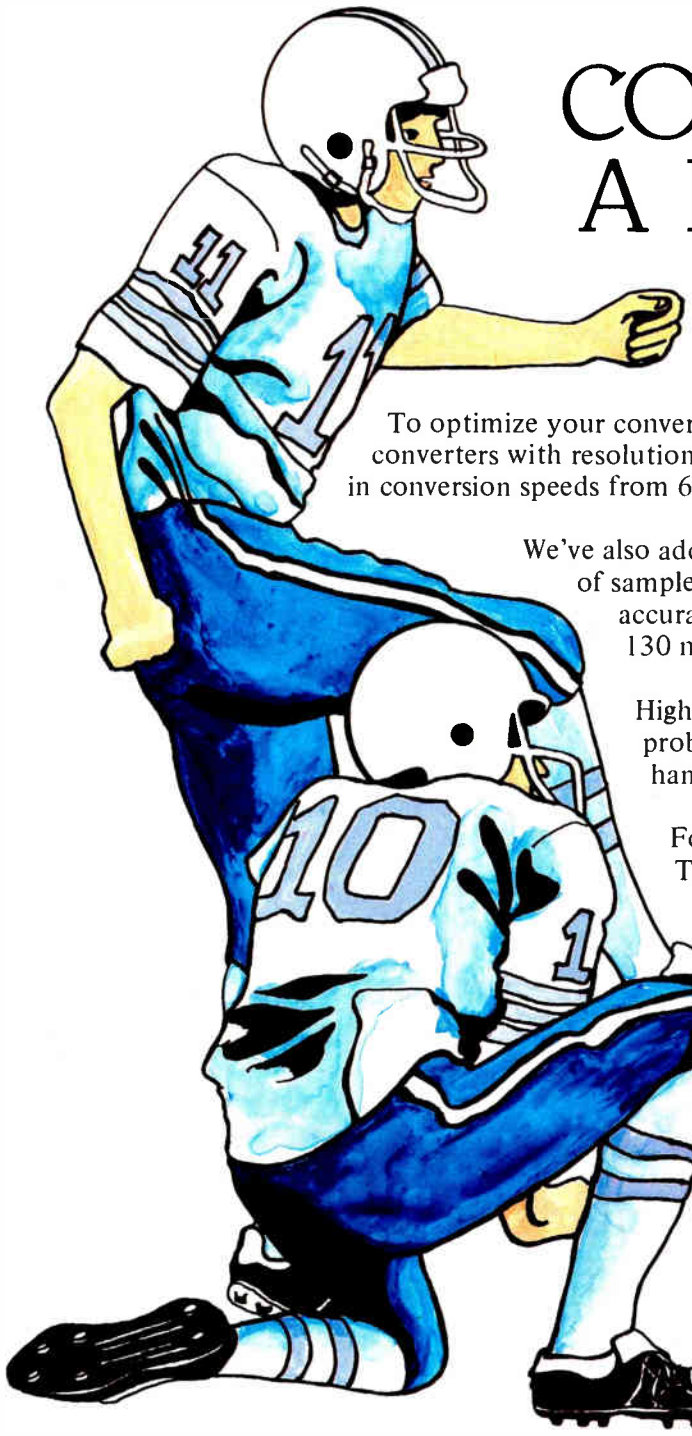

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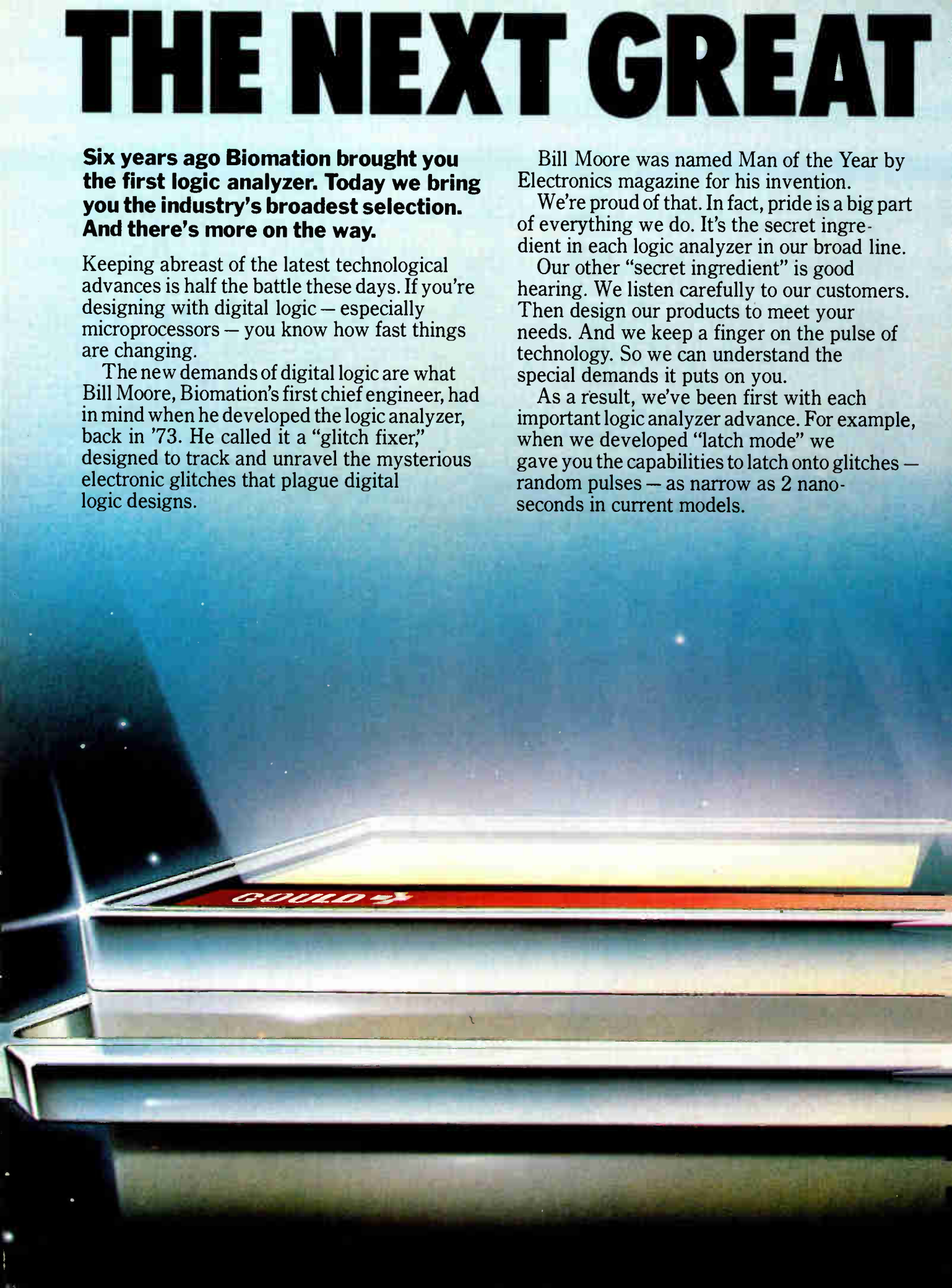

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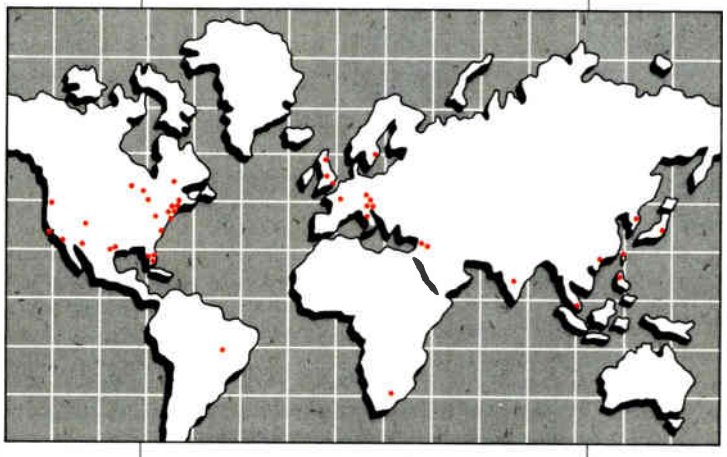

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TI Regional Technology Centers hold monthly courses on the TM990 modules, the 9900 Family microprocessors, Power Basic, Microprocessor Pascal, and the AMPL lab. Check your nearest TI distributor or TI field sales office for dates, locations, and fees.

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☆☆☆ Discrete Testing News NEW

VOL. 33, ISSUE 4

Teradyne adds microprocessor-controlled system to discrete testing line.

New T327 is heavy on performance, light on price.

Amidst considerable hoopla, Teradyne today unveiled its new microprocessor-controlled discrete semiconductor test system.

Dubbed T327, the new system is well suited to both manufacturers and users who desire high throughput coupled with a mid-size data processing capability.

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Uses for the T327 include probe, final test, vendor monitoring, device evaluation and many more.

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Six (6) or more test stations can be run off a single system at a low cost-per-station unmatched in the industry.

Standard features are impressive, as well. As one prospective buyer noted, "I can get excited about a basic system that comes complete with floppy disks, a thermal printer and a CRT."

Other advantages.

Like all Teradyne discrete test systems, the T327 stresses high throughput, ease of use and easy setup.

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To distributors, pervasiveness is key

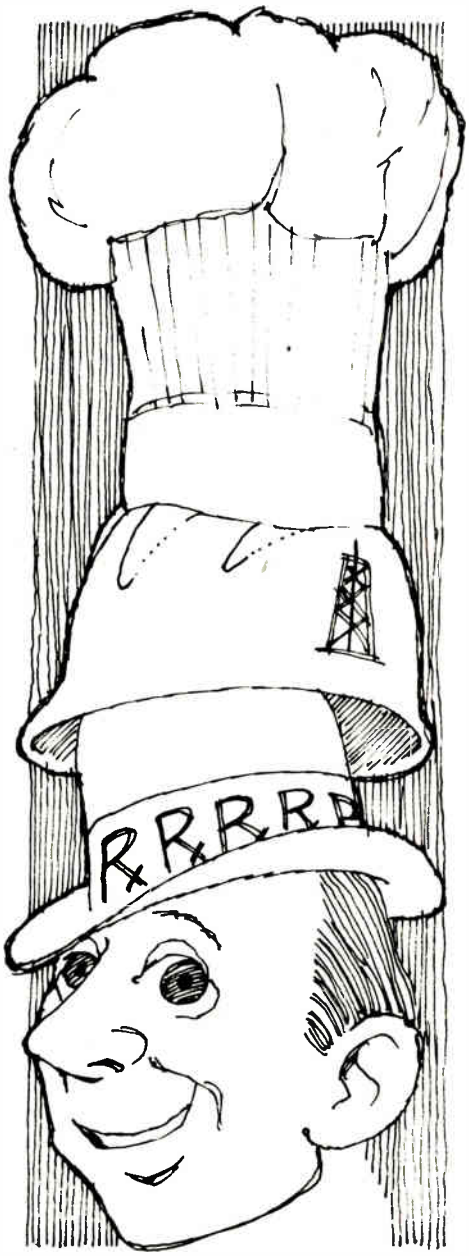
Penetration of electronics into new markets will soften impact of any downturn in 1980, executives agree

by Larry Waller, Los Angeles bureau manager

Whatever next year holds for electronic component distributors—and management opinions vary all over the landscape—top officials agree with one another and their fellow executives who manufacture the devices (see p. 111) on one thing: if a recession indeed hits, it will not be as bad as the disastrous downswing in 1974–75. While not playing down the perennially underfinanced condition of many distributing outfits made even worse by 15¾% prime interest rates, the executives point out that there have been several improvements.

"Pervasiveness" is the key word, referring to onrushing penetration of electronic parts into new uses, helping to smooth out business cycles. As William C. Cacciatore, senior vice president of distribution giant Hamilton/Avnet Electronics, puts it, "Pervasiveness will offset any slower growth rate overall in the economy." His boss, Anthony R. Hamilton, the eternally optimistic president of the Culver City, Calif., company, says this translates into more customers than ever—some 102,000 for his firm alone, or about double the total five years ago. More importantly, unlike 1974, new distribution customers are outside the electronics industries themselves. They come from such sectors as pharmaceuticals, petrochemicals, and food processing, where microcomputer-based controls have been replacing electomechanical equipment.

Two other factors also contribute: better control of inventories, based on new data-processing systems, that keep management more on top of what became a runaway problem in 1974; and the solid financial health of the distributor's major suppliers, the big semiconductor houses. "There's not a bad balance sheet among them," notes Sidney L. Spiegel, president of Wyle Distribution Group in El Segundo, Calif., who keeps close tabs on distributor finances [*Electronics*, March 16, 1978, p. 84]. Such a positive stance is a far cry from the situation five years ago, when pressure and subsequent panic selling sent many distributors to the brink of financial disaster.



Finally, the obvious effects of three years of boom have allowed many distributors themselves to shore up their financial underpinnings somewhat. "But not all," sighs Spiegel.

But when queried for their views about 1980 business, industry officials go differing ways. As might be expected, Hamilton sees little trouble. "We're still plunging ahead, investing in inventory, facilities, and people." While much depends on the overall economy, he admits, growth rates for his firm of from 12% to 18% seem to be in the cards. (Industry figures are notoriously difficult to come by, but most sources think the distribution field grew at a 25% or so clip in 1979, on the heels of a 34% rate in 1978.)

Also optimistic about 1980 is Joel H. Girsky, secretary and treasurer for Jaco Electronics Inc. The Hauppage, N. Y.-based firm grew at a 25% rate in 1979, opening outlets in Dallas, Boston, and San Jose, Calif. "Unless the national economy really goes into the tank, the electronic components business will remain relatively unscathed," says Girsky, who is planning on a 20% to 25%

growth rate next year. Even if things do go badly, he thinks a 12% rate is still possible.

Dim picture. From these fairly rosy views, projections vary downward. Harvey E. Sampson Jr., president and chairman of Harvey Inc., Woodbury, N. Y., expects today's "very strong business to continue for six months—beyond that, the picture's just too cloudy." In Dallas, Byron Kirkwood, president of KA Electronics Sales, a small independent, says, "We feel if there is a recession we're going to hold our own, or at worst, we'll see some leveling off."

From a Midwestern vantage point, Abe Halegua, president of Advent Electronics, Rosemont, Ill., is participating in very strong business. "We are expanding, and sales next year should be up at least 10% over current levels." Head of an independent doing $5 million to $10 million a year, Halegua believes high-technology items will continue to fuel growth, but "commodity-type components, such as resistors, are in better supply than ever and may not keep pace." For just this reason, Robert Throop, president of Intermark Electronics, Sunnyvale Calif., emphasizes advanced technologies. "A recession would have a much greater effect on mature products," he thinks. And six months out, distributors "will see the recession eroding business."

On the low side of prognostication, as usual, stands Wyle's Spiegel, who admits he sometimes errs by being too cautious. "We're making plans for a flat first six months, then look for a 10% to 15% growth for the rest of 1980." He bases much of this on data from industry consultants, but observes, "If you ask me if I have any confidence in it, the answer is no." Speigel pinpoints March as the critical month. "If the industry is solid through then, we'll go marching right on through."

Inventory worries. One industry-wide concern is inventories and what can happen if they start to pile up. In 1974, for example, a three-month lag effect, beginning with the build-up of stock during February and March, was reflected in much lower sales by late spring. "The big question," says Spiegel, "is whether an inventory glut is building, and none of us really know that now."

Closely related to this nagging worry is the skyrocketing interest rates distributors have to pay banks to finance operations. Every manager is in the throes of reevaluating what these rates (as high as 20%, reflecting such factors as compensating balances and premium over the prime rate) can do to business. Profits, for example, seldom make this level of borrowing sensible for anything more than the short term. "Any distributor working on less than 15% [profit] margin ought to have his head examined," flatly states Advent's Halegua.

Along with what Semmer calls "incremental, not critical" inventory buildup to date, an inevitable result of tight money is lengthening receivables. This is starting to alarm every distributor who will talk on the record. Samson of New York's Harvey Group sums it up as "a very troubling development" and notes that accounts receivable for his firm now stretch out to as long as 55 or 56 days.

What to do? Customers slower to pay bills test the resolve of distributor management that is caught in a ticklish dilemma. At Advent Electronics, Halegua has no hesitation about cutting off "bad accounts" of a certain kind, those that are taking delivery on parts in tight supply. They suffer a "fate worse than bill collectors because there's no sense in shipping valuable parts to non-

Growing weak amid the strong

When news of serious troubles at Cramer Electronics Inc. surfaced earlier this year, a purchasing manager for a nearby manufacturer made a trip to Cramer's Newton, Mass., warehouse. In pulling ordered items from stock, he was struck by the chaotic state of Cramer's inventory: "Their shelves were loaded with things people haven't bought for years."

That was just one symptom of the terminal illness afflicting the second-ranked (in terms of sales) member of the fast-growing distribution industry. Rapid growth, in fact, produced most of the problems besetting Cramer's management, sources say. It is now merging with Arrow Electronics Corp. of Greenwich, Conn.

Booming sales in the early and mid-1970s encouraged companies like Cramer to borrow heavily. That was a response aimed solely at increasing sales volume, the standard by which manufacturers traditionally judged distributors [*Electronics*, March 30, 1978, p. 24], but it did little to enhance profit margins. Cramer's bank debt—reportedly $26 million at the end of 1978—was absorbing 60% to 70% of the firm's income from accounts receivable, according to one industry observer.

One recently departed top officer notes that Cramer's management was conditioned by boom years "when you could sell anything." Former Cramer president Timothy X. Cronin, under whose guidance Cramer expanded "to get in on the boom," agrees. "Volume for volume's sake" is a characteristic obsession of distributors, he says.

But Cronin, not surprisingly, focuses on later developments in assessing Cramer's fall. Ousted in early 1978, he asserts incoming leadership made some serious mistakes. Firing nearly all the firm's top management, Cronin says, lost many franchises as confidence in stability ebbed. In his opinion, it also failed to develop necessary controls to regulate inventory. He admits this had become a problem during his tenure, "at about the time sales got to the $125 million level."

"It takes a terrific amount of time and trouble, not to mention a restructuring of sales procedures, to establish good monitoring, and companies haven't been willing to bite that bullet," says an ex-Cramer executive. He adds that the problem continued at Cramer because so much energy was required "just to keep the ship afloat."

The view of both the Cramer executives and observers is that Cramer's woes are not unique in an industry goaded by good times and manufacturers' expectations to emphasize sales growth above financial stability. Left unattended, these issues could produce more Cramers, they say.

-Linda Lowe

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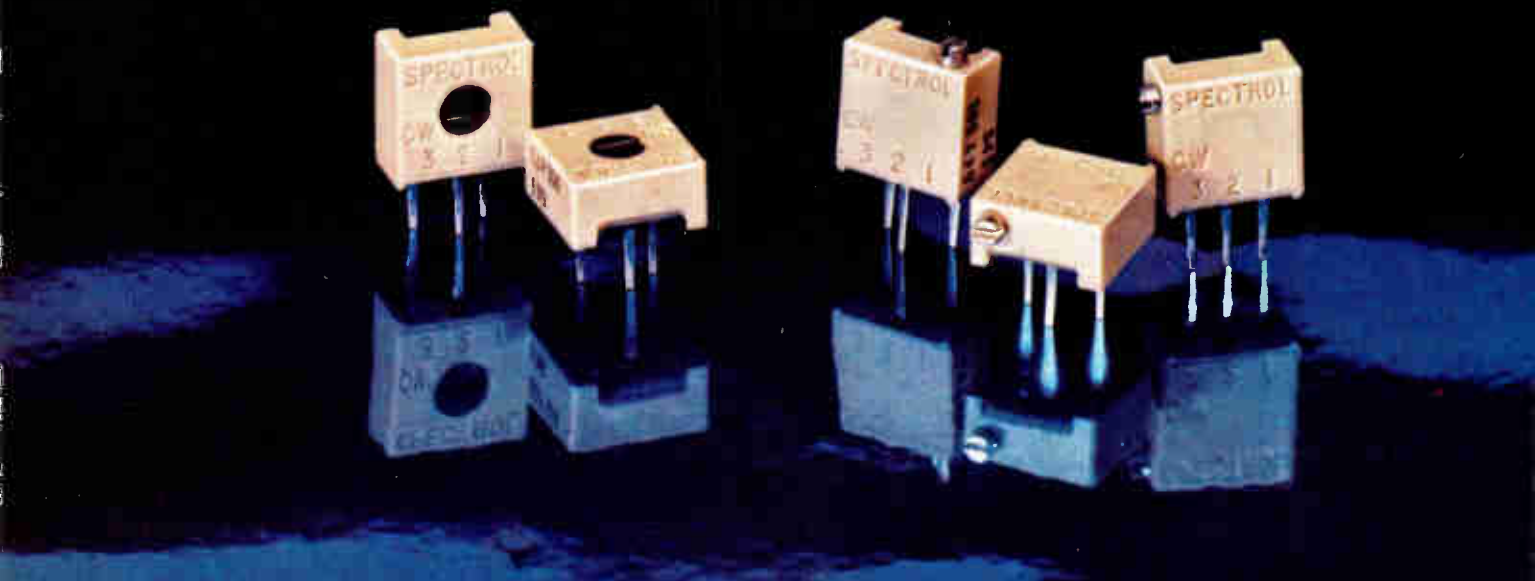

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payers," he notes.

With emphasis on watching profit margins during a tight money period, the question of the availability of high-margin, leading-edge technological components still in short supply becomes even more insistent, industry executives agree. During all of 1979, the lead times of new memories, low-power Schottky (LS) devices, and many microprocessors stretched in many cases to six months. While most maintain these parts still are difficult to obtain, some slight changes are starting to show. "We are seeing better deliveries of both microprocessors and memories," notes Larry Pond, executive vice president of Wyle, "except for 64-Ks." He thinks LS, in short supply for many months, will not improve much because of its big backlog, but here, too, others see things differently.

More coming. According to Joseph Semmer, director of business development for Dallas-based Hall-Mark Electronics Corp., reports are circulating that Texas Instruments Inc., the biggest LS supplier by far, feels it can deliver 20% more parts than promised during the first quarter. If this happens, says the Texas executive, "it will clear up delinquencies and get 20-to-26-week lead times back to normal."

Although shortages have driven distributors up the wall, there is a positive aspect. For perhaps the first time in years, rampant price cuts did not sweep over the business just when hot-selling parts were set to make nice profits for all hands. To the contrary, prices of some hard-to-get products are being increased, say Semmer and KA's Kirkwood.

Chiming in with increases have been Fairchild Camera and Instrument Corp., Motorola Semiconductor Products Group, and TI, with jumps of 5% to 10% on LS. And 16-K random-access memories are firming up with increases in the 10% range. Such a trend has been building over the past six to nine months, estimates Semmer.

This indicates to both Semmer and Spiegel that pricing philosophy may be changing among the semiconductor manufacturers, who previously thought largely in terms of buying market share with lower prices. Spiegel thinks such a change, if it proves to be more than a short-term glitch resulting from short supplies, could become more pronounced as the 1980s progress and stems from the basic recognition by semiconductor management "that more profits are needed to finance the investments they have to make to expand capacity." It has already manifested itself in paring back some product lines, notes Semmer, and the reduced competition itself has a tendency to hold prices firmer.

What this means to distributors is so far unclear, but Spiegel hopes it also could help in getting manufacturers to recognize that distributors need better profits to finance their own growth. "This is a lament that has fallen on deaf ears in the past," as one industry veteran says.

Looking into 1980, if a recession actually bites the industry (against the majority expectation), the usual question should resurface about which weak firms might go under or be acquired. Paradoxically, Spiegel does not foresee a major fallout during lean times. "That frees up cash so banks can be paid. But when the next expansion comes, they [banks] are more suspicious."

Failures are more likely to happen during boom times, he says, because financing growth is more expensive in terms of new investment. Wyle's Pond puts this at "30 cents to finance every new sales dollar. For one with a great debt overhead, that figure is more like 40 to 50 cents." Most industry sources point at this requirement as a major cause in the failure of Cramer Electronics during an industry boom time (see "Growing weak amid the strong").

But the potential payoff for successful distributors can be noted in continued industry growth, which, by most reports, reached $3.2 billion in 1979, up from $2.7 billion in 1978. And the importance of semiconductors in this pie is underlined by their increasing share, put by Spiegel at about 37% of the total for this year.

Furthermore, pressures to succeed heighten as the stakes get bigger, he thinks. As an example, he singles out the recent move of two top executives to Arrow Electronics from Hamilton/Avnet, and the subsequent lawsuits from both sides. This would not have happened two years ago, he believes. □

Value added means profit plus

An idea being pushed by smaller regional distribution firms as a way to negate the size advantages of their bigger competitors is a "value-added" approach. By no means a new gimmick, since distributors have put together systems and assembled parts for years, it is an opportunity for a smaller firm to pick out a niche, specialize, and hope to offer both supplier and customer better service than a competitor who might simply lump the product into a wider mix.

One tip-off to the accelerated value-added activity comes in California, where flat-cable and mass-termination connectors represent a good market for small firms, but one evidently not juicy enough for the big boys to zero in on. Cetec Moltronics division of Cetec Corp., for example, will distribute the flat cable and connectors made by Spectra-Strip of Garden Grove, Calif., through its three California branches and one in Phoenix.

Such an arrangement is "almost manufacturing, but not quite," explains Johnny Johnson, vice president of marketing for Moltronics, which is in South Gate, Calif. It involves cutting cable, mating connectors to customer specifications, and testing. To serve customers efficiently, Moltronics has hired a "value-added sales manager" with a manufacturing background and is investing in tooling and quality-control procedures. By any standard, "we are entering into a new phase of business," says Johnson.

But he and president Donald Cassidy expect value-added volume to grow to 20% of Moltronics' gross. And even with the hefty investments, profit margins will be bigger than when just selling components. Since Moltronics' gross margins (before taxes) run in the upper 20% range, the potential is apparent, they say.

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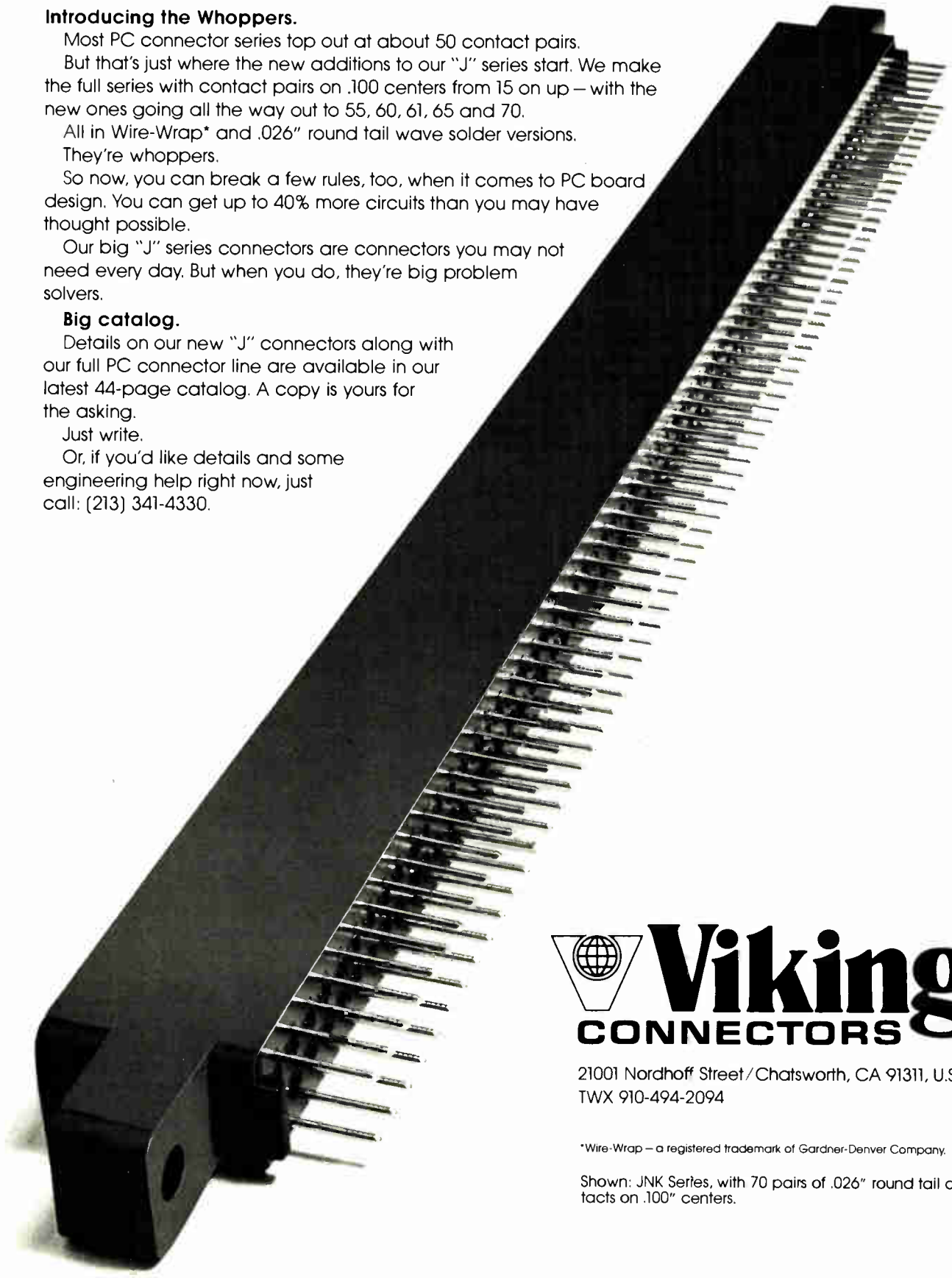

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Shown: JNK Series, with 70 pairs of .026" round tail contacts on .100" centers.

Electronics abroad

West German growth to cool off

Higher energy costs to cause drop in spending for electronics hardware, especially consumer items

by John Gosch, Frankfurt bureau manager

Chancellor Helmut Schmidt and the coalition government he heads have grappled resolutely with West Germany's economic problems over the past couple of years. They have done better than any of their West European neighbors at the tremendous task of keeping prices and wages under control despite surging energy costs, all the while managing to log rising growth rates. But resolution alone, it seems, cannot cope forever with the escalation of oil prices: West Germany now faces a slowdown that should force its economic growth rate, an adequate 4% this year, down to a barely respectable 2.5% in 1980.

"With consumers and industry having to dish out more for energy, there is bound to be a decline in spending on other things," says Manfred Beinder, chief economist for the ITT subsidiary, Standard Elektrik Lorenz AG in Stuttgart. And "other things" next year, according to *Electronics*' annual survey, will include a lot of hardware, particularly things consumers buy. After chasing down market estimates at dozens of firms, *Electronics* calculates that hardware sales in West Germany for 1979 will total $12.28 billion, a rise of 9.3% over 1978. Next year's gain will be more modest, only around 7%; the chart forecasts 1980 markets at $13.20 billion. (All dollar figures are based on the mid-November exchange rate of 1.80 Deutschmarks to $1.)

There is another reason that the consumer slowdown is going to come: the nation's domestic color television market is saturated, and that's that for entertainment equipment—once the mainstay for West German electronics—until video recorders start to come on strong, which is not expected to happen next year.

Medical electronics is another soft sector. "In the medium term, we will have rather slow rates—from 5% to 6% annually—compared with past years," comments Günter Schmettow, a market researcher at the medical equipment division of Siemens AG at Erlangen.

The strong sectors for 1980 are equally clear. The data-processing sector always provided a thrust of sorts, and "lately it has been replacement sales spurring the computer market," asserts Jochen Rössner, a marketing specialist at Sperry Univac in Sulzbach. And with investments in plant and equipment still going strong, industrial electronics gear will also help boost the overall market next year. Communications systems producers will not do badly, although the post office, their biggest customer, will be a bit more conservative in its spending in 1980 compared with the past two years. Test and measurement equipment makers will benefit from the good communications business, "as well as some ongoing avionics and satellite projects," says Wolfgang Rucker, sales manager for Hewlett-Packard GmbH in Frankfurt.

Meager. As for components suppliers, they face a "rather meager year," as one of them puts it. Indeed, the survey bears this reading out. It predicts a lackluster year overall—a 4% rise in 1980 to $3.53 billion—despite a strong showing by integrated circuits.

Computer makers always seem to have something special going for

WEST GERMAN ELECTRONICS MARKETS FORECAST
(IN MILLIONS OF DOLLARS)

	1978	1979	1980
Total assembled equipment	11,234	12,284	13,196
Consumer electronics	4,007	4,085	4,131
Communications equipment	1,447	1,733	1,950
Computers and related hardware	4,045	4,637	5,181
Industrial electronics	774	819	871
Medical electronics	667	682	706
Test and measurement equipment	205	230	253
Power supplies	89	98	104
Total components	3,256	3,387	3,532
Passive and electromechanical	1,527	1,611	1,702
Discrete semiconductors	471	477	485
Integrated circuits	507	575	648
Tubes	751	724	694

(Exchange rate: $1 = 1.80 Deutsche marks)

Note: Figures in this chart are consensus estimates of consumption of electronic equipment obtained from a survey made by *Electronics* magazine in September and October 1979. Domestic hardware is valued at factory sales prices and imports at landed costs.

them no matter how the economy is faring. New customers getting into data processing for the first time keep turning up, and sooner or later they want more sophisticated equipment to streamline their operations. Eventually, everyone winds up in the replacement market. That explains what underlies the mood of optimism among computer suppliers at the moment—a thumping replacement market.

Electronics' survey reflects their optimism. It estimates next year's markets for computers and related equipment at $4.64 billion, almost a 15% increase over 1978. For next year, the forecast is $5.18 billion, a smaller but nonetheless solid rise of nearly 12%.

"Systems at the lower end of the range will do better than medium-sized machines," Sperry Univac's Rössner remarks, and Nixdorf Computer AG does not quarrel with that assessment. The Paderborn-based company estimates that about 80% of the number of systems installed last year came from small machines and intelligent terminals. Still, there is plenty of action in large systems. Rössner, for example, says they performed especially well this year, and Anton Peisl, head of the Siemens Data and Information Systems division in Munich, figures the market for large machines will grow by about 10% annually.

Communications. West Germany's communications equipment makers were kept busy in 1979 by a spending spree of their biggest customer—the Bundespost. Next year, the post office is expected to cut back its investments somewhat. Even so, producers can look forward to a strong increase: *Electronics*' survey predicts a rise to $1.95 billion in 1980 for communications gear, up from $1.73 billion this year.

The private sector—customers other than the post office—should gain a bit more than the public. "PABX [private automatic branch exchange] switching systems and teletypewriters will provide a big push," SEL's Beinder expects. In the public sector, the market is bolstered by replacement sales of switching systems, says Erwin Biermeier, a market researcher for the Siemens Communications division. "Replacements are expected to determine the market action for quite some time," he adds.

Consumer electronics. Once the high strutters among West German electronics producers, the television set makers have slowed to a shuffle. The color TV market that kept them stepping out sharply in the mid-1970s is now saturated and its growth next to nil. As a result, the consumer sector as a whole is stalled at just over $4 billion. The survey puts the 1979 markets at $4.08 billion and 1980 markets at $4.13 billion. Color TV sets account for more than 40% of the total.

The numbers are large, but deceptive. Actually, West German color TV sales last year hit a record 2.5 million sets. But set makers had figured on a much better year than that and wound up with hundreds of thousands of unsold units on their hands. To make matters worse, Japanese firms started making inroads in the small-screen market. "Many companies slid deeply in the red," comments Lüder Beeken, head of the Consumer Electronics division of Philips GmbH, the Hamburg-based subsidiary of NV Philips Gloeilampenfabrieken of the Netherlands.

This year and next, color television sales at best could edge up only slightly. Hanns-Dieter Horn, chief of the video group at Philips GmbH, maintains that he is "absolutely sure we can sell 2.6 million sets this year." He thinks that figure will climb to 2.7 million next year and that the market could tack on another 100,000 units in 1981. Johanna von Ronai-Horvath, head of market research at Schaub-Lorenz GmbH, an entertainment electronics producer of the ITT group, sees much the same kind of stagnation.

But von Ronai thinks the situation should improve in 1981 when sales of video cassette recorders start making an impact on the consumer market. Market watchers generally expect sales of VCRs to hit 250,000 units next year and then bound up to about 1,000,000 units yearly by the mid-1980s.

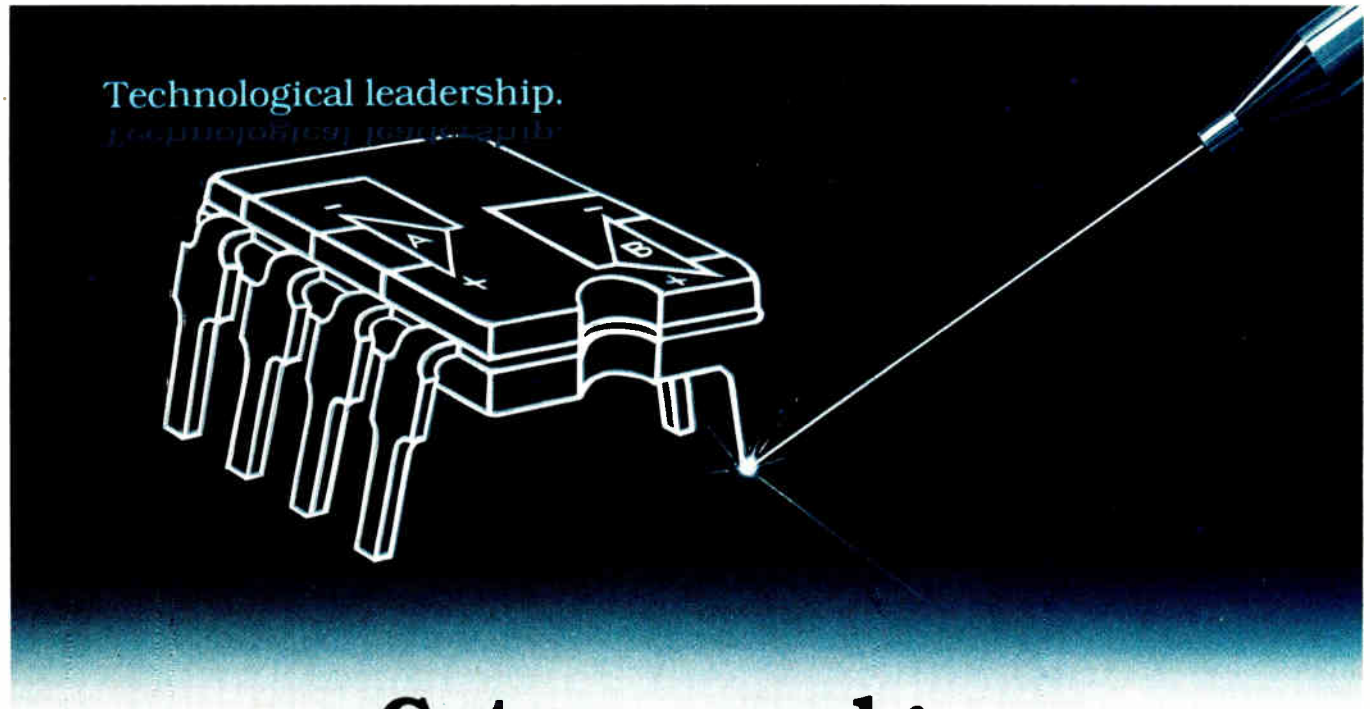
Numbers of units sold, though, are only part of the story. What Philips and Grundig, Europe's only two VCR producers, are up against is fierce competition from Japanese firms. And although the two companies claim their combined share of the European VCR market is still bigger than that of their Far Eastern competitors, industry observers maintain that they are losing ground. To make up for losses to the Japanese, they are banking heavily on their jointly developed Video 2000, an eight-hour reversible cassette recorder system [*Electronics*, July 5, p. 72], volume production of which is about to get started.

As for audio, that sector's impact on the overall consumer market is still big—slightly more than $1.74 billion, according to *Electronics*' survey. Propping up the audio business are strong sales of high-fidelity stereo equipment, cassette recorders, and car radios. Ingwert Ingwertsen, head of the audio group at Philips GmbH, for example, says that the West German market still gobbles up about 19 million pieces of equipment a year, despite the high level of penetration. Some 115 million audio units of all kinds are in use in the country's 23 million households.

Components. For West German components suppliers, a sluggish consumer electronics market casts a pall on business. And the numbers in the components market forecast, ICs excepted, lack any luster. This year's markets total $3.39 billion. Next year, they should edge up only 4.2% to reach a total of $3.53 billion.

Semiconductor makers, by contrast, can presumably count on a strong rise for ICs—about 13%. That would push the market to just $650 million. The business will be coming mainly from the professional electronics sector, explains Dirk G. Vogler, manager of marketing administration for Texas Instruments GmbH, Freising. He cites communications equipment and computer makers as heavy buyers. Klaus D. Wosylus, sales manager for industrial semiconductors at Fairchild Camera and Instrument GmbH, Garching, figures that computer makers bought 14.5% of all the semiconductors that were sold in West Germany. □

First in a series examining European markets.



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	MC35001	2 or 5	-55 to 125	Metal, Ceramic
Dual	MC34002	2, 5, or 10	0 to 70	Metal, Plastic, Ceramic
	MC35002	2 or 5	-55 to 125	Metal, Ceramic
	MC34022	0.5, 1, or 2	0 to 70	Metal, Plastic, Ceramic
	MC35022	0.5 or 1	-55 to 125	Metal, Ceramic
Quad	MC34004	2, 5, or 10	0 to 70	Plastic, Ceramic
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Consumer electronics

Home systems gain complexity

Fall conference is studded with papers on such subjects as tuner memories and home shf antennas

by John G. Posa, Solid State Editor

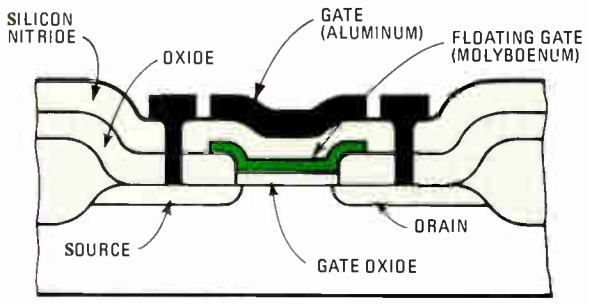
The Ninth Annual Fall Conference on Consumer Electronics in Des Plaines, Ill., proved to be a cross between a devices meeting and a circuits convention. At the meeting site overlooking nearby O'Hare Airport, 20 papers spanning topics from analog memory to gigahertz television reception delivered a clear picture: complex electronics is heading for radios, television sets, telephones, toys, and games.

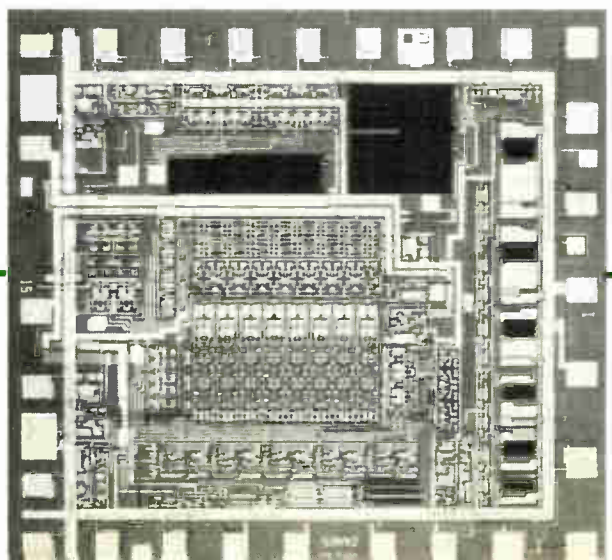
The program, held Nov. 12 and 13, was divided into four sessions—two on tuning systems for television and radio receivers, one on TV signal processing, and a miscellaneous grouping covering subjects like plastic optics for projection TV, speech processing for telephony, high-power audio, and microcomputers.

In one of the sessions on tuning, Sanyo Electric Co. of Japan described a part-digital, part-analog nonvolatile memory chip that stores tuning information in Sanyo's latest TV receiver. The 104-by-104-mil p-MOS device stores 5 digital bits and one analog voltage for each of 16 channel frequencies. When a station is selected, the five digital bits are fed to a digital-to-analog converter; it in turn provides a rough voltage to a varactor tuner. The fine-tuning voltage, from 2 to 28 volts, comes directly from one of 16 analog cells in the memory. Sanyo says that without the unusual device, a comparable system would require a more expensive 13-bit d-a converter.

Sanyo's memory cell uses metal nitride molybdenum oxide or, as Sanyo calls it, MNMoOS technology. With the gate negative, the floating gate is erased as electrons flow into the channel and are swept away. To write an analog potential into the cell, the drain is pulled negative and electrons are injected into the floating gate until the output voltage sufficiently fine tunes in that station.

RCA Corp. unveiled a charge-coupled-device comb filter that it will install in limited editions of its 1980 line of ColorTrak TV models [*Electronics*, May 24, p. 34]. The filter provides enhanced separation of chroma and luminance (color and black-and-white) information on each horizontal scan, resulting in a





Memorable. A part-analog, part-digital nonvolatile memory chip, right, was designed by Sanyo to store tuning data for its latest TV set, above. A cross section of the analog cell is above right: it uses metal nitride molybdenum oxide, which Sanyo calls MNMoOS.

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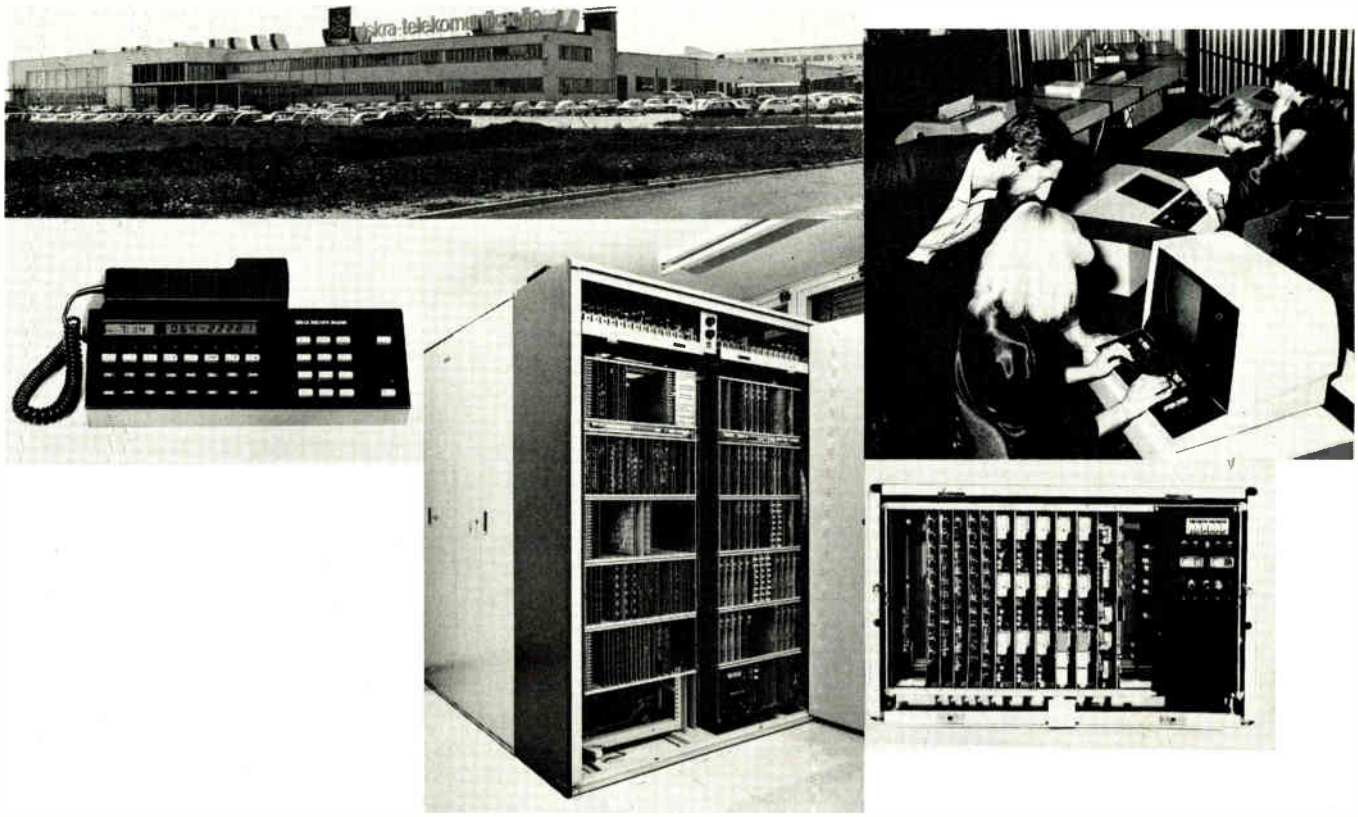

Iskra group has some 28,000 employees including 1,600 research and development engineers in 75 factories, research, marketing and other organizations, and the most up-to-date technologies to work with. With a total turnover of 1.027 billion dollars last year, it has been classified among 17 largest manufacturers of electronic products in Europe.

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Iskra

Probing the news

cleaner image. In fact, the chip, which contains clock drivers, logic circuits, and an analog signal processor, has enabled RCA to up horizontal resolution as well, from 260 lines to 330.

Super picture. In place of ordinary community-access television, many countries are considering terrestrial and direct satellite transmission at super-high microwave frequencies. For example, the first ground-based super-high-frequency (shf) broadcast service was initiated in Tokyo recently to service about 2,000 homes fitted with parabolic-dish antennas. To shift the 12.092- to 12.20-gigahertz incoming signals into the 662- to 770-megahertz ultrahigh-frequency TV range, Hitachi Ltd. designed an entire frequency converter on a 56-by-90-millimeter Teflon-fiberglass substrate.

The Hitachi hybrid circuit fits neatly into the base of the antennas 40 cm in diameter. On the substrate, metalized with copper on both sides, is an 11.430-GHz local oscillator, mixer, and uhf amplifier. The oscillator is based on a gallium arsenide field-effect transistor having a gate length of only 1 micrometer. The converter, with antenna, weighs only 1.5 kilograms (3.3 pounds) and consumes under 1.5 watts.

Another presentation that created enthusiasm was entitled "Developments in plastic optics for projection television systems." The authors, from U. S. Precision Lens Inc., Cincinnati, Ohio, stated that cathode-ray tubes, viewing screens, and lenses will all enjoy future improvements, and the U. S. market may swell from this year's 60,000 units to a half-million units by 1983.

Projection lenses will be made more affordable through the use of methyl methacrylate (acrylic) plastics in place of glass. Doing its part, U. S. Precision Lens has come up with a three-element all-plastic system with a 114-mm focal length at fl.0. The lens projects an image from a 5.1-inch-diagonal CRT to a 45-to-50-in. screen with a relative illumination of 25% in the corners.

Phase-locked loops are creeping into radio and television receivers in increasing numbers. To be used at such high frequencies, however, circuit designs often dictate the inclusion of separate emitter-coupled-logic ICs to prescale frequency down to a level that MOS technology can handle.

All that's needed. In contrast, Sanyo has upped the speed of its MOS technology and has built a PLL capable of directly accepting fm, shortwave, and medium-wave frequencies. The chip contains all loop electronics except a crystal and a voltage-controlled oscillator. It handles fm input signals in the range of 30 to 130 MHz and shortwave and medium-wave signals from 0.5 to 35 MHz and generates the appropriate local oscillator frequencies. Frequency division information is supplied in serial fashion by a microprocessor.

SGS-ATES Componenti Elettronici SpA, of Milan, Italy, gave two papers at the show, one on an electonic speech circuit for telephone applications and another on a monolithic audio amplifier. SGS's speech circuit consists of one bipolar integrated circuit, four small capacitors, and a few resistors on a printed-circuit board mounted inside the handset. With the circuit, the carbon microphone can be replaced with a solid-state transducer, and the handset can be connected to the phone over a two-line cable.

SGS's audio chip contains two 10-W class B amplifiers, complete with drivers and preamplifiers, on a 16,000-mil² die. Thus, the device suits stereo systems or monophonic applications where it will deliver over 20 W. A new package with a heavy copper tab will dissipate up to 30 W at a case temperature of 90°C, so SGS feels the chip and package are ideal for automotive applications.

From Albion. Plessey Semiconductors Ltd. of Britain delivered three papers. One was about a TV frequency synthesis system that could be adapted for various worldwide tuning standards; another concerned a TV preamplifier that reduces adjacent-channel interference, and a third paper described an infrared remote control system for toys and games. Plessey says that its laboratories are now crowded with engineers enjoying their second childhood as they race toy cars across the floor. □

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Computers

Reliability is in eye of beholder

Study says even definitions are not standard throughout the industry as Government also tries to codify performance

by Ana Bishop, Assistant New Products Editor

The reliability of computer systems is becoming an increasingly important parameter in manufacturers' sales pitches and users' purchase decisions. Yet despite the relatively objective and advanced state of electronic data-processing technology, there are no industrywide standards to compare system reliability.

The magnitude of the problem was pointed out in a recently released study of reliability, availability, and serviceability (RAS) features and facilities in commercial EDP systems. Technology analysts at Advanced Computer Techniques Corp. in New York said they encountered problems in comparing the systems because of the lack of consistent definitions—of 100 companies contacted, only 40 maintained consistent enough data on reliability, and definitions varied among them. For example, they ran into a variety of ways to describe an unscheduled disruption of computing system operations. The terms ranged from "faults" and "failures" to "malfunctions" and "errors," each term carrying different connotations for different users. ACT ended up defining its own terms, much as everyone else does, before proceeding with the study.

Another example of the present concern with the problem is a current effort by the nation's largest user of data-processing equipment, the Government's General Services Administration, to standardize the performance parameters by which it decides what equipment to buy. GSA is even preparing a guidance handbook for Federal agencies that will say, "If you want to have these reliability factors, you must provide this environment, and this is what you measure," says GSA's director of special projects, Gerald Findley.

The need for standardization of reliability criteria was seen four years ago by James White, president of Reliability Research Inc., in Ridgefield, Conn. When he started the company, he went around telling prospective customers, "I can measure and compare your system hardware's reliability, but only if you use my algorithm to determine what's happening and how long it lasts."

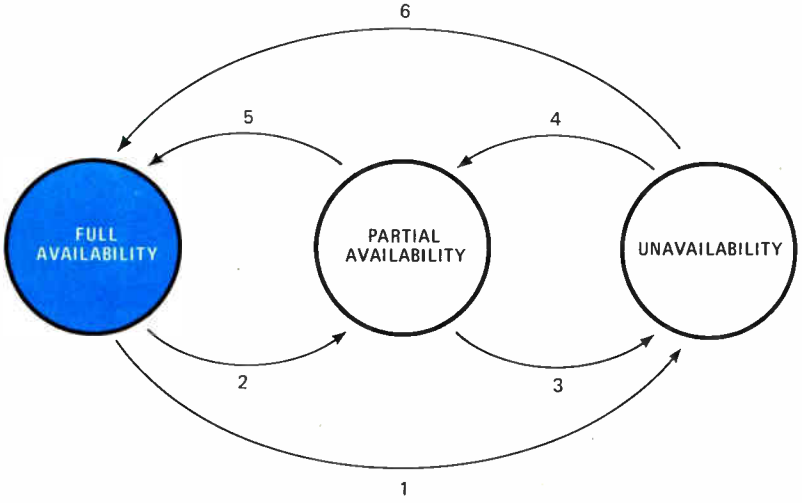
"Data processing grew up as a mystique," says White, "and nobody

Ups and downs

The system state diagram below shows Advanced Computer Techniques Corp.'s conception of system conditions and the transitions between them. The transition from full availability to unavailability (1), also called a total system crash, may be caused by, among other things, loss of power, failure of a critical hardware component, or damage to system-wide software programs or data entities within the operating system.

Less cataclysmic is disruption (2). It is caused typically by such occurrences as failure and removal of a noncritical hardware unit from the system or damage to programs or data sets—or both—belonging to a particular user's service facility that is not system-wide. Sometimes, the shift from full to partial availability may indicate conditions that require a controlled shutdown of all user services (3).

The reverse transitions (4, 5, and 6) take place when failing hardware or software—or both—are restored to their normal operating condition. In systems supporting multiple-user services, recovery of different sections will take place at different times, so that a two-stage recovery with some time spent as partially available is more likely.



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Probing the news

applied to it the objective criteria that are applied to other businesses." He adds that it is possible to measure anything if a commonality can be established. "But if you go around taking each system user's opinion, you get a hundred definitions of down time."

What they found. ACT analysts point out in their recent study that a field engineer, a computer facility operations staff, and an individual user at a terminal all define a failure in different ways. Using mean time to repair and mean time between failures is fine for measuring the serviceability and availability of a mechanism whose up and down states can be well and readily observed, says the ACT study. However, that measure becomes "less applicable as a universal measure of availability in a context where the total service facility is a complex hardware/software environment," it concludes.

In order to narrow down definitions, ACT limited itself to evaluating the IBM 3033 Processor complex of the System/370, and the DEC VAX-11/780 systems because it found them "highly representative of the state of the art in RAS technology." A system's RAS features were evaluated in terms of the system's ability to deliver end-user services, and a down was defined in terms of whether the system was on the way to complete unavailability or on its way to complete recovery (see chart). ACT concludes that present technology can provide availability of 99% or more, but only if installations "do take a serious view of service integrity and do set goals."

The GSA has tried to approach availability by setting its own goals when buying its system in separate parts—the agency may purchase a system by obtaining units from different vendors. So it can procure the front-end central processing unit and peripherals separately from the network and separately from the terminals. For example, a GSA booklet entitled "Remote Terminal Emulation" is being put out this month to aid the Federal agency user to arrive at a good evaluation of terminals.

GSA's Findley says the agency is temporarily defining a down as "the time when the Government cannot use the equipment," whether or not the equipment is evaluated in segments. The GSA is trying to specify reliability for hardware working from the model already established by Reliability Research.

"The hardware measurement was the easiest to create," says Reliability's White. He defines a down as "if an operating system tries to execute an event, and it fails." The definition may not be the best in the world, he says, but it is consistent.

Four years and 400 regular customers later, White still sets his own rules. "If there isn't a commonality in whatever you're measuring, set one up yourself," he advises. "You have to be arrogant enough to make your own rules." His company now provides customers with a way to get their money's worth from their respective vendors, as well as to compare quality.

"Despite our industry's technical capability being so great, our capacity to tell one vendor from another has until recently been limited," says White. "Nobody competes in quality; they only compete in price." This is because the user has had no way to measure quality, he explains.

ACT analysts agree. "The typical user approach to RAS proficiency is quite casual. Only in relatively few cases does one find RAS objectives management established as a formal, dedicated function within the corporate EDP organization. The installation practices for failure and maintenance reporting are frequently incomplete, inaccurate, and somewhat irrelevant," they conclude.

If there's a problem with hardware, the problem of measuring software reliability is even worse. Reliability Research will next turn to measuring the effectiveness of development systems by again setting its own rules. White feels that since his firm handles hardware evaluation for the major data-processing corporations, as well as the Government, its reliability parameters may become the *de facto* measurement standards for the industry. "Three years from now," he says "other measurements for software may be developed from our model." □

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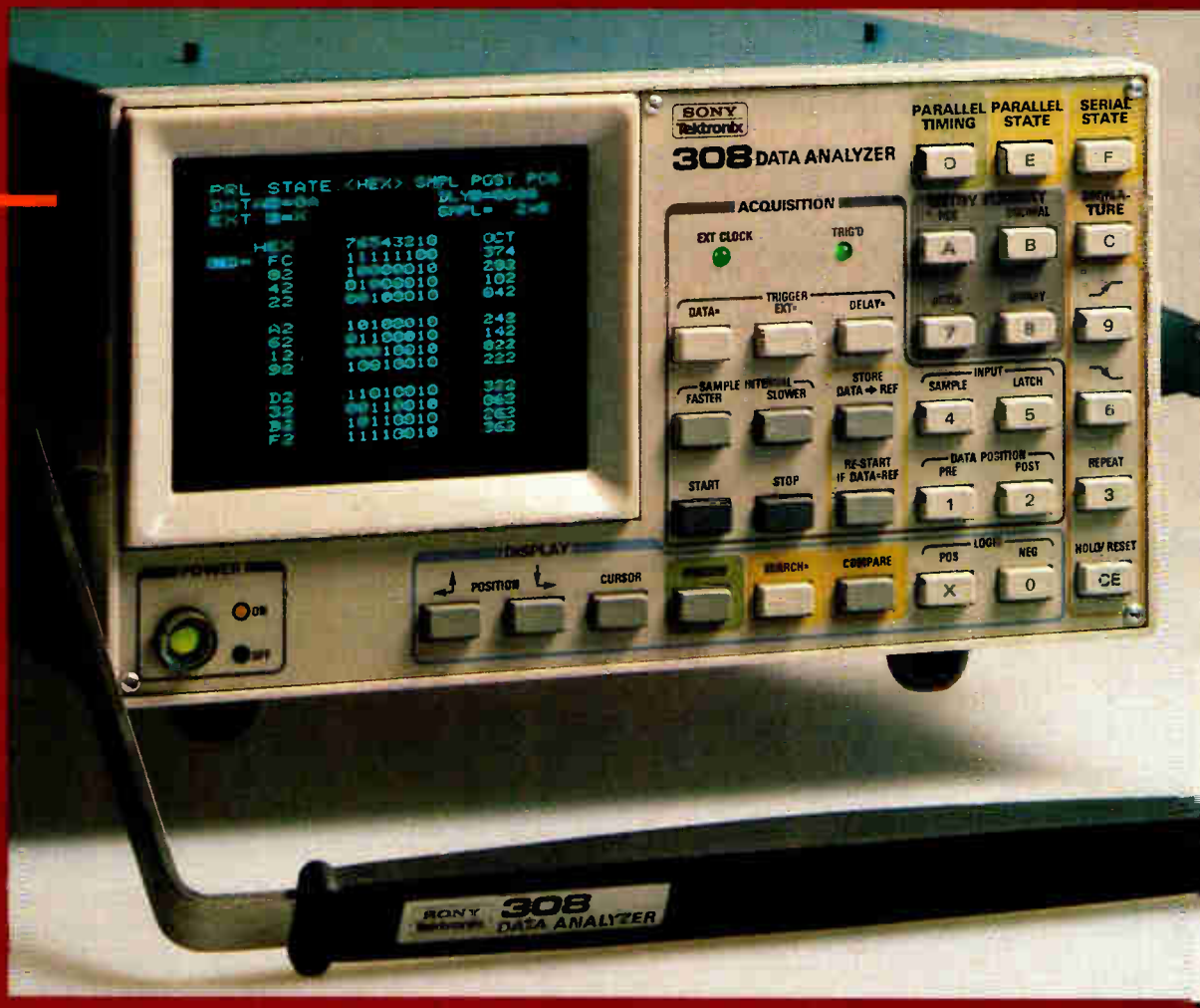
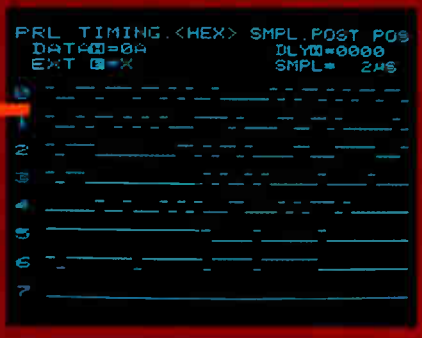
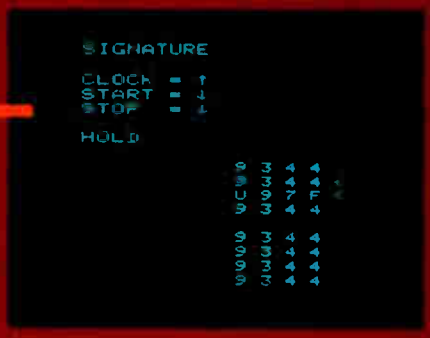
308 DATA ANALYZER



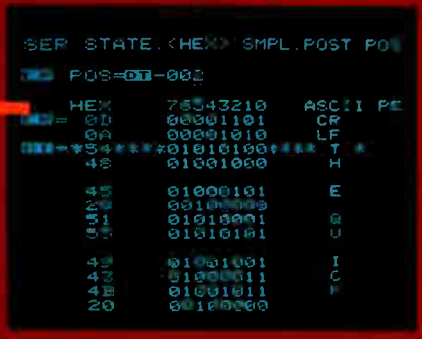
308 display of parallel state data.



Parallel timing diagram can also be displayed as a state table in hex, binary and octal.



Signature display will hold and display up to 8 signatures at once.



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CD40061	256 × 1
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CDP1822	256 × 4
MWS5101	256 × 4
CDP1823	128 × 8
CDP1824	32 × 8
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ROMs.

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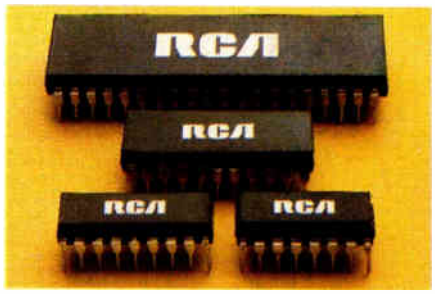
CDP1854	UART
CDP1854A	High Speed UART
CDP1855	Multiply/Divide Unit
CDP1856	Bus Buffer/Separator
CDP1857	Bus Buffer/Separator
CDP1858	4 Bit Latch/Decoder
CDP1859	4 Bit Latch/Decoder
CDP1861	Video Display Controller
CDP1862	Color Generator Controller
CDP1863	Programmable Frequency Gen.
CDP1864	PAL Compatible Color Interface
CDP1866	1K × 4 Latch/Decoder
CDP1867	4K × 1 Latch/Decoder
CDP1868	4K TV Game Latch/Decoder



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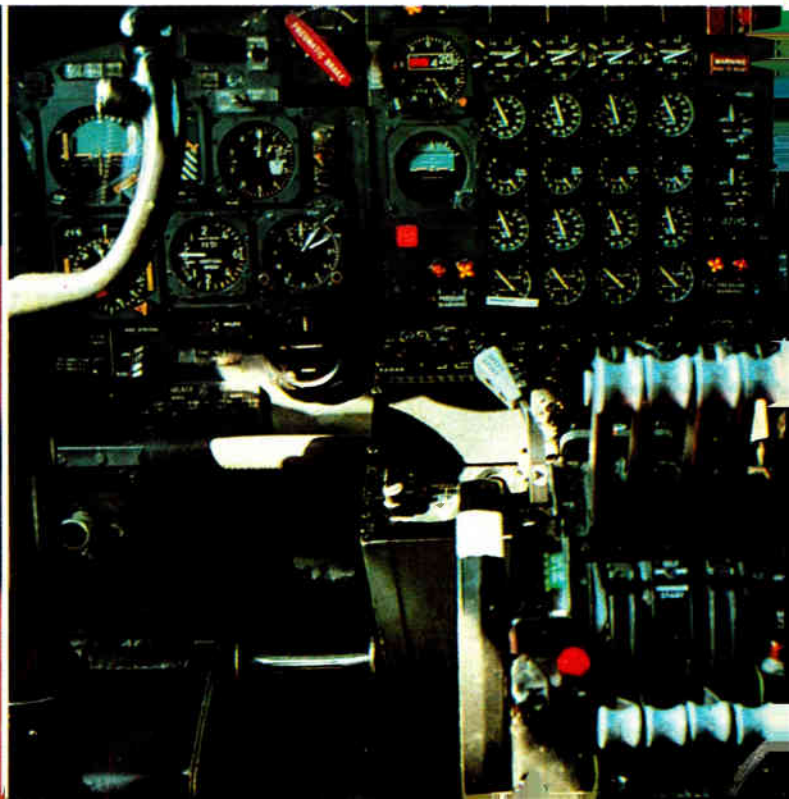

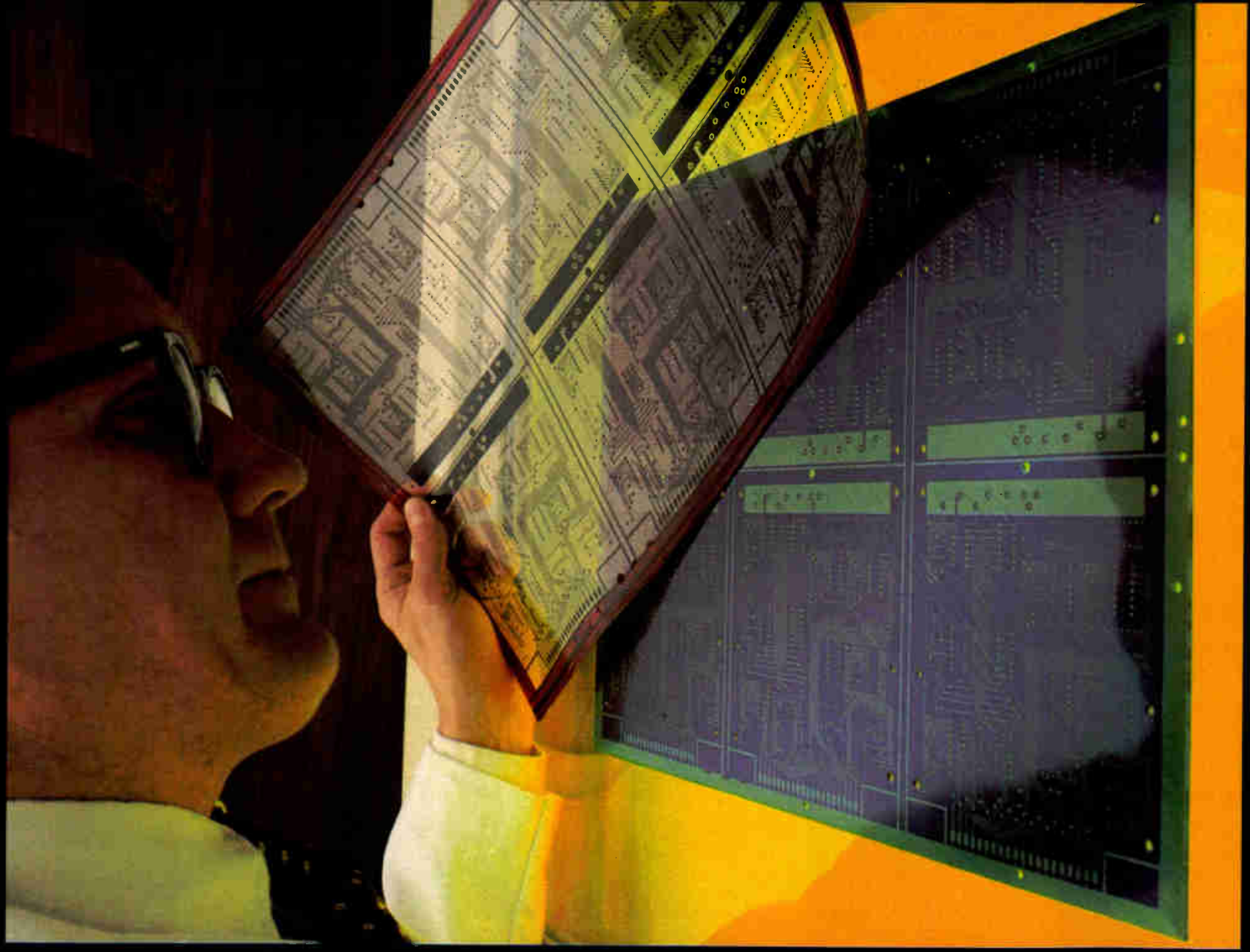

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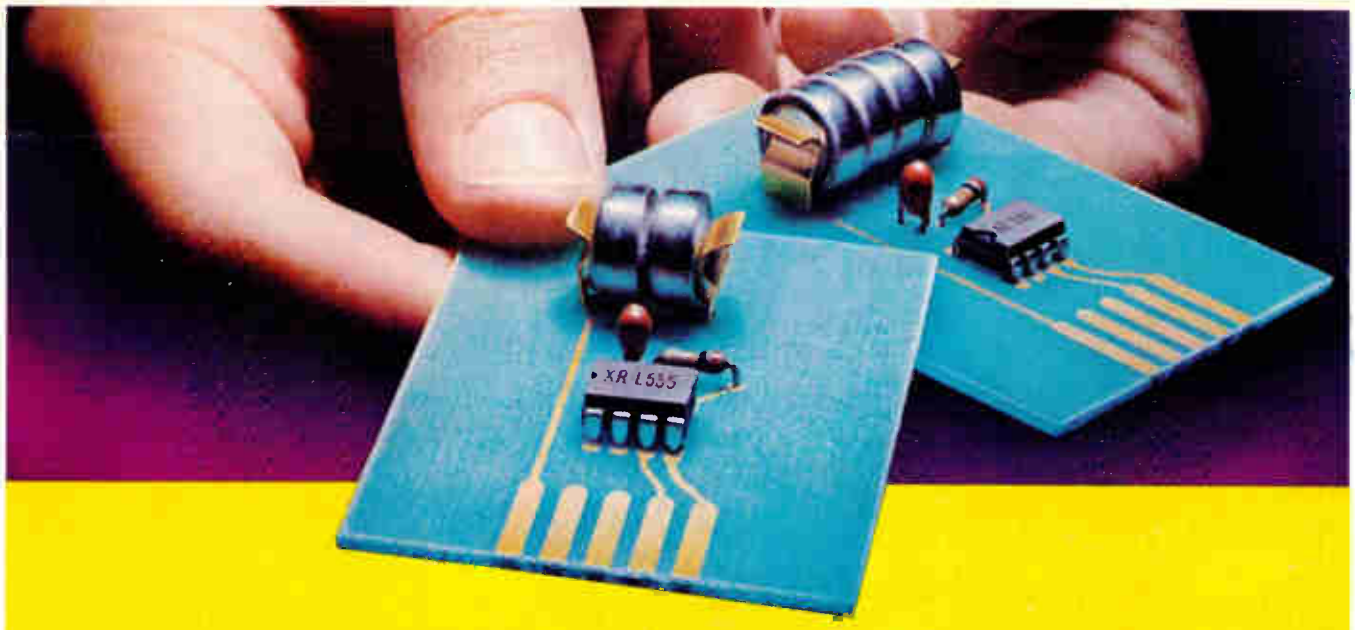

This board, using an XR-L555 micropower timer with only half as many batteries, will last 16 times longer.

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Quad Timers	XR-558 XR-559	Quad Timer Quad Timer	Open collector Emitter follower
Timer Counters	XR-2240 XR-2242 XR-2243*	Timer/Counter Long Delay Timer Micropower Long Delay Timer	Programmable μSec's to days μSec's to days

*Soon to be introduced.

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Executives voice optimism and expect upcurve to go on even as they watch for slump

However, most expect downturn to be less severe than the 1974 recession; inflation also ranks high on lists of major concerns for the coming year

HERBERT J. RICHMAN
senior vice president,
Data General Corp.

Richman is more worried about the semiconductor industry than the minicomputer business. And with good reason: last month, Data General confounded Wall Street and itself when it posted its first loss quarter ever; one of the key causes was an inability to get 16-K random-access memories for its Nova 4 computer line. But Richman should have as clear a view of the semiconductor business as any computer industry executive; he came from Fairchild to help found Data General in the late 1960s and has followed the industry closely ever since.

"I'm concerned about the ability of vendors to supply. For the first time, semiconductor backlogs are real and not inflated by multiple ordering or big floats. Also, the semconductor makers are smartening up, and their margins are rising. They are going to play the production-capacity–profit-margin game with their cards pretty close to the belt. I don't see deliveries loosening up until the second half of 1980."

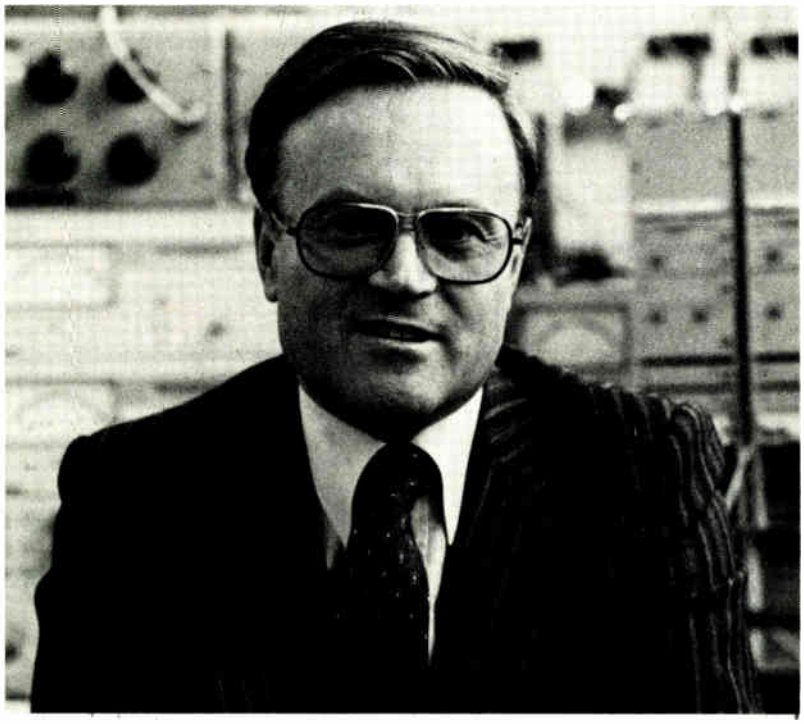
There are other problems ahead for integrated-circuit makers. "From the 2-K to the 16-K memory, technical breakthroughs paved the way and helped cut costs. Between the 16-K and 64-K level, though, my friends tell me, there weren't the same kind of breakthroughs—the larger chips are made using brute-force techniques, very capital-intensive ones.

"I see the price-learning curve going asymptotic, and that means that a lot of semiconductor users like ourselves are going to have to rethink pricing structures."

Aside from these worries, he is upbeat about the electronics business. "There's not going to be any depression, although planners tend to get sweaty palms about this time of year as the pundits get together to predict the end of the world."

Richman saves his irritation for Government. "We [Americans] have positioned ourselves to be on the receiving end of competition that we made possible through postwar reconstruction programs. Nobody seems to have thought that Japan and Germany wouldn't remember our aid forever; now they are competing hard for sales in the United States and Washington doesn't seem to understand how this can be. Well, I can't understand our Government's trade or foreign policy, either.

"The elections should have a positive effect on the economy as Carter and Congress pump money in to make things appear healthy and generate votes. Happens every two years."



HELMUT LOHR
president, Standard Elektrik Lorenz AG

An accelerating trend towards protectionism in many countries worries Lohr, as does the way prices and costs are going. "On top of the rising labor and production costs come the increases in oil and raw material prices we must cope with, and it's becoming harder and harder to cushion the effect through higher productivity."

As a result, it will be more difficult for producers to maintain the price stability typical of the electronics industries in the past if they don't want to put up with further drops in profits. "The cost-profit squeeze will hurt the smaller companies. Many will have a hard time surviving."

Protectionism ties in with the oil situation. To pay the higher prices for oil, not a few countries tend to keep the lid on imports of other products. Serious though it may be, the energy crunch "offers a multitude of stimulants for the electronics industry. It can spur the development of electronic devices that can help save energy in heating and air-conditioning equipment as well as in cars, for example. It could spawn many new ideas for rationalizing the use of energy in its various forms."

On the personnel situation, Lohr says "every now and then it is difficult to get qualified engineers." Especially in software development, the Stuttgart-based West German firm "can't get the kind of people we need." Aggravating the problem is that "the engineer here tends to be stationary," in contrast to his counterpart in the U. S. He often lacks the mobility needed to pull up stakes and move about either geographically or from one sector of the industry to another.

Competition from Japan? "It's a peril also for West Germany inasmuch as Japanese manufacturers have an edge both in production capacity and prices." As a result of the yen devaluations, Japanese goods have a price advantage of 15% and more over domestic products. But as a strong believer in an open market and free enterprise, he is not one to clamor for protectionist measures. "We must counter the Far Eastern competition with performance and know-how, not with restrictions. With novel ideas, high-quality products, excellence in engineering, and a good marketing strategy, we can meet the challenge."

HAROLD H. POPE
chairman, Sanders Associates Inc.

"The factors are there" for a recession, if Carter imposes fiscal restraints on Government spending. "But I have trouble seeing him do that; the history of election years has been that of more spending—and more inflation" says Pope. If history repeats itself, any recession will probably be fairly mild and short-lived, "but instead of 15% inflation, we're liable to find ourselves grappling with 20%."

Whether 1980 brings inflation or recession, there will be no "grinding halt" in the growth of the electronics industries. Sanders, for one, will be largely unaffected: "We have fairly substantial cash reserves and no significant debt."

There could, however, be a personnel problem for the Nashua, N. H., company. "We need more talent, particularly in our fastest-growing area, software, but we've been able to get it, and on fairly short notice. I don't know how long we'll have it so good."

Financial capabilities and reserves will determine how well individual companies fare in the coming year, Pope believes. Some relatively new industries—medical electronics, for example—where rapid growth has nurtured many small companies, may see a shakeout as capital availability tightens. And manufacturers of capital-intensive equipment like mainframe computers may suffer slowdowns as customers postpone purchases. The semiconductor industry, on the other hand, should continue at its present pace, moving into faster memories and bulk storage, where "the payoffs are just too big to let things slow down."

D. LEIGHTON DAVIES
deputy managing director, Racal Electronics Ltd.

The only problems that disturb Davies' sleep at night are those of success. He has responsibility for Racal Data Communications Ltd., one of the fastest growing sectors in the Racal conglomerate. "Its sales are solidly up and up. We have never seen any pause at all in the last decade. In fact, the group could soon be Racal's biggest breadwinner. If I don't pass them [the group that handles Racal's military radio business] this year, I am sure I will next."

Racal's strategy is to grow both organically and by acquisition. "At any time we may have 10 companies under review as takeover prospects." Some are relatively small companies that fit well with Racal's existing business, but many expect Racal to swallow even bigger fish during 1980. The British electronics industries are ripe for takeovers, with one or two big companies vulnerable. At the same time, the removal of capital export restrictions coupled with a strong pound will make overseas acquisitions that much easier.

As far as Davies is concerned, data communications is proof against prevailing economic and political conditions. The change of government in Britain "has had no discernible effect," but the decision to lift the post office monopoly on terminal equipment "must be good for our business." The union troubles that bog down much of British manufacturing have so far left the Bracknell, Berkshire, group unscathed, as the company is organized in small, relatively autonomous manufacturing units.

SAM K. SMITH
group vice president, Texas Instruments Inc.

Though its severity is an unknown, a downturn in the general economy during 1980 is now all but certain, says Smith. Among the electronics industries, the consumer segment will probably be one of those most severely affected.

That's bad news for TI, which has a heavy commitment to calculators, watches, appliance controls, and other consumer products. The good news is that softening consumer sales next year are expected to be offset by an increasingly strong TI position in Government electronics, as well as by continuing strength in distributed computing markets for minicomputers and terminals, among other things.

Even during the 1974–75 recession, minicomputer and terminal sales continued to grow at about a 20% annual pace. "We believe these products are highly aimed and used by customers in productivity improvements and that they will thus be less affected in an economic downturn than any of our other product lines."

Another reason Smith sees for optimism lies in the increasing pervasiveness of semiconductors *per se*. If the general economic downturn is sharp, the electronics industries will not be unaffected. But precipitous drops in demand for semiconductor products similar to the 20% to 30% variations experienced in previous recessionary times will not occur again, Smith predicts. "I truly believe that the semiconductor thing under any circumstances is not going to swing as it has in the past."

It is not likely that the business community will offer President Carter any hurrahs for his performance. "From my point of view, the most glaring deficit that we have—and you may blame it on Carter or on Congress—is still the lack of an energy policy after all this time."

As Smith sees it, the recent money-tightening steps by the Federal Reserve Board that resulted in record high interest rates were long overdue. "To me, it's a dose of medicine that had to be taken and we took it too late." Though the Fed's efforts may still have the desired effect of reducing inflation, it will take longer and be more painful than if the action had been taken earlier.

GEORGE R. REA
vice president, Centronics Data Computer Corp.

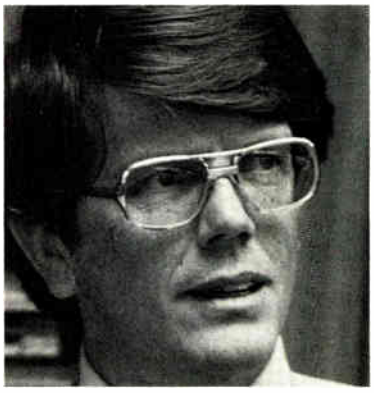
Anticipation of a recession has been a way of life for so long in the electronics industries that the real thing, if it comes, will probably not be too severe. "Everyone's ready for it," says Rea. He sees one indication of that in the cautious ordering patterns of Centronics' customers: "They're ordering only a month, rather than 90 days, in advance, and they're waiting until the last minute to do that." But, Rea adds, the number of orders has not fallen off, and the company's customer base is growing at a healthy pace.

If the electronics industries are not recession-proof, they certainly are recession-resistant; those segments particularly whose products increase productivity and save money will probably "sail through a recession as if it wasn't there." Growth is still explosive, new technologies keep sprouting up, and the momentum will keep electronics well ahead of other businesses.

The Federal Reserve Board's move to limit available capital poses more of a problem for companies than does the soaring prime rate of interest. "Our industry has demonstrated its return on investment far outstrips the cost of money, so people aren't going to give up market share or growth because of high interest rates. But without enough money to go around, we may have to accept some lost ground." Hudson, N. H.–based Centronics plans to increase capital investment in the coming year.

The Carter Administration has not been very responsive to the needs of business, Rea feels. Interminable licensing reviews and red tape hamper companies pursuing international trade, are a powerful disincentive to other companies, and prevent the U. S. from taking advantage of its technological edge to improve the balance of trade. The Administration "talks licensing reform—and then hits us with something like the White House review on exports to the USSR, another great way to have a good business deal blown."

Nor has Carter made enough of the right moves to encourage entrepreneurial enterprise and investment: "Lowering the capital gains tax was a good first step, but the first step is all it is."



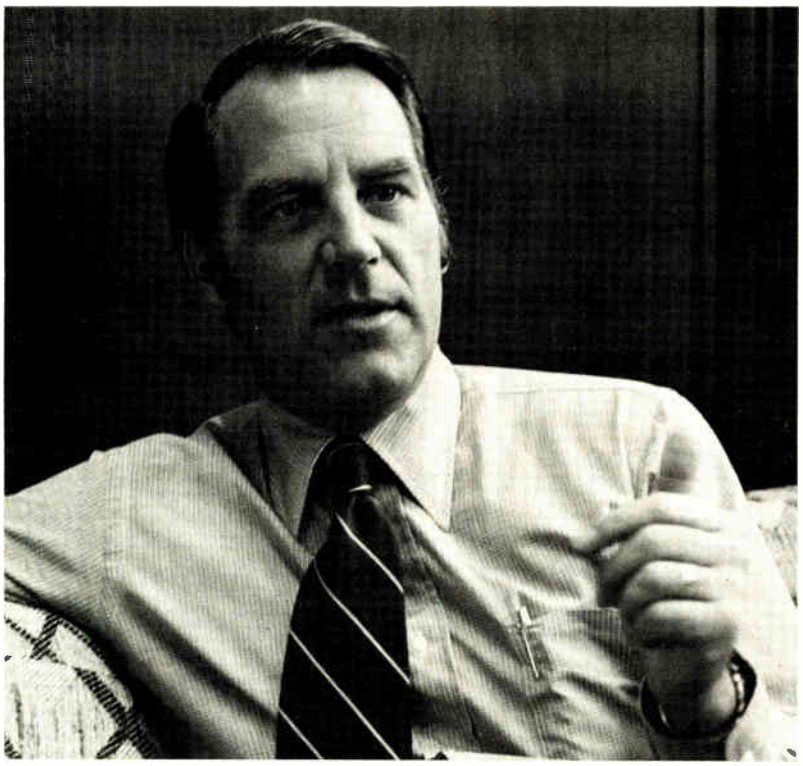
E. FLOYD KVAMME
vice president and general manager, Semiconductor division, National Semiconductor Corp.

"Of course, I can't help but say that I would like to see a better economic view. My advice for the boys in Washington is that we need a trade policy." Secondly, Kvamme would like to see less uncertainty in the economy to "stop people from being so skittish." But "we're going into an election year next year. A lot of folks right now wouldn't believe anything anybody said regardless."

Confidence in the U. S. economy would be bolstered by more news like the September data that showed durable goods up. A continuous string of such information would be seen as a positive sign. As for a recession, "I think the definition of a recession has changed. Certainly on the semiconductor side we haven't seen any indications."

Have the electronics industries become more resilient in the face of downturns? "I don't think so," Kvamme says. "I don't think that is necessarily true." He does think, on the other hand, that the electronics industries are supplying more sophisticated products that have "a positive impact on customers' products" and should see less of a recession than in the past.

Although energy is a serious national problem, electronics "is part of the solution, not part of the problem. The sensitivity to energy conservation is a real market opportunity for electronics, because efficient control of energy means electronics in the form of computers, low-cost sensors, and the like."



JOHN A. YOUNG
president, Hewlett-Packard Co.

"We're looking in balance for a reasonable year, but won't see as startling a growth rate as we've had the last few years." Young sees "a lot of uncertainties, a lot of events that aren't all that predictable next year."

Different demand factors could affect the 38 operating divisions spread through HP's major computer and instrument businesses and minor medical and components lines. For example, "computer sales could be affected by recent Fed moves to control the money aggregate, which could squeeze small-business men."

To its advantage, half of HP's business is outside the U. S., a large part in Europe. "Economic turning points there generally lag behind those in the U. S. by 12 to 18 months." He points to potentially strong French and West German economies. Moreover, HP's markets are unaffected by a slowdown in consumer spending. Everyone he has talked with says that business looks strong; it looks as if the electronics industries are more immune to some kinds of economic cycles than to others. Although everyone is talking about a recession, the economy is technically not in one because there have not been two consecutive down quarters.

However, he mentions a recent conversation with a chief financial officer in Chicago who was really concerned about the short-term cost of money. Rising interest rates help create uncertainties for business. Consequently, Young says he will try to stay in a flexible position. One tack might be to "pay out gradually" HP's abnormally high backlog of orders. Another factor, because HP has never had mass layoffs, is "continuity of employment."

The Carter Administration does not get "very high marks." Although President Carter "finally moved to protect the dollar in international markets," the President's "whole leadership on energy is questionable." And the Administration opposed the lowering of capital-gains taxes, which Young and business generally favored because it stimulated investment in industry.

KAZUO IWAMA
president, Sony Corp.

Iwama is surprisingly sanguine about the energy crisis. He hedges his optimism, though, with the observation that whereas Japanese manufacturers did a splendid job of overcoming the first oil crisis and thus should be able to handle the current situation, they will have to adjust operations to absorb price increases. Prices are inching up, he says, but "fortunately the electronics industries are not energy- or materials-intensive."

He also points to government policy in dealing with current budget deficits as a major concern for the coming year. A tighter budget will help reduce deficits and suppress inflation, but if business fails to pick up the slack, the government's income could easily shrink along with the tax base.

The mild recession in the U. S., which he expects to continue through the first quarter, does not particularly affect Sony's business. Iwama does not expect things to get worse than they are now during an election year.

Sony does need more and more engineers with a variety of skills as rapid progress in system design is made in consumer electronics. Among those changes are the addition of microprocessors to television tuners and tape recorders, and upcoming products such as pulse-code–modulation audio, digital videotape recorders, and video disks. The solution for the company so far has been to hire many new graduates and to recycle engineers it presently employs. Fortunately, says Iwama, Sony is a postwar company that was small in its early days so that it employs mainly young engineers who learn fast.

LEWIS F. KORNFELD
president, Radio Shack division, Tandy Corp.

From the standpoint of world economics, next year's looming recession is "one of the ugliest-looking ones I've seen," says Kornfeld. "We have the worst inflation rate I can remember; add that to a weakening dollar, and you have a problem the degree of which is unprecedented."

On the domestic front, he foresees "a lot of bankruptcies" next year in the audio retail business, which he says is overpopulated with small stores working on inadequate margins. However, despite the fact that 20% to 25% of Radio Shack's sales are in the audio business, he is optimistic about his own company's 1980 prospects.

That optimism rests on 31 years of experience with Radio Shack, which operates more than 7,300 broadly based retail consumer electronics stores worldwide from its Fort Worth, Texas, headquarters. Even during previous recessions, Radio Shack sales have never turned down. "Our business depends on the disposable income that's left after room and board are taken care of. So far in my lifetime, we've found that people will spend part of that dollar on entertainment and we are to a large extent in that business."

Adds Kornfeld: "I can't see the economic downturn impacting the part of the computer business we're in." Even though general economic indicators are falling, the young and still relatively small personal computer market is poised "at the bottom of a very steep upward curve."

EDOUARD GUIGONIS
senior vice president, Thomson-CSF

"Continuity" is the key to the 1980 outlook for Thomson-CSF, according to Guigonis. "I do not see any radical changes occurring. The worries we have for next year are the same ones we had for this year." High on the list is international monetary instability. "Monetary disorder, especially the instability of the dollar, poses serious problems for a company, such as ours, with substantial export activities."

But Thomson-CSF does not expect monetary problems to seriously hamper growth, certainly not in the group's burgeoning telecommunications division. "Most telecommunications equipment contracts cover several years, and as far as actual sales are concerned, we already have about 90% of our orders for 1980."

Noting that the company's telecommunications division—Le Matériel Téléphonique Thomson-CSF—scored some impressive victories in international competitions for digital switching systems in 1979, he philosophizes that "in telecommunications, there are strong years and there are weak ones." But "even if there are no spectacular results in 1980, telecommunications is a promising sector, with markets likely to be characterized by substantial long-term growth."

Within the public sector in France, he likewise predicts continued moderate growth, noting that the absence of any recent boom years tends to lessen the chances for a bust. "The French economy is simply not likely to change very much. It could be worse—and it could also be better."

IVOR COHEN
managing director, Mullard Ltd.

It is ironic that oil should be contributing as it is to industrial woes in Britain, a country that will soon be self-sufficient in petroleum. "We are talking about an oil-based recession in 1980," says Cohen, whose Philips subsidiary is one of Britain's largest component manufacturers.

But despite the general gloom, the electronics industries are showing a fair degree of resilience. "There is still growth and order books have not yet turned down." Some sectors will fare better than others. The British Post Office has embarked on a hefty modernization program and defense spending under the new Conservative government is rising. The consumer sector is an enigma, but could be helped by a hefty wage increase during the winter's bargaining. "A big wage push may also force manufacturers to invest sooner in automation."

Even if consumer spending heats up in 1980, a strong pound spells trouble for Britain's consumer electronics sector. One bright spot will be the growth in videotext systems of both teletext and viewdata types. These systems have a promising future both as a public service and for the in-house needs of companies.

Though the British government is busily disengaging from industry, Cohen would like to see it using its purchasing power; government departments could look at ways to exploit viewdata internally and place seed contracts. The technology could provide the basis for a new European industry.

RICHARD A. CAMPBELL
executive vice president, TRW Electronics, TRW Inc.

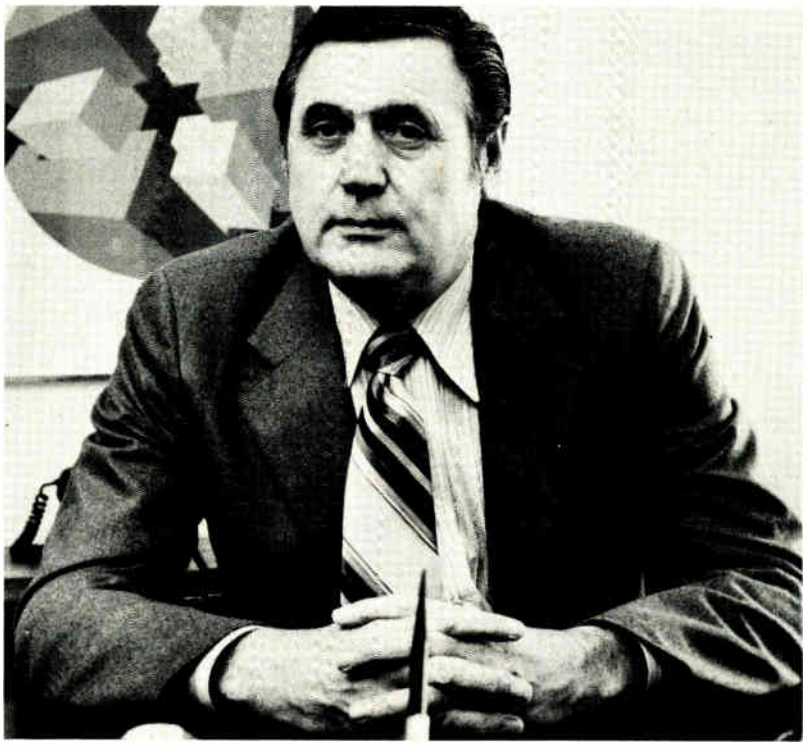
The recession is "still coming, as a matter of fact, and in the U. S. a downturn has already started in consumer products." Campbell's highly diversified group sells components to the appliance and automotive industries, where consumer buying has slackened. In the industrial and government segments, "we have not yet seen a slowing order rate, but expect a slowdown next year."

The other issue that concerns the Los Angeles-based head of the $500 million group is inflation, particularly its effect on manufacturing and raw-materials costs. "We're already getting big increases in the prices of raw materials—copper, gold, chemicals, all sorts of things."

The shortage of electronics engineers and technical people has "gotten worse, particularly in the West and Southwest." Coming economic trouble in general is "more regional in character than in 1974, with the Midwest and Northeast the softest."

While candidly noting these negatives for 1980, Campbell also sees bright signs, both for TRW and the industry: with its ability to improve efficiency and productivity, the electronics business should be more recession-resistant than in the past.

Another reason for that new resistance can be seen in moves by TRW Electronics itself. It has pushed to diversify into such new markets as automobile electronics and telecommunications since 1974 and is "in much better shape this time." More international diversification is especially important.



JACK K. SAUTER
vice president, general manager, RCA Corp., Consumer Electronics division

Tradition has it that a recession bloodies the consumer electronics business, leaving manufacturers of television sets, audio equipment, and the like bathing in red ink. But at RCA's Indianapolis consumer operation there is no hand-wringing over 1980 prospects. In fact, Sauter claims that "1980 could be an extremely good year."

He is not a pollyanna. He reflects the confidence of an executive who sees not just a slight downturn from the current annual sales level of 9.75 million color television sets, but a healthy business environment. "Nine million sets is an extremely good year," he says, remembering the last recession's 6.5 million.

His optimism also stems from perceived differences between previous economic disasters and the current malaise. Most of the big dollar volume for color televisions now will be coming from the replacement market, with consumers trading in older sets for the better performance and low prices of the new models. "There are more than 30 million sets which are more than seven years old. It's a vast market of consumers willing to upgrade." But those hidden strengths in market demand must be nurtured by aggressive marketing moves, and Sauter foresees heavy advertising and rebate programs to bring more consumers into the stores.

Some of the key factors that indicate health for color set sales spell trouble for video cassette recorders, though. Most of the VCR buyers are in the market for the first time, and that's a tougher sale in a recession. "While VCR sales will continue to grow, they won't expand at the rate they would in a strong economy."

The intense price competition in the consumer industry will continue in the 1980s, but with a significant difference from the past decade—the price leaders in the U. S. market are the other domestic brand-name products, not imported products.

Other concerns include tight supplies of integrated circuits and design engineers, which will not ease in response to softening sales of some products. And tough cost-control moves are in place at RCA—"Productivity improvement is a company-wide goal."

JOSEPH F. CALIGIURI
senior vice president, Litton Industries Inc.

Prospects for selling electronic equipment to government customers, both U. S. and international, seldom have looked rosier in peacetime. Particularly strong potential is in "NATO countries who recognize the Russians are coming on in astounding fashion."

That's good for government suppliers in general, but for Caligiuri's Advanced Electronic Systems Group headquartered in Beverly Hills, Calif., this translates into a "30% up in 1980 sales and operating profit over 1979 unless something dramatic or unforeseen happens." His group, with 12,400 employees in four countries, sold command, control, and communications gear; navigation systems; electronic countermeasures systems; and shipboard electronic equipment worth a total of $479 million in 1979.

U. S. military spending will grow at least 3% in real terms and maybe more, providing a stable market. But U. S. firms cannot count on getting a share without investing heavily into the "right technology," involving state-of-the-art large-scale integration across the board. To make sure of staying in the forefront, Litton research and development spending is at its highest level ever.

But even with those factors, the road ahead does have some potholes. "The toughest problem we have is hiring," and not just in the still-booming U. S. "Europe is very tough, especially West Germany," where Litton has a plant in Freiburg. If a recession hits the non-government sector hard, "those who left the aerospace business might come back." But he is not sure this will happen the same way it has in past downturns.

Even while steering Litton's advanced electronics to exploit the strategy of the U. S. and its allies to arm themselves with high-technology weapons to counter Russian quantity, Caligiuri is not so sure that is the final answer. "We can outproduce them, too, as we've proved in the past, and shouldn't be excluding that approach."

Despite the upcoming turmoil of a national election year, he does not see any important changes in defense thinking or spending patterns in the cards.

TARO KUNINOBU
president, Matsushita Electronic Components Ltd.

Kuninobu is wary about the coming year. The sales of assembled products are not adequate to support 1979's high demand for components, and television set manufacturers, as they raise production to jockey for market share, are hoarding and perhaps even double-ordering components. "This will lead to a reaction in 1980, and the shock will be severe when it comes."

Still, Kuninobu sees many bullish factors ahead. The future promises orders from auto manufacturers for components for microprocessor systems for 1982 models, with much of the new business for sensors. There will also be other microprocessor-related business as these ubiquitous devices are designed into a wider variety of products.

Sales of video cassette recorders and video cameras, both of which use about three times as many components as TVs, will increase. These will remain strong markets even as competition forces set manufacturers to cut the number of components used. Video disks will also become a good market, though for different components. Coming along too are pulse-code–modulation audio and perhaps digital video.

Although the use of chip components in consumer products really started with parent company Matsushita's introduction of a thin radio three years ago, this is the first year these parts are selling in large quantities. There is now a big shortage as these components spread from 35-millimeter cameras to radios, tape recorders, VCR cameras, and TV tuners.

CHARLES W. MISSLER
president, Western Digital Corp.

Except for what he reads in the financial pages, Missler sees no signs of recession. On the contrary, "here at Western Digital, we're scratching our heads to figure out how to keep up." And he expects little slowdown ahead for his small semiconductor firm, which aims for proprietary market niches.

"The real threat is the component shortage that hangs over the whole field," with 16-K random-access memories and low-power Schottky parts the tightest. He fears that unless production limitations are soon resolved, "in six to nine months, empty sockets" in products manufactured by semiconductor customers will exert a drag industrywide.

He is meeting the challenge of the shortage of technical and production personnel in labor-tight Orange County, Calif., by an unusual stratagem: splitting up the pie with everyone. "We have over a million shares in the employee trust, and that is helping us." The firm has 700 employees and hopes to double sales to $20 million for the 1980 fiscal year that began July 1.

A comparative newcomer to semiconductors, having taken the firm over during Chapter XI bankruptcy proceedings in 1976, Missler is aghast at some business practices in the field, and speaks up against them. Particularly galling is what he calls "major members ripping off proprietary designs." Broken promises and personnel pirating are other bad practices he singles out. "We cannot tolerate the rape and pillage that characterize the actions of some in the industry."

RAY STATA
president, Analog Devices Inc.

Despite projections of a slightly cooler economy next year, "I expect an industry average of 25% to 30% growth in 1980." Stata says there would be cause for worry only if it turned out to be significantly below this average. "That might cause a slowdown in the third and fourth quarters of 1980."

The electronics business may already have been through its version of the recession. "Orders slumped a bit in August and September, but have bounced right back again."

A 30%-growth year looks like a vacation to the president of the Norwood, Mass., company. "It's hard to grow at 50% or so a year, year after year; management gets fatigued, you run into vendor capacity shortages, shortages of good people, and long equipment lead times. You worry a little less in a cooler period. Another 50% growth year would have been hard on the nerves, especially as the number of technical professionals isn't growing at a similar rate." If 1980 is a 25% to 30% year, "managers will be able to sit back, count blessings, deglitch organizations, and just let the torch cool."

Stata saves his greatest worries for the semiconductor manufacturing sector of the market, where he sees some changes coming. "For years, the rate of technical innovation offset inflationary cost inputs, but now, that's turning around as the price of gold rises and packaging costs increase."

As for the role of Government, he appears resigned about the Carter Administration, but sees some hope on other fronts. "Fiscal policies look as if they are going to change for the better. Business may be about to get a better break in the form of tax incentives, etc. One of the most encouraging things I see is that, because of continuing inflation and economic stagnation in other business sectors, Congress and the bureaucracies are beginning to listen to a new set of advisers; they are starting to see a new sort of reality, and the bottom line is 'Let's give capitalism a chance.' I like that idea."

JOHN R. WELTY

senior vice president and general manager, Motorola Semiconductor Products Inc.

The inability to forecast intelligently, according to Welty, continues to be one of the semiconductor industry's major problems. "Industry calculations on capacity usually are either behind or ahead. Right now we're behind. Why? Partly because our memory banks are filled with painful reminders of 1975. And partly because in the second half of 1978 we predicted there was going to be a recession. Later this was moved up to the second half of 1979. Now we've moved the recession to 1980. When you keep predicting an imminent recession and it doesn't happen, industry tends to be cautious about expansion. Now that we're in a shortage situation in many areas, will we overreact and build more capacity than we need? I don't think so. I don't think we'll catch up in the next five years."

Although the traditional side of Motorola's semiconductor business is showing signs of softening—examples are alternator rectifiers for autos, consumer-oriented products like TO-90 transistors, and some linear circuits—new business arising out of high-technology products like microprocessors is growing faster than the traditional side is slowing.

One of the problems uppermost in Welty's mind is increased pressure for higher return on investment. "One of our great strengths in the past has been willingness to forego a great killing for a stake in the future. A lot of people now say we have to stop that because industry has become so capital-intensive that we're having a tough time financing our own growth. We have to increase our margins to finance the growth." As yields improve, device prices go down, attracting more and more applications, generating greater sales volume. "If industry goes too far in increasing ROI [return on investment], we will no longer be a vital force in the marketplace."

In general, he believes that 1980 will be a pretty good year for the semiconductor industry. The Semiconductor Industry Association's forecast of 12% growth is "on the conservative side." The automobile industry will generate new business on the order of several hundred million dollars in the next couple of model years. And telecommunications may grow to the point where it exceeds autos in importance for the electronics industry. Beyond that a whole new mass of microprocessor-based business will arise. "We'll end up in a great arena of applications, which will give rise to a whole new industry of middlemen. For example, we won't be dealing with bakeries, but we will sell to middlemen who understand the bakery business and can design microprocessor-controlled ovens."

TAIYU KOBAYASHI
president, Fujitsu Ltd.

The side effects of oil-price increases are Kobayashi's biggest worry even though energy accounts for only 1.5% of his firm's purchases. The price of oil is reflected by the rapidly falling value of the yen, which is expected to trigger inflation by increasing the price of imports. Salaries represent a high percentage of the operating expenses for knowledge-intensive companies like Fujitsu, so inflation is frightening. Inflation could also possibly trigger a recession, but Fujitsu's sales are not greatly affected by the state of the economy.

In the coming year there will be no new stimulation of the economy by the government, which is expected to make moves that could discourage investment. Already the discount rate has been raised several times to suppress inflation; this is being done faster than necessary out of excessive fear, he feels. The increased interest rates make for a slightly uneasy investment climate.

Kobayashi is not worried about moves to restrict his company's sales of memories in the U. S. because of the critical shortage of the devices. "American companies won't have the time to raise a big fuss until there is a surplus, which may not come until 1981." The 64-K random-access memories are in shorter supply than 16-K devices, so 64-K memories will be short for a long time. If the 16-K supply starts to catch up with demand, prices will fall, causing increased demand for these parts in personal computers and toys.

CHARLES C. HARWOOD
president, Signetics Corp.

Harwood is suspicious. "In face of a general economic downturn, our customers are extremely bullish. My worry is that this demand doesn't sound logical in the face of the economic picture and high interest rates." Further clouding the 1980 outlook is that "certain segments of the economy clearly are in a recession, but it may be a recession affecting only parts of the economy."

How does he manage growth while guarding against a widespread recession? By checking sound inventory programs, ensuring quality control, and determining whether the "backlog on our books is a good, solid, sensible backlog." Harwood says he sees no evidence that his customers are double- or triple-ordering, "but human nature tells me they are."

In the high-demand semiconductor market, the industry is maturing so that "there is less a view of grabbing a market or position with price and more a view of establishing a market or position with good products. The basic strategy of 'drive the other fellow out' has been put aside." He is less sanguine about a downturn "when supply exceeds demand. In our industry, what happened before when supply exceeds demand will happen again."

Like many electronics executives, Harwood is not looking to Washington for any rays of light. "I think the mood of the country and the mood of Congress are such that not much can happen in Washington. We're going through a fallow period. Vietnam is over. The intellectuals are discovering that you can't solve problems by spending money. There really isn't a national need that's apparent to everybody. Many people still think the oil companies are busy conjuring up something while the Arabs, who used to get $2 a barrel, are now getting $20." Nor will a change of Administration change the country's listless mood.

What if the energy crisis worsens? "If anything, it would help us because it would increase the use of electronics." Another concern is the shortage of engineers. "We have a vast number of open requisitions for competent, highly technical people. We'll just have to be smarter in hiring, but it will be tough."

LARRY MAYHEW
group vice president, Tektronix Inc.

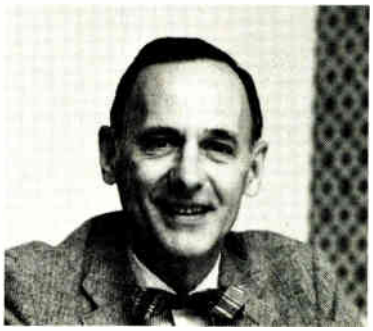
Mayhew has not yet seen any sign of a downturn. In fact, "our order book is running ahead of what we planned," even in one or two areas, which he declines to name, that are showing temporary softness. Tektronix' backlog of orders probably will increase over the year as the instrument company balances meeting customer demand and safeguarding against being caught short by a recession. In general, "we're cautious. We're watching all the indicators more closely than we ever have before."

Technically the U. S. is not in a recession because there haven't been two consecutive quarters of minus signs, but "there certainly are patches of the economy, particularly in consumer goods, that are in recession. But I don't see any worldwide industrial recession right now." Instead, he thinks there may be a three- to four-quarter slowdown and then "things will get strong again." One reason is that a high rate of inflation is built into the American economy for another two to five years, he believes.

Thanks to the microprocessor, which is "about as revolutionary as the introduction of the fractional horsepower motor was in the electrical industry of the early 1900s," the electronics industries have strength. But Mayhew questions whether the pervasive industries are immune to recessions. "All recessions are different; there aren't any generalizations you can make. Each one has to be looked at differently."

On the national scene, "with an election coming up, we're pretty sure that the executive branch won't do anything drastic." He also expects interest rates to "inch up a bit more" before they begin to decline.

The darkening energy picture is perturbing because the Government is not responding sensibly to the crunch. "I have a personal opinion, and I'm not an expert, but the executive branch and the legislative branch are taking a very illogical approach to the problem. On one hand, you have an energy problem and on the other, you have a social problem, which is inflation, and they're separate."



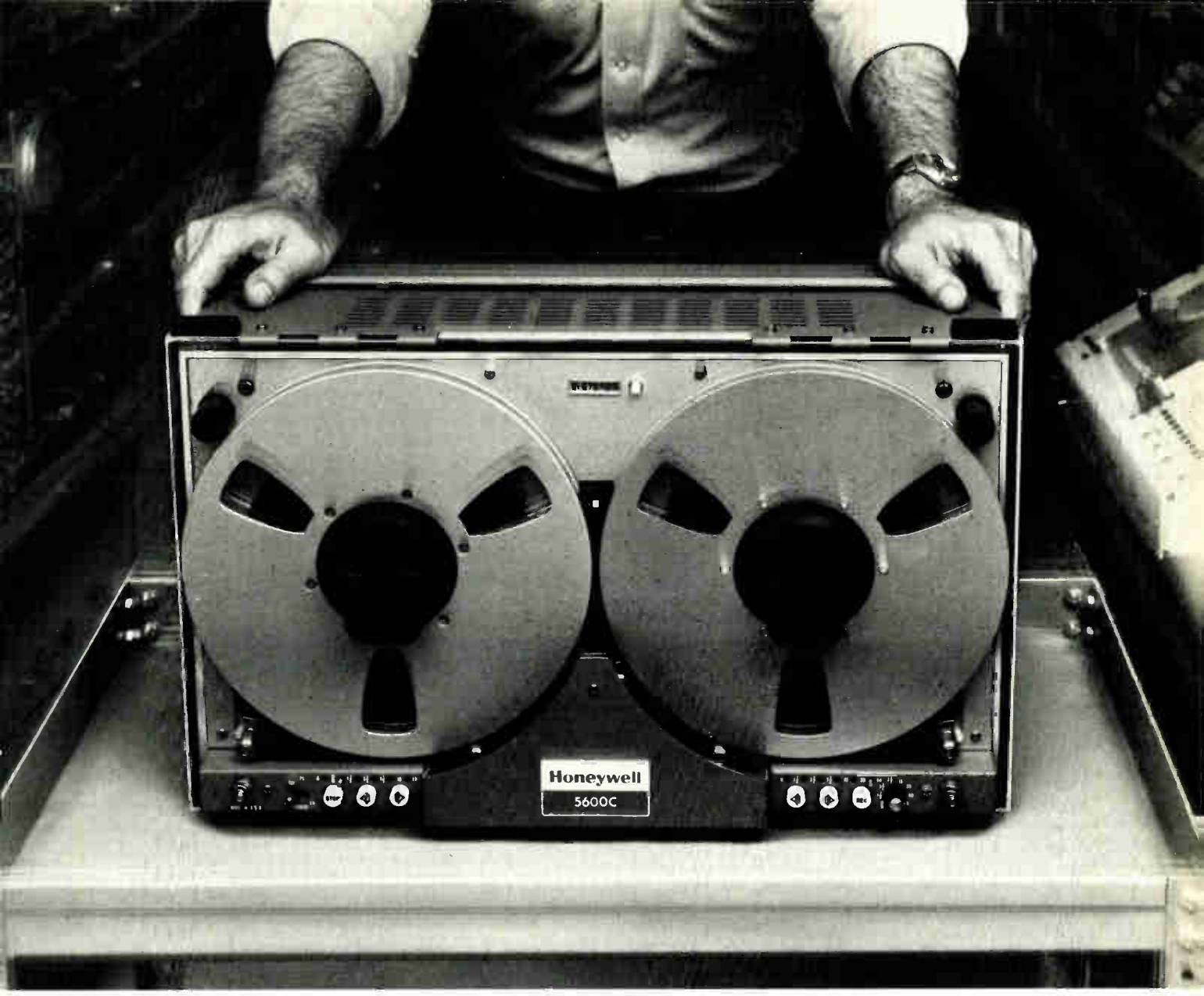
WALTER L. CHERRY
president,
Cherry Electrical Products Corp.

The impact of the recession may be first on most executives' worry list, but Cherry says the biggest problem is inflation. "It injects an indeterminacy in all of your thinking. You don't know how to plan for it, how to cope with it." The Carter Administration's moves to control inflation may succeed in reducing it to single-digit levels in 1981. Meanwhile, the recession is merely a "promised" event, not a reality for the Waukegan, Ill., producer of electrical and electronic switches and custom semiconductors. "It seems to be recalcitrant in its arrival."

Cherry is one of the growing number of Midwest component manufacturers finding lucrative markets overseas, ringing up sharp sales increases despite the foul economic forecast in the U. S. "Our foreign business in the United Kingdom and West Germany probably will grow somewhat. There are no signs of a recession in Germany," though performance in the UK might not fulfill expectations.

His confidence stems from a conviction that, no matter how weak things may get in one area, such as automobiles, the industry has become so diversified that it can survive a localized downturn. "Our industry is probably going to be injured less by a recession than others because of its aggressive nature."

Respite from the torrid pace of orders will not ease the burden of recruiting new engineers. Cherry expects the shortage of qualified engineers to continue, though he notes that the pool of general staff personnel seems to be increasing.



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MOS memories, bipolar VLSI, GaAs logic and mixed technologies star at this year's gathering

by John G. Posa, *Solid State Editor*, and Roger Allan, *Components Editor*

☐ *This week's International Electron Devices Meeting in Washington, D. C., reveals many secrets in as many different areas of device and process technology. The techniques used by Texas Instruments to build devices on annealed polysilicon or by Toshiba to build a 2,500-volt, 600-ampere gate-turn-off thyristor are all sparking excited interest.*

Not the least of the revelations is made by Intel Corp., whose revered static random-access memory design group agreed to tell the story behind the Santa Clara, Calif., company's forthcoming 16-K static RAM [Electronics, *Nov. 22, p. 40*]. *But the Japanese semiconductor manufacturers give by far the fullest disclosures. Plans are detailed for a new cell design that could yield a million-bit RAM by as early as the end of next year. Indeed, several Japanese companies are disclosing many processing tricks to bring the goals of their very large-scale integration effort closer to reality: a quadruply self-aligning MOS process, scaled complementary-MOS memory designs, and a molybdenum-gate MOS process that builds a 64-K RAM.*

In keeping with the contemporary device topics, IEDM begins with a plenary session comprising invited papers that review the status of optical circuits, photovoltaics, and VLSI. Michael K. Barnoski of TRW Inc.'s Technical Research Center in Torrance, Calif., highlights the accomplishments and problems in fiber optics and the components related to optical data transmission. Following that, Harold J. Hovel from International Business Machines Corp.'s Thomas J. Watson Research Center in Yorktown Heights, N. Y., lends credibility to the potential of solar cells in his discussion of photovoltaic materials and devices for terrestrial solar energy applications.

The final paper, presented by H. Dean Toombs, vice president of Texas Instruments Inc. in Dallas, details the departures from standard techniques that will be necessary as submicrometer device barriers are crossed and as chip complexities exceed 100,000 components.

Intel's 16-K static RAM is not the only one described in Session 15; another comes from Toshiba Corp., Kawasaki, Japan. Arranged as 2-K by 8 bits, the memory employs 100% complementary-MOS technology. With four n-channel-MOS transistors and two p-channel MOS load transistors per cell, it all adds up to more than 100,000 devices and 130,000 contact openings for the audacious RAM design, a design as difficult as that of a 64-K RAM—if not more so (see Fig. 1).

Toshiba had to resort to the electron beam for mask preparation, as well as to dry processing. The cells wound up measuring 1.74 square mils and the chip, 55,218 mil^2. The small cell size restricted metal widths and spacings to about 6 micrometers, so reactive ion etching was used to make 2-μm contact cuts. Toshiba concludes that the process allows "a reasonable margin of fabrication." For the record, the resulting RAM accesses in 95 nanoseconds at an operating power of 200 milliwatts. During standby operation, however, the device draws a mere 200 nanoamperes from the single 5-V supply.

It seems as if static RAM designers would like to achieve the high density of polysilicon load devices with the versatility of active pull-ups. Enter Toshiba Corp. again in Session 15 with what it calls the polysilicon transistor load. Operating as a p-channel FET for incorporation into a C-MOS static RAM, the new load device allows data to be retained at holding currents as low as 10^{-10} A per bit. However, when the "transistor" is conducting, current is high enough to circumvent processing idiosyncrasies and radiation effects.

A C-MOS cell using the polysilicon transistor is shown in Fig. 2, along with a cross section of the pull-up device. The load is actually a thin-film polysilicon transistor, with current flow through the intrinsic polysilicon controlled by an implanted n^+ gate located underneath the thin gate oxide. Up to the oxidation of the 700-angstrom-thick gate oxide, processing is standard. After gate formation, a large dose of arsenic ions is shot through the thin oxide to form the buried gate, in addition to interconnecting paths. Using 3-μm design rules, Toshiba has so far made a 16-by-16-bit experimental RAM. The minimum supply voltage for the device was "rather high," however, but the Toshiba firm plans to amend this by adjusting threshold voltages.

Another scheme for reducing MOS circuitry is described in a Session 25 paper authored jointly by researchers from the University of Waterloo, Ontario, and Bell-Northern Research in Ottawa, Canada. The scheme also benefits dynamic logic—even analog circuitry—and mixed technologies, with a 50% area reduction in all cases. The idea is to use one doped well for both enhancement- and depletion-mode transistors—hence the name single-device-well MOS FET. The single-well structure positions the two devices perpendicular to one another, sharing a common gate.

The researchers liken the merged transistor concept to integrated-injection logic, because in I^{2}L a single diffu-

sion (or ion implantation) forms the gate of one transistor and the collector of another simultaneously. So far, only an experimental chip has been fabricated on an n-type substrate. The source and drain of the enhancement devices are p-type, while the source and drain of the depletion-mode transistors are of the same polarity as the substrate.

Two Japanese IEDM papers in Session 25 focus specifically on self-alignment techniques. One of them, from the Japan Cooperative Laboratories in Kawasaki, claims to be about the ultimate in self-alignment: quadruply self-aligned MOS. Deep junction areas, shallow source and drain ion implantations, contact openings, and polysilicon gates are all lined up in QSA MOS. Processing begins with the patterning of the polysilicon gates, and to get successive regions to register, undercutting of the gates and anisotropic ion etching of oxide layers is used.

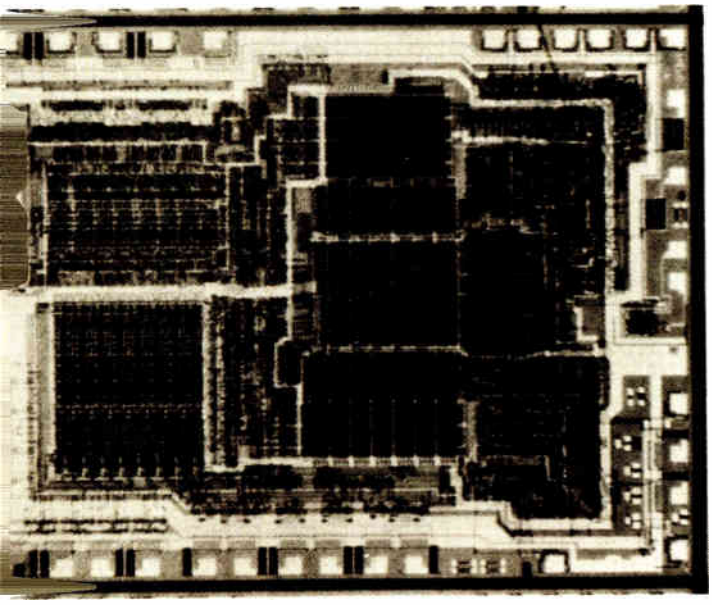
Most minute

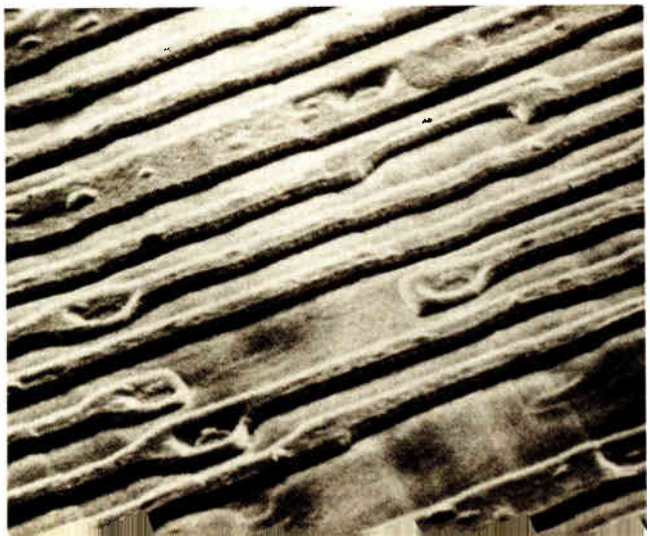
The Japanese researchers show that a rectangular transistor can be fabricated in QSA MOS that measures two by three minimum features on a side. They consider this the ultimate. Thus, with a 1-μm smallest dimension, a 6-μm^2 memory cell is possible. Their assumption also means that a monolithic 1-megabit dynamic RAM could be crammed onto a die slightly larger than 6 square millimeters, which works out to only 9,300 mil^2. Such an area is minute, even compared to the die sizes of today's 64-K dynamic RAMs, which measure over three times that size at least. Figure 3 compares a QSA cell with that of a 64-K RAM.

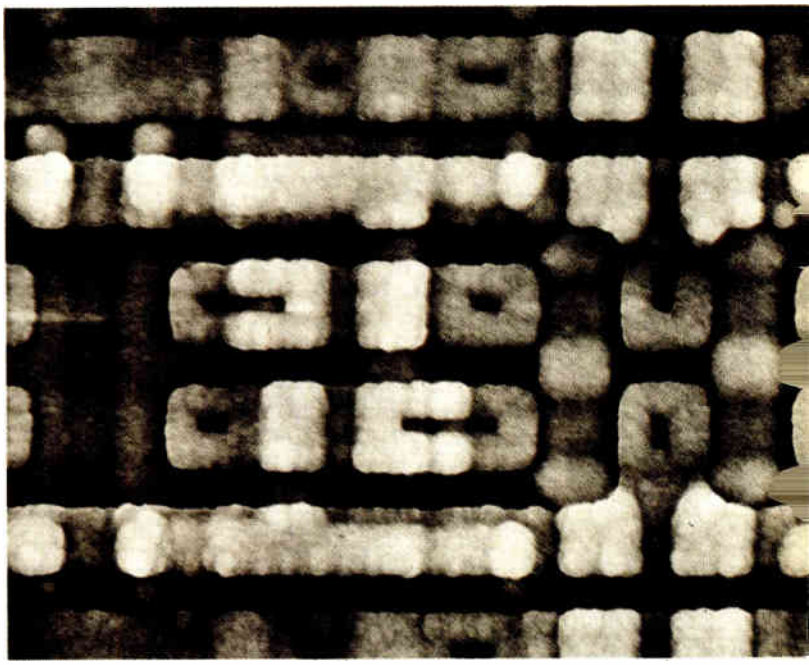
With another version of self-alignment from Nippon Electric Co., also located in Kawasaki, an 8085-like microprocessor has been built with a die size of 111 by 149.8 mils or roughly 16,519 mil^2 using 3-μm design rules. The 8085 look-alike runs from a 6-megahertz clock and consumes only 300 mW. In contrast, the present 8085A-2 from Intel Corp. measures 164 by 222 mils, can go as fast as 5 MHz, and dissipates 850 mW.

The three cross sections in Fig. 4 illustrate NEC's process. In (a), after conventional preparation of gate and field oxides, contact vias are made in the 300Å gate oxide and a polysilicon layer is deposited, doped, and oxidized. Silicon nitride deposition follows, and except for the areas above the source and drain, gate, and interconnection regions, the nitride is removed.

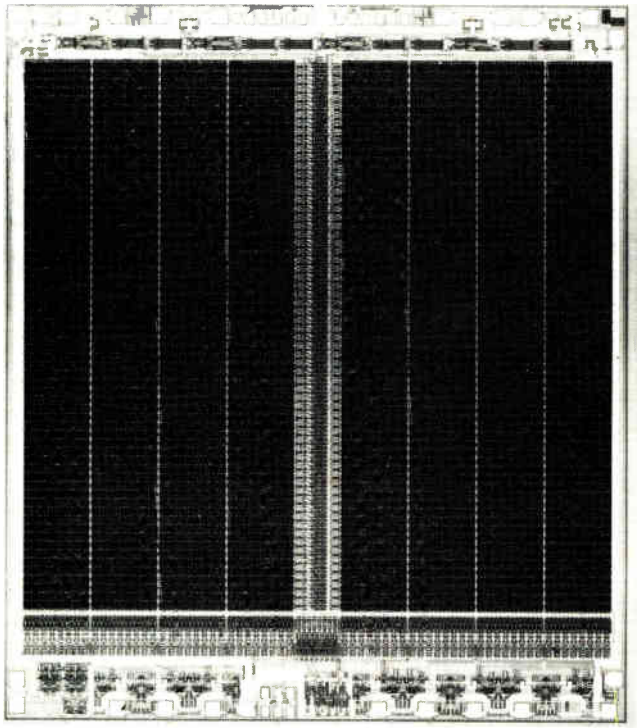
The tricky part is (b). The polysilicon is completely oxidized except for those areas masked by the nitride. But, concurrently, impurities from the doped polysilicon diffuse through the contact openings to form the source and drain regions. In (c), the remaining nitride is removed, oxide is chemically vapor-deposited, and openings are made for aluminum metalization. These contact windows may even be oversized and slightly misaligned



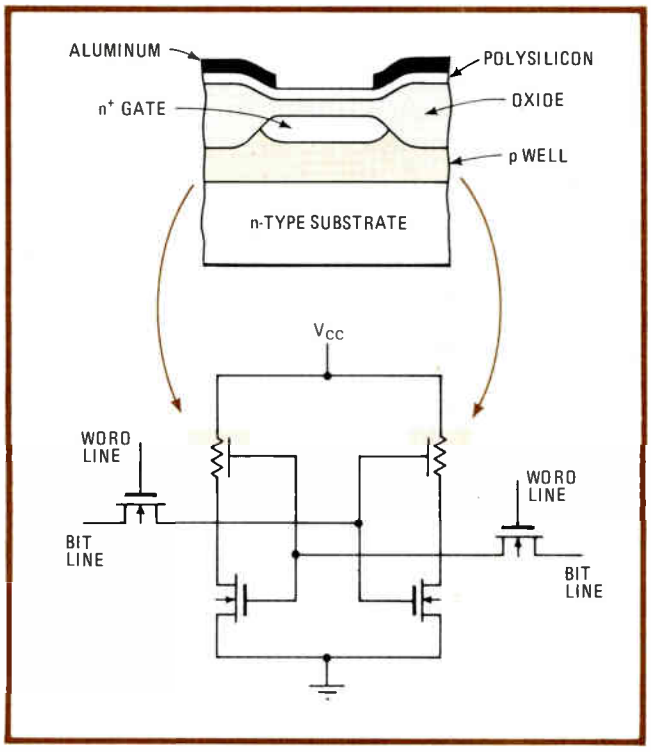




Made in Japan. Japanese technology makes a big showing in this year's Devices Meeting. Shown at left is an 8085 type of microprocessor from Nippon Electric Co. that uses self-alignment and 3-μm design rules. A close-up view of the processor is shown below at left. On the right is a scanning electron micrograph of a C-MOS 16-K RAM cell produced by Toshiba Corp. The entire chip is shown in Fig. 1.



1. 100% C-MOS. As ambitious, if not more so, as a 64-K dynamic RAM is a 16-K C-MOS memory from Toshiba Corp. High density describes the part, which has over 100,000 devices and 130,000 contact vias, the latter being cut with reactive ion etching.



2. Poly pull-ups. Toshiba Corp. has invented a load device that gives the high density of doped polysilicon load resistors and the versatility of depletion-mode transistors. In an experimental 16-by-16-bit C-MOS static RAM, the pull-ups only consume 10^{-10} A/bit.

without adverse effect because of the protection provided by the existing thermally oxidized polysilicon.

NEC will also be delivering a paper on a 64-K dynamic RAM in Session 15 that uses 1-μm molybdenum gates for an extremely small die size. And Texas Instruments Inc. of Dallas is, in the same session, discussing its ability to ground the substrate of its 16- and 64-K dynamic memories. In particular, TI will disclose its model for short-channel MOS devices and explain the implications of its 256-cycle, 4-millisecond refreshing. It is saving detailed circuit descriptions of its 64-K part for the International Solid State Circuits Conference to be held next February in San Francisco.

TI, a major contributor to this year's IEDM with 11 papers in all, has two strong entries in bipolar technology as well. In Session 8, one of its research groups tells of work on a 1-μm bipolar process that relies on direct-slice writing with a vector-scanning electron-beam machine. The group fabricated a version of the company's integrated-injection-logic SBP0400 bit-slice processor using the electron-beam process.

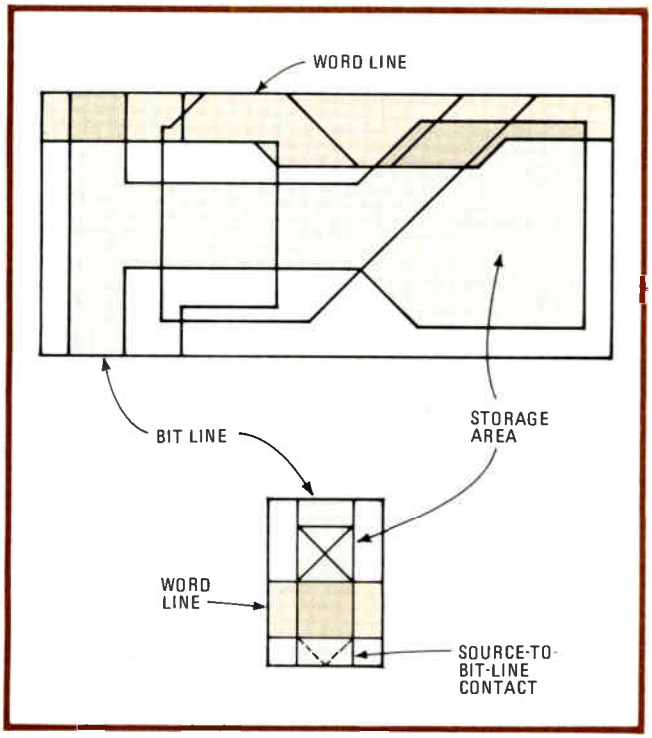
Results are impressive: the SBP0400 went from 20,925 mil^2 to 5,270 mil^2. Assuming that interconnections occupy 60% of the chip area, the 1-μm process packs more than 1,000 gates to a square millimeter. The speed of the processor improved significantly, too, even though the process and structure were optimized for the full-sized—and not the scaled—part: with a 50-milliampere injector current, the scaled SBP0400 operates at about 5 MHz, whereas the full-sized part with four times the chip area operates at less than 2 MHz. What's more, TI estimates that if Schottky contacts were to replace the ohmic ones, the clock speed would rise to about 8 MHz.

Also from TI, a paper in Session 14 discloses the details of Schottky Transistor Logic, an I^2L version of diode-transistor logic that uses a Schottky barrier diode to clamp the switching transistor out of saturation and minimize charge storage delays. TI has built several circuits with minimum features that range from 5 μm down to 1.5 μm. Gate delays of less than 0.5 ns and power-delay products of below 50 femtojoules have been realized. Most interestingly, TI has fabricated several circuits, including a parity generator of 50 gates and a 16-bit arithmetic and logic unit with over 500 gates, using automatic routing of an STL gate array.

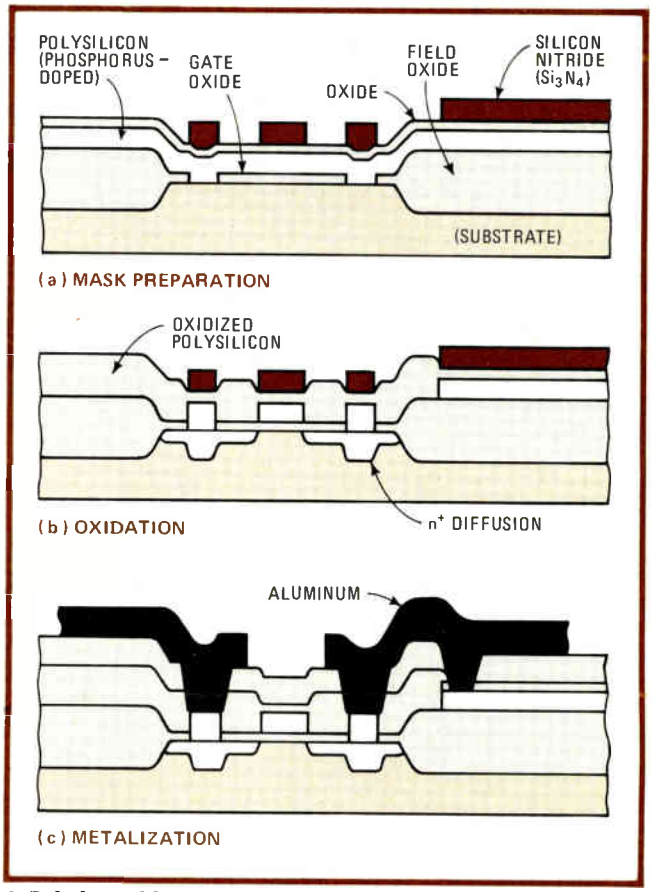
It turns out that the packing density of STL is not quite as good as that for I^2L—close to 60% as dense—because of the area consumed by the base resistors and because of wiring constraints brought about by the top-side ground-lead routing. But the performance specifications are especially noteworthy at the smaller geometries: gates with 1.4-μm features show a delay of 0.5 ns and a power-delay product of 30 fJ with a 2-V supply.

Also in Session 14 is a new bipolar fabrication technique from OKI Electric Industry Co. in Tokyo called BEST, for base-emitter self-aligned technology. OKI increases the packing density while cutting power with a selective-oxidation process, and it reports delays of 0.65 ns and 0.6 mW power per gate when measured in a right-oscillator configuration of current-mode logic.

The BEST process reduces the active region over standard walled-base transistors by 50% or better, with a corresponding reduction in parasitic capacitance to 0.04 pF. OKI's process, which relies on polysilicon, brings a lot



3. The ultimate. Using four levels of self alignment, the Japan Cooperative Labs build rectangular memory cells measuring 2 by 3 minimum features. It says that this is the smallest cell to hope for. The 64-K RAM cell shown above the self-aligned cell looks massive.



4. Poly impurities. This is how Nippon Electric Co. builds its 8085 look-alike. After nitride masks are prepared in (a), doped polysilicon is completely oxidized. Remaining polysilicon (b) forms source, drain, gate and interconnections. Metal contacts are made in (c).

to the bipolar party: the transistors' emitters, inactive base regions, and load resistors are formed accurately by one mask; walled emitters are still easily formed, while base areas reduce drastically over those possible with conventional methods; the polysilicon load resistors exhibit far lower parasitic capacitance than conventional diffused resistors; and finally, even with 3-μm lithography, 2-μm emitter regions can be formed.

I^2L diversifies

Extending the domain of integrated injection logic is Toshiba Corp., which presents two papers on I^2L process made compatible with other bipolar devices. One in Session 14 pairs a high-speed I^2L process with emitter-coupled-logic devices. In that process, shown in Fig. 5a, the impurity profiles are optimized for each device type—hence, all base regions are formed in different doping steps. However, a single n^+ diffusion forms the I^2L collector and the linear transistors' emitters at once. The process successfully combines I^2L with 4-gigahertz-cutoff ECL transistors. Toshiba will use the process in very high-speed logic applications, most certainly for phase-locked-loop synthesizers in television receivers.

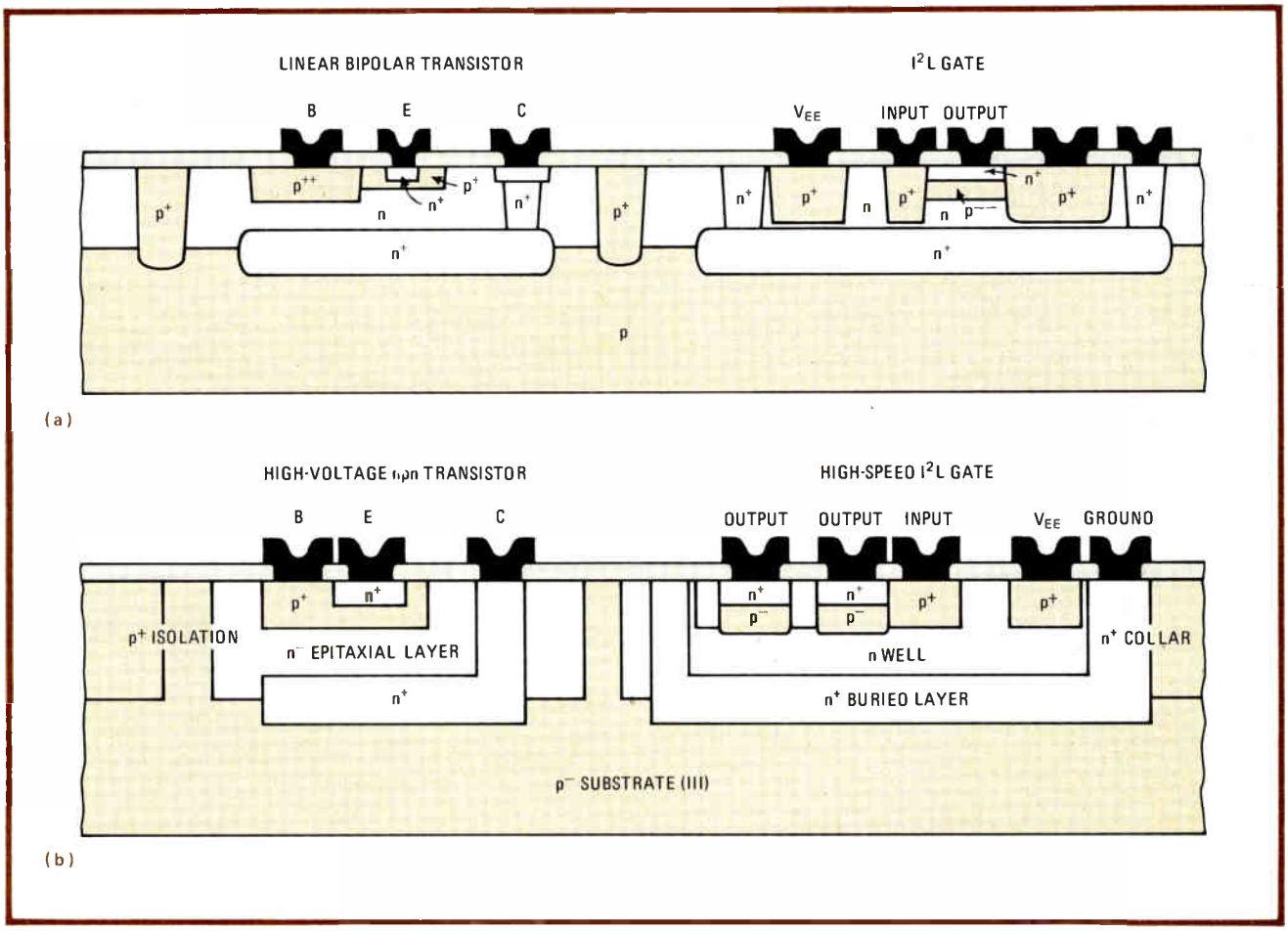
Toshiba is also mating I^2L with high-voltage analog transistors. As discussed in Session 8, Toshiba achieves a 75-V breakdown for an analog device mated with high-speed I^2L gates. The integration of high-voltage devices with standard logic is usually difficult because the buried layers of the two normally end up at different depths. To solve that problem, Toshiba uses a double-diffused base structure with a phosphorous-implemented n-well emitter for the I^2L and a single-diffused base with a lightly doped epitaxial collector for the analog transistor. The resulting structure, shown in Fig. 5b, helps clear the way for combined analog-digital LSI.

Toshiba is active as well in the discrete power-transistor area. It describes in Session 10 a 2,500-V, 600-A gate-turn-off (GTO) thyristor. The GTO has received much attention lately because of its advance over thyristors that require current interruption by commutation or other means. The GTO could well find its place in many inverter and chopper circuits, since its surge-current capability far exceeds that of bipolar transistors.

Toshiba's goal was to find a way to increase the maximum GTO current while keeping other thyristor characteristics in balance. The answer involved decreasing the base surface resistance and the n-emitter width, as well as using a thick p-base layer with an extremely low acceptor concentration. To get the high breakdown voltage, Toshiba uses a new phosphorus redeposition annealing process to increase carrier lifetime in the base of the device.

MOS power devices challenge bipolars

MOS field-effect transistors continue their trend of higher densities and lower on-resistances. Seven papers in Session 4 on power transistors provide an excellent review of MOS FET and bipolar transistor advances. A paper from International Rectifier Corp., El Segundo,



5. I²L mixed. In two papers, Toshiba Corp. mixes I²L with emitter-coupled logic (a) and high-voltage transistors (b). The ECL has a cutoff frequency of 4 GHz—perfect for TV tuning. The high-voltage device has a 75-V breakdown—great for power control.

Calif., on power MOS FETs, makes mention of its HEX FET structure, using individual hexagonal FETs.

A team from Siliconix Inc., Santa Clara, Calif., provides details about a third-generation power FET, called a K-gate structure, that sets new levels of packing density for lower on-resistance. Employing a meshlike configuration, the V-MOS device is reported to offer a multifold improvement in packing density over the first generation of Siliconix' V-groove MOS FETs.

As an example of its capabilities, the authors cite a device with a 0.19-centimeter-squared chip area having the following features: a channel-width-to-length ratio of more than 750,000 within a 0.15-cm² active area; 200-V breakdown at 0.1-ohm on-resistance; and 50-A drain current at 10-V gate drive. In another K-gate V-MOS FET with a 0.14-cm² chip area, performance is typified by a drain-source sustaining voltage of 450 V, energy dissipation of 27 millijoules without failure, surges of 25,000 V/microsecond, and 5-A switching in 30 ns. Reliability of 1,000 hours at 150°C burn-in (250-V reverse bias) was reported. The new V-MOS FETs are in a preproduction phase and are being readied for introduction early next year.

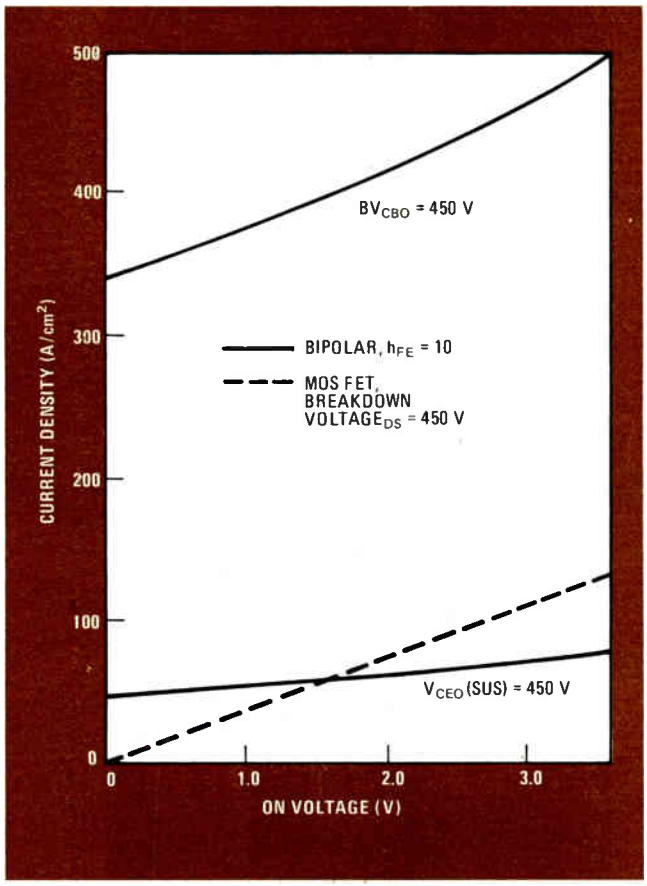
With all of the publicity surrounding MOS power transistors, bipolar technology might seem to be in trouble. Not so, according to a paper from Westinghouse Electric Co.'s R&D Center, Pittsburgh, Pa. The invited Session 4 paper concludes that, although bipolar devices inherently require more chip area to handle higher powers, MOS FETs have higher conduction losses than bipolars on a per-unit basis. Only where the operating frequency is high enough to take advantage of its lower switching losses is a MOS FET to be preferred. It is emphasized that when current density is studied as a function of forward voltage drop for both types of devices, bipolar devices exhibit greater room for improvement (Fig. 6).

By improving a bipolar transistor's reverse safe operating area, it is felt that it is possible to increase bipolar transistor current-handling performance significantly.

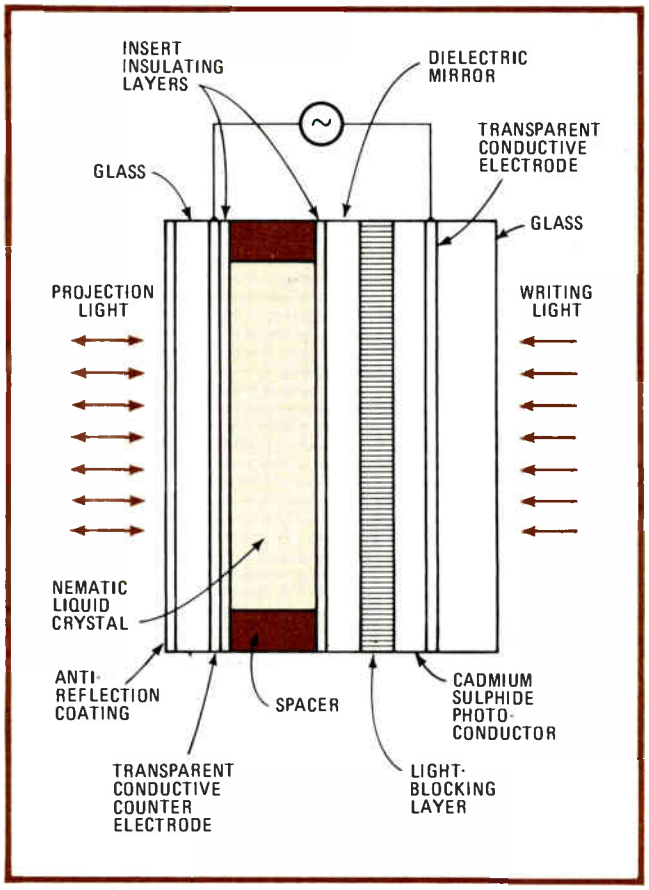
Liquid-crystal displays shine brighter

Session 23 includes five papers on various display technologies, including an overview paper from IBM Corp., Kingston, N. Y., on ac plasma panel technology. It reviews the technology choices available for ac plasma-panel display fabrication and relates them to specific applications. Material yield and reliability factors are also reviewed, as are available processing options.

Three other papers are devoted to liquid-crystal displays, underlying the rapid improvements in this technology. Researchers at Bell Laboratories, Holmdel, N. J., report on a new electrically addressed bistable mode in field-effect nematic liquid crystal that may



6. Improvements. If reverse safe-operating area of bipolar transistors were extended from collector-emitter breakdown of 450 v to collector-base breakdown of the same magnitude, greater current densities would be possible. Dotted line shows MOS FET limits.



7. Light valve. This liquid-crystal light valve was designed for real-time optical processing and large-screen displays. The device includes a liquid-crystal material coupled to a cadmium sulfide layer. An improved new-generation device has a silicon layer instead.

alleviate the normally stringent multiplexing limitations such devices face. This is because of the need for refreshing. The researchers report that they have produced predominantly horizontal or vertical configurations of stable nematic liquid-crystal materials featuring long-term stability without the need for conventional refreshing. The displays can be optically differentiated by the incorporation of pleochroic dyes and have demonstrated 5:1 contrast ratios.

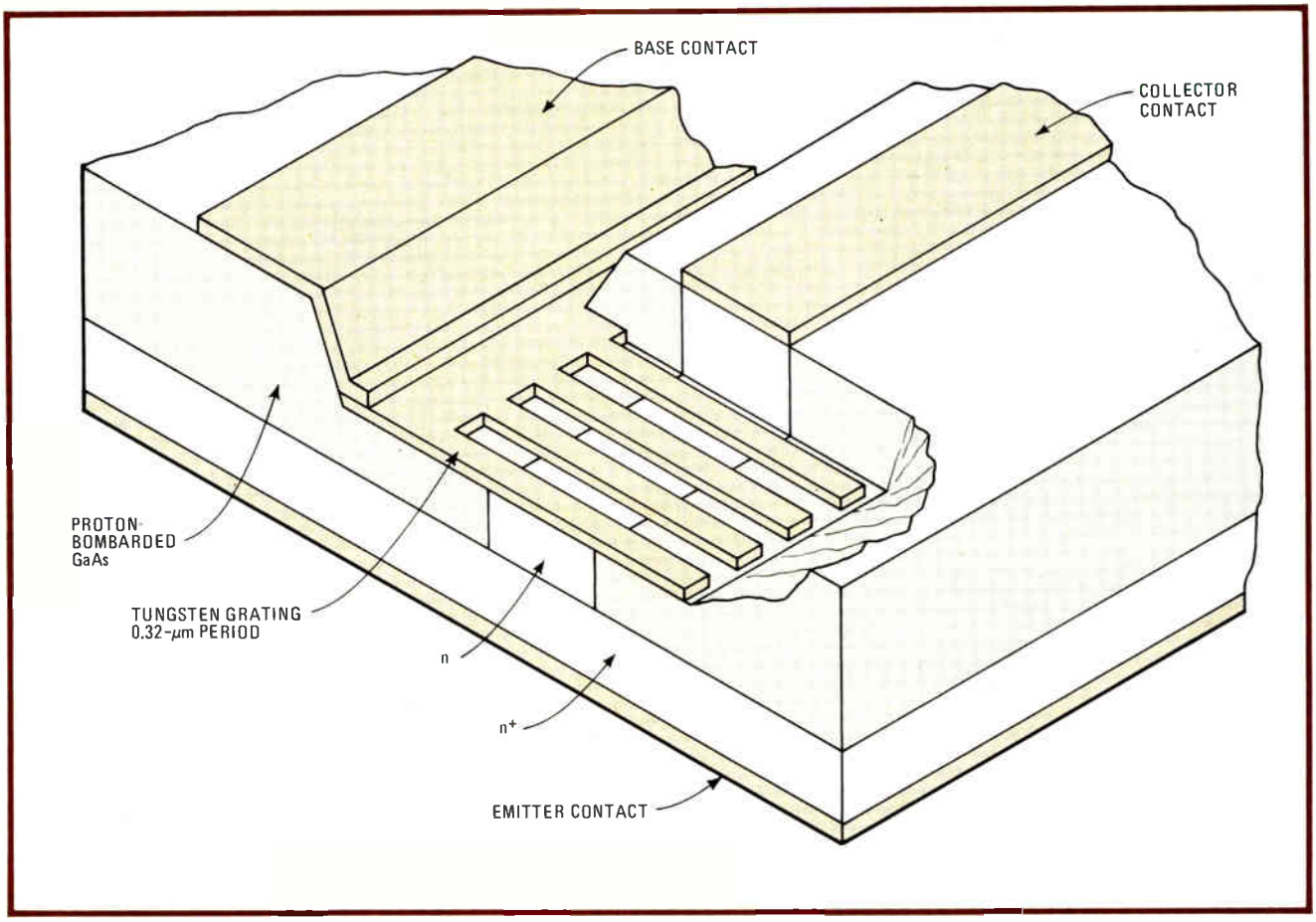
From the Hughes Research Laboratories, Malibu, Calif., comes an exciting development in liquid-crystal light valves. A high-performance silicon and liquid-crystal device was designed for applications requiring real-time optical processing and large-screen displays. The device consists of a high-resistivity single-crystal silicon photoconductor and a silicon-dioxide insulating layer operated in the MOS configuration. This silicon and silicon-dioxide structure is coupled to a liquid-crystal display that operates in the hybrid field-effect mode with a cermet light-blocking layer and a dielectric mirror. The entire structure is then sandwiched between transparent electrodes that are deposited on optically flat glass substrates (Fig. 7).

For operation, a strong light source is modulated by the weaker one, to be projected elsewhere. In effect, this is like a triode vacuum tube whose plate voltage is modulated by a small grid signal. The use of a silicon photoconductor offers fast and linear reponse and broadband photosensitivity. Resolutions of 22 line pairs/mm were routinely achieved, as was a contrast ratio of 30:1. Sensitivity of up to 10 microwatts/cm² at 30 frames/s was possible. The device has been successfully demonstrated for live television broadcasts.

Xerox Corp.'s Webster Research Center, Rochester, N. Y., presents a paper on photofabricated thin-film transistor arrays, pointing out that although conventional fabrication methods of high-vacuum thin-film depositions (in conjunction with pattern-defining metal stencils) offer advantages of simplicity, they limit the array's resolution, latitude, and repair capability. The use of photolithographic processing, on the other hand, allows for greater fabrication flexibility, at the expense of some complexity. Researchers fabricated 25 test-vehicle thin-film transistors in a 1-in.² area. Each of the transistor cells was 20 mils to a side, allowing up to 50 cells to be placed in a 1-in. line. Line widths of 1 mil were used. The results show that arrays that are suitable for display applications can be made by this technique. The array cells can withstand gate and drain bias voltages up to 20 v depending on insulator thickness.

Into microwaves with gallium arsenide

Judging from the flurry of gallium arsenide developments coming out of the laboratories of major corpora-



8. **Permeable base.** This unique permeable-base transistor produces 13-decibel gain at 4 GHz. The base is a 300-angstrom-thick layer of tungsten patterned into a 3,200-Å period grating. The grating is epitaxially embedded in single-crystal n-type gallium arsenide.

tions, it is not surprising to see two full sessions, each with seven papers, devoted to this subject. Session 2, "Analog Microwave Devices and Integrated Circuits," includes several papers on broadband gallium arsenide amplifiers. The Raytheon Co., Waltham, Mass., describes using a four-FET GaAs power combiner as the basis for a monolithic X-band amplifier with 50-ohm on-chip matching and a 2-W power output. The amplifier's bandwidth at the 1-decibel point is 1.5 GHz at a gain of 3.3 dB. A gain of 5 dB was reported when driving the amplifier with low-level signals. The four-FET GaAs amplifier evolved from a one-, then a two-FET amplifier, central to whose developments were the use of two novel circuit techniques—air-bridge overlays and via holes, which provided low inductance grounding.

Monolithic GaAs metal-semiconductor FET amplifiers with a gain of 6 to 7 dB at 10 GHz are reported by Rockwell International Corp.'s Electronic Research Center, Thousand Oaks, Calif. The experimental GaAs FETs employed were fabricated by electron-beam lithography and had gate-structure dimensions of 0.75 by 300 μm on 2-by-8-mm chips.

Silicon-on-sapphire technology has also been found useful for microwave ICs, as shown by two papers in Session 11 from General Electric's Corporate R&D Center, Schenectady, N. Y., which describes the use of SOS materials to make monolithic MES FET amplifiers for L- and S-band applications requiring low noise, wide dynamic range, and high gain. Previous attempts to fabricate monolithic amplifiers with SOS materials have been stymied by the high isolation and conductor-to-substrate capacitances normally associated with SOS. The researchers solved this problem by fabricating a MES FET on an SOS substrate. The resulting performance included amplifiers with impressive gains of 10.5 dB at 2 GHz and 5.5 dB at 4 GHz, for a cutoff frequency of 4.2 GHz. Gate structures 1 μm long and 400 μm wide were used. The linear dynamic range was in excess of 60 dB with a 1-dB gain at 10 dBm, for 9.5-dB gain at 2.25 GHz. SOS MES FET devices were fabricated with gate widths ranging from 400 to 1,600 μm and with lengths of 0.75 and 1 μm. Platinum silicide, molybdenum, and gold were used for metalization. The drain, source, and channel regions of the MES FETs were ion-implanted.

Session 16 deals with GaAs transistors and diodes; several new device designs are unveiled, including a unique three-terminal device from the Massachusetts Institute of Technology's Lincoln Laboratory, Lexington, Mass. The device is a permeable-base transistor that has been shown to produce a 13-dB gain at 4 GHz (Fig. 8). It is said to have many advantages over GaAs FETs and exhibits a 3.5-dB noise figure at an associated gain of 9 dB. The transistor's base consists of a 300-angstrom-thick layer of tungsten patterned into a 3,200-Å-period grating, which is epitaxially embedded in single-crystal n-type GaAs. □

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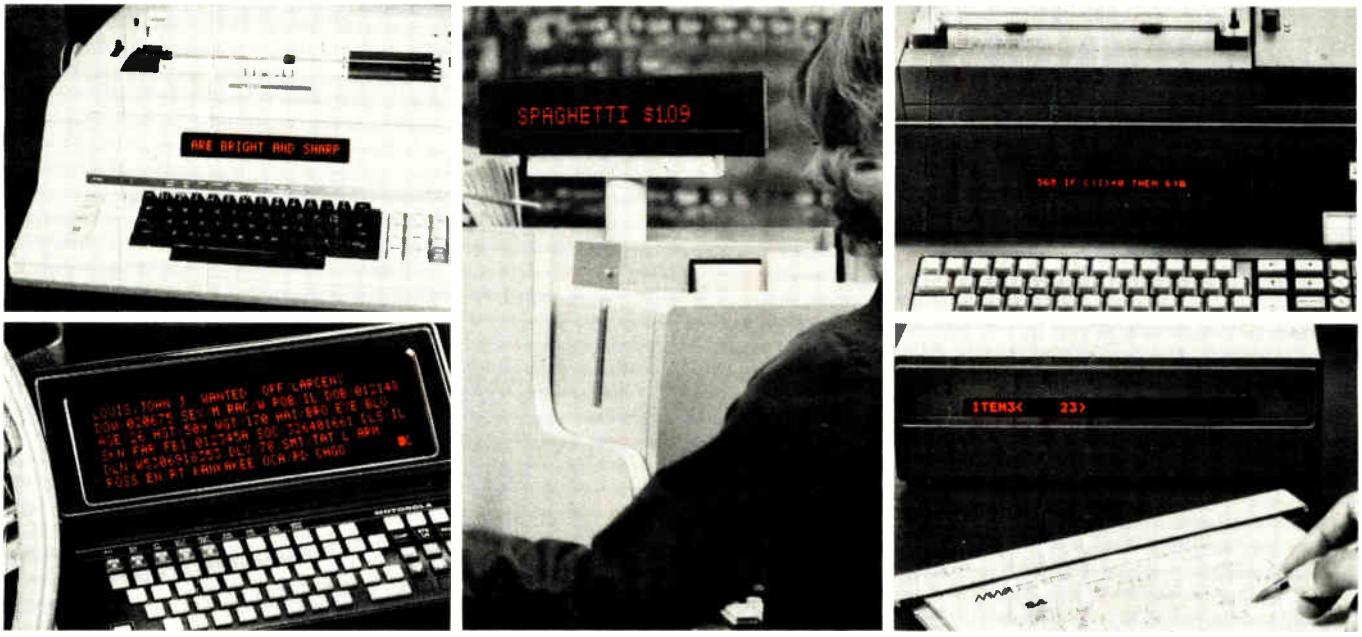

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Switching preamp improves a-d converter sensitivity

by Peter Bradshaw
Intersil Inc., Cupertino, Calif.

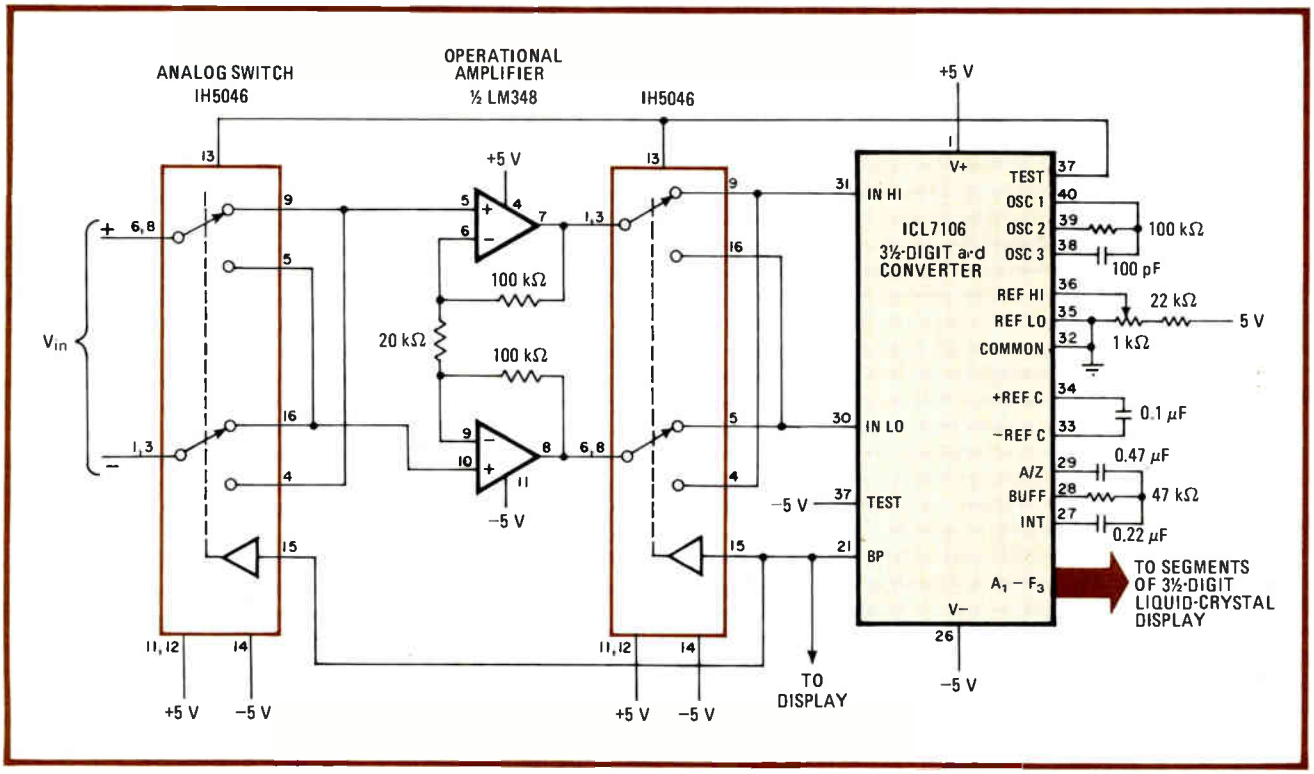
The low-signal resolution of even the best analog-to-digital converters, including those equipped to eliminate input-offset disturbances, is limited by the noise generated at the inputs. But the resolution, and thus the true sensitivity, of a converter can be inexpensively improved by an order of magnitude if a switched, differential amplifier is employed at the input to precancel offset errors without affecting the normal conversion process.

The technique is illustrated for Intersil's ICL7106 3½-digit autozero converter/display driver, which normally handles signals over the range of 100 millivolts to 2 volts. In such a converter, the small input noise voltage trapped on the autozero capacitor during a conversion sets the aforementioned lower signal-handling limit. The noise (which is caused by the equivalent noise resistance at the input, not a component of the signal) can be minimized to a great degree with preamplifiers having low offset voltage, but this can be a rather expensive solution to the problem.

As shown, an alternative approach is to use the liquid-crystal-display backplane (BP) drive output of the ICL7106 to synchronously switch one half of the low-cost LM348 quad operational amplifier via analog switches so that, over a switching cycle, the input of the converter sees no instantaneous change in the magnitude or polarity of sample voltage V_{in}. Offset voltages, including that of the op amp, on the other hand, are virtually canceled because an equal but opposite noise component (average value is near zero) is applied to the IN HI (and IN LO) ports of the converter over a given interval. In this case, the switching (BP) signal is set at 45 kilohertz, but this can be varied by suitable selection of the RC components at pins 38 and 39 of the ICL7106. In this configuration, excellent performance is obtained for input signals ranging from 1 to 20 mV full scale.

Most dual (matched) op amps will be suitable for the switching task, but it is important that both the positive and negative slew rates of the device be reasonably close. Op amps having significant crossover distortion (such as the LM124/324) should not be used.

The CD4053 or the Intersil IH5046 will serve well as the analog switches. In the case of the 4053, 1⅓ devices will be required. Only one double-pole, double-throw switch is contained in each 5046, however, and so two of these devices would be required. □



Precanceled. Switching the signal-handling op amp at supersonic rate virtually eliminates input-offset errors of converter, thereby improving sensitivity. Converter's input sees no instantaneous change in V_{in} during switching cycle, and normal conversion process is not affected. But offset voltage at input is alternately fed to (+) and (−) ports; thus equivalent noise voltage over cycle is near zero.

Bipolar and V-MOS hybrid delivers fast power pulses

by Robert H. Hamstra Jr.
Searle Ultrasound, Santa Clara, Calif.

The major advantages afforded by the up-and-coming V-groove MOS transistor—low cost, moderate power capability, high-frequency operation, and immunity to mismatch—are utilized in this relatively inexpensive, compact pulser that, with the aid of two bipolar power transistors, will deliver a peak power of 5 kilowatts at widths as narrow as 20 nanoseconds. In terms of voltage and current, the unit can supply an output pulse of as much as 250 volts or 30 amperes.

This pulser overcomes the size, weight, and standby power limitations of vacuum tubes, the bulkiness and limited frequency response of charged delay lines, and the exponential fall rate and lack of constant output impedance that occur with silicon controlled rectifiers. Bipolar transistors that are fast enough cannot handle the current or voltage. The drawbacks are overcome by combining the bipolar transistors and V-MOS devices, which are fast but cannot deliver great amounts of power.

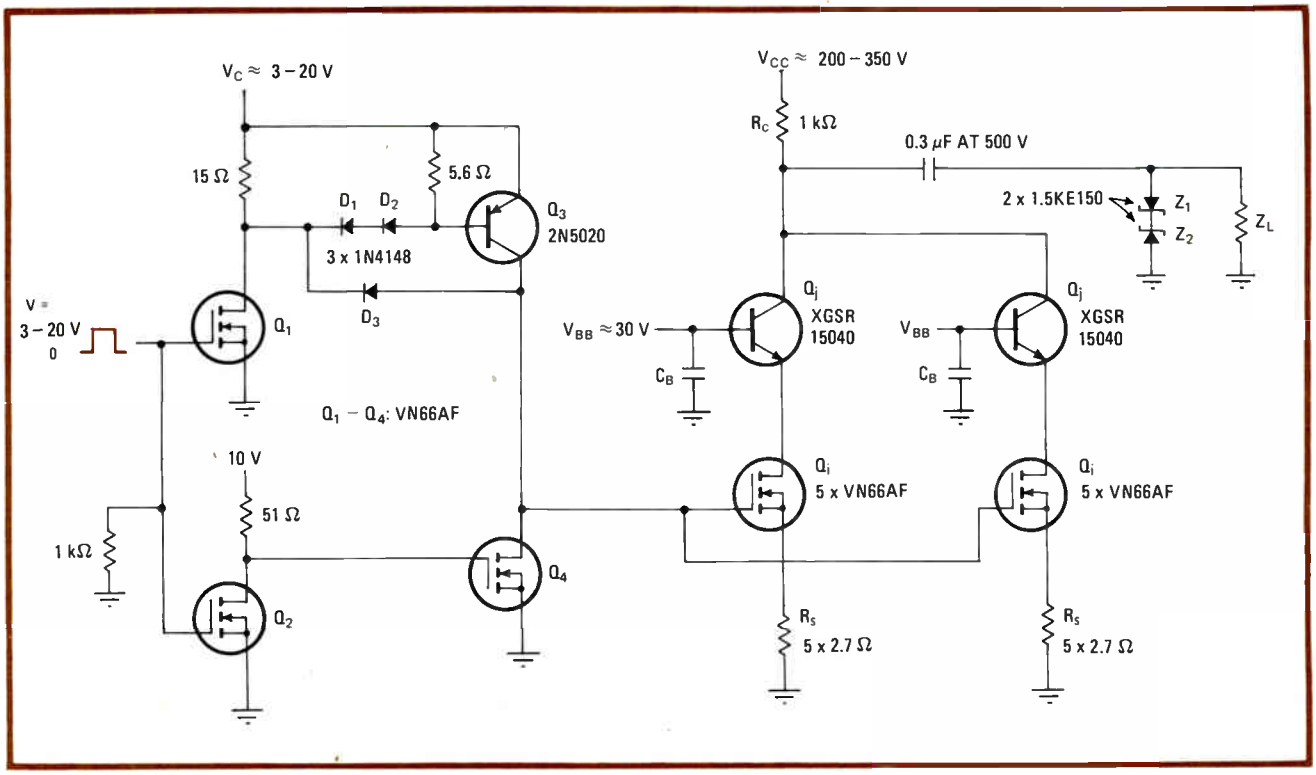
Transistors Q_1–Q_4 comprise the driver circuit for the pulser. The energizing waveform is provided by an external low-power pulse source applied at Q_1 and Q_2. Q_1 and Q_2 are directly coupled to Q_3 and Q_4. The base current to Q_3 is set at about 1.5 A, a necessary condition for achieving rise times of 10 ns across the V-MOS input capacitance of 500 picofarads.

D_1–D_3 serve as clamping diodes to prevent Q_3 from saturating on the rising edge of the pulse, and the 5.6-ohm resistor helps turn off Q_3 quickly. The amplitude of the output pulse is determined by the control voltage, which is applied to Q_3's emitter. The circuit could be further simplified if a p-channel V-MOS device were to replace Q_3, but unfortunately the p-channel units are not yet readily available.

In general, the basic output circuit is in a cascode arrangement using 10 V-MOS transistors Q_i and two bipolar transistors Q_j, with the gates of Q_i driven by the pulse. The base of Q_j is at ac ground. In this way, the current delivered to the load Z_L is approximately proportional to the voltage applied to Q_i.

The cascode circuit helps minimize the effect of the gate-to-source and gate-to-drain (input) capacitances of the V-MOS transistors, thereby enhancing the response time or speed of the circuit. Note that the output voltage of Q_i overcomes the drop across Q_j's (internal) emitter inductance (10 to 20 nH) when the stage is made active, and that Q_i is selected to withstand the inductive kick (10 to 20 V) that occurs when the stage is switched at slew rates as fast as 2 A/ns. In addition, Q_j is never driven into saturation, and as a consequence, fast response times are maintained.

The usual precautions for protecting V-MOS gates have been observed. The input-pulse amplitude is within the gate-voltage ratings. The source-to-drain voltage is not exceeded when the device is off. No attempt to bias the gate near its turn-off point to improve device linearity has been made, either, as a small misadjustment may



High-stepping quickly. Advantages of bipolar and V-MOS transistors are combined in circuit that delivers pulses to 5 kilowatts at a nominal width of 20 ns, if load is resistive. Output pulse width is limited by the 0.3-μF coupling capacitor.

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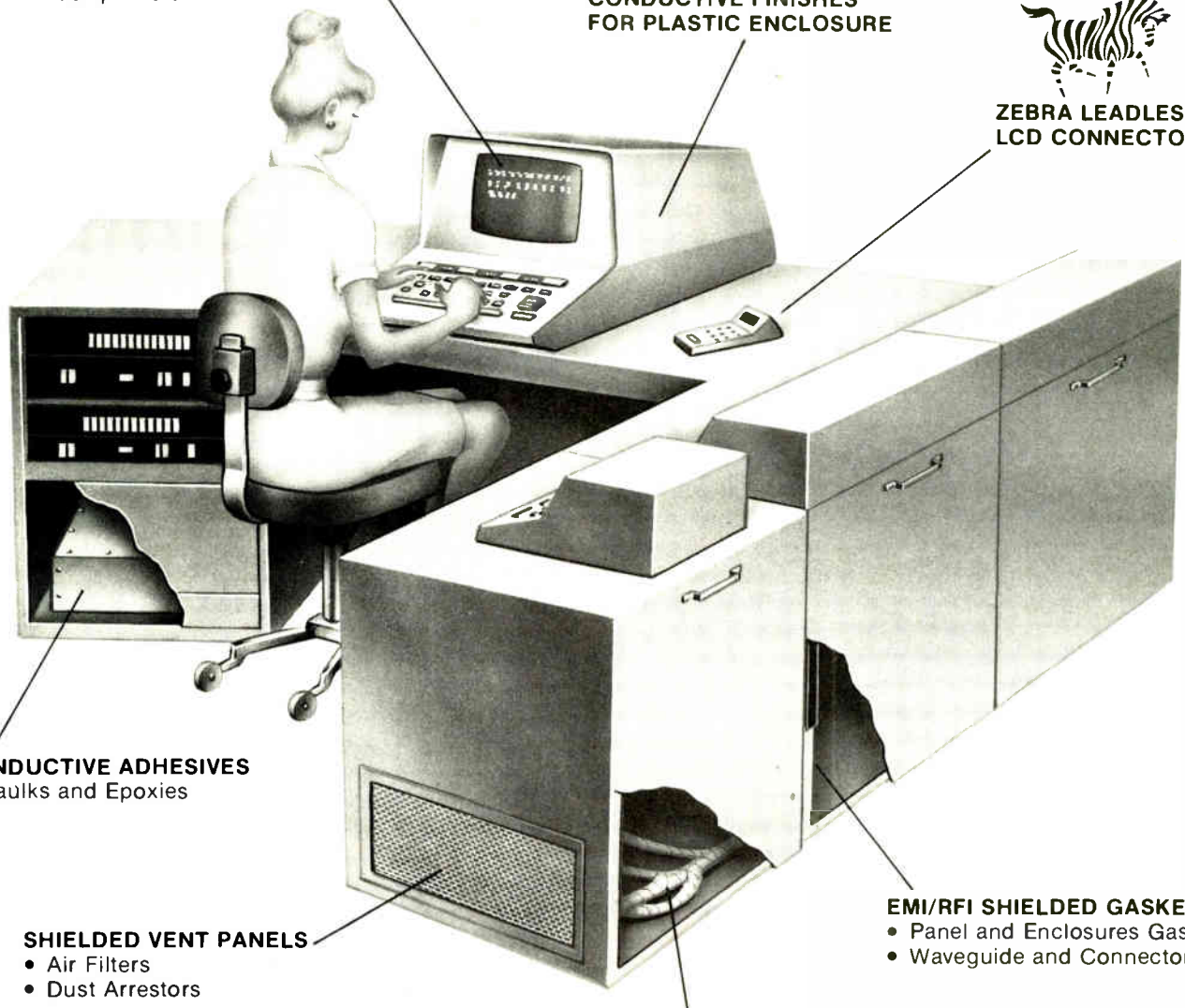

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cause excessive dissipation and device failures.

The bipolar transistor is a current source and so short circuits at the output of the pulser cause no trouble. Protecting the output transistors from voltage spikes is important, however, and fast transient suppressors Z_1 and Z_2 have been added to avoid transistor damage. Z_1 and Z_2 work well for low-impedance loads (10 Ω or less) but their high capacitance may otherwise serve to slow circuit speed.

The circuit has been built on a brass plate, to avoid parasitic oscillation problems in V-MOS that would be manifest if the circuit were constructed on a printed-circuit board. Very low-impedance bypass capacitors (monolithic ceramic) are connected between the base of the bipolar transistors and ground. Note that the gates of each V-MOS device are connected directly in parallel without a resistor or ferrite bead. This arrangement is equally effective in improving the suppression of parasitic oscillations. □

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 $50 for each item published.

Improved analog divider finds large-signal quotients

by Umesh Kumar
New Delhi, India

The linearity and signal-handling capability of the divider circuit proposed by Kraus for finding the quotient of two analog voltages [*Electronics*, Aug. 5, p. 112] can be easily improved. What's more, the cost of the updated unit is virtually equal to that of the original design.

As shown in the voltage-to-time converter portion of the system, input signal V_y drives constant-current source A_1–Q_1. Note that V_y is capable of assuming a peak value of at least 10 volts, in contrast to the original circuit where A_1's gain of 15 limits V_y's maximum input value to 1 v for a 15-v supply voltage. In addition, the constant current source affords a virtually linear charging of C, unlike the scheme employed initially, where a field-effect transistor operates as a voltage-controlled resistor (R_{ds}) through which C is charged.

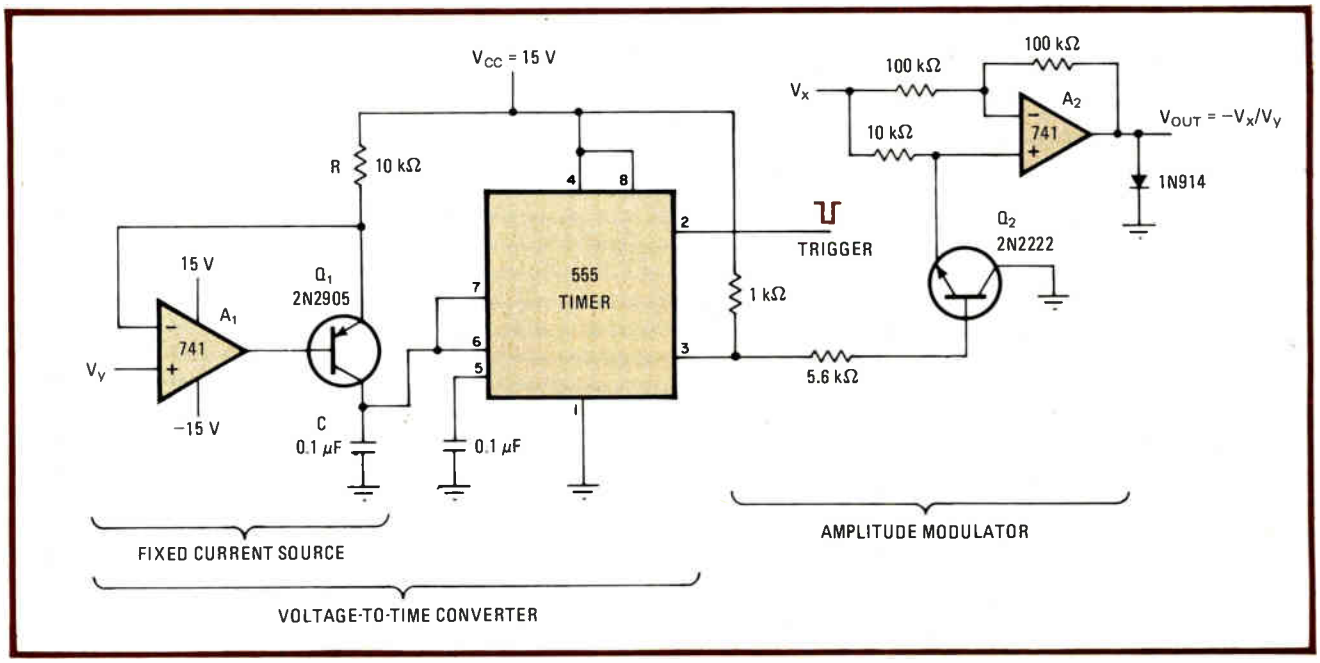
Upon application of a trigger pulse at pin 2 of the 555, the output (pin 3) of the one-shot goes to logic 1 and C charges toward $\frac{2}{3}$ V_{cc}. When the voltage across C indeed reaches $\frac{2}{3}$ V_{cc}, the capacitor discharges and the output returns to its low state. The process thereupon repeats, with the oscillating output of the 555 serving as a modulating signal at Q_2–A_2.

Thus, during the charging of C, $\frac{2}{3}$ $V_{cc} = (I/C)\, t_c = (V_y/RC)\, t_c$, or $t_c = (2V_{cc}RC)/3V_y$, where I is the current emanating from the current source and t_c is the charge time of the capacitor. At this time, Q_2 is on and so the output voltage is $V_{out} = -V_x$.

If τ denotes the period of the trigger pulse, the timer will be low for the fraction of the period when $(\tau - t_c)/\tau$, during which time Q_2 is off and the output voltage $V_{out} = 0$. Therefore, the average voltage over a cycle is:

$$\overline{V}_{out} = -V_x t_c/\tau = -\tfrac{2}{3}(V_{cc}RC/\tau)\,(V_x/V_y)$$

where $\overline{V}_{out}$ can be recovered by an RC network placed at the output of the circuit or read with an average-responding meter. If RC/τ is made equal to 10 and $V_{cc} = 15$, then $V_{out} = -V_x/V_y$. □



Quality quotients. Wide-range input stage and constant-current source increases signal-handling capability and linearity of analog divider Output of 555, which is a function of V_y, R, C, and τ, modulates V_x so that $\overline{V}_{out} = -V_x/V_y$ for $1 < V_y < 10$ and $0 < V_x < 15$.

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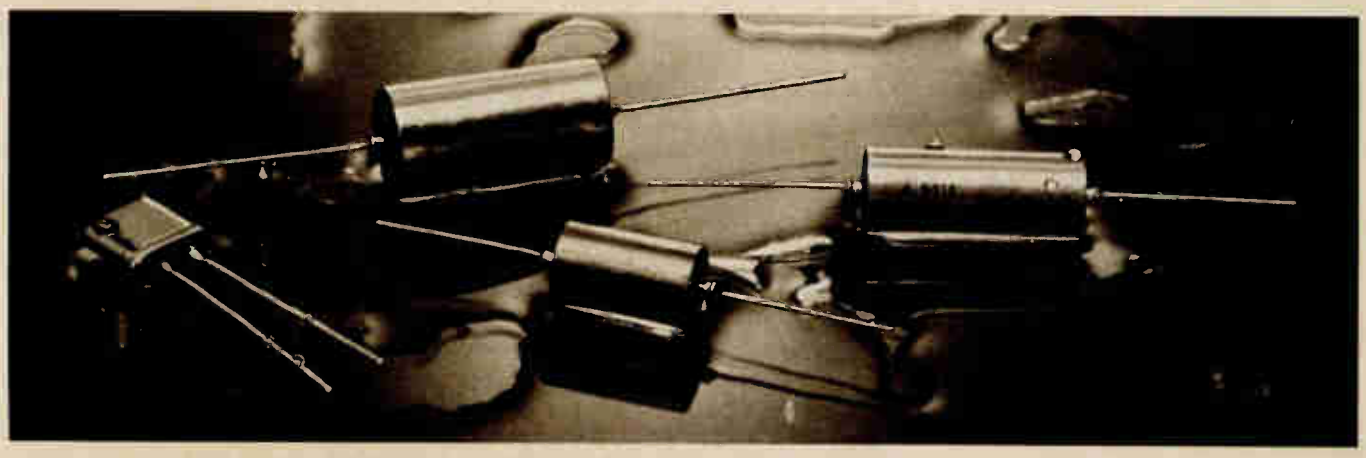

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THE NEW LSI PROCESSES

Isoplanar-S scales down for new heights in performance

Device scaling, the source of MOS's spurt to overtake bipolar, will also give Isoplanar processing a second wind

by Devereux Rice, *Fairchild Camera and Instrument Corp., Mountain View, Calif.*

☐ Bipolar leadership in high-speed static random-access memories has recently been threatened by the latest MOS processes. N-channel HMOS II in particular has achieved speeds once held to be possible only with a bipolar technology. However, the same mechanism that has improved MOS access time—device scaling, that is—will increase the performance of bipolar memory and logic even more dramatically. In fact, with the advent of scaled Isoplanar processing, or Isoplanar-S, bipolar RAMs, programmable read-only memories, and logic devices will see speed and density improvements in the space of the next three years comparable to those seen over the entire past decade.

Isoplanar-S is not one set of design rules that defines a particular process; rather, it represents continuing process enhancements that will evolve through the 1980s (see Table 1). In addition to scaling down from current geometries of 4 micrometers to less than 1 μm, it will enjoy process improvements through new diffusion and metalization techniques, as well as changes in device structures.

Scaling down device geometries should not be confused with circuit shrinking (which has also been applied to Isoplanar devices). Shrinking refers to optically reducing all mask dimensions to cut overall die size. Scaling down, however, reduces horizontal and vertical dimensions by changing design rules.

Scaling down

Recent developments in photolithography, notably direct-step-on-wafer (DSW) techniques, are key to scaling down geometries. The new DSW equipment permits geometries of 1 μm, whereas projection alignment has a practical limit of about 2 μm (Fig. 1).

Figure 2 illustrates the reduction in transistor structures and the key differences between Isoplanar-S and its ancestors. By scaling down transistor geometries, base resistance and collector-to-substrate capacitance both are decreased because of the smaller junction area. In addition, as emitter geometries are scaled down, the emitter-to-base capacitance is also decreased. Adding arsenic-doped emitters, which allow shallower junctions, minimizes transient time such that operation at up to 7

This is the sixth in a series of articles on the new LSI processes. The previous articles appeared in the Sept. 13 issue, pp. 109, 116, and 124; in the Sept. 27 issue, p. 141; and in the Nov. 22 issue, p. 111.

TABLE 1: DIRECTIONS IN DESIGN AND PROCESSING FOR ISOPLANAR-S

	Now	The 1980s
Device dimensions	4 μm	⩽1 μm
Emitter size	5 by 7 μm	1 μm
Cell size	3.2 mil^2	<0.7 mil^2
Equipment	projection alignment	direct step-on-wafer and electron-beam
Processing	mostly wet processing	mostly dry processing
Wafer size	3 in.	4–5 in.
Metal lines/spaces	6 μm/2 μm	2 μm/1 μm
Typical gate delay	750 ps	300 ps
Power-delay product	3.3 pJ	1 pJ

THE NEW S PROCESSES

to 8 gigahertz with typical gate delays of 300 to 400 picoseconds is achieved. Another benefit of the smaller emitter is that the collector cutoff current, the dominant defect mechanism in bipolar transistors, is reduced.

Fine-line geometries will also decrease metal width and spacing from a current 8-μm pitch (metal width plus space divided by 2) down to 3 μm. This reduction results in lower metal capacitance and increased density by allowing device structures to be packed more closely. Thus, on-chip interconnection delays decrease to yield a faster part.

Fine lines

The fine-line metalization required by scaling down presents two challenges. First, since the metal lines must carry a higher current with respect to cross-sectional area, electron migration becomes a major factor with today's aluminum-copper-silicon metalization. As a result, a new metalization scheme must be employed to accommodate the higher current density in the future, especially as metal widths approach 1 μm. In addition, new methods for depositing metal are being investigated to reduce defect levels. Second, wet etching also becomes useless for such fine metal definition. Consequently, this process is being replaced by dry plasma etching, which will provide extremely fine metalization patterns.

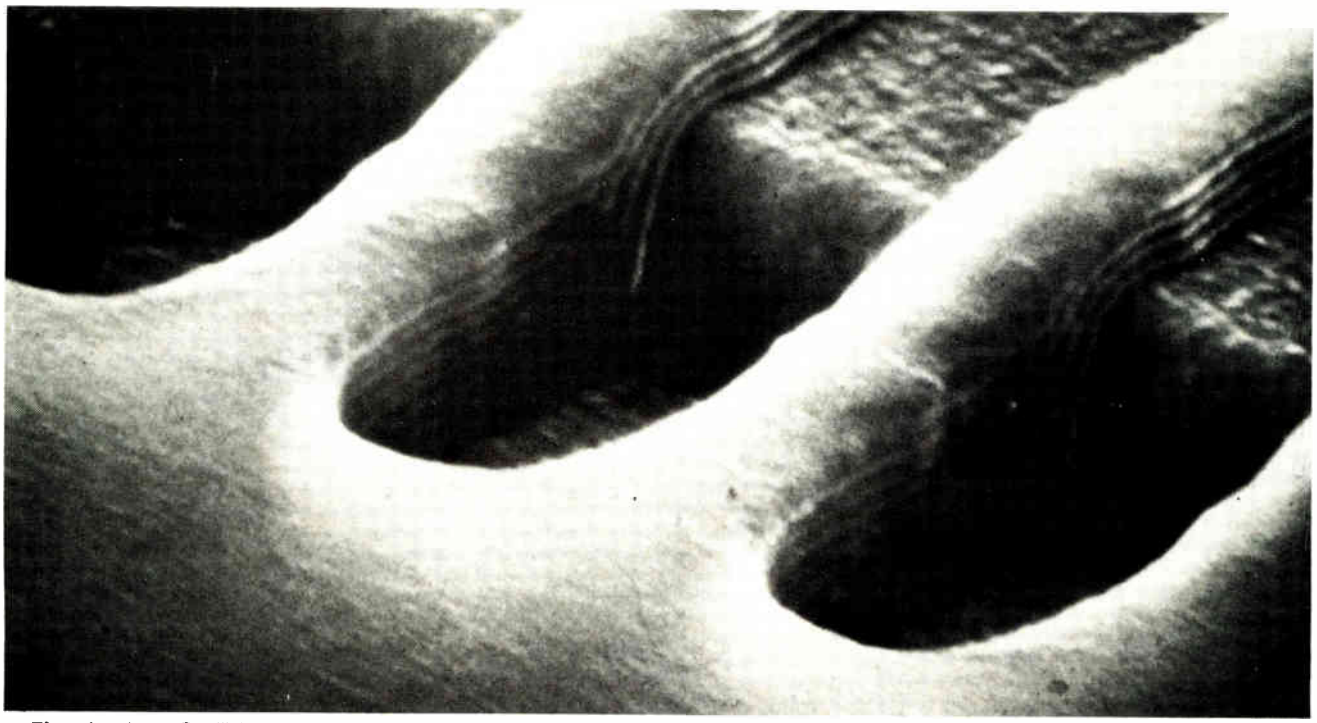
The myth that bipolar techniques are inherently more expensive than MOS counterparts is invalid for high-speed approaches. Table 2 compares the major factors of processes capable of producing high speed. There are two predominant cost factors for any semiconductor: die size and process complexity. Isoplanar-S is the definite leader in die size and this edge is particularly advantageous, since Isoplanar-S is currently at 3- to 4-μm minimum geometries, whereas HMOS II is at 2 μm. As Isoplanar-S is scaled down to 2- and then to 1-μm geometries, die size and performance advantages will become all the more apparent.

Complexity

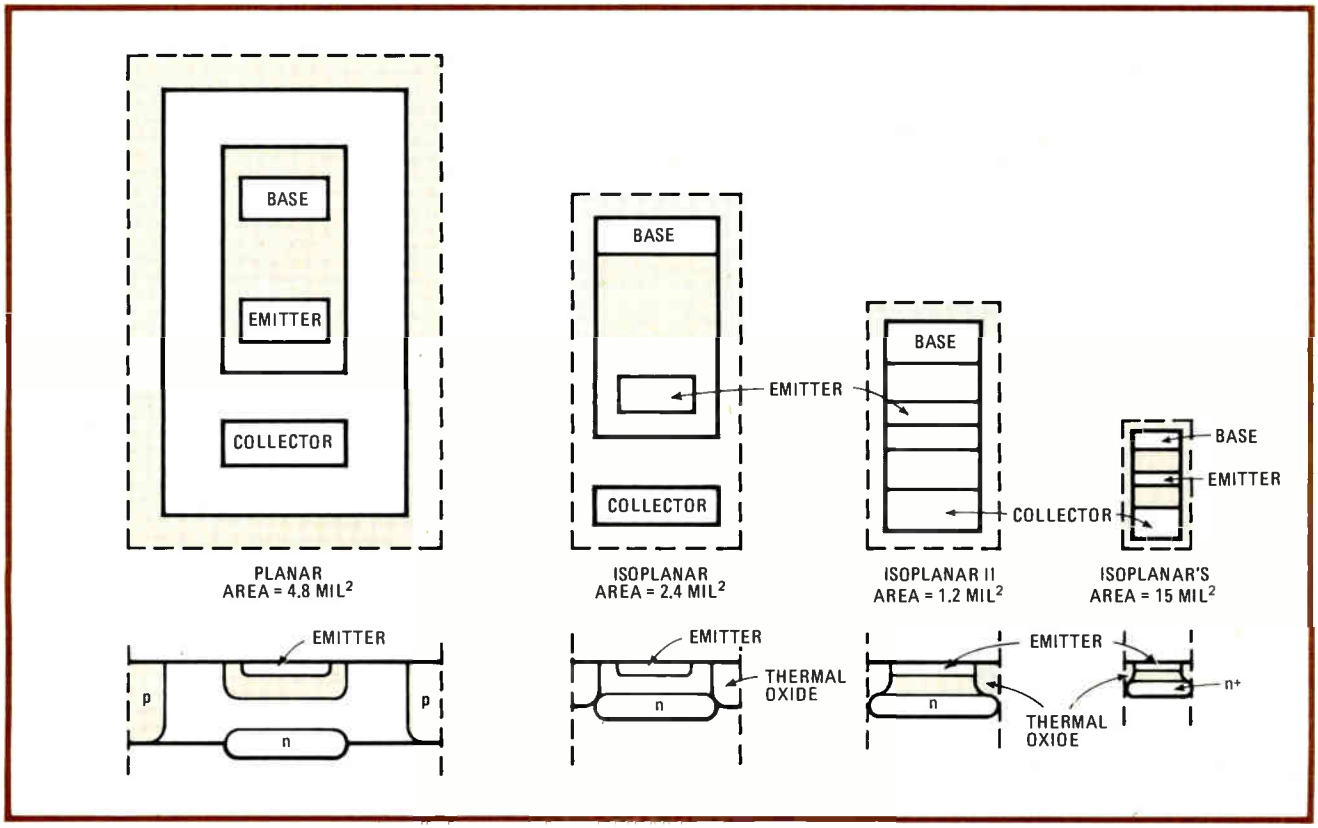
Process complexity hinges on two parameters: defect density and the number of masking steps. Defect densities for the high-speed processes are approximately equal, as they all are currently manufactured using silicon. The number of masking steps therefore becomes the critical variable. The advantage that MOS technology once had from requiring fewer steps has been eroded because of the necessity of adding extra steps to enhance performance. In fact, the masking steps for all high-speed processes have become about equal in number, as Table 2 shows.

Self-alignment is another key to the process advantages enjoyed by Isoplanar-S. As seen in Fig. 3, oxide isolation of the transistor body, coupled with walled emitters (where the emitter mask overlaps into the isolation region), yields active emitters of a constant size. The mask for the self-aligned transistor defines the fixed emitter area and also allows the distance between the emitter and base to be greatly reduced. This reduction makes possible extremely tight ac characteristics and improved yields over previous bipolar processes.

As Isoplanar-S is basically a scaled-down version of Isoplanar, the long-term reliability of Isoplanar-S is comparable to that of Isoplanar. The Isoplanar failure



1. Fine. Isoplanar-S will be scaled down for increased density and speed. Whereas projection alignment has practical limits near 2 μm, direct-step-on-wafer (DSW) techniques can get down to 1 μm. The 1-μm metal lines above used DSW equipment and plasma etching.



2. Continually better. In the past decade, bipolar LSI experienced three major advances. In 1971, Isoplanar used oxide isolation. In 1975, Isoplanar II emitters extended to the walls of the oxide for a 50% reduction in area. Now, in 1979, Isoplanar-S has scaled those devices down.

TABLE 2: PROCESS COMPARISONS FOR HIGH-SPEED RANDOM-ACCESS MEMORIES

	Isoplanar-S	Bipolar diffused isolation	HMOS II	V-groove MOS
Die size (normalized)	1	3	1.7	1.2
Masking steps	10–11	9–10	9–12	11
Defects (normalized)	1	1	1	1
Performance (normalized)	1	2	2	2
Number of years in production	7	12	2	1

rate is 0.0004% per 1,000 hours of operation at 100°C, based on over 2 billion device-hours of accelerated life tests. Isoplanar-S is also able to avoid the static-discharge problems apparent in MOS, as well as alpha particle sensitivity, which leads to soft errors. These features of Isoplanar-S yield a process that excels in performance, density, and reliability while remaining cost-competitive.

Fast RAMs

The first devices to use all aspects of Isoplanar-S will be the 93480 and the 10/100480 16-K-by-1-bit RAMs. The 93480 is implemented in transistor-transistor logic, the 10/100480 in emitter-coupled logic. Minimum geometries of 2 μm will yield a die size of 19,400 square mils for both chips. New device structures are also used to lower power requirements and to ease future scaling down below 1 μm.

The memory cell used in current bipolar RAMs will be replaced by a new design to take full advantage of the fine-line geometries (Fig. 4). Cell size is at present limited by the resistor-diode load. By switching to pnp transistors for loads, the cell becomes based entirely on active devices.

Besides a reduction in size, the new memory cell boasts two other advantages. One is lower power dissipation. The resistor-diode load network requires 10 microamperes of current to hold data. However, with pnp loads, the required current is reduced by an order of magnitude to 1 μA. This allows the typical total current

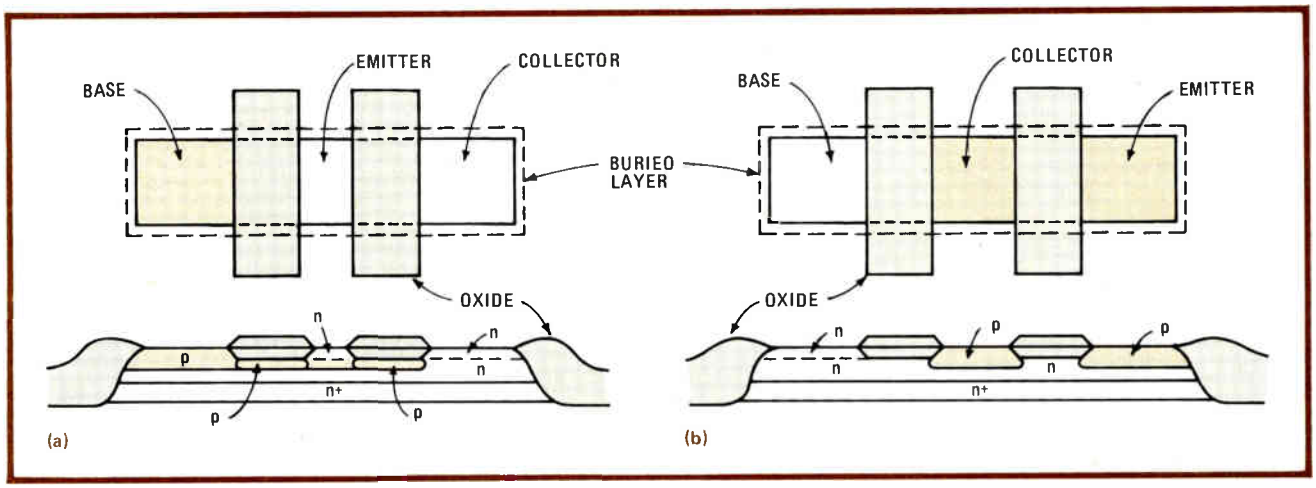
for the device to be 100 milliamperes.

The other advantage is more straightforward future scaling. Pnp transistors are easily reduced by a scaling factor, whereas resistors must be redesigned because of the length versus width relationships that determine resistor value. Moreover, those resistors still needed outside of the array will be walled off. The resistors will incorporate oxide isolation to obtain high resistivity for a small physical size.

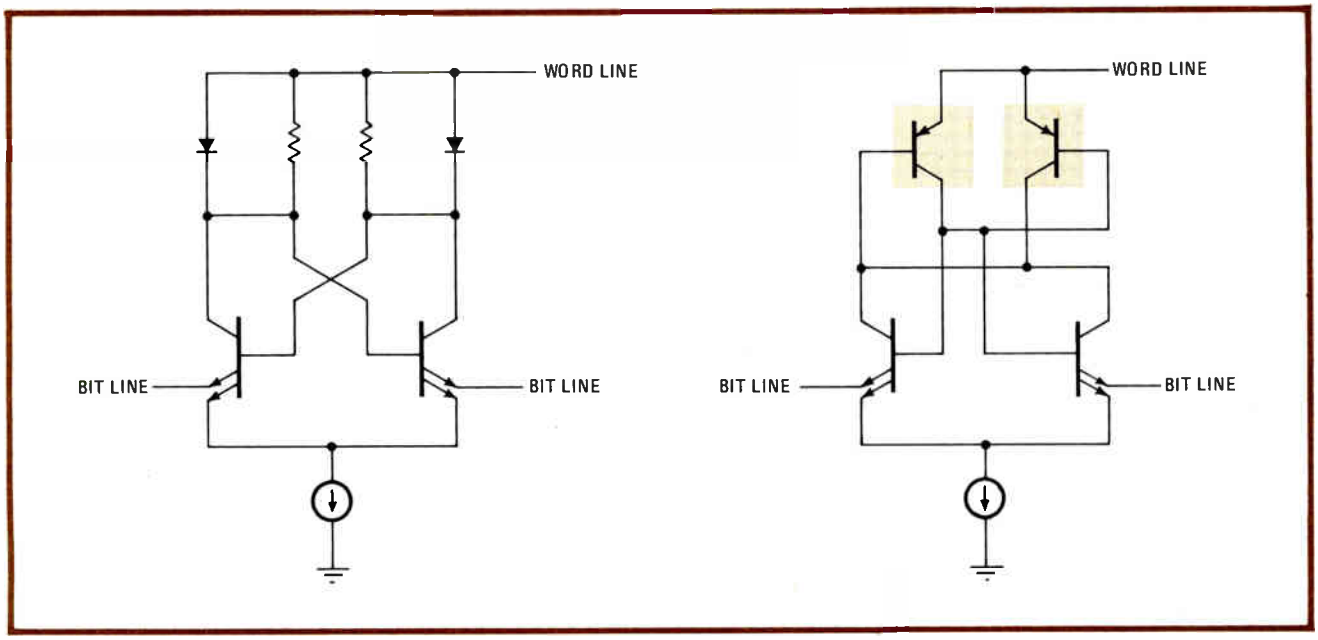
The advantages of Isoplanar-S will also be given to the 93415 1-K-by-1-bit RAM. When first introduced in 1972, the 93415 featured a 70-nanosecond maximum access time and a die size of 19,500 mil² The latest versions, the 93F415 and 93F425, both offer a maximum access time of 20 ns and a die size of only 6,060 mil². The typical access time for the RAMs is 14 ns, and no selections are required as with other high-speed technologies to obtain the 20-ns maximum speed. In fact, Isoplanar-S RAMs have the fastest address-access times of any TTL-compatible RAMs available today. As mentioned, these speeds will continue to be improved in the near future as the devices are scaled down from their current 3-to-4-μm minimum geometries to features of less than 1 μm (Fig. 5).

As for ECL RAMs, this is one area where bipolar technology has seen no viable competition. Isoplanar-S offers 1-K RAMs (either 1 K by 1 or 256 by 4 bits) that have maximum address-access times of 10 ns. These times, too, will decrease with scaling.

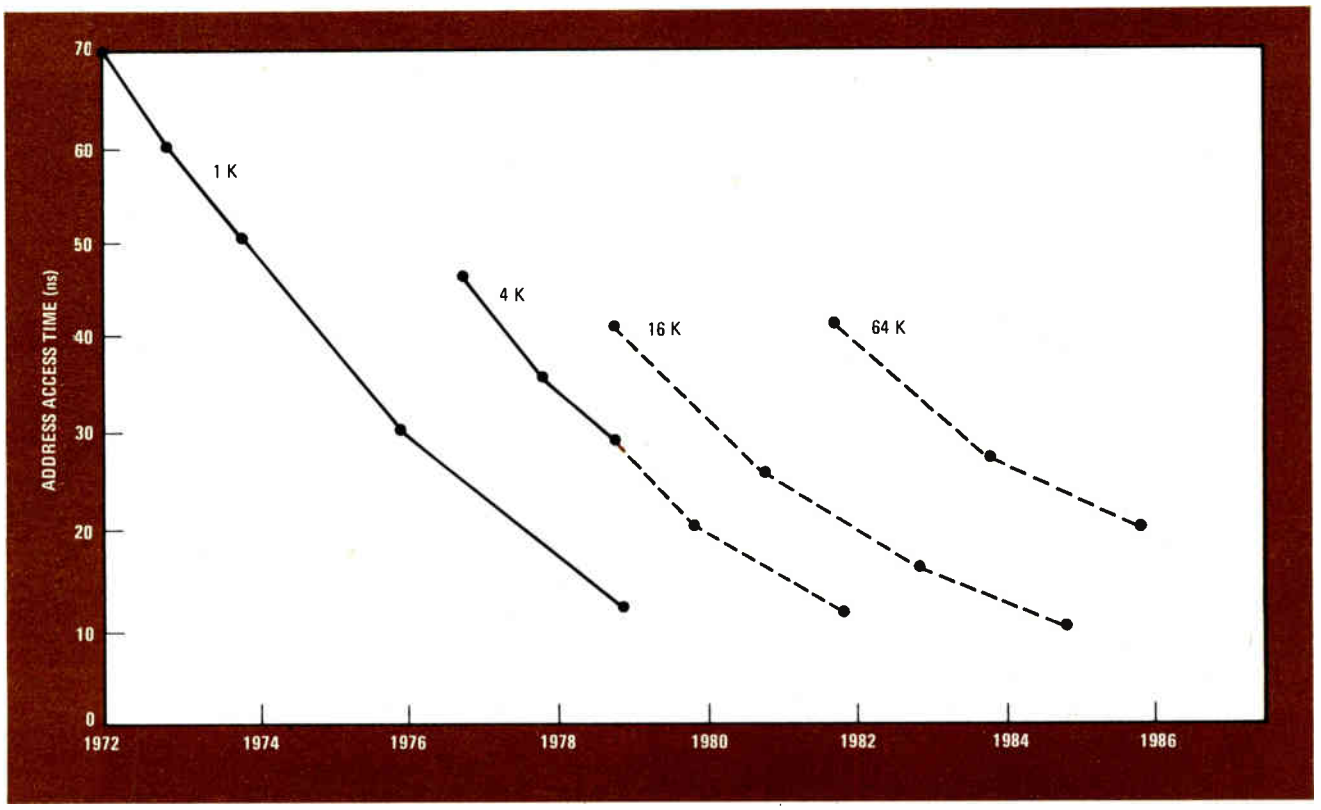
Although fast RAMs have been emphasized, Isoplanar-S is also being applied to bipolar PROMs and logic devices with equallv handsome improvements. PROMs,



3. Both types. Isoplanar-S is used to fabricate both npn (a) and pnp (b) transistor structures. The oxide stripe on both device types is used for self-alignment. With such alignment, emitter sizes do not vary, so that ac characteristics are kept consistent.



4. All active. Besides scaling down Isoplanar-S transistors, new circuit designs will further improve device operation. For example, the resistors and diodes in present emitter-coupled RAM cells (a) will be replaced with two pnp transistors for an all-active design (b).



5. Future RAMs. Isoplanar-S represents continuing process enhancements that will evolve through the 1980s, rather than being a single set of design rules that defines a particular process. RAM speeds, for instance, will be improved as minimum features allow 1-μm line widths.

for instance, benefit in three ways from Isoplanar-S: greater density, higher speed, and lower power. Device scaling is again the key. The decrease in typical access time from 35 to 25 ns for the 93450/1 1-K-by-8-bit PROM, for example, coupled with the tightening of the speed distribution due to Isoplanar-S, allows a reduction of the maximum specification from 55 to 40 ns.

PROMs and logic

A rule of thumb for memories is that approximately 40,000 mil² is the upper limit for the die size. Above that limit, yield losses become prohibitive. The current size of an 8-K PROM memory cell is 1.0 mil². Thus a 64-K PROM designed with this cell would have a die size of greater than 80,000 mil² and therefore should be totally impractical. However, the same memory cell design based on Isoplanar-S yields a cell less than 0.3 mil². The smaller size permits production of a 64-K PROM having a die of less than 35,000 mil². The design of such a part has already begun, and it should be available in late 1980 with a typical access time of 35 ns. Hence, Isoplanar-S has made possible the manufacture of previously impractical devices.

Even though speed is often the prime consideration, some applications require low power as well. The recently introduced 93L450/1 low-power PROM features a 50% decrease in power with only a 20% loss of performance compared with the standard device. Thus any one of the three major semiconductor design parameters—performance, density, or power—may be a focus for improvement through Isoplanar-S without significantly influencing the other two.

Fast logic is a final area to which Isoplanar-S is being applied. A 3-GHz prescaler has been manufactured exploiting the technology, and it is now being evaluated. An F100K ECL gate array having a 400-ps gate delay has also been produced.

The emphasis in the area of logic is on ECL. Even with the new F2900 TTL family, ECL will be utilized internally, with TTL converters on the inputs and outputs. ECL allows high speed and high noise margins because of its small voltage swing and constant current. With typical gate delays of 400 ps, system interconnection delays become the major factor in overall system performance. Thus interconnections must and will be made on the chip wherever possible to take full advantage of the speed inherent with large-scale integrated Isoplanar-S.

Two approaches are being taken for LSI logic. One is dedicated designs, like the F220 8-bit-slice family. The other is gate arrays that allow custom designs to be realized in a short time. Design of a 2,000-equivalent-gate array, the F300, has been initiated that will fully use Isoplanar-S. Featuring two-level gating, macroselectable input/output (TTL or F100K), and three speed/power versions (8 watts at 0.4 ns, 4 W at 0.8 ns, and 2 W at 1.2 ns), it is intended to provide a standard for the 1980s.

The future of Isoplanar-S draws upon the experience gained through 10 years of Isoplanar production; the process is already time-tested. And as photolithographic equipment evolves from direct-step-on-wafer, to electron-beam direct-write-on-wafer, and on to X-ray, Isoplanar-S will cash in on these advances for continued device scaling down to submicrometer levels. □

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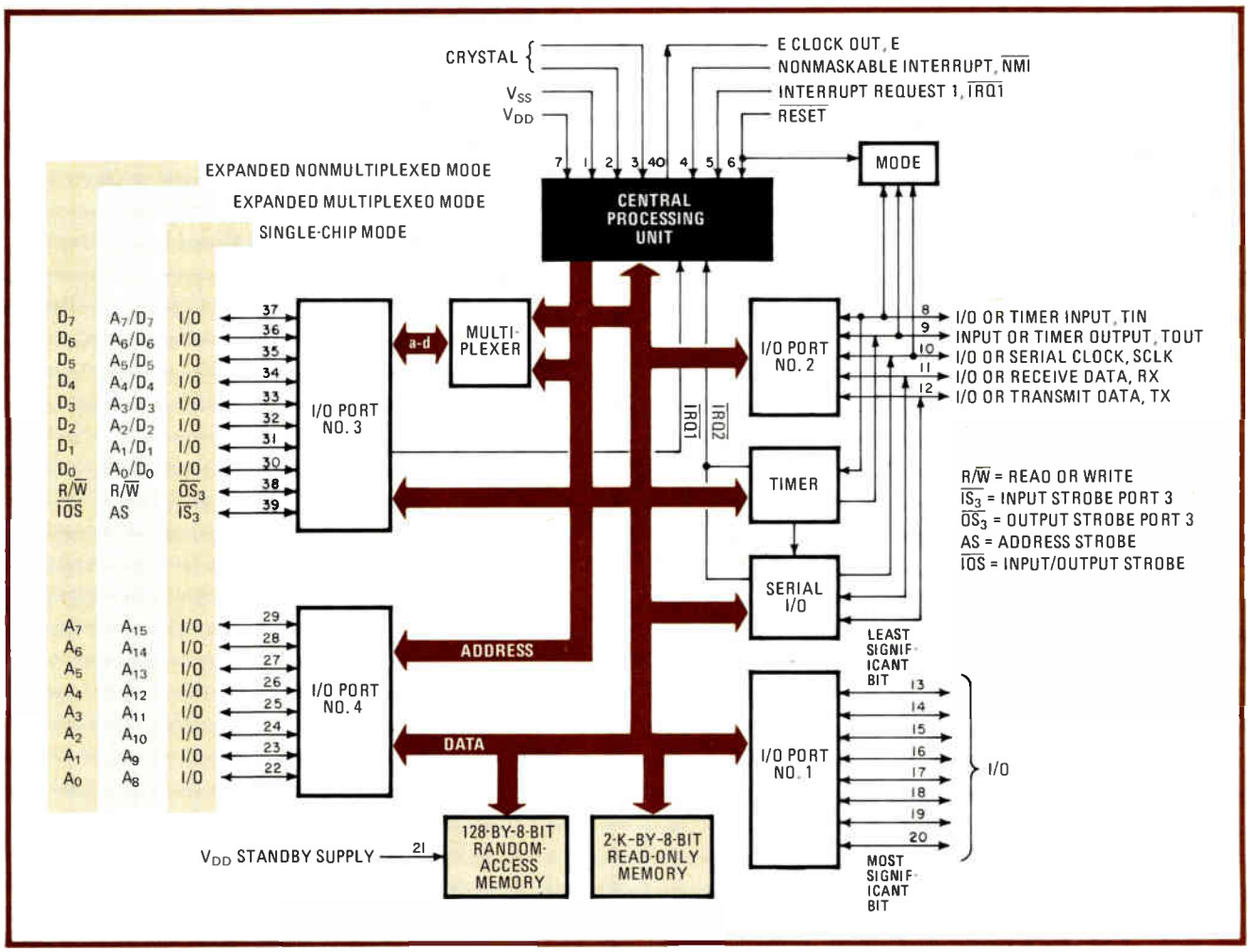
by David Wayne Smith, *Motorola Inc., Austin, Texas*

☐ A completely self-contained microcomputer, the MC6801 offers the best of two worlds. Not only can it function as a powerful single-chip 8-bit microcomputer containing 2-K bytes of mask-programmed read-only memory, 128 bytes of random-access memory, 29 input/output lines, and an on-chip timer and clock driver, but it can also switch to an expanded mode in which it operates with off-board ROM, RAM, and I/O.

The device has many features distinguishing it from other single-chip units. Rather than a down-graded version of stand-alone central processing units, the 6801's CPU is actually an enhancement of the 6800. A serial communications interface is also on chip, where it saves more precious ROM code than is immediately apparent—it can be serviced by interrupts, whereas other single-chip microcomputers must perforce handle



1. Multimodal. More than just a single-chip microcomputer, the MC6801 operates in eight modes. It has 128 bytes of random-access memory, 2-K bytes of read-only memory, 29 input/output lines, and a central processing unit that improves on the 6800. Ports 2 and 3, which handle input and output in the single-chip modes, transfer data and address information in the expanded modes.

their serial communications by means of software.

Finally, the 6801 design aims at maximum flexibility. When only external memory is to be used, the ROM-less MC6803 suffices. The MC68701, on the other hand, makes quick work of prototyping single-chip controller applications, for it replaces the 6801's 2-K bytes of on-chip ROM with ultraviolet-light–erasable programmable ROM.

The secret of the 6801's power lies in its many operating modes. When the chip is reset, the mode selected may entirely change its internal state—its memory map, its I/O configuration, and its reset vectors. As the chip's block diagram in Fig. 1 shows, addresses and data are placed in the expanded mode on lines defined as I/O in the single-chip mode.

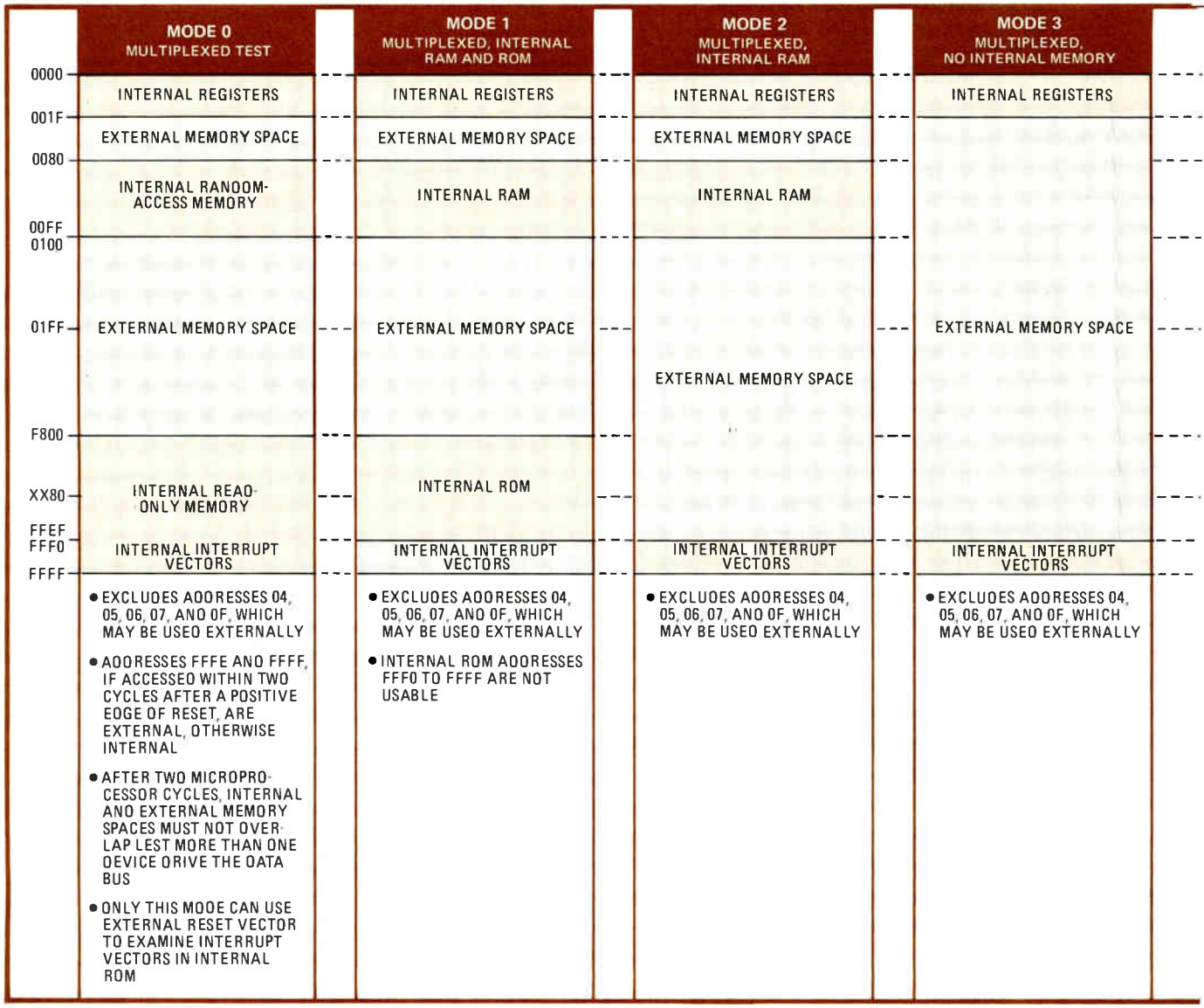
TABLE 1: 6801 SERIAL PORT INTERNAL BAUD RATES

Crystal frequency (MHz)	4.0	4.9152	2.4576
E clock frequency (MHz)	1.0	1.2288	0.6144
E ÷ 16	62,500	76,800	38,400
E ÷ 128	7,812.5	9,600	4,800
E ÷ 1,024	976.6	1,200	600
E ÷ 4,096	244.1	300	150

Family compatibility

Still, the 6801 maintains its family ties with the 6800 in both software and system architecture. An example is its memory-mapped I/O, which allows all standard memory-manipulation instructions to be executed on I/O locations as well. It is also this family compatibility that lets the 6801 be emulated completely by a 6803 with just a few external components.

The enhanced CPU in the 6801 boasts hardware multiplication, new index manipulation on the D register, and a 16-bit concatenation of the A and B accumulators.



2. Mode maps. The memory address scheme employed by the 6801 microcomputer chip changes with its mode of operation. Here the maps show the memory spaces that are available to the user for the five multiplexed modes, the two single-chip modes, and the one nonmultiplexed mode (test modes are included in this list).

Further, the device has multiple-interrupt capability. The interrupt vectors, which differ for each internal component and function (such as serial input and serial output), along with two unique external interrupt lines, greatly simplify the design of an interrupt-driven system.

Monitor ROM

The first versions of the 6801 are offered with a monitor program masked into the ROM. Called the MC6801L1, the chip contains a monitor called Lilbug, developed in Motorola's Microcomponents Systems group. It is an excellent demonstration of the capabilities of the 6801, since it lets the user send monitor commands through the serial port to a standard RS-232-C terminal either in the single-chip mode or in the expanded mode.

The E-PROM version of the chip, the 68701, can take special advantage of the multiple-mode architecture. If operated in the expanded mode, with external control program in ROM and the object-code program in external RAM, the 68701 can literally program itself.

Of the 128 bytes of RAM on the 6801, 64 bytes can retain data with only a low standby power dissipation. If standby power is lost during main power-down, a standby-power status bit informs the processor that the data in RAM is suspect. That same bit, when set and tested immediately, also indicates the status of the standby power for verification before power-down procedures. Also provided is a RAM-enable bit, which disconnects the RAM locations from the bus and thus guards against spurious memory writing while the system is shutting down or starting up.

Serial input and output

The serial communications interface (SCI) on the 6801 is intended as an interrupt-serviced serial I/O port. While the interrupt-service technique is not absolutely necessary—registers could be polled, as would be done with software on other single-chip processors—the 6801 SCI's interrupt technique saves much program space.

The communications format on the SCI can either be standard mark-space (nonreturn-to-zero, or NRZ) or biphase and may be sent either half or full duplex. The selection of those modes, as well as baud-rate selection,

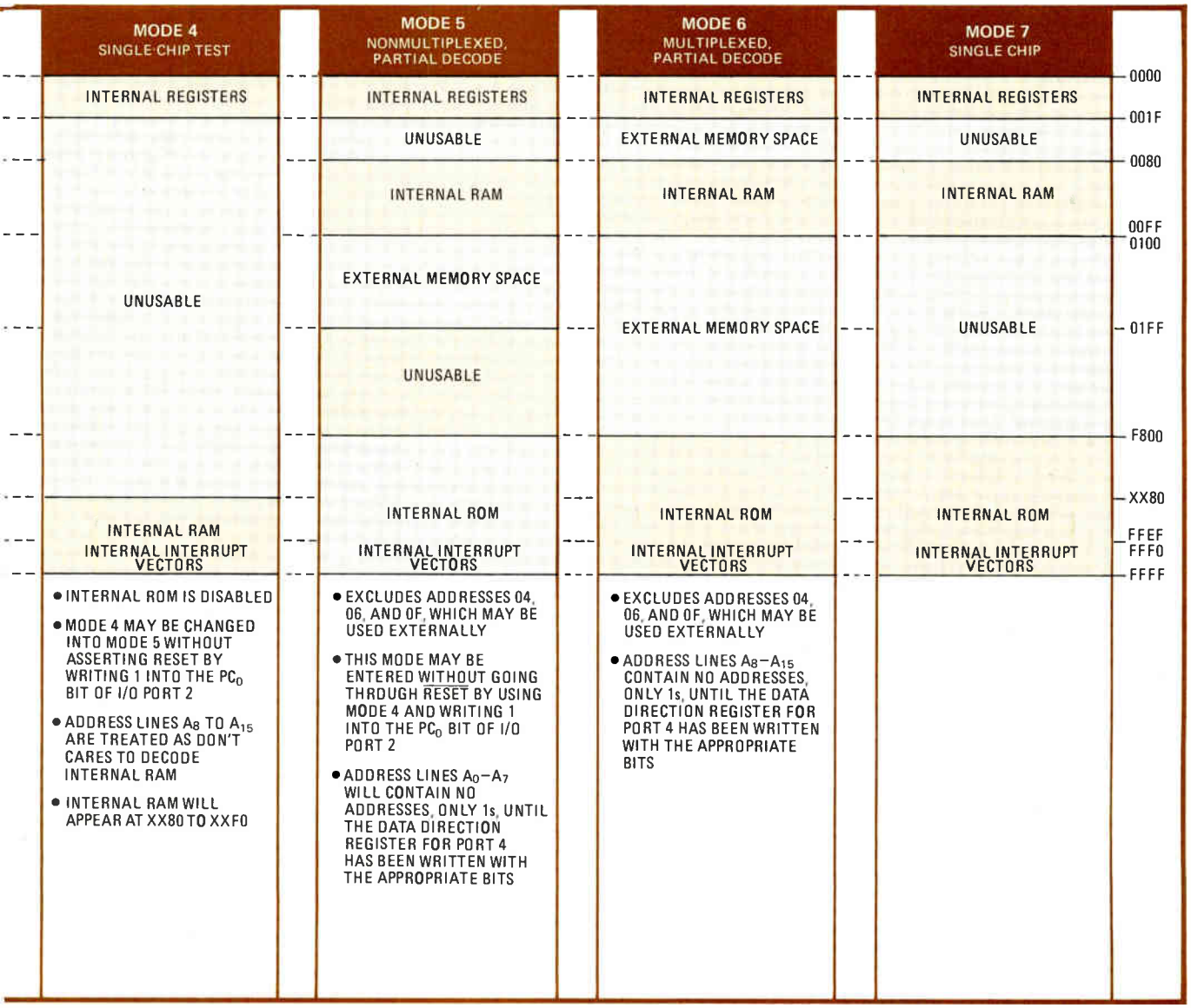


TABLE 2: MODE CHARACTERISTICS

Mode	Program control			ROM	RAM	Interrupt vectors	Bus mode	Operating mode
	Pin 10	Pin 9	Pin 8					
7	1	1	1	I	I	I	I	single chip
6	1	1	0	I	I	I	MUX	multiplexed/partial decode
5	1	0	1	I	I	I	NMUX	nonmultiplexed/partial decode
4	1	0	0	I[1]	I[2]	I	I	single-chip test
3	0	1	1	E	E	E	MUX	multiplexed, no RAM or ROM
2	0	1	0	E	I	E	MUX	multiplexed, RAM
1	0	0	1	I	I	E	MUX	multiplexed, RAM and ROM
0	0	0	0	I	I	I[3]	MUX	multiplexed test

[1] disabled
[2] address for RAM: XX80, XXSS optional with ROM mask
[3] first two addresses read from external after reset

I – internal
E – external
MUX – multiplexed
NMUX – nonmultiplexed

TABLE 3: 6801 INTERNAL REGISTERS

Hexadecimal address	Register
00	data direction 1
01	data direction 2
02	I/O port 1
03	I/O port 2
04*	data direction 3
05**	data direction 4
06*	I/O port 3
07**	I/O port 4
08	timer and control status
09	counter, high byte
0A	counter, low byte
0B	output compare, high byte
0C	output compare, low byte
0D	input capture, high byte
0E	input capture, low byte
0F*	I/O port 3 control/status
10	serial rate and mode
11	serial control and status
12	serial receive data
13	serial transmit data
14	RAM control
15-1F	reserved

* external addresses in modes 0, 1, 2, 3, 5, and 6
** external addresses in mode 0, 1, 2, and 3

TABLE 4: MEMORY MAP FOR INTERRUPT VECTORS

Priority	Vector	Description
1	FFFE – FFFF	restart
2	FFFC – FFFD	nonmaskable interrupt
3	FFFA – FFFB	software interrupt
4	FFF8 – FFF9	interrupt request 1 (IRQ1)/interrupt strobe 3
5	FFF6 – FFF7	IRQ2/timer input capture
6	FFF4 – FFF5	IRQ2/timer output compare
7	FFF2 – FFF3	IRQ2/timer overflow
8	FFF0 – FFF1	IRQ2/serial input/output interrupt

can be done internally through the setting of appropriate register bits. Table 1 lists the baud rates, selectable from four choices, for three different clock speeds. If a baud rate other than those shown is desired, the system may use an external clock input.

Interrupt and wake-up control

The two features of the SCI that are especially important are the interrupt arrangement and the wake-up control. The internal interrupts generated by the receive-register-full and the send-register-empty status are independently maskable. Also, their combination communication interrupt is unique in the interrupt vector map, simplifying the planning of service routines and allowing more diversified use of those interrupts. The wake-up control feature simplifies message handling in a multiple-processor, serial-communications system.

Scenario for a system

The scenario for a typical multiple-6801 system would appear as follows: a certain idle time (called a message division time and defined as 10 or more consecutive 1s) between any two messages causes all of the processors to set their wake-up bits true—the state that allows the receive-interrupt to operate in the normal manner. When the identification character is received by all the processors, each decides either to process the remaining data in the message or to ignore the rest of the message. But if a given processor chooses to ignore a message, it does not set a flag to inform the software that the remainder of the message should be discarded as each character is processed individually. Instead, it sets the wake-up bit false, causing the SCI to mask off the receive interrupt for the remaining message—or until another message division appears. This hardware feature saves not only flag locations, but processor service time as well. But it

especially makes the 6801 more suitable to random-send, random-destination communications than any other one-chip microcomputer.

There are 29 parallel I/O lines, all compatible with TTL, available to the designer of a 6801 single-chip system. Five of the lines are also shared with the serial interface and the timer and can be selected under software control for either purpose. What remain are three full 8-bit I/O ports, one of which offers input and output latches for handshaking capability. When the 6801 is used in the expanded mode, data and address information is transferred on ports 2 and 3 under the control of an address strobe and the standard 6800 bus signal known as read/write (R/$\overline{W}$). The other byte-oriented port, port 1, is always available for parallel I/O, regardless of the 6801's mode.

Time-based functions

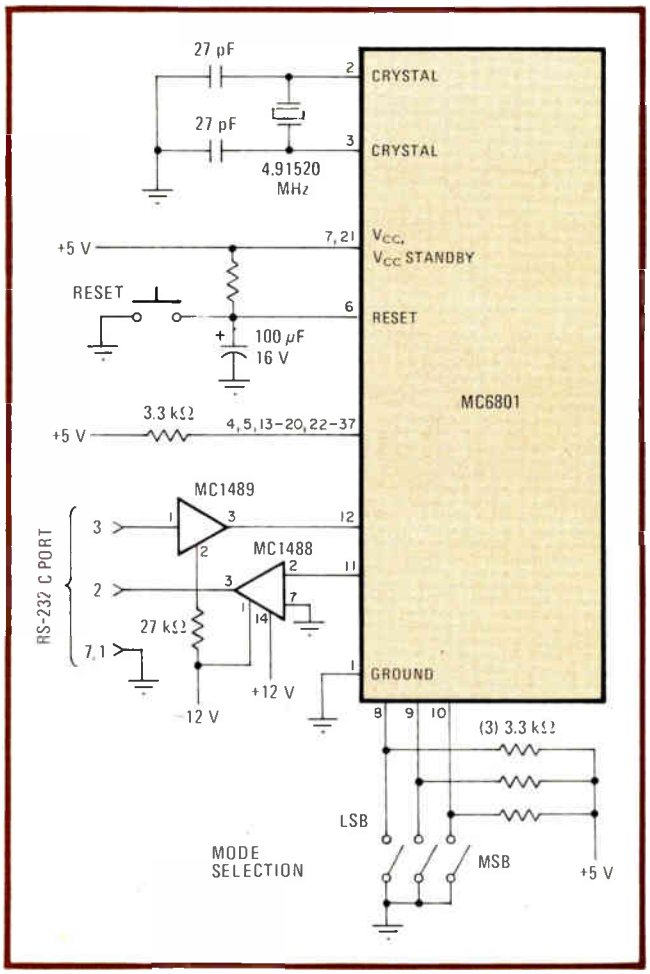
The timer on the 6801 is useful for many time-based functions, including pulse, frequency, and period synthesis, as well as measurements of frequency, period, and duty cycle. The timer comprises a 16-bit counter that increments at the system-clock rate, an input-capture register, and an output-compare register. Each of the capture and compare registers, as well as the register overflow bit, contributes to the combination timer interrupt, and each is maskable. In addition, the interrupt that occurs for the entire timer has its own unique interrupt-service vector.

The input-capture register holds the value of the free-running counter at the transition of the external timer input line. (The polarity of the transition—low-going or high-going—can be set through software.) The output-compare register holds a value that is compared at all times with the counter. When equal, the timer output bit is set to the current state of the output level bit. The use of those two register and control circuits allows the measurement or synthesis of almost any time-based function.

The system clock for all devices, internal to the 6801 as well as external, is generated in the clock-driver section. This section is intended for use with only a crystal, but can also use an external TTL-compatible clock. The frequency of either would be four times the system-clock (E clock) speed maximum of 1.0 megahertz, or 4 MHz.

The CPU in the 6801 handles 8-bit data and 16-bit addresses and its object-code is compatible with the M6800 family of microprocessors. The 6801 CPU includes many new features, one of which is an 8-by-8-bit hardware multiply that yields a 16-bit product. The product is stored in a new register assembled from a concatenation of the A and B registers called the D register. The D register allows 16-bit manipulations with six new instructions specifically for its use, including double-precision add, 16-bit left-shift and right-shift, and double-byte stores and loads.

Three new instructions on the 6801 ease index-register manipulation. They are instructions to push or pull the index register onto or off the stack, as well as an instruction to add the B register contents to the X register—useful in table offset loads and stores.



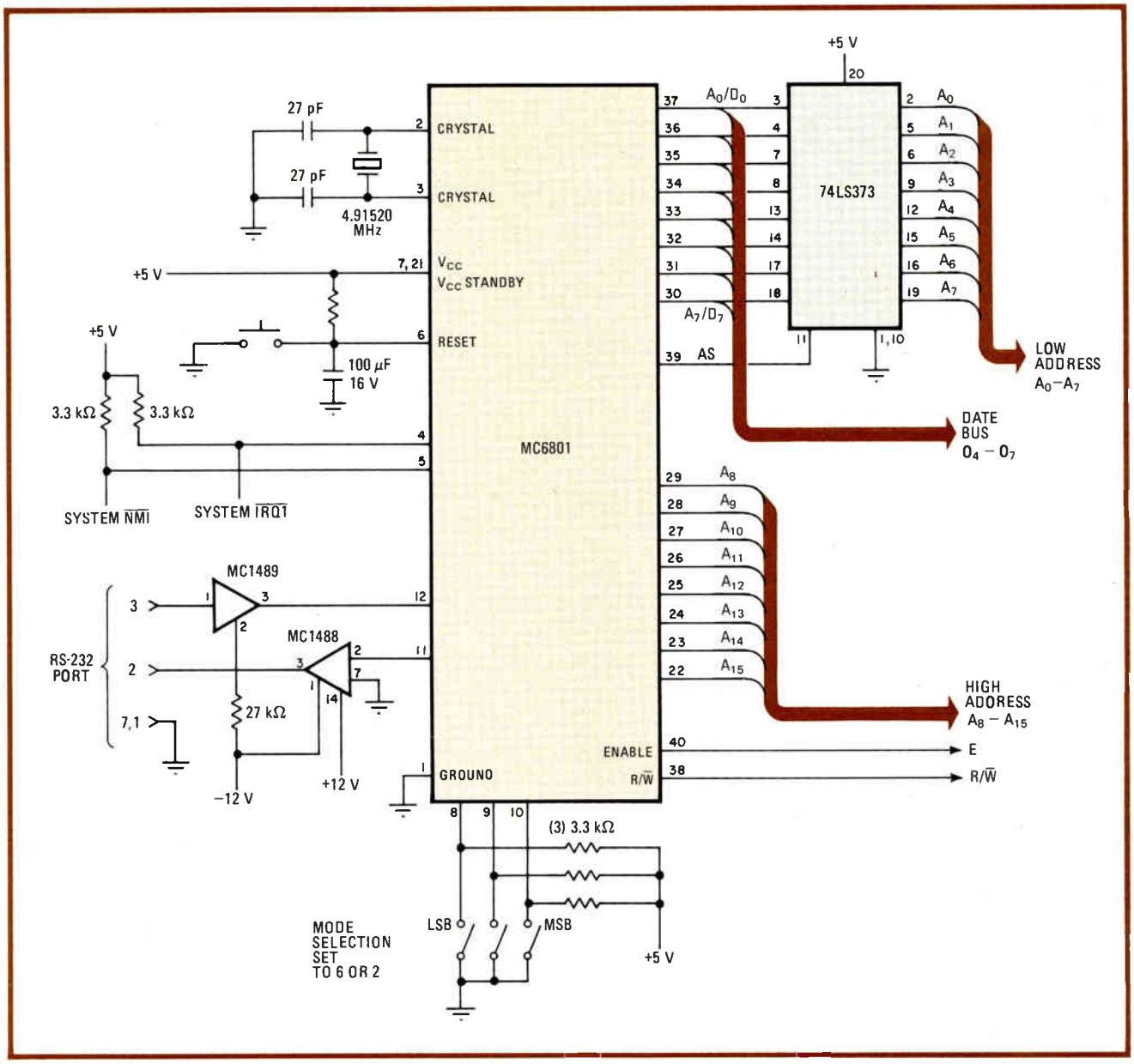
3. Debug monitor. With a monitor program called Lilbug in its read-only memory, the 6801 becomes the MC6801L1. A minimum of external connections is necessary: a pair of line-driver/receiver chips buffers the serial line for RS-232-C hookup to a terminal.

The normal 6800 family valid-memory-address control line, VMA, has been eliminated on the 6801, since it is no longer needed—dummy cycles appear as $FFFF_{16}$ on the address bus. In addition, many instructions have been shortened and many of the wasted cycles removed for a more efficient machine.

Mode selection

Of the many aspects of circuit design with the 6801 that have to be considered, mode selection is the most basic. Table 2 lists the eight modes available. Common to all the modes are I/O ports 1 and 2, timer operation, serial-port operation, and the reserved register area for all on-chip memory. The RAM, ROM, I/O, and interrupt vectors are available internally or externally depending on the mode selected. Figure 2 displays the memory map for each mode of operation.

Basically, there are two types of modes: single-chip and expanded. Of the expanded modes, there are also two versions: a standard multiplexed mode, which allows the full addressing of 64-K bytes of memory, and the nonmultiplexed mode, which on the one hand can address only 256 bytes over its eight address lines but on the other hand requires no external demultiplexing latch



4. Expanded mode. In the expanded multiplexed mode the 6801 can use external read-only and random-access memory. The Lilbug version of the 6801 allows a program to be developed and debugged in RAM and then burned into a programmable ROM to build a complete system.

chip. The 256 bytes are decoded by the processor to begin at location 0100_{16}.

Mode 0 is a test mode, the only one to allow a reset vector to be supplied externally (a maximum of 2 cycles after reset) while the ROM and reset vectors can still be read internally. Mode 1 is the same as mode 0 but with external vectors at all times.

Modes 2 and 6 are multiplexed expanded modes, the difference between them being the use of external ROM in the former and internal ROM in the latter. (Interrupt and reset vectors are included in all references to ROM except in modes 0 and 1.)

Mode 3 is expanded and multiplexed, but with external ROM and RAM. Mode 4 is another test mode, used to test single-chip functioning. Mode 5 is the nonmultiplexed expanded mode that uses internal ROM. With only eight lines of address available externally, it is generally used for 256 I/O addresses. Finally, mode 7 is the fully internal single-chip mode, which uses all 29 I/O lines for functional input and output.

Although it is not hardware, the internal register complement of a microcomputer should always be considered, since the registers control the hardware functions. Table 3 shows the register map for the 6801 and how the internal register locations can be addressed by the user. Equally important are the interrupt vectors and their locations, shown in Table 4.

Crystal clocking

If standard-speed serial communication is necessary, a 4.91520-MHz or a 2.4576-MHz crystal must be used. The clock frequency for the higher-frequency crystal would be approximately 1.22 MHz, which requires the use of a 6801A version capable of 1.25-MHz operation. However,

an external oscillator could be used for the SCI to eliminate the speed constraint.

As previously mentioned, emulation of the 6801 can be accomplished with either a 6803 ROM-less version of the processor or a 6801 in the expanded mode. The locations of the I/O ports, which are used for address and data in the expanded mode, are decoded on the bus externally to emulate those ports as they would appear in the single-chip mode. Locations that would be senseless to access in that mode are ignored internally to facilitate just such emulation. The CPU, however, obtains those values off the data bus and knows to go externally (to turn on its input data buffers) for that data. The locations that would be emulated are the data and the data-direction registers for ports 3 and 4.

Calling Lilbug

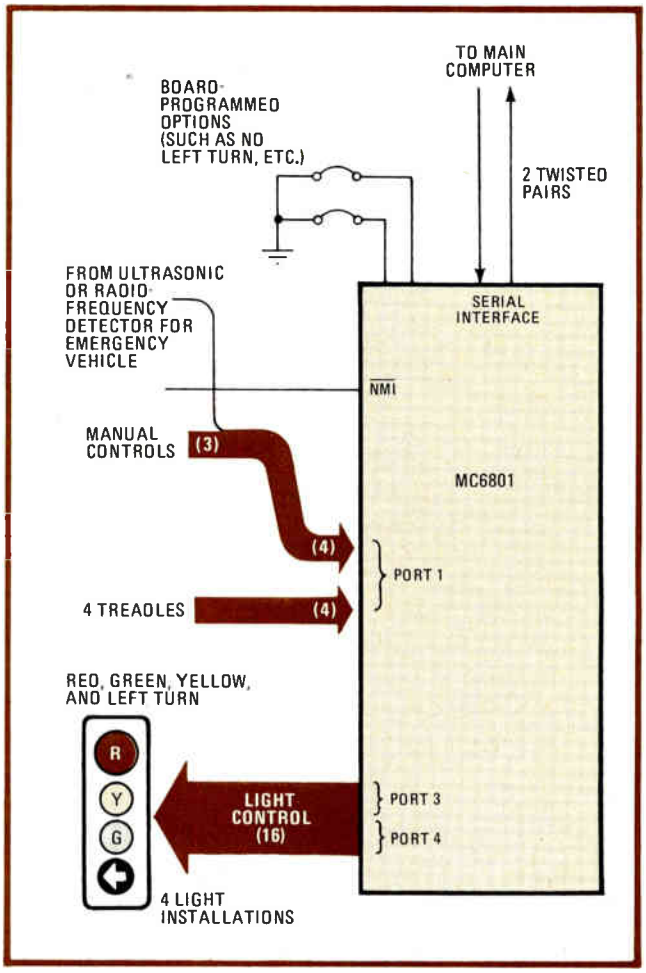
The on-board Lilbug monitor available in the 6801L1 operates just like other powerful monitors and includes a hardware trace, which operates with a jumper from the timer output to the interrupt input. On trace, the timer is loaded with the number of cycles needed to finish the trace routine, return from interrupt, and begin execution of the desired instruction. At that instant, the timer effects the nonmaskable interrupt (NMI), which is then serviced by the processor at the end of the instruction. The stacked information is thus available for the programmer to examine between trace times.

Figure 3 shows a minimal 6801L1 demonstration system. The circuit includes a method for gating the mode information to the proper lines during reset and a simple serial port connection using MC1488 and MC1489 transmitter and receiver level-shifting chips. The circuit operates in mode 7 and when hooked to the RS-232-C port of a computer terminal allows complete demonstration of the capabilities of the 6801 through the use of the monitor program.

Figure 4 shows an expanded version of the demonstration circuit. The 74LS373 is the lower-address latch, which is controlled by the address strobe (AS) to demultiplex the address from the combined address-data information. In this expanded, multiplexed-mode circuit, external RAM and ROM can be used. For example, the designer could use external RAM to write a program through the Lilbug monitor in mode 6. Once satisfied that the program is correct, he could burn it into a fuse-link programmable ROM, which would then be tied to the bus. The combination of the 6801 (or 6803) with the external PROM would then be enough to comprise an entire system.

The more powerful 6801 circuits involve more work than the preceding examples, but in the software area only. Figure 5 shows a traffic control unit that puts to use the 29 I/O lines. Sixteen of the lines drive the red, yellow, green, and left-turn lights for a full intersection. Port 2 I/O lines select the mode (such as no left-turn signals, or other hardware differences), which is read by software. Three of the lines serve as manual controls with the nonmaskable interrupt used to alert the system to the change. The road treadles for each direction are read with the lower-order lines of port 1.

If the system is to be linked to a larger city computer, the serial I/O lines take care of that chore without the use of extra software wait-loop time. There would be enough lines left to sense a radio or ultrasonic signal emitted from an approaching emergency vehicle. Then, in conjunction with data provided by the larger computer on which direction the vehicle was moving, the appropriate lights could be switched to allow the emergency vehicle's unobstructed passage. The entire application could be fulfilled with a 6801 or 6803 microcomputer, an external PROM, and a little extra hardware.



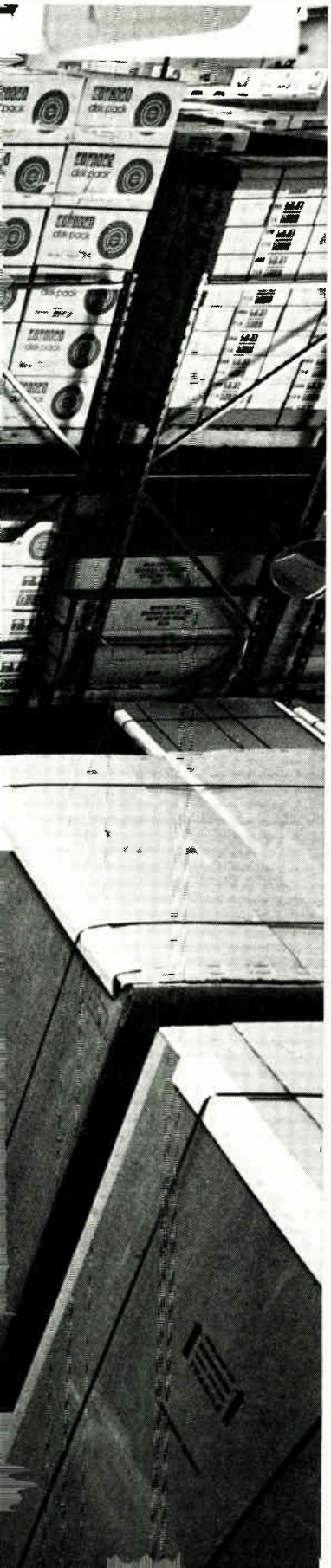
5. Traffic controller. A stop-light controller makes use of the 6801 microcomputer's 29 input/output lines in the single-chip mode. The design is smart enough to accommodate treadles, board programming options, and signals from emergency vehicles. Through the serial port it may be linked to a large central computer.

More to come

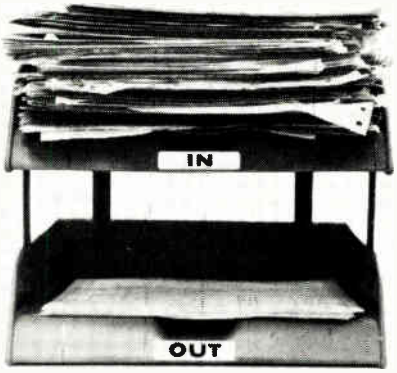
Additional versions of the 6801 are available, and still others are in planning. The MC6803NR—a 6803 without RAM—is currently available, at a proportionately lower cost than the 6803 and the 6801. In planning is the MC6801PC, a peripheral controller with dual-ported RAM that allows external access to its on-chip RAM. Also planned is a preprogrammed MC6801 controller version for the IEEE-488 bus. When mated to an MC68488 general-purpose interface adapter, this device will act as a full-scale bus controller over serial or parallel computer interface lines. □

Moving 10,000 items

in 24 hours.



Problem Digital Equipment Corp. has been growing tremendously. Last year the Accessories and Supplies Group found it was receiving orders in such volume that it needed a new system to handle them.



Sorting mail orders was slow and costly.

The group determined to speed up and simplify its order processing procedures. To save money and be more responsive to customers' needs were the goals.

Curious about the Bell System's focus on problem solving, Digital asked its Bell Account Executive for an opinion. He, in turn, summoned a team of Bell electronics industry specialists to survey the problem.

Solution After a month of hard looking and talking, Digital reorganized its Accessories and Supplies Group. And Bell designed a communications system to fit the new structure.

A computer parts and supplies distribution center was established at the warehouse, with 800 Service and a staff trained by Bell in advanced techniques for selling by phone.

Customers can now call in orders direct, and in most cases get 24-hour shipment. A trained staff is also available to answer technical questions.

Results? Digital is rapidly approaching 24-hour service on 10,000 off-the-shelf supplies and operational parts, keeping customers' systems on line. Order processing costs have been greatly reduced, and customers are receiving excellent service.

Trained staffers turn phone contacts into sales calls.

If you haven't talked with your Bell Account Executive lately, you're missing something.

The system is the solution.

Bell System

Circle 151 on reader service card

Standard bipolar process yields 12-bit monotonic d-a converter

Segmented ladder of diffused boron resistors eliminates the need for trimming

by John A. Schoeff, *Advanced Micro Devices Inc., Sunnyvale, Calif.*

☐ A new, inherently monotonic resistor-ladder technique has been developed at Advanced Micro Devices that makes possible the first high-speed 12-bit digital-to-analog converter that uses diffused resistors and a standard bipolar process. The Am6012 converter does not require thin-film resistors or trimming and so makes possible a record low price for a 12-bit d-a unit—less than $10 in lots of 100 or more.

The new ladder design, which uses diffused boron resistors, combines the advantages of the classic R-2R and 2^n-R resistor networks, yet contains fewer resistors than either approach. It is component-tolerant, yielding 0.01% differential nonlinearity through the use of components having errors on the order of 0.1%. No dynamic error-correction techniques are employed, and no traditional material trimming, cutting, blowing, or zapping is needed.

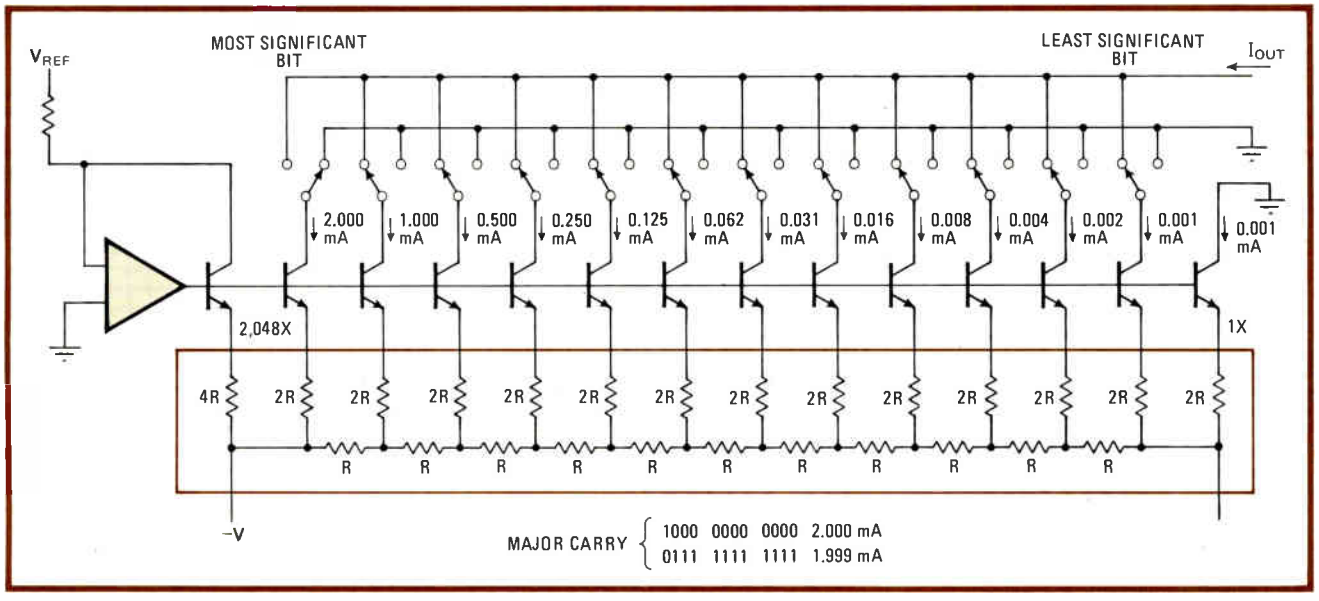
Reexamining conventional designs

One of the primary goals in designing the 6012 was to avoid using special processing. This goal implies the use of standard diffused resistors, which have not been appropriate for precision applications up to now. Therefore the traditional approaches to designing d-a converters were reexamined.

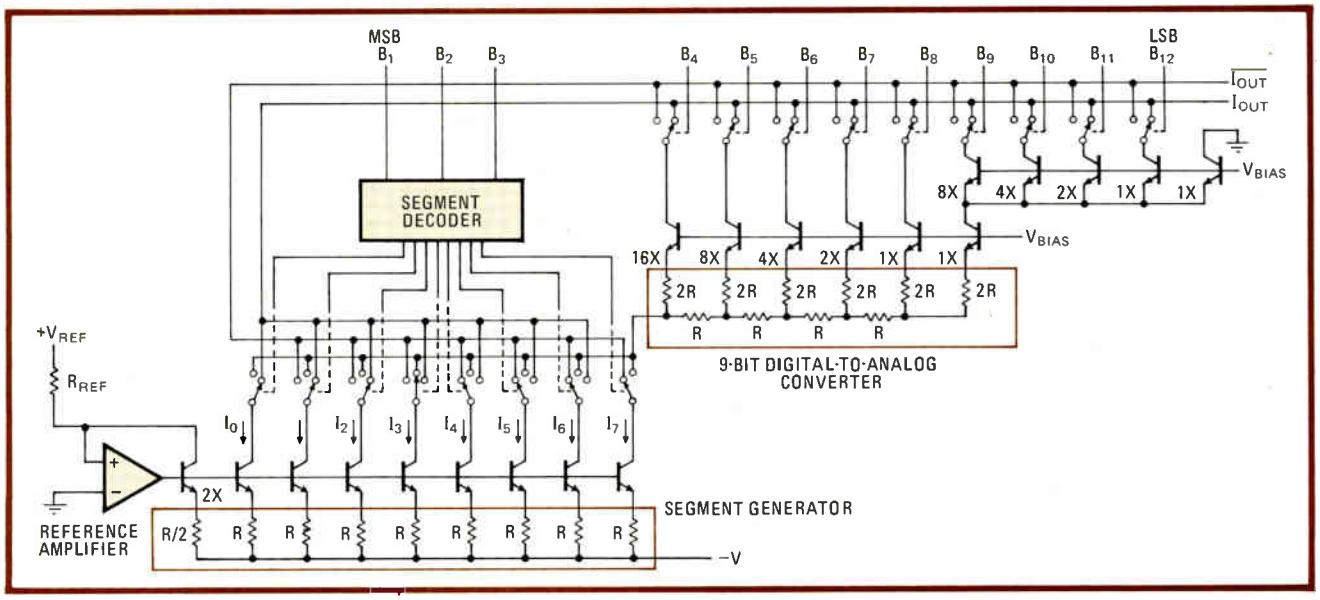
Figure 1 shows the traditional binary-weighted R-2R ladder network. Virtually every fast, highly accurate converter available uses this technique or a minor variation of it. A 12-bit converter makes use of 12 binary-weighted current sources in all possible binary combinations to produce 4,096 (2^{12}) analog output levels. The main advantage of the R-2R ladder is that it uses a minimum number of components.

To guarantee 12-bit converter monotonicity, however, nonlinearity must be no more than ±0.01% (see "Key parameters for a d-a converter," p. 157). This requirement places very tight matching and tracking demands on the R-2R network's resistors, increasing costs. (Actually, few applications require such low nonlinearity, and those that do can usually make use of slower, integrating-conversion methods. Even the best transducers exhibit no better than 0.1% nonlinearity, and in video display systems the human eye has difficulty discerning nonlinearity of less than 5%.)

The most critical element in the R-2R circuit is the most-significant-bit (MSB) resistor. For a converter with



1. Standard. Nearly all fast, highly accurate digital-to-analog converters use the R-2R ladder circuit (or a variation of it). Its main advantage is its low resistor count. But special resistors are needed for high accuracy and stability, thereby increasing the cost.



2. Segmented ladder. The Am6012 combines the advantages of the R-2R and 2^n-R ladder techniques to realize a low-cost 12-bit d-a converter that is inherently monotonic and fast. It is made with a standard low-cost bipolar process, but its resistors need no trimming.

a full-scale output current of 4 milliamperes, the MSB is 2 mA. Each successive bit is divided by 2, all the way down to the least significant bit (LSB) of 1 microampere. At the major carry, the 11 LSBs are turned on to produce on output current of 1.999 mA for an input code of 011111111111. When the input code is incremented by one count to 100000000000, the lower-order current sources turn off and the MSB source turns on, yielding an output current of 2.000 mA.

If the MSB source has an error of more than -1 μA, monotonicity cannot be met. This figure corresponds to a resistor error of 0.05%, which must be maintained over a converter's entire operating-temperature range. Even when the R-2R's resistors match well, trimming can alter their tracking characteristics and affect yields over temperature changes.

Despite the fact that diffused resistors can be matched to within $\pm 0.05\%$, they are not practical for use with the R-2R technique. These resistors have high temperature coefficients of approximately 2,000 parts per million/°C. Also, they are pressure-sensitive and have a high voltage coefficient, exhibiting nonlinear behavior with applied voltage. What's more, they are not trimmable with existing production techniques.

However, they have some strong advantages. For one, they are built with a standard bipolar process, so that they are simple and compatible with high-volume manufacturing techniques. For another, they are stable because they are diffused at 1,000°C and are thermally oxidized. Also, they are not altered by trimming, which might otherwise disturb their long-term stability.

Other advantages of diffused resistors include the fact that they are fabricated from single-crystal materials rather than from amorphous substances that might change conductivity with time and temperature. Contact resistance is stable, since the contact is a simple alloy of aluminum and silicon, instead of a sandwich involving polycrystalline films and barrier metals. Furthermore, diffused resistors track very tightly with temperature because they are simultaneously fabricated close together within the same material. In addition, no burn-in is required for stability. Finally, if laid out properly, for practical purposes diffused resistors match as well as thin-film resistors.

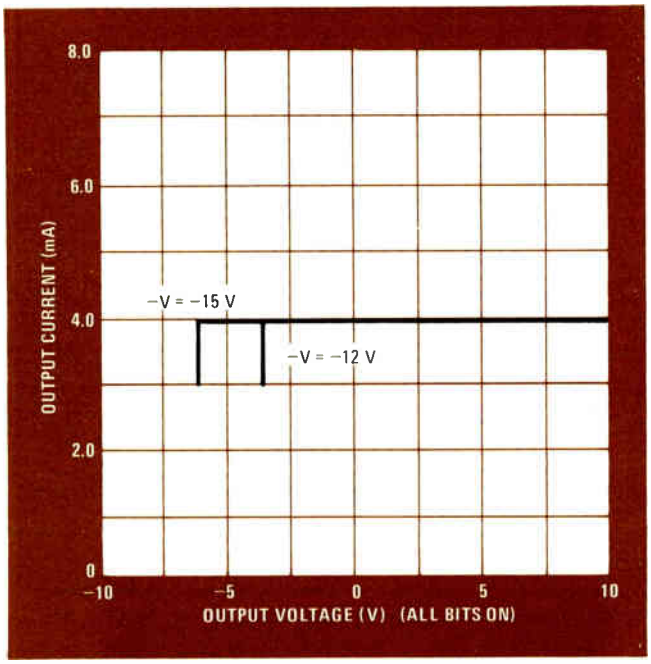
Monotonicity can be obtained from nonprecision resistors by the use of an MOS 2^n-R switch-resistor string, which does not have to be highly linear. This circuit, a complement of the R-2R network, is unfortunately slower than the latter, has a voltage output, and would require 4,096 resistors for 12-bit resolution.

However, Advanced Micro Devices' segmented design (Fig. 2) combines the advantages of the R-2R and the 2^n-R approaches. Besides inherent monotonicity and the use of untrimmed resistors, this design yields high speed and employs fewer resistors than either the R-2R or the 2^n-R technique.

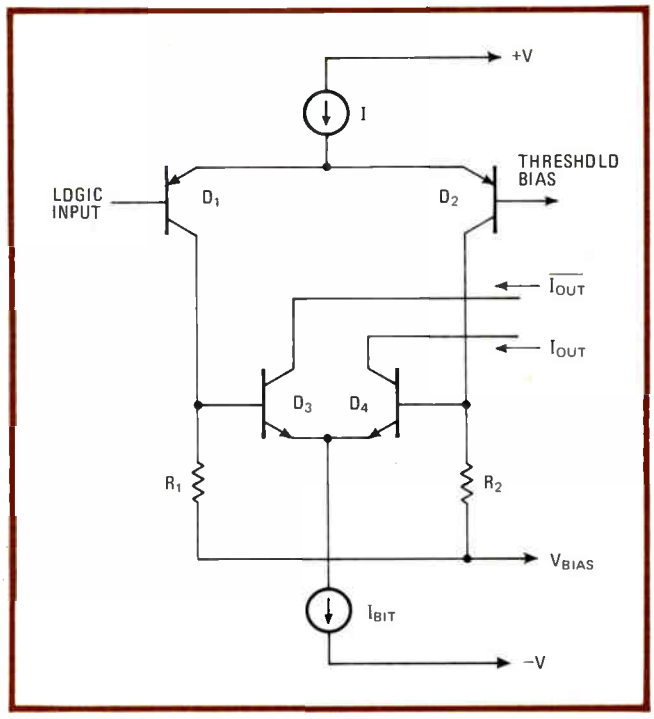
Dividing down tolerances

For a 12-bit d-a converter employing the segmented approach, the output current as a function of the digital input code consists of 4,096 analog levels divided into eight groups of 512 steps each. The key to the inherent monotonicity of the d-a converter may be seen by considering the major carry. Instead of switching in an entirely different current, as is done in an R-2R converter, the current from the segment prior to the major carry is retained and additional steps are created by adding current increments. Consequently, the converter is monotonic regardless of the relative slopes of all the segments. What is important is not the conformance of the output to an ideal straight line, or the linearity, but the uniformity of the output step sizes—that is, the differential linearity.

The only critical resistor matching occurs at the major carries or at the midpoints of each of the eight segments, and the tolerances are equivalent to that of a 9-bit d-a converter, or eight times lower than that of a 12-bit R-2R approach. In essence, the problem is divided into



4. High-speed switch. By keeping the common-emitter point of an npn transistor pair at the same voltage regardless of logic state, a current of 1 microampere can be switched in 30 nanoseconds.



3. Output current. Shown is a graph of the transfer function of the Am6012. Current from the segment prior to the major carry is retained, and current for additional steps is added to it (inset).

eight separate problems of lower tolerance.

For a given 3-bit code at the input of the decoder (Fig. 2), a segment, say, I_3, is selected and fed to the 9-bit d-a converter, where it is divided into 512 levels. All lower-order segments are fed to the current output (I_{out}) and summed with the 9-bit d-a converter output. All higher-order segments are fed to the complementary $\overline{I_{out}}$, which can be thought of as at ground potential.

At an input code of 011111111111, 511 of the 512 levels of the 9-bit d-a converter appear at I_{out}. The 512th level is the remainder current on the right that is fed to ground. When the code is incremented by one count, I_3 is switched away from the 9-bit d-a converter and fed to I_{out}, taking the remainder current with it (Fig. 3). Thus the output of the d-a converter increases by 1 LSB and the segment carries are independent of resistor values.

The most critical element in the circuit is now the MSB resistor of the 9-bit d-a converter, and as noted, its tolerance is eight times lower than that of a traditional R-2R 12-bit unit. Building a monotonic 9-bit d-a converter with an R-2R ladder is well within the capabilities of present production techniques.

Fast switching

Currents are switched in a fully differential manner at high speed. For example, 1 μA can be switched in about 30 nanoseconds by high-speed switches (Fig. 4). Such rapid switching times are possible because the common-emitter connection of the differential npn transistor pair remains at the same voltage regardless of logic state, and the bit current need not charge or discharge the parasitic capacitance at this node. For a capacitance of 2 picofarads, a single-ended switch with a 0.7-volt swing requires 1.4 microseconds to turn the LSB on.

The use of the switch shown in Fig. 4 makes possible high voltage compliance, high impedance, and complementary differential outputs. The output impedance is typically 10 megohms. Since the I_{out} and $\overline{I_{out}}$ outputs are analog complements of each other, as I_{out} increases with an increasing digital input code, $\overline{I_{out}}$ decreases. The sum of the two outputs is equal to the full-scale current regardless of input code.

Other advantages provided by the differential current switch include the ability to adjust the logic threshold by varying the base bias on the pnp transistor opposite the input, a logic input range from below ground to above the potential of the positive power supply, fabrication with a standard bipolar process, and level shifting independent of the positive or negative power supply.

Because low currents may be switched quickly, the ladder current may be divided in a binary fashion all the way down to the LSB. No artificial current boosting or switching of equal current sources with output attenuation is necessary. The 9-bit d-a converter has a "master-slave" ladder arrangement, whereby the MSBs are generated by an R-2R ladder and the remainder current of this ladder is divided by active current splitting into the 4 LSBs. This technique minimizes the range of emitter scaling necessary to generate nine binary-weighted currents. It also eliminates ladder resistors in lower-order bits, where the tolerance for error as a percentage of the bit-current value is much tighter.

Resistors in the segment generator have no bearing on the differential linearity of the converter; they only determine linearity. Each resistor carries one eighth of the full-scale current. As noted earlier, their values are thus less critical than that of the MSB resistor of an R-2R ladder. At the major carry, the four left resistors are balanced against the four right ones. As a result, the converter's linearity benefits from statistical averaging

TABLE 1: COMPARING SPECIFICATIONS FOR LADDER NETWORK RESISTORS

	Number of resistors	Initial matching required for ±1-LSB differential nonlinearity (%)	Tracking required for ±1-LSB differential nonlinearity (ppm/° C)		Tracking required for ±½-LSB differential nonlinearity (ppm/° C)
			0 initial DNL	½-LSB initial DNL	¼-LSB initial DNL
Straight R–2R	37	± 0.05	5	2.5	1.25
Segmented 3 + 9 bits	24	± 0.4	40	20	10

and is higher for a given resistor tolerance than that of a converter using an R-2R ladder.

Table 1 compares resistor requirements for a standard R-2R approach and a segmented design. The R-2R circuit requires 37 resistors that must, as stated, match to within 0.05% to guarantee monotonicity, which is defined as a differential nonlinearity of ±1 LSB or less. Assuming perfect converter performance at room temperature, resistor tracking within ±5 ppm/°C would successfully maintain d-a converter monotonicity from −55° to 125°C.

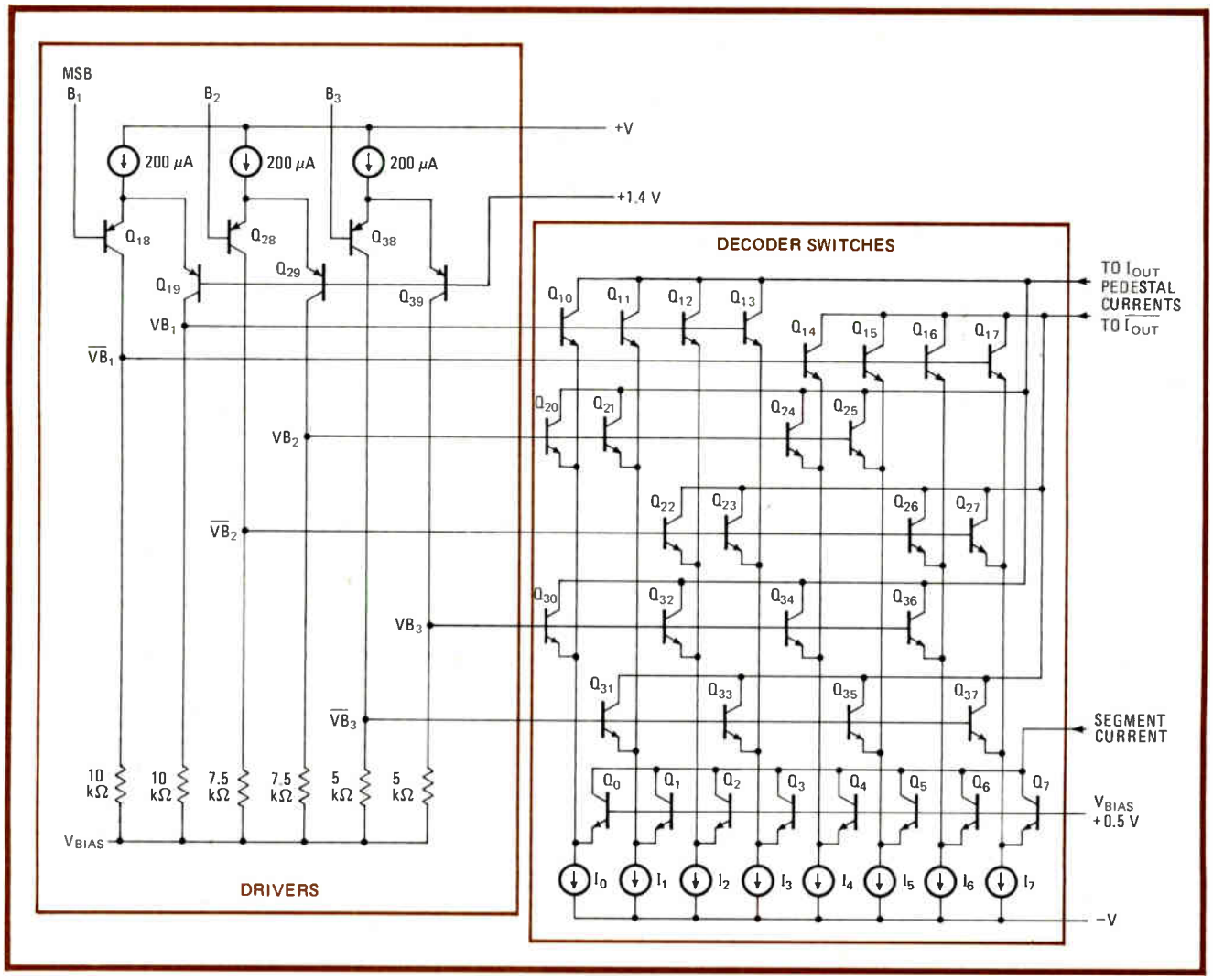
Some allowance must be made for error, however, so that if the initial differential nonlinearity were ±½ LSB, tracking to within ±2.5 ppm/°C would be necessary. For 13-bit performance over a wide temperature range (±½-LSB differential nonlinearity), allowing ±¼ LSB of initial error produces a resistor tracking requirement of ±1.25 ppm/°C, a difficult task for any technology.

Easier tracking

The segmented approach, though, requires only 24 resistors and the initial resistor matching is within ±0.4%. Note that all the specifications listed in Table 1 are relaxed by a factor of eight with respect to the R-2R ladder. Tracking of ±40, ±20, and ±10 ppm/°C, respectively, is necessary. Typical diffused-resistor tracking is on the order of ±2 ppm/°C. Thus there is plenty of room to maintain 13-bit differential linearity over the temperature range of −55° to +125°C.

To summarize, the segmented ladder network for the 12-bit d-a converter incorporates three principles:

- Active current scaling in the slave network for the



5. Segment switch and generator. The three inputs at the upper left switch the eight precision current sources at the bottom right to three analog outputs. A standard one-of-eight decoder, two encoders, and some high-speed current switches can be used to achieve this switching.

TABLE 2: ELECTRICAL SPECIFICATIONS OF THE AM6012 12-BIT DIGITAL-TO-ANALOG CONVERTER

Resolution	12 bits
Monotonicity	>12 bits
Differential nonlinearity	±0.01% (13 bits)
Nonlinearity	±0.01, 0.02, 0.05%
Settling time to ±0.01% of full scale	250 ns
Output voltage compliance	−5 to +10 V
Full-scale drift	±5 ppm/°C typically
Reference input (full-scale transition)	500 ns
Logic inputs	
Threshold	1.4 V
Current	4 μA
Power-supply voltages	+5 to +15 V −12 to −15 V
Power dissipation (+5 and −15 V)	230 mW

least significant bits, where accuracy is traded for area savings.

- R-2R current division up to 9 bits in the master ladder, taking advantage of the precision possible with diffused resistors.
- Segment generation for the 3 MSBs, since resistor matching and tracking of either diffused or thin-film resistors is not adequate.

Figure 5 shows the segment switch and generator portions of the converter. Three digital inputs switch eight precision current sources in a predetermined pattern to three analog outputs. Achieving this function with standard binary building blocks would require a one-of-eight decoder, two priority encoders, and a large number of fast current switches.

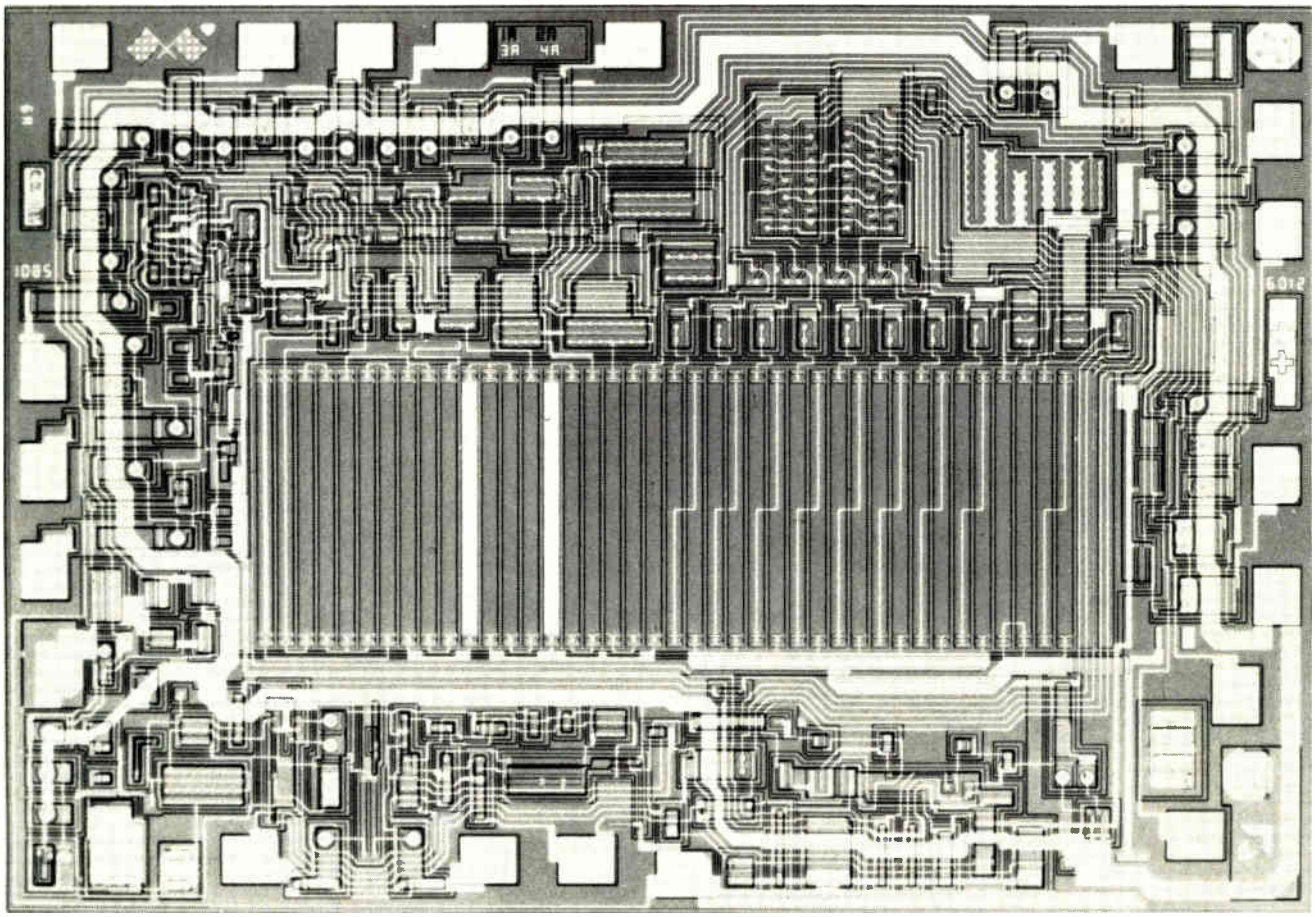
For a given input code, seven of the eight segment currents are switched to the output pair and the eighth is presented to the 9-bit d-a converter at the segment-current output. The key to this circuit lies in the use of multiple logic levels to simplify the switch matrix. Nodes VB_1, VB_2, and VB_3 have high levels that are spaced 0.5 V apart. There is also a fourth, low level.

The multilevel segment switch is very fast, since a switching signal must propagate only through a pnp transistor pair to reach the base of the current-switching devices. Thus it is possible to switch at approximately the same speed as a single fully differential bit-current switch. This circuit function might be called "high-speed, multilevel, priority-encoded analog multiplexing."

In operation, the transistor group Q_{10}–Q_{13} can override all transistors beneath them, so that when the MSB is high, I_0–I_3 will be routed to I_{out}. The voltage drive levels for each set of switch devices are ranked with regard to the significance of each controlling input bit.

The segment decoder occupies only three isolation pockets, allowing liberal use of common-collector connections. Many common-base connections also increase its density.

Table 2 lists the electrical specifications of the 6012.



6. The chip. The Am6012 12-bit d-a converter's ladder network and segment generator are in center; multiplexer is above segment generator. At top are 9-bit d-a converter switches, current sources, and decoder drivers. Bias network and reference amplifier are at bottom.

Differential nonlinearity is as low as ±0.01%, or ±½ LSB, which defines 13-bit performance. Since all parts are monotonic, the user does not have to pay for unneeded linearity. Full-scale power-supply rejection is very high and all linearity specifications are independent of the power supplies over the full operating range. The converter's speed is close to that of dielectrically isolated laser-trimmed thin-film converters, yet it has higher differential linearity and consumes less power. It is fabricated on a 12,500-square-mil chip (Fig. 6).

If the 6012's nonlinearity were to be plotted on a graph, in LSBs as a function of all 4,096 digital input codes, each LSB would correspond to 0.025% of full scale. Such a graph would show that the nonlinearity band is within ±0.012%. The largest differential linearity error of the 6012 is well under ±½ LSB, for an overall differential nonlinearity of better than ±0.01%.

The 6012's design offers some additional benefits. Its high-impedance differential open-collector current outputs suit it for a number of applications that cannot be

Key parameters for a d-a converter

The most general specifications for a digital-to-analog converter involve **dynamic range:**

Resolution expresses a d-a converter's dynamic range. A binary n-bit converter has 2^n levels and a resolution of 1 part in 2^n.

Monotonicity means that there is always an increase in the output level for each increase in digital input. If the output decreases, the converter is nonmonotonic and can seldom be used to its full resolution.

Differential nonlinearity (DNL) is a measure of the deviation of each individual step size from the ideal 1 least significant bit. A perfect converter has zero DNL. A differential nonlinearity of more than −1 LSB defines nonmonotonicity. The left-hand figure shows the output of a converter with a DNL of −1 LSB, so that two output levels are equal. Technically, this converter does not offer a full 2^n levels of useful resolution. The right-hand figure shows the output of a converter with a DNL of −½ LSB; in other words, all output levels are separate and distinct.

The more specific and most stringent specifications for a d-a converter concern **accuracy:**

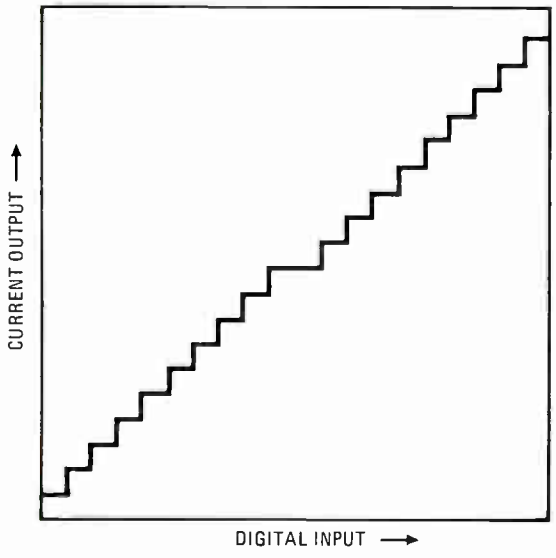
Nonlinearity (NL) is the maximum deviation of the converter's transfer characteristic from a straight line drawn between the actual zero- and full-scale outputs of the converter, expressed in LSBs or as a percentage of full scale. Some products specify the deviation from a best-fit straight line. This is specsmanship, though, because the straight line will usually not terminate at the full-scale value. Thus the converter cannot be calibrated by the user to take advantage of the better value offered by this specification method.

In an R-2R converter, ±½-LSB nonlinearity will guarantee monotonicity. In a segmented converter, nonlinearity and monotonicity (and hence differential nonlinearity) are independent specifications.

To distinguish nonlinearity from differential nonlinearity, the former is often referred to as **integral nonlinearity.**

The end points of a converter are **full scale and zero scale.** The full-scale output value is usually independent of the other converter specifications and is sometimes expressed in terms of gain—the ratio of the output current or voltage to the reference input current or voltage. Once full scale is calibrated, its temperature drift becomes the most important specification. The zero-scale value of a current-output converter is not dependent on the offset voltage of an amplifier. Thus it needs no calibration, and drift is usually insignificant.

Absolute accuracy is the overall accuracy of the converter, in which all levels are compared with an absolute standard. Absolute accuracy includes the combination of all nonlinearity and end-point errors.



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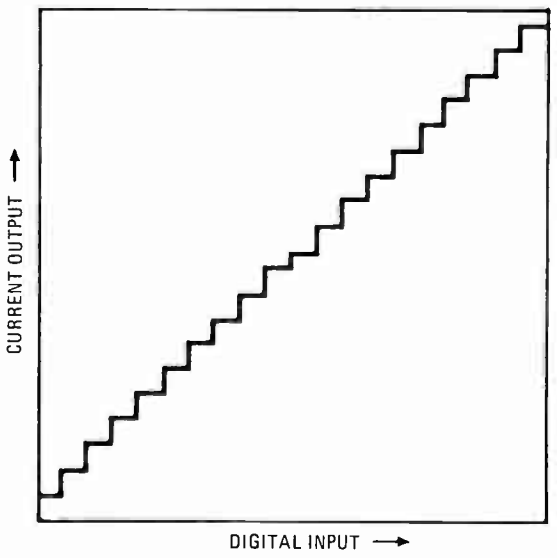
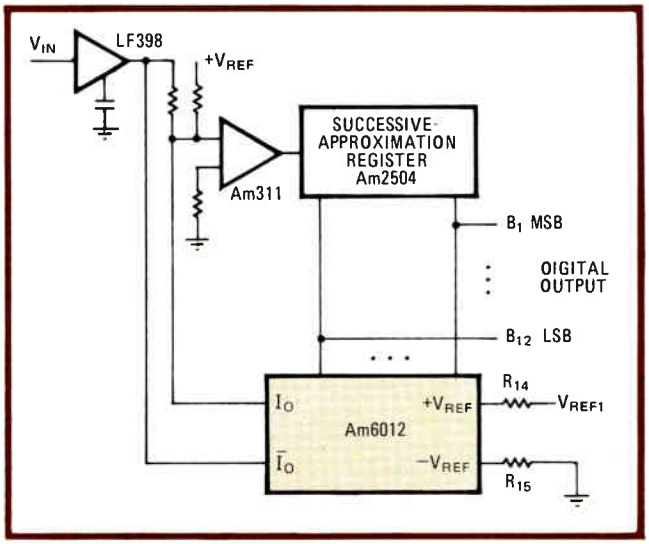
(±0.025% OR 12 BITS)



SEGMENTED 12-BIT d-a CONVERTER
±½-LSB DIFFERENTIAL LINEARITY
(±0.012% OR 13 BITS)



7. Fast a-d converter. The high speed of the 12-bit Am6012 d-a converter lends itself to building fast analog-to-digital units that are inexpensive as well. The 12-bit successive-approximation a-d converter shown here has a conversion time of less than 10 μs.

performed by either conventional voltage- or current-output converters that use resistive networks. Many such converters must use ladder networks or resistor attenuators to interface with a load. Their resistive outputs, however, lower the output resistance, degrading either full-scale current or linearity as the output is operated away from ground.

Offset-binary operation of the 6012 can be achieved with the use of a balanced load. The balanced load converts the difference of the two output currents into a single-ended voltage, eliminating the need for an offset resistor from the reference supply. Thus the analog ground at the load may be unrelated to ground at the converter. A twisted-pair wire may therefore be used for current transmission between the converter and an output amplifier, where converter and load are separated, as in process control. An additional 2.5-kilohm load resistor to ground provides the amplifier with an effective gain of 2, for a swing of ± 10 V, despite the fact that the d-a converter's output compliance is -5 V.

Figure 7 shows a 12-bit successive-approximation a-d converter using the Am6012. Conversion time for this circuit is under 10 μs. When a sample-and-hold amplifier is used, the changing load current for each data sample disturbs the feedback loop, which then must settle to within 0.01% of full-scale value in less than 1 μs. Connecting the open-collector current, I_{out}, to the sample-and-hold amplifier provides the amplifier with a constant-current load. This load enables a faster clock rate that in turn increases the a-d converter's throughput. Total parts cost under $16, yielding the lowest speed-accuracy-price product of any 12-bit a-d units.

Making sure by testing

Expensive test systems costing on the order of $300,000 provide high throughput for production volumes. But for characterization, such test systems provide no more than a list of all 4,096 values for each converter. Manual testing, on the other hand, is out of the question, as it consumes too much time. A test technician would need 34 hours to test each converter (assuming 30 seconds to increment each digital code, watch for the analog output result, and record it) and still produce only a list of 4,096 values.

A better solution is to let a desktop computer perform all the detailed work and provide a graphic output. Accordingly, a test system consisting of a Hewlett-Packard model 9845A desktop computer, two power supplies, a Data Precision high-speed digital voltmeter, and a custom test fixture was assembled for less than $30,000. This equipment allowed each d-a converter's nonlinearity to be characterized in just 5 minutes, and the computer's graphics feature allowed test results to be interpreted instantly. Plots of nonlinearity, differential nonlinearity, and transfer characteristics thus were created quickly and easily.

For simplicity's sake, two separate programs were written: one to test nonlinearity and the other to test differential nonlinearity. Since both programs are largely identical, they could conceivably be combined and used via an option that allows an operator to choose either one. Alternatively, both can be used simultaneously to create two separate plots.

Calculating nonlinearity (NL) is fairly straightforward. For example, let:

R = actual voltmeter reading
J = input code expressed in decimal notation
NL = actual reading − ideal reading
= deviation from ideal straight line through zero and full scale

then:

$$\text{Ideal reading} = \frac{J}{4{,}096}\,(V_{\text{full scale}} + 1\ \text{LSB})$$

$$= \frac{J}{4{,}096}\,(10\ \text{V})$$

and:

$$\text{NL} = R - \frac{J}{4{,}096}\,(10\ \text{V})$$

for each input code.

Before a test is started, however, full scale should be calibrated by applying to the converter a code consisting of all 1s. The reference voltage is then adjusted for the ideal full-scale output value of 9.9976 V.

Differential nonlinearity (DNL) is even easier to calculate. If:

A = actual step size
= difference in output voltage between two adjacent steps
I = ideal step size

$$= \frac{V_{\text{full scale}} + 1\ \text{LSB}}{4{,}096}$$

then:

$$\text{DNL} = A - 1$$

A refinement in the test programs allows the user to select the program loop size—that is, the number of bits incremented each loop iteration. □

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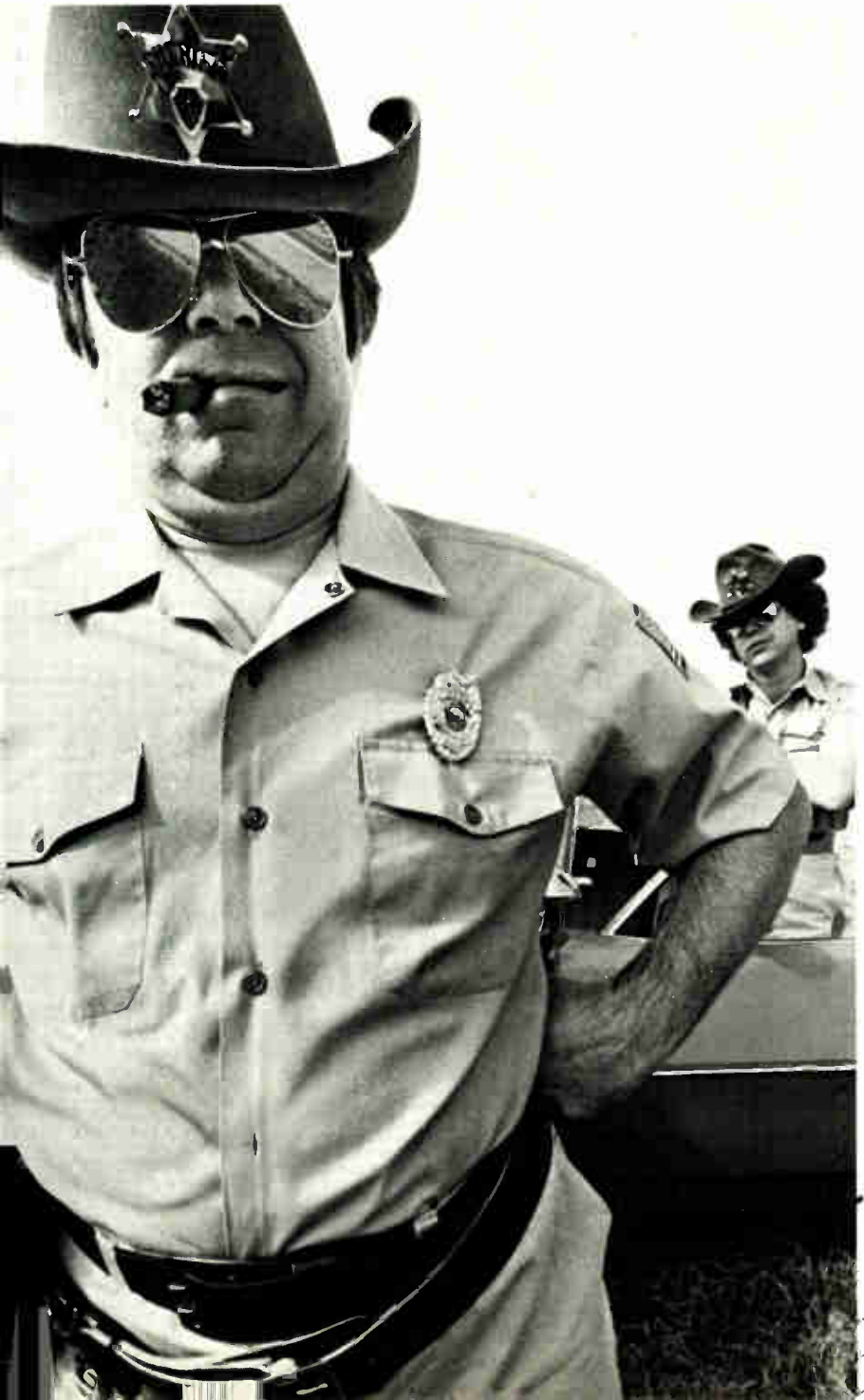

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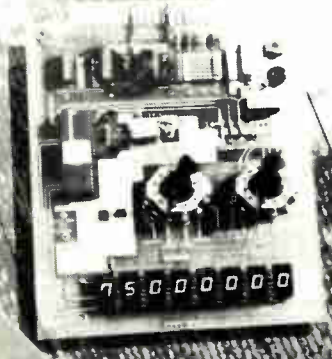

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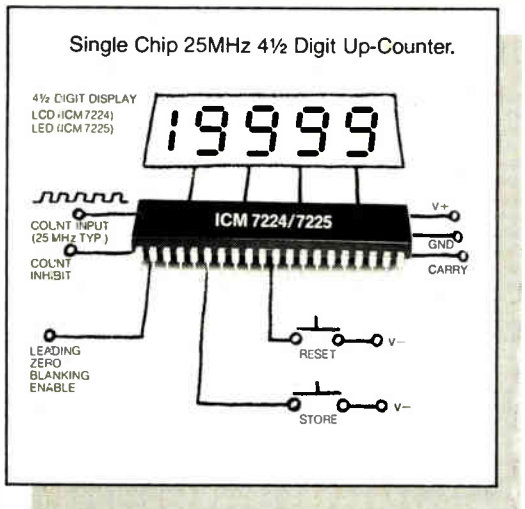

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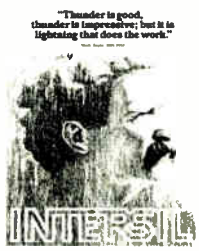

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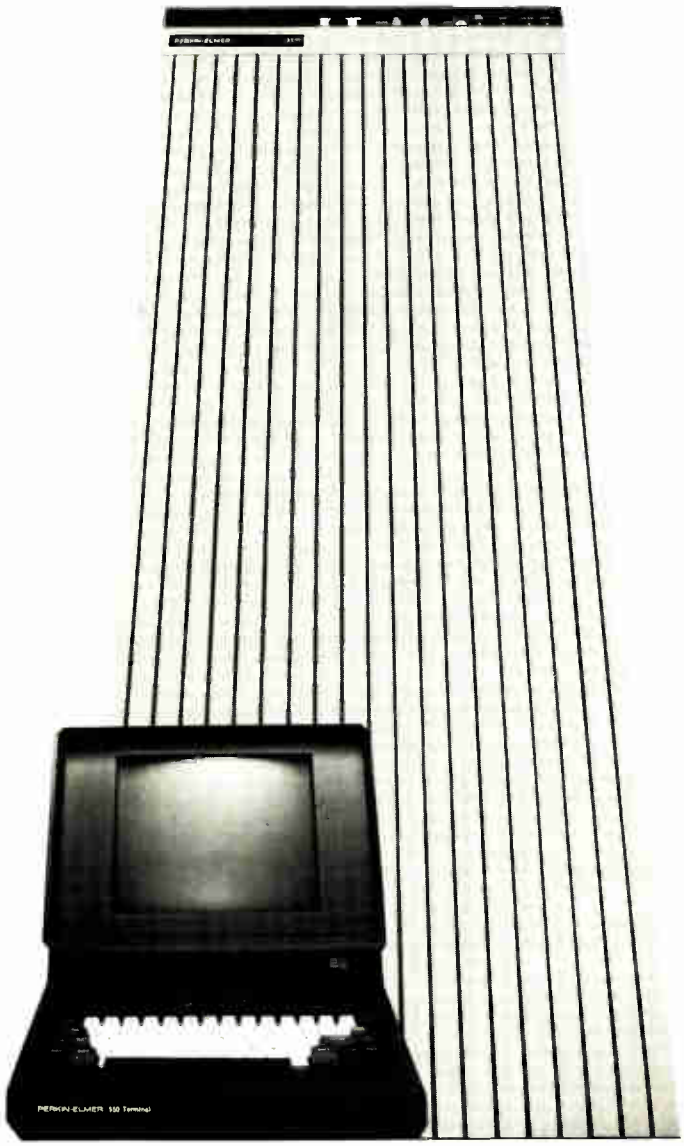

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Indian Institute of Technology, Powai, Bombay, India

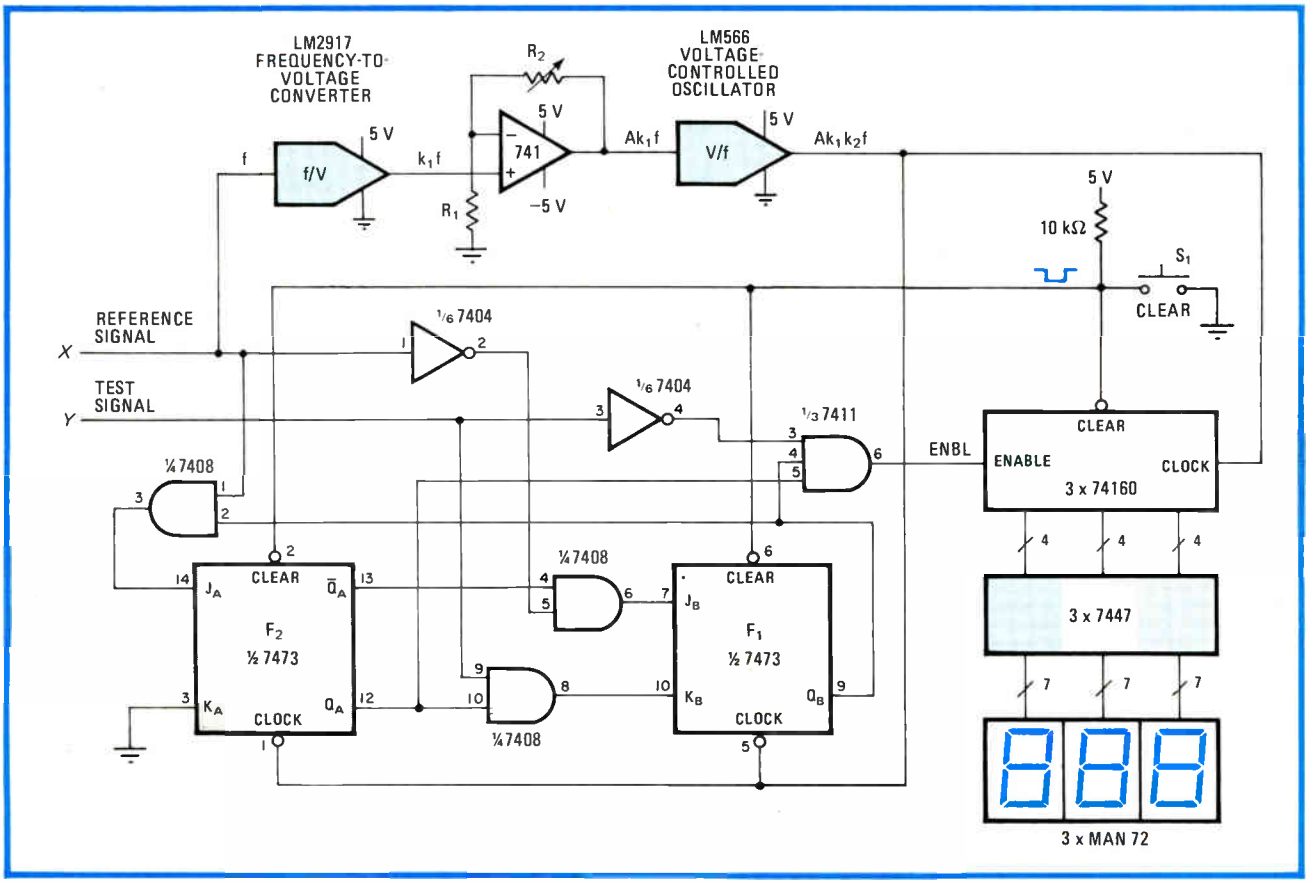
Performing measurements digitally, this meter determines the phase angle between two signals that can be separated by as much as 180°. The resolution of the measurement is ±1°, independent of the shape or the amplitude of the waveforms under observation.

In this circuit, the leading edges of the reference (x) and test (y) signals are used to enable or disable, respectively, the counting of three cascaded 74160 binary-coded decimal counters. These counters are clocked at a much higher frequency than is present at the x or y inputs, and at a rate proportional to the reference frequency. Thus the number of clocked pulses that occur during the enabling time represents the phase delay of the test signal with respect to the reference.

As shown, the LM2917 frequency-to-voltage converter, the 741 op amp, and the LM566 voltage-controlled oscillator convert reference signal x to a frequency equal to Ak_1k_2f, where k_1 and k_2 are the conversion constants of the 2917 and 566, A is the gain of the op-amp stage, and f is the incoming frequency. This signal serves to clock the 74160 counters.

When enabled, the counters advance once each $T_c = 1/Ak_1k_2f$ seconds. Thus the count reached after time Δt is $n = \Delta t/T_c = (\theta/\omega)(Ak_1k_2f)$, where θ is the phase difference between x and y, and ω is the radian frequency (note $\theta = \omega t$). Thus $n = k_3\theta$, where $k_3 = Ak_1k_2/2\pi$. But k_3 can be selected easily (by varying the gain of the op amp) to equal $180/\pi = 1$, so that $n = \theta$ in degrees.

The 7423 flip-flops and their associated logic generate the enable signal, which has a width equal to the phase difference between the x and y pulse trains. The rising edge of the enable pulse ENBL is generated at the first high-going transition of the x signal following a system clear, and the pulse falls on the arrival of the y signal. If the clear command occurs during the time the x signal is low, the J input of flip-flop F_1 is immediately brought high and F_1 is set upon the arrival of a clock pulse. When x goes high, F_2 is set, and the output of the 7411 NAND gate is brought to logic 1.



Count on delay. Phase meter finds angle between two signals to ±1°. Number of pulses counted during enable time, which is determined by the interval between the rising edge of x and test signal y, represents the phase delay, in degrees.

When the y input moves high, pin 3 of the 7411 is brought low and F_1 is reset, also bringing ENBL low and deactivating the circuit until a system clear is again initiated. Meanwhile, the counters advance and their final value is presented to the 7447 drivers and displayed by the MAN 72 seven-segment displays.

If a system clear occurs while x is high, the process is similar. The fact that x may be high at this time has no effect on setting flip-flop F_2 because the Q output of F_1 is low. But F_1 will be set when x moves low, and the rising edge of x's next pulse enables the setting of F_2 and the generation of the ENBL pulse as before. □

Scope's autoslope sweeper captures recorded transients

by S. Manickavasagam and A. Pedar
National Aeronautical Laboratory, Bangalore, India

The sweep output of most digital recorders that store waveform transients is one of constant amplitude and slope, and if it is used for driving the X axis (time base) of an oscilloscope, the user may miss a portion of any long transient he wishes to display. In this circuit, the speed of the sweep is made to accord with any amount of data to be displayed, so that any portion of any transient can be fully displayed across the entire scope face.

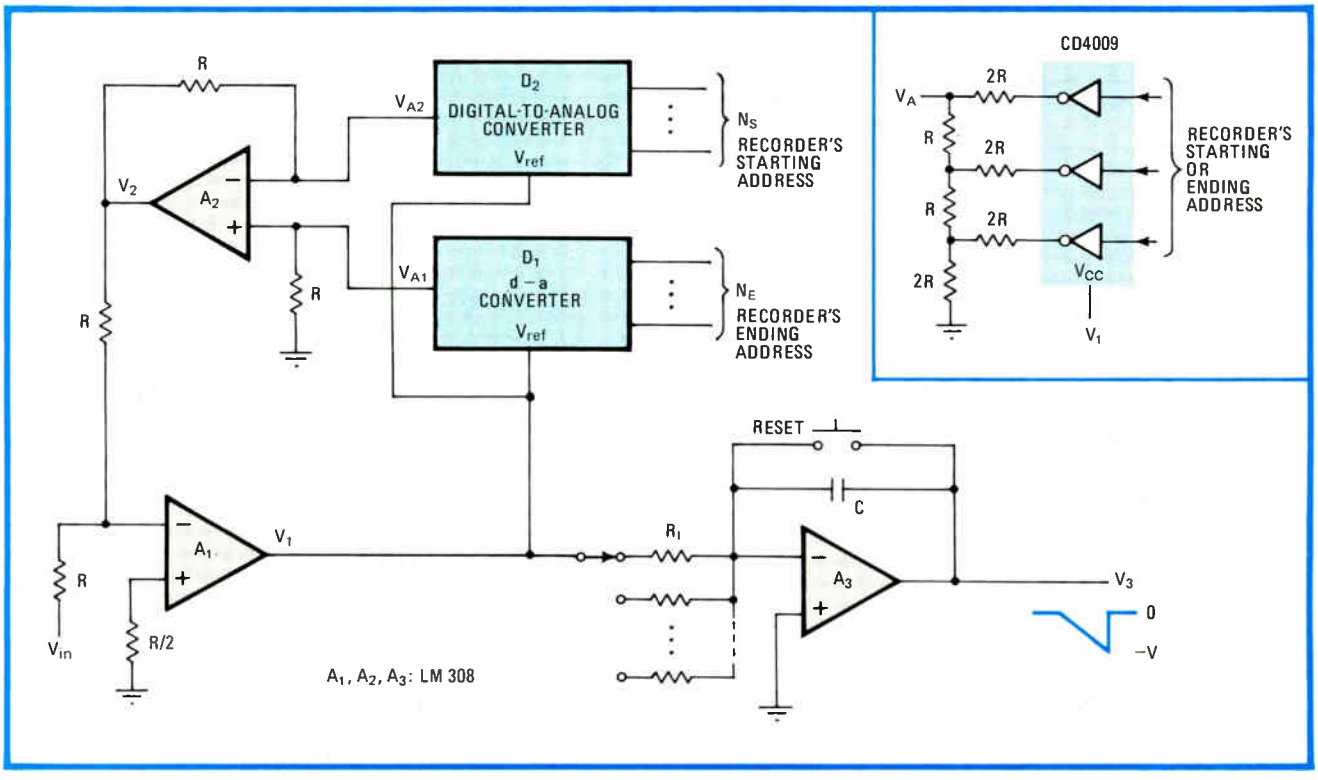
To capture all of the transient on screen, the slope of the sawtooth generator driving the X axis is automatically adjusted to be inversely proportional to the number of recorder memory pages holding the data. The recorder's memory is partitioned into N pages. Thus, any portion of a stored transient is selected by setting the starting address (N_S) and ending address (N_E) of the particular pages of interest by means of the recorder's front panel switches. As shown, the binary equivalent numbers of these addresses are presented to differential digital-to-analog converter D_1-D_2, which is in the feedback circuit of operational amplifier A_1. As a result:

$$V_2 = V_{A1} - V_{A2} = (V_1/2^N)(N_E - N_S) \quad (1)$$
$$V_{in}/R = (V_1/2^N)(N_E - N_S)/R \quad (2)$$
$$-V_3 = (V_1/R_1C)(N_E - N_S)\, D_n\, T_R \quad (3)$$

where D_n is the number of data words in each page and T_R is the period of the recorder's read-rate clock.

Note from Eq. 3 that $-V_3 = V_1(N_E - N_S)K$ for a given read rate and that the magnitude of V_3 can be made constant if voltage V_1 is made inversely proportional to $(N_E - N_S)$, a necessary condition for displaying the desired portion of the transient irrespective of the number of pages selected. This last requirement is achieved by setting $V_{in} = 1/2^N$, as seen in Eq. 2.

Thus it is seen that the larger the number of memory locations to be displayed, the smaller V_1 becomes, and the longer it takes the output of integrator A_3 to reach V_3 before it needs to be reset by the push-button switch. The scope trace therefore takes a correspondingly longer time to traverse the screen.



Caught in time. Slope of sweep generator driving timebase of scope is made inversely proportional to portion of recorded waveform to be displayed, unlike recorder's sweep output, so that all transients can be observed. Voltage to integrator is determined by page length.

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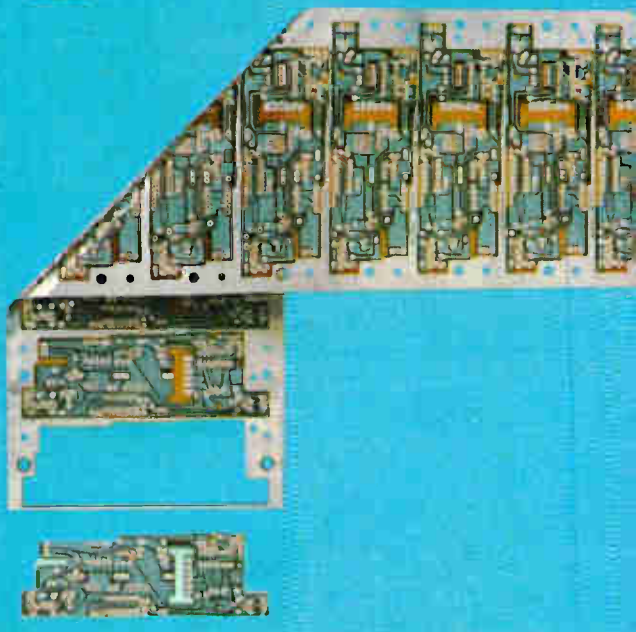

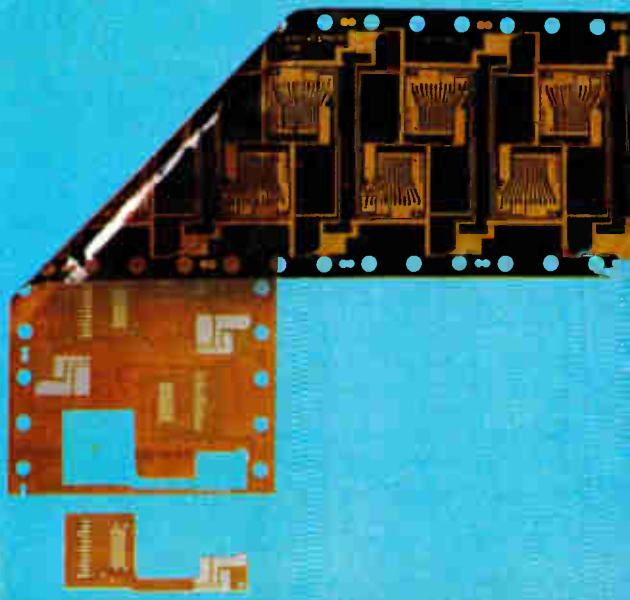

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Circle 166 on reader service card

As mentioned previously, V_3 remains a constant for a given read rate. If the rate is changed, it is necessary to adjust the integrator's RC time constant through R_1 in order to keep V_3's (maximum) value a constant.

In cases where only a few address lines must be handled, a simple d-a converter will suffice. Shown in the upper right of the figure is such a converter, using a single 4009 complementary-MOS inverter and buffer and a complement of resistors that form a rudimentary R-2R network for resolving the analog output voltages. □

M6800 program performs cyclic redundancy checks

by S. V. Alekar
Lectrotek Co., Pune, India

Detecting bit errors using check-sums, this subroutine offers a simple way to perform a cyclic redundancy check on a serial data stream. The software approach is less cumbersome than its hardware counterpart, which requires a CRC generator and associated circuitry.

Written for the M6800 microprocessor, the subroutine implements the same algorithm used in Fairchild's 9401 CRC generator. In this algorithm, a 16-bit check word is generated and added to a check-sum value stored in memory for every byte transmitted (to a cassette tape, for instance). The final check sum for a given block of data is compared with the check sum produced by the algorithm when the data is called back into the system. The form of the check-word generated can be made to comply with several polynomial standards now widely accepted, including the CRC-16, CRC-16 reverse, CRC-CCITT, and CRC-CCITT reverse specifications.

The subroutine is called once for each byte transferred to or from the microprocessor and the input/output chips. The hexadecimal codes corresponding to the polynomial standard to be generated are loaded at locations HPLY and LPLY before the subroutine is called. For the CRC-16, 80_h is entered into HPLY and 05_h is entered into LPLY; for CRC-16 reverse, 40_h and 03_h, respectively, are entered; for CRC-CCITT 10_h and 21_h, respectively; and for CRC-CCITT reverse, 08_h and 11_h, respectively. The data byte being transferred is stored at location DATA. Locations HCHK and LCHK store the higher and lower bytes, respectively, of the check word. These two locations are cleared before the subroutine is called. The user must add the check words in an external location to form the check sum.

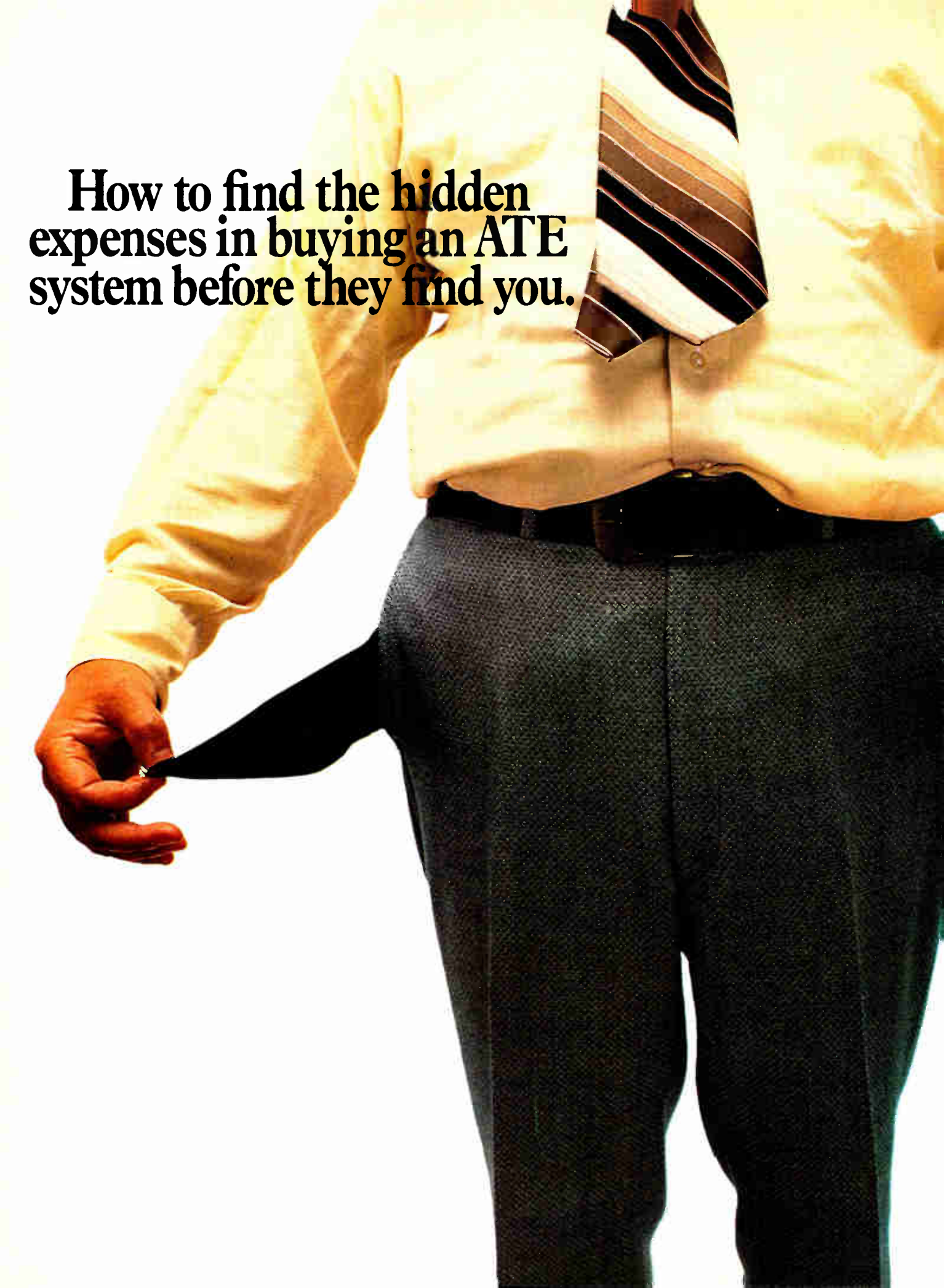
The execution time required to handle one byte of data is 544 machine cycles. The M6800's cycle time is 0.5 microsecond, so that the maximum data rate that can be transferred will be about 14 kilobauds. In practice, however, the M6800 will not be dedicated to the redundancy-check task, but the microprocessor can be expected to handle a standard transmission rate of 9,600 bauds with ease in most cases. □

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

M6800 CRC ALGORITHM

Location	Label	Op code	Operand	Comments
2000		LDX	DATA	Load register
2003		LDA A	08H	
2005		STA A	CNT	Store bit count as 08
2007	LOOP	LDA A	HCHK	
2009		EOR A	DATA	Exclusive-OR most significant bit of data and MSB of partial checkword: Put result in carry bit
200B		ROL A		
200C		LDA A	HPLY	
200E		LDA B	LPLY	
2010		EOR A	HCHK	Exclusive-OR partial check word and polynomial
2012		EOR B	LCHK	
2014		ROL B		Shift checkword left and put carry bit in least significant bit
2015		ROL A		
2016		STA A	HCHK	Store partial checkword
2018		STA B	LCHK	
201A		ASL	DATA	Shift data left
201C		DEC	CNT	Check for bit count
201E		BNE	LOOP	
2020		RTS		Return
2021	DATA			Stores data byte
2022	HPLY			Polynomial
2023	LPLY			
2024	HCHK			Checkword
2025	LCHK			
2026	CNT			Count

How to find the hidden expenses in buying an ATE system before they find you.



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Circle 169 on reader service card

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Engineer's newsletter

Kit for TRS-80 simplifies keyboard modification

Although much documentation abounds on adding a lowercase and control-key option to the popular Radio Shack TRS-80 microcomputer, things can get a bit sticky for the user who has never tried dismantling such a system to perform the modification. Finding all the right parts is not easy, either. Happily, there's now **a kit that includes everything needed**—wire, solder, control key, 2102 memory chip, slide switch, and mounting hardware, plus detailed and complete instructions. Documented by Leah O'Connor, Chicago, and distributed by Emmanuel B. Garcia Associates, 3950 N. Lake Shore Drive, Rm. 2310, Chicago, Ill. 60613, the kit costs only $19.95. Dealer discounts are available on quantity orders.

Interchanging ports adds versatility to multiplying d-a units

Many popular multiplying digital-to-analog converters such as the AD7523 or the DAC331 are operated such that their current-port outputs swing the device's outboard operational amplifier from either 0 to $-V_{ref}(1-2^{-N})$ in unipolar operation or from V_{ref} to $-V_{ref}(1-2^{-(N-1)})$ in bipolar operation, where V_{ref} is the reference voltage determined by the user and N is the resolution of the converter in bits. But in many cases a swing from V_{ref} to a second reference voltage, $V_{ref'}$, is desired; fortunately, this can be easily achieved if the converter's input and output ports are simply interchanged, notes Noel Boutin of the University of Sherbrooke, Quebec, Canada.

Driving the aforementioned current ports of the converter by each corresponding reference and using the V_{ref} port as an output does the trick. Although the unit's R-2R ladder network now operates in a voltage rather than a current mode, resulting in a small nonlinearity in the d-a conversion, in many cases the increase in versatility obtained will be well worth it, Boutin says. With this configuration, the limits of the swing are $V_{ref}(1-2^{-N})$ to $V_{ref'}(1-2^{-N})$.

C-MOS op amp builds ultrastable RC oscillator

Malcolm McWhorter, professor of electrical engineering at Stanford University, Stanford, Calif., offers a simple solution to the problem of reducing the effects of supply and temperature variations on the low-frequency output of an RC oscillator. He notes that the low input-offset voltage of the CA3130 complementary-MOS operational amplifier and its ability to switch between ground and its supply voltage without introducing a substantial temperature-dependent voltage drop makes it an ideal source for an RC oscillator whose stability exceeds that of any conventional design. Utilizing a simple configuration, McWhorter claims a stability of 22 ppm/°C, virtually equal to that of the RC combination alone. **The circuit exceeds the stability of a typical 555 timer circuit by 90 times for a supply variation of 10 to 16 V.**

McWhorter connects a series RC network between the output of the op amp and ground, with its junction connected to the (−) input. A two-resistor voltage divider placed between V_{cc} and ground develops a switching reference voltage for the (+) input, with the circuit's switching points partially controlled by a feedback resistor between the output of the op amp and its (+) input. The frequency of the oscillator is $f = 1/RC$. The divider resistors and feedback resistor R_1 can be arbitrarily selected for 220 kΩ, and 330 kΩ, respectively. Either R or R_1 can be varied to change the frequency without affecting its square-wave symmetry.

-Vincent Biancomano

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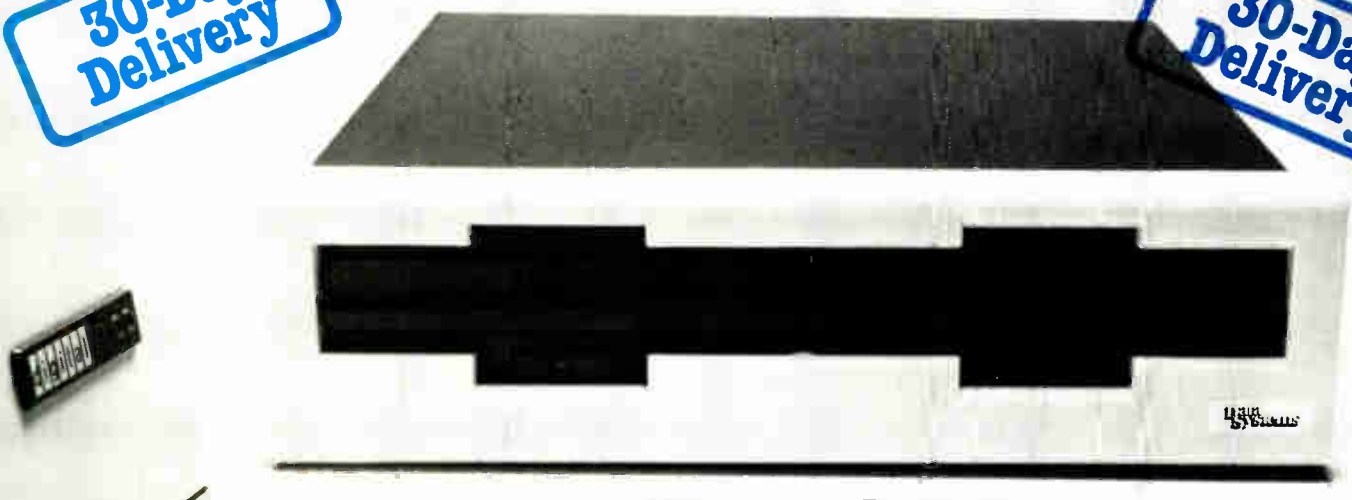

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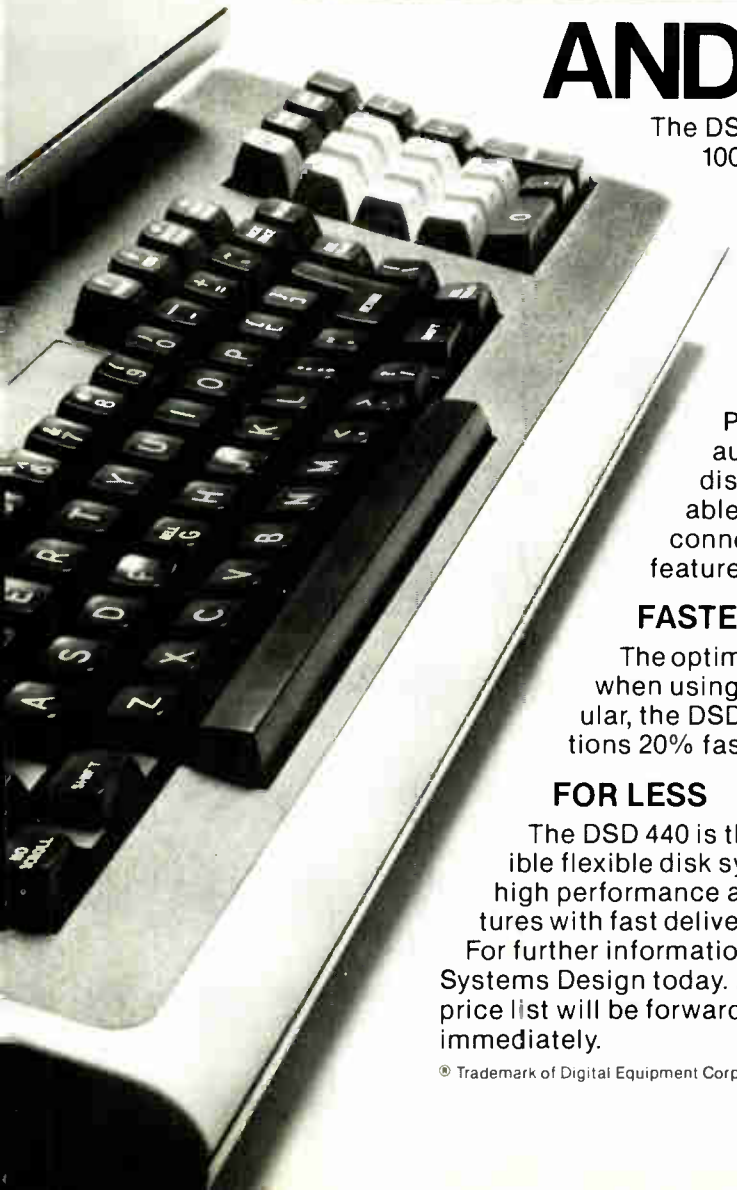

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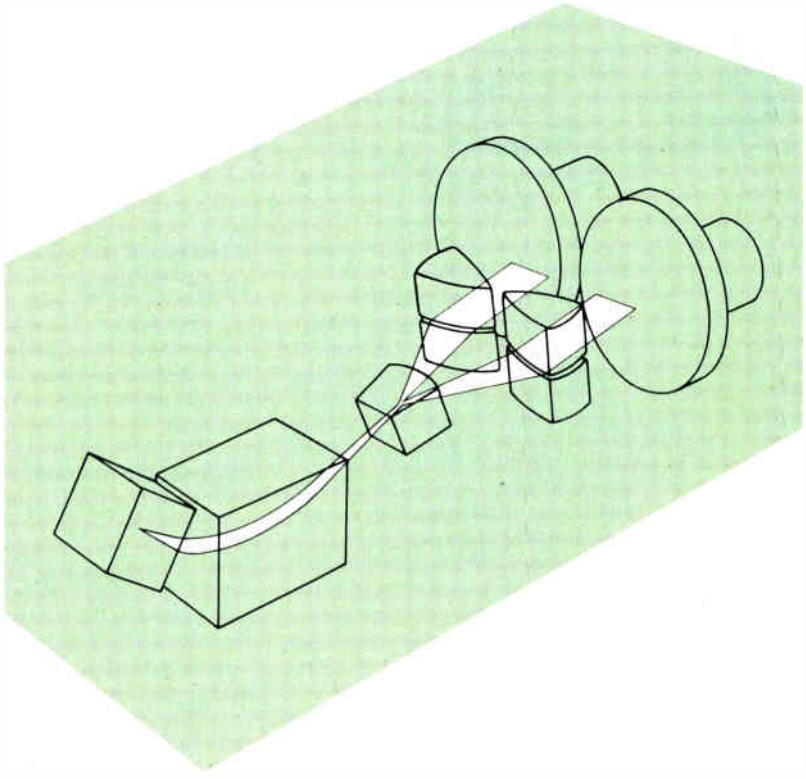

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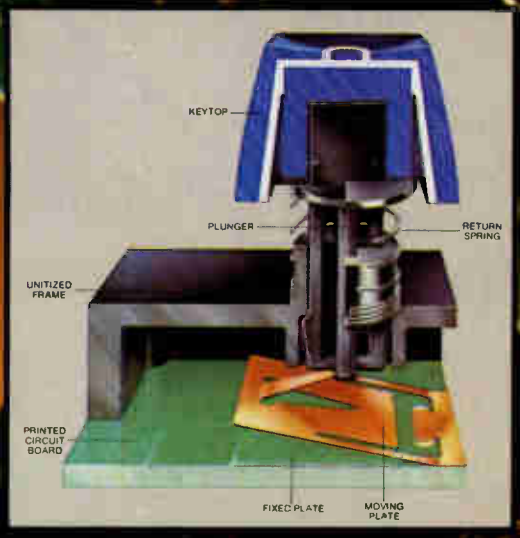

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IC combines optical sensor, trigger

Optical detector chip puts a voltage regulator, a Schmitt trigger, a differential amplifier, and a photodiode on the same substrate

by Wesley R. Iversen, Dallas bureau manager

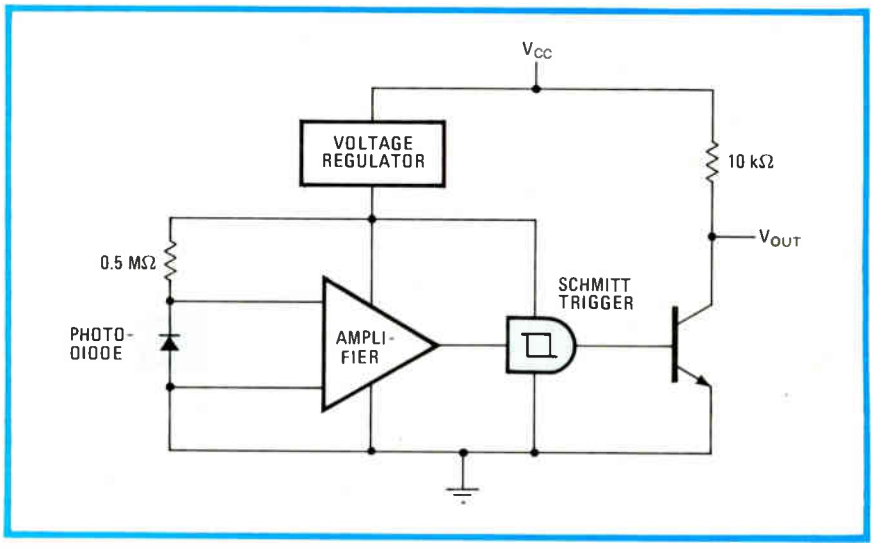
Using optoelectronic components will become easier as manufacturers increasingly move to integrate associated circuitry functions on the optical-device chips. A prime example of that trend is the SDP8600, an opto-Schmitt detector IC from Spectronics, the Richardson, Texas –based division of Honeywell Inc.

Designed for use in optical sensing applications in combination with an infrared emitter, the 8600 represents a step down the road toward integration of optical components. In the 8600, Spectronics' engineers have put a voltage regulator, a light-sensitive photodiode, a Schmitt trigger, a differential amplifier, and various other conditioning circuitry functions all on the same chip. The result is a bipolar IC that replaces a small printed-circuit board of discrete components and offers compatibility with a range of standard logic families—from TTL to complementary-MOS. Improved noise immunity also comes in the bargain, Spectronics officials say.

To be available in March for $2.95 in 1,000-unit quantities, the 8600 is actually no bargain initially—if viewed exclusively in terms of discrete component replacement cost. A system designer could probably assemble a discrete implementation that would perform the same optical switching function as the 8600 for around $3, says Jim Oursler, Spectronics product marketing manager. But high-volume production has the potential to drive the 8600 price to as low as 50¢ within the next three years.

Expected 8600 applications include replacement of discrete and hybrid phototransistor-array packages currently used to sense motion when passing objects break the infrared beam coming from a nearby array of LEDs. Such assemblies typically provide sensing inputs to a microprocessor in applications ranging from computer peripherals to toys to automotive cruise-control systems. In addition, Spectronics chief scientist J. R. Biard notes that the improved noise immunity, smaller function size, and eventual reduced cost offered by the 8600 may help opto-electronics penetrate new market areas.

The plastic-packaged 8600 is a successor to the SD5600, a lower-performance device that represents Spectronics' first pass at integrating the opto-Schmitt detector functions on one chip. The 5600 is offered in a TO-46 dome-lensed metal can, which pushes the price up to $5.85 in 1,000-piece quantities. Oursler notes that the 5600, which reached the sampling stage about 60 days ago, can be used as a breadboard vehicle for designers contemplating use of



New products

the 8600, which may be brought in later on in the design process.

A look at 8600 specifications reveal significant improvements over the 5600. Typical propagation delay time at 25°C, for example, is reduced from 100 μs for the 5600 to 10 μs for the 8600. Likewise, output rise and fall times have been halved, from 100 ns to 50 ns. Additionally, maximum clock frequency was improved twentyfold from 5 kHz on the 5600 to the 100-kHz rate specified for the 8600.

A good portion of the 8600's improved performance is traceable to an implanted-resistor process used in its fabrication, Biard says. This new process makes possible a smaller chip and the use of a substrate photodiode as a substitute for the phototransistor employed as the optical element in the 5600. In part because of its smaller junction area, the 8600 photodiode has a smaller capacitance associated with it and can thus operate significantly faster than the phototransistor, which is confined to the epitaxial layer in the 5600, Biard says. In addition, the photodiode has an acceptable response over a wider range of infrared wavelengths. This permits the 8600 to be used with a wider variety of emitter devices operating at wavelengths of up to 9,300 Å.

The voltage regulator used in the 8600 also operates over a wider range than does the regulator used on the 5600, enabling the 8600 to accept a supply voltage ranging from 4.5 V to 16 V. The circuit's design is such that the 8600's output swings with the level of the supply voltage, notes Spectronics senior principal engineer Ben R. Elmer. Consequently, the 8600 output is compatible with whatever logic family is being used, be it complementary-MOS with a 15-V supply or TTL requiring 5 V. In some applications, Elmer adds, the 8600's single-supply operation can save money compared with a discrete implementation, which often requires that designers use more than one power supply.

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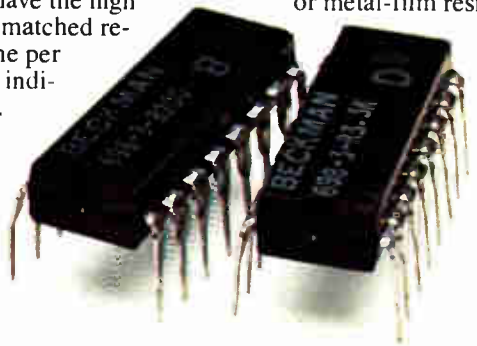

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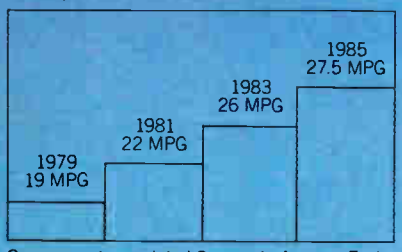
Circle 179 on reader service card

MOTOROLA HELPS STRETCH GAS MILEAGE

Automotive manufacturers are caught between a rock and a hard place. They are obliged not only to reduce fuel consumption, but also, at the same



Government mandated Corporate Average Fuel Economy (CAFE) standards. Source: NHTSA

time, to reduce harmful exhaust gas emissions. And these objectives seem to be mutually exclusive.

An engine whose carburetor and spark timing are adjusted to give high mileage tends to produce unacceptable levels of pollution. The same engine, adjusted for low pollution levels, uses more gas and gives disappointing performance.

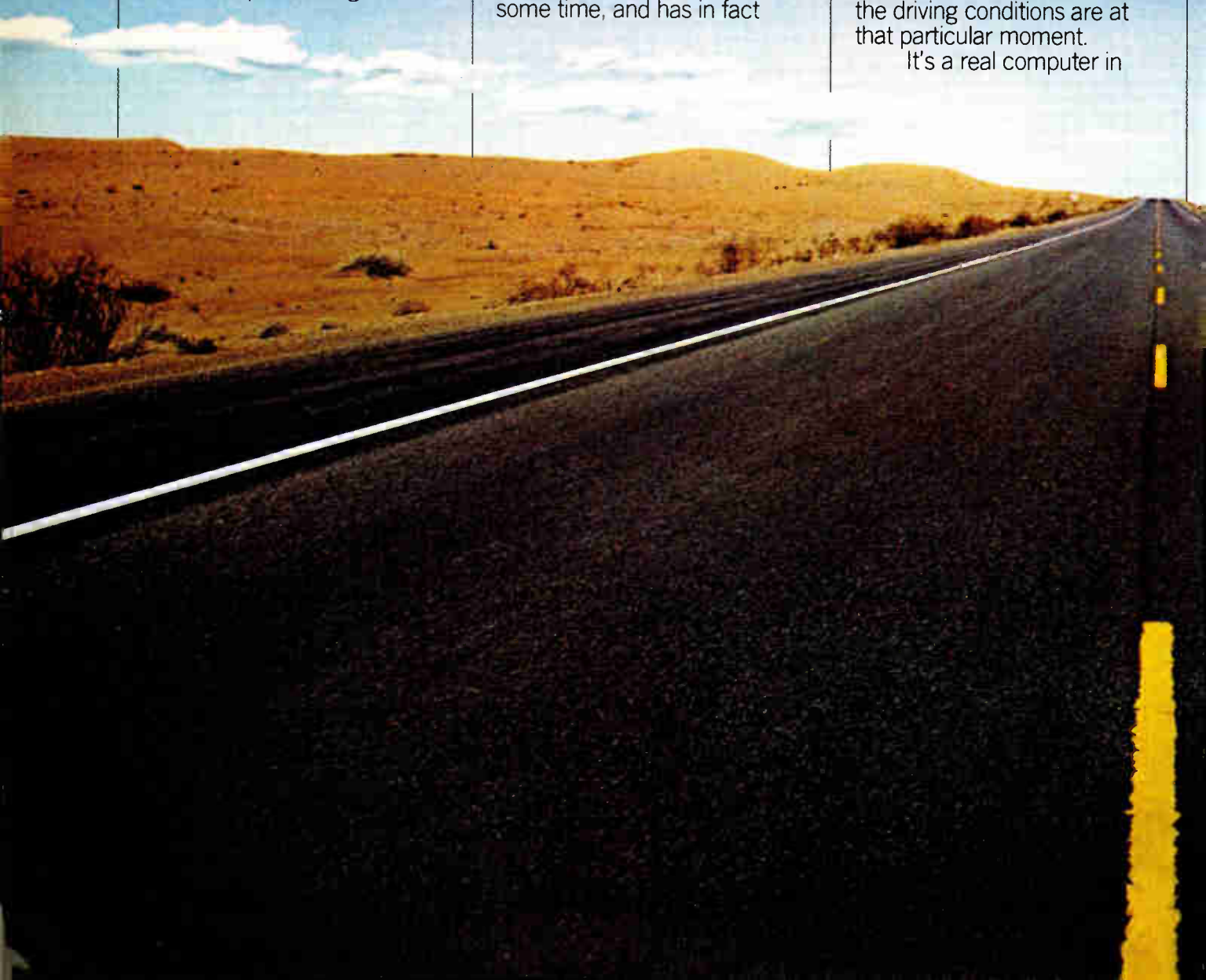
The trick is to burn exactly the right amount of fuel at exactly the right moment. But what is "right" depends on a whole complex of constantly changing factors, including terrain, engine and air temperature, barometric pressure, and the load and speed of the car.

It would take a genius to juggle all those factors. Fortunately, Motorola has been working on the problem for some time, and has in fact produced just such a genius.

ELECTRONIC ENGINE MANAGER.

It's an electronic engine-management system, controlled by a microcomputer that thinks like a first-rate automobile mechanic. It lives inside the car, and because it can make a million calculations each second, it can automatically regulate carburetion, spark timing, and the recirculation of exhaust gases through the engine. It makes all these adjustments continuously, so you get as much performance with as little pollution as possible, whatever the driving conditions are at that particular moment.

It's a real computer in



BY MAKING ENGINES THINK.

miniature, with a memory and the ability to manipulate what it learns in terms of what it already knows. It works so well that car and heavy-duty-equipment manufacturers in America and Europe plan to use it, some as early as the 1980 model year.

IMPOSSIBLE WITHOUT ELECTRONICS.

Such precise, continuous engine management would be impossible without the integrated circuit, an electronic microcosm that contains the equivalent of twelve thousand transistors and measures about 5mm square. These small miracles are the central nervous system of Motorola's electronic engine-management system, and they're a remarkable but not unique demonstration of the kinds of things Motorola is doing with microelectronics today.

A microcomputer, drawn larger than life.

IMAGINATIVE ELECTRONICS.

Motorola is not only one of the world's largest manufacturers dedicated exclusively to electronics, but also one of its foremost designers of custom and standard semiconductors.

We've come a long way from the time when we put radios into cars fifty years ago, and TV sets into America's living rooms. Now we make hundreds of models of two-way radios, and we no longer make home TV sets here at all.

We make microelectronics carry telephone services to places where there are no phone lines. Transmit electrocardiograms and voice messages simultaneously from the scene of an accident to a nearby hospital. Help the energy industries develop the resources of the earth, the sea and the sun.

And we help make automobile engines think about how they use precious fuel.

MOTOROLA

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Circle 181 on reader service card

For further information, write Public Affairs Office, Corporate Offices, Motorola, Inc., 1303 E. Algonquin Road, Schaumburg, Illinois 60196.

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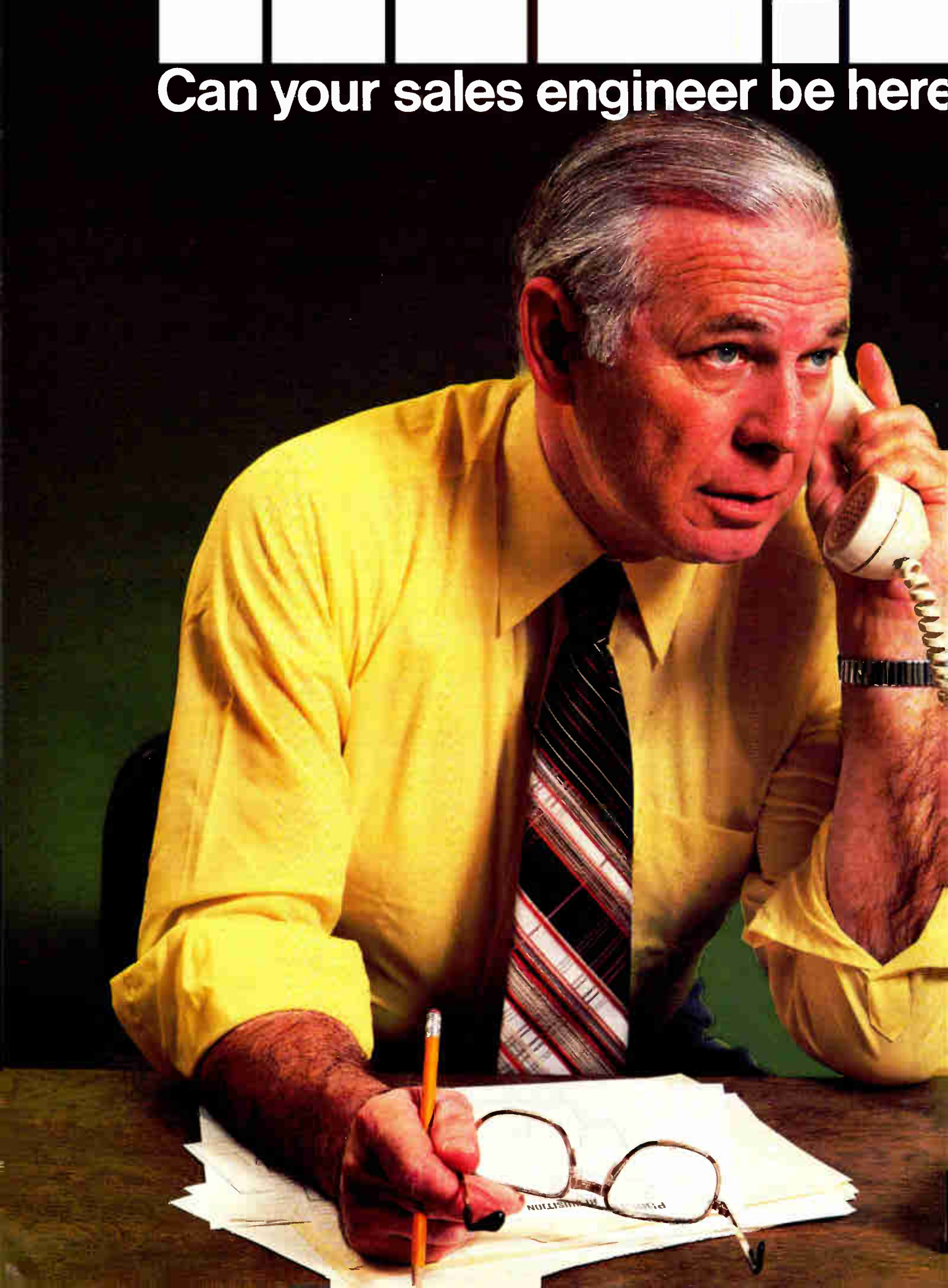

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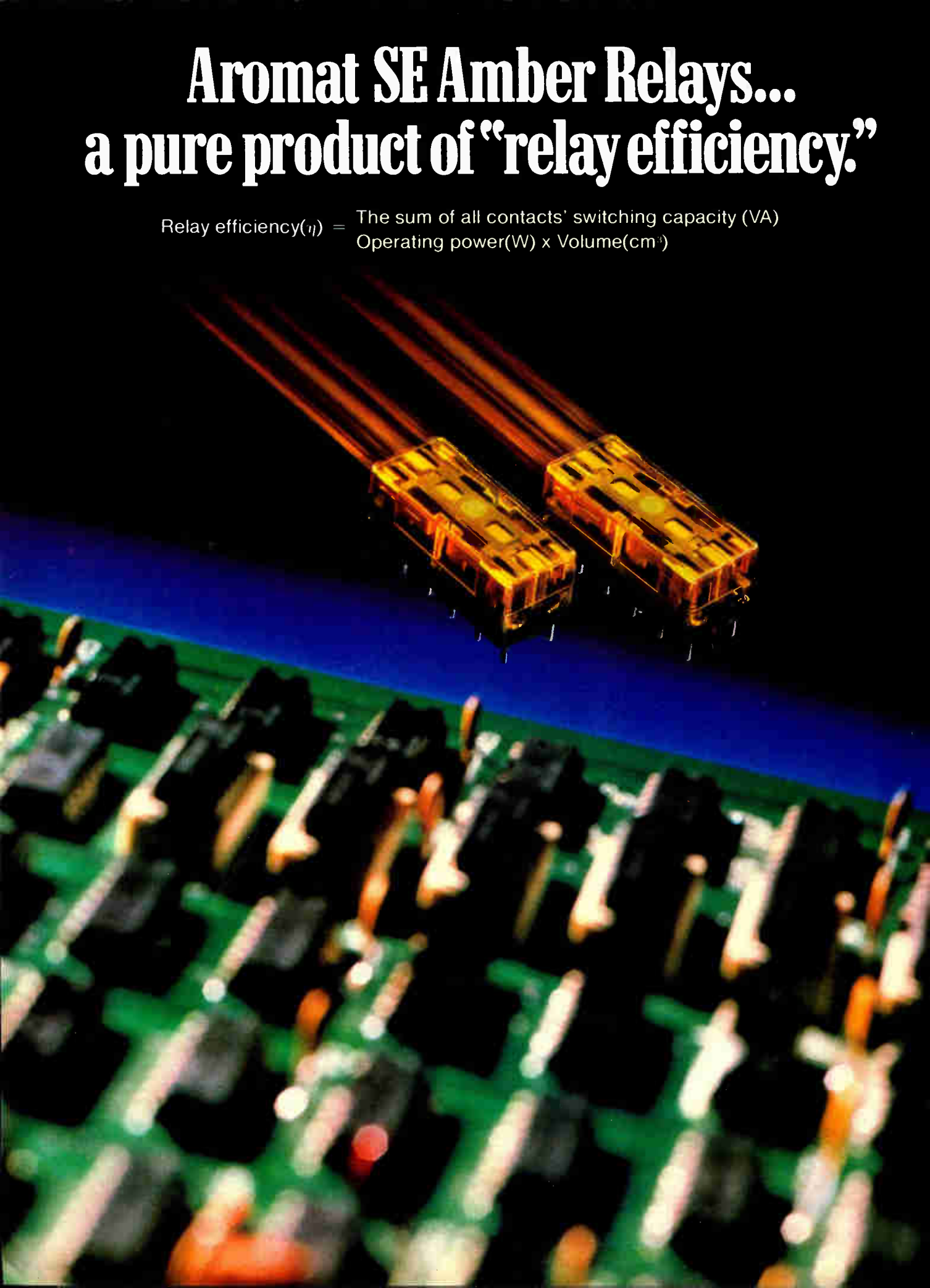
$$\text{Relay efficiency}(\eta) = \frac{\text{The sum of all contacts' switching capacity (VA)}}{\text{Operating power(W) x Volume(cm}^3\text{)}}$$



A breakthrough in relay efficiency.

The SE Amber relay's key to higher efficiency lies in greater miniaturization coupled with high reliability and greater switching capacity.

- **High sensitivity in small size.**
  [Operating power (W) x Volume(cm^3)]
  The SE Amber relay's 4-gap balanced armature delivers a highly efficient polarized magnetic circuit—sensitive enough to be driven directly by an IC, in a space 28L x 12W x 10H mm.

Sensitivity

Pick-up power	100 mW
Nominal operating power	200 mW

Dimensions

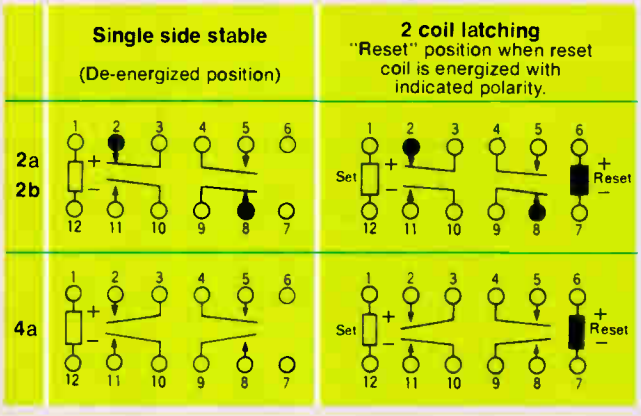
Volume	28L x 12W x 10H mm 1.102 x .472 x .394 inch
Header area	336mm^2 .521 $inch^2$
Height	10mm .394 inch

- **Wide switching range.**
  [The sum of all contacts' switching capacity (VA)]
  Switching is possible from 100μA 100mV DC to 4A 250V AC, thanks to the 4-gap balanced armature system and special multi-layer clad contacts. A single SE relay can handle maximum and minimum switching simultaneously.

- **High reliability and long life.**
  The balanced armature system with permanent magnets gives larger contact pressure. Bifurcated contacts and lower contact bounce add to contact reliability and expected contact life.

- **Amber design and construction.**
  Designed for automatic wave soldering and cleaning, the sealed SE Amber relay performs reliably under conditions where hydrogen sulfide, silicone and ammonia fumes prevail.

- **High vibration/shock resistance.**
  The balanced rotating armature provides great resistance to shock and vibration. Vibration resistance: 10 to 55G (amplitude: 3mm) Shock resistance: 50G (11msec.).



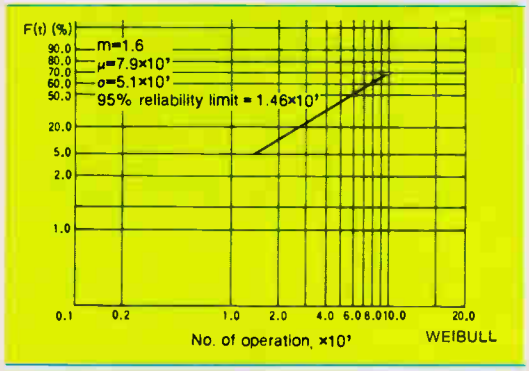
- **Varied contact arrangement.**
  SE relays are available with bifurcated contacts in 2a2b and 4a contact arrangements.

- **Multiple latching.**
  2-coil latching types are available, in addition to single side stable types. Since SE relays have a latching capability with multiple contacts, one contact can control the circuit while the other can switch the load simultaneously.

- **Low thermal electromotive force.**
  Because the SE relay has completely separate coil and contact chamber areas, extremely low thermal electromotive forces are possible.

- **Dual in-line package arrangement.**
  This 2-track terminal arrangement allows easier component insertion, easier layout and identification of terminal locations, and simpler in-line checking.

Contact reliability Test condition: DC1V/1mA, 4 contacts in series Detection level 10Ω Sample: S4E-24V Q'ty = 10



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Circle 185 on reader service card

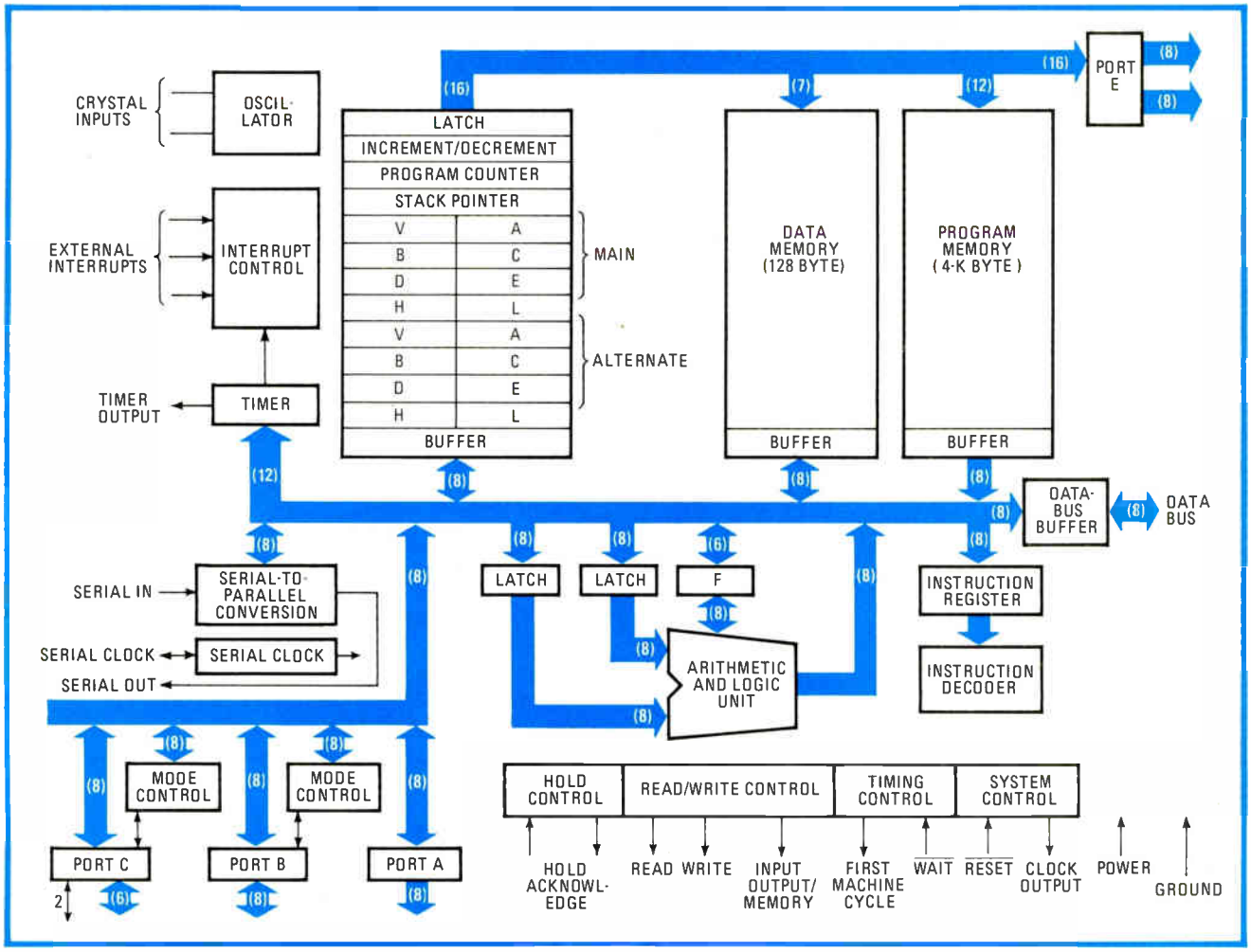
Microcomputer grants wishes

Single-chip 8-bit unit boasts 32 kilobits of ROM, a 128-byte scratchpad, two 8-byte register banks, and an internal clock generator

by John G. Posa, Solid State Editor

Single-chip microcomputers answering designers' needs for more power come along infrequently. So the 8-bit μPD7801, produced in Japan by Nippon Electric Co., will be welcomed because it is "probably the most powerful single-chip microcomputer yet announced," to quote Dwain Aidala, product manager for NEC Microcomputers Inc., the Wellesley, Mass., company that will be distributing the device in the U. S. The 7801 is a wish-chip; that is, it is for those designers who wish their present microcomputer had more internal registers and memory, more input and output lines, and the ability to address external devices.

Aladdin's chip. With the 7801 those three wishes are more than granted. No currently available single-chip microcomputer has more read-only memory than its 32 kilobits. In addition, other on-chip storage includes a 128-byte random-access scratchpad and two 8-byte register banks. To reduce system package count, the 7801 further incorporates both an internal clock generator, which can support a 2-μs cycle time, and a 12-bit counter/timer, which the designer is able to program to count from 4 μs to 16



Facts from Fluke on low-cost DMM's

Our new 4½-digit bench/portable: You've never seen anything like it.

Take a close look at the face of this instrument. Notice anything new? If you just realized you've never seen *words* on a low-cost DMM display before, you're on the right track.

This is the new 8050A from Fluke, the *lowest* priced 4½-digit multimeter available that uses microprocessor technology.

The legends on the LCD are clues to what makes the 8050A unique.

dB: You're right. The 8050A delivers direct readouts in dBm, referenced to any of 16 impedances. Use the "REF Z" button to scroll through the memory and locate the zero dBm reference you need, then set it and forget it. No more tedious calculations or conversions.

REL: For relative references in the dB mode or offset measurements in all other functions. Lets you store any input as a zero value against which all others are automatically displayed as the difference. Another timesaving convenience.

HV: Just a reminder when your input is over 40V, so you won't forget about safety while in the dB or relative modes.

Of course there's much more to the 8050A. True RMS measurements to 50 kHz. Conductance for measuring resistance to 100,000 Megohms and leakage in capacitors, pcb's, cables and insulators. Diode test, 0.03% basic dc accuracy and full input protection. Plus a large family of accessories. Just $329 U.S.

For all the facts on the versatility and value of the new 8050A, call toll free **800-426-0361**; use the coupon below; or contact your Fluke stocking distributor, sales office or representative.

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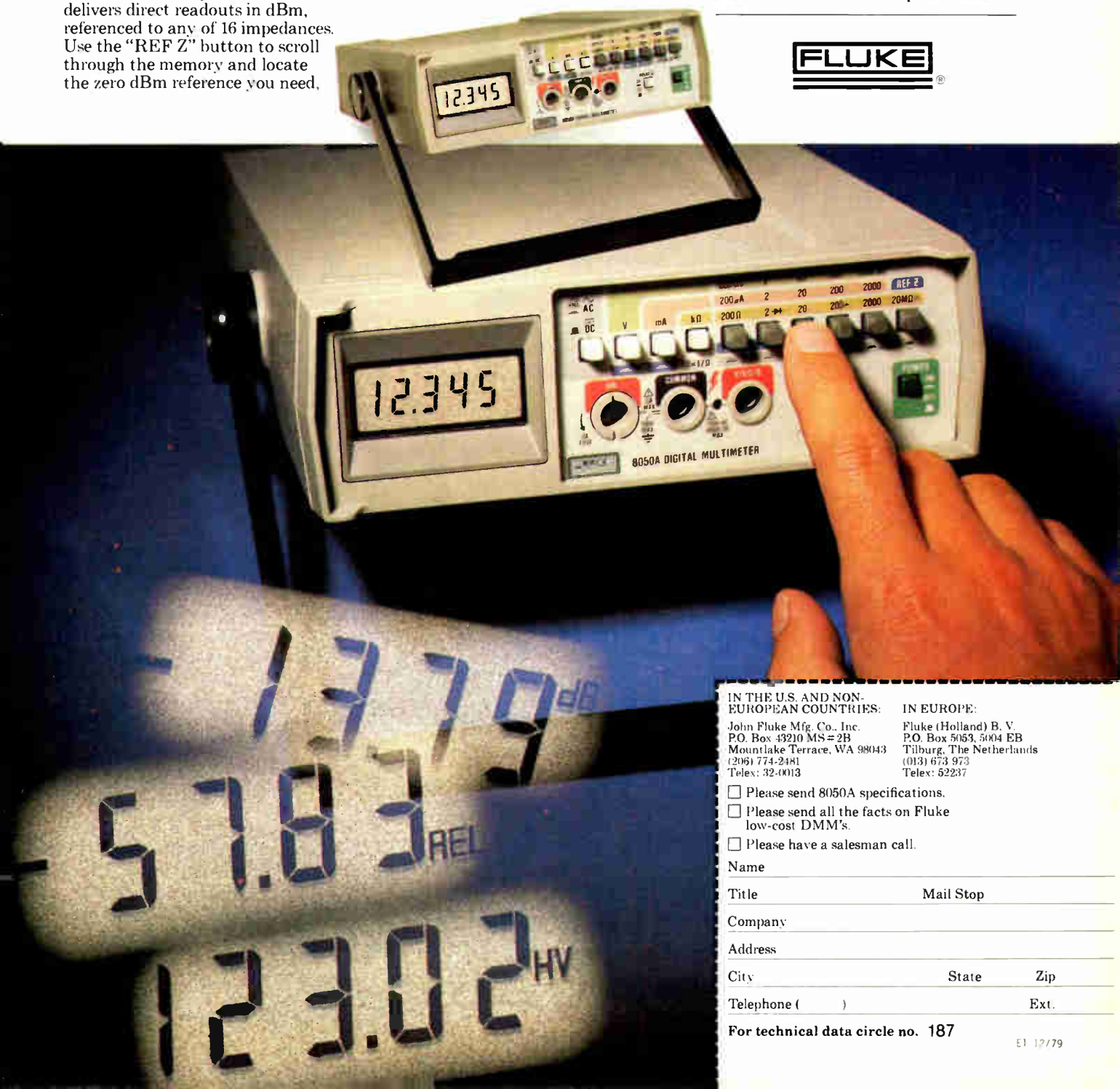

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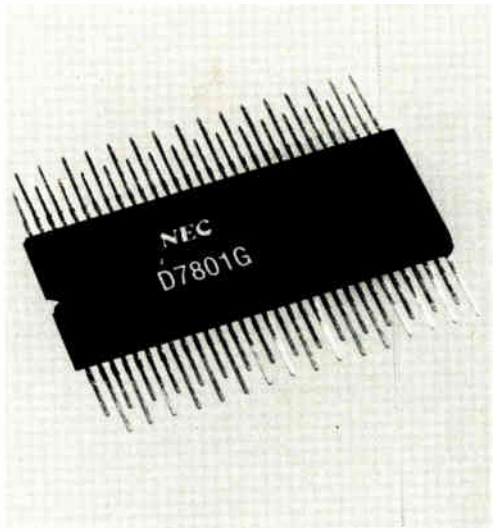
minutes in 4-μs intervals.

If expansion off chip is required, the 7801 can handle it, too. Its 64-pin package (see block diagram) accommodates 48 input and output lines that are grouped into an 8-bit bidirectional data bus, an 8-bit latched output port (port A), two 8-bit input/output ports (B and C), and a 16-bit address bus/output port (port E). Port E may be programmed for three operating modes; to have 16 output lines, or 16 address lines, or 4 output lines and 12 address lines. When functioning as an address bus, port E can be used in conjunction with the data bus to address any of the multitude of peripheral devices compatible with the popular 8080A microprocessor.



If port E is used as a 16-bit address bus, up to 60 kilobytes can be accessed off chip.

The microcomputer has five vectored interrupts, two of them internal (INTS and INTT) and three supplied externally to pins INT_{0-2}. INT_0 is level-sensitive, triggered when high; INT_1 is edge-sensitive, triggered on a low-to-high transition; and INT_2 can be programmed to sense rising or falling edges.

Finally, the μPD7801's instruction set consists of 125 powerful commands. Besides 8080 and 8085 instruction types, the repertoire has on hand "additional types to enhance code efficiency in restricted-ROM applications," says Aidala.

With so much on chip, the 7801 can compete head on with multiple-chip solutions. More specifically, David Millet, NEC Microcomputers' product marketing manager, states that the 7801's hardware is like that of an 8049 and an 8355 rolled into a single unit. The 8049 8-bit microcomputer gives 2-K bytes of ROM, 128 bytes of RAM and 27 I/O lines, while the 8355 memory-and-I/O-chip provides an additional 2 kilobytes of ROM and 16 more I/O lines. However, says Millet, while the 1,000-piece price of the 8049/8355 combination is about $25.00, the 7801 is being introduced at a price of about $20.00 in the same quantity.

NEC Microcomputers Inc., 173 Worcester St., Wellesley, Mass. 02181. Phone (617) 237-1910 [338]

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Investigator for hire: Powerful. Professional. Portable.

Sometimes it takes both hands, both feet and your undivided attention to get a job done right.

For balancing acts like this you need the new 8024A Investigator from Fluke – the first DMM you can both see *and* hear. So you can use it with confidence. Even behind your back.

With nine functions, the 8024A is the most versatile 3½-digit multimeter you can buy. Special skills give the Investigator powers you won't find in any other handheld DMM.

The Investigator's level detector provides an instant visual (▲▼) and audible signal for continuity checking, logic pulse detection, and timing measurements. You can make rapid circuit checks with both eyes on the test points while the Investigator's "beep" guides you.

Another exclusive among low-cost DMM's is the Investigator's ability to deliver fully compensated direct temperature readings with any K-type thermocouple.

The 8024A also has a peak hold feature that locks onto and retains transient signals, such as motor starting currents. And with conductance (measures leakage and high resistance), 0.1% basic accuracy, custom accessories and all the excellence you expect from Fluke, the Investigator lists at only $199 U.S.

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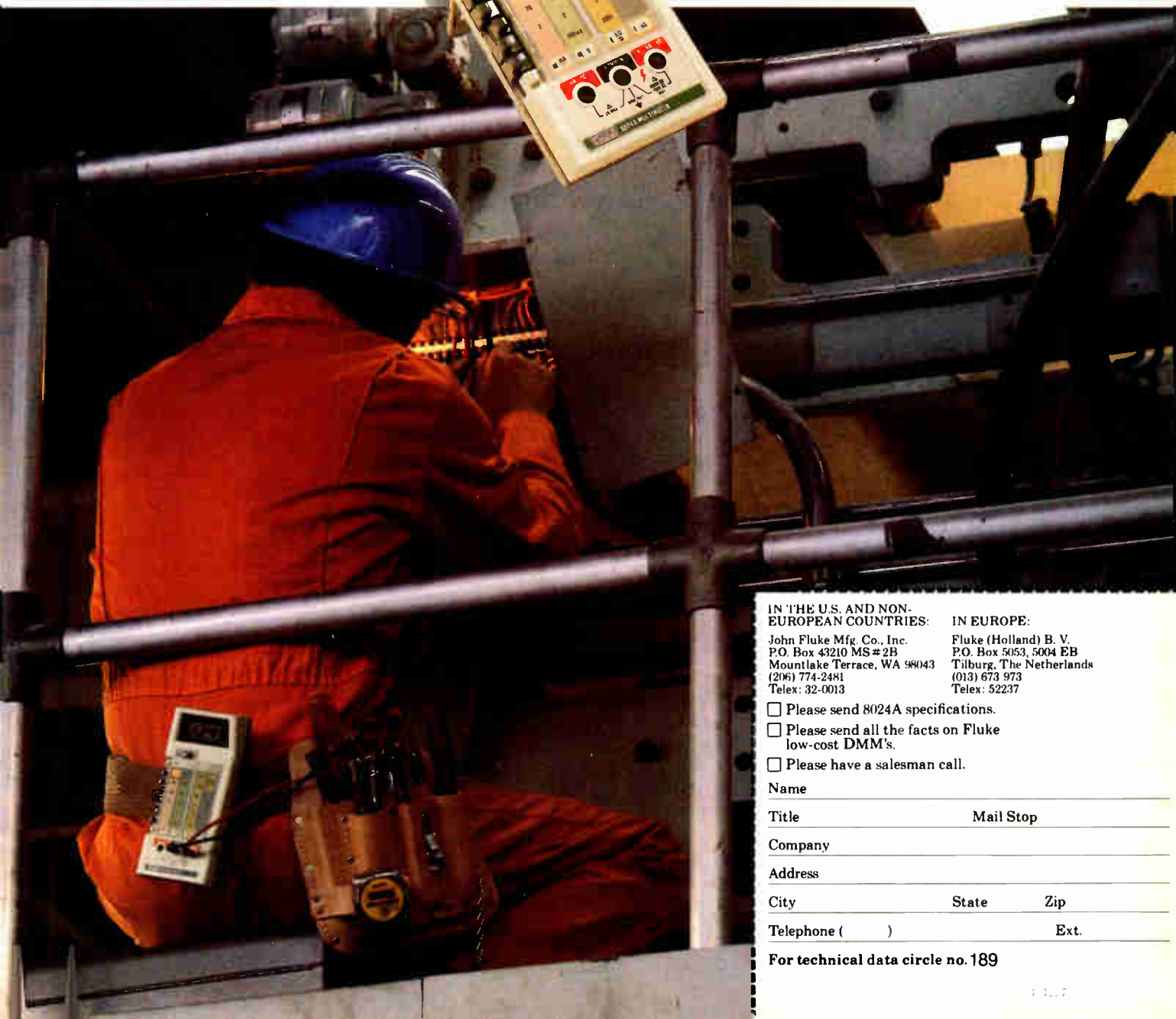

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Semiconductors

Single IC emits multiple signals

Frequency synthesizer uses dual-modulus prescaling to replace up to 12 ICs

A new family of complementary-MOS one-chip frequency synthesizers coming from Motorola Semiconductor takes square aim at what looks like a growing need in communications equipment: providing several stable frequency signals from a single source. Motorola's intention is to replace the 8 to 12 integrated circuits typically required for this job at present with one of its phase-locked-loop synthesizers. Two of the new devices, both programmed by serial inputs, already are available; five additional parts will follow shortly.

The trick in replacing up to 12 ICs with one large-scale integrated chip admittedly "is a difficult thing to pull off," says John Hatchett, principal staff engineer involved in the synthesizers' development. "We have to walk a tightrope in configuring them so as not to constrain the equipment designer in choosing how to prescale the signal."

Some of the synthesizers employ a "dual modulus" prescaling concept, says Hatchett. This technique uses paired prescaling values for dividing an input, providing the signal required for controlling external dual-modulus prescalers. Currently available IC prescalers of this type can extend the system frequency capability to beyond 500 MHz. In contrast, single-modulus devices operate directly at the frequency of the system's voltage-controlled oscillator.

Of the seven-part Motorola LSI family, both dual- and single-modulus configurations are available in each of three programming interfaces. The first two devices are the MC145155 18-pin single-modulus model and the MC145156 20-pin dual-modulus unit.

Still to come are parallel-programmed chips in both configurations and three other LSI synthesizers with functions for 4-bit data-bus programming. The serial and 4-bit data-bus units are "ideal for interfacing with microprocessor and microcomputer controllers," says Hatchett, whereas parallel-programmed devices mesh well with mechanical switches and programmable read-only memories.

Though differing in programming, packaging, and on-chip options, the chips share a number of operating specifications. These are: an operating voltage range of 3 to 9 V dc, an operating temperature from $-40°$ to $+85°C$, selection by the user of the reference frequency, and dc current drain of less than 5 mA for the 10-MHz reference and divided input signals. Common features include a crystal reference oscillator, a programmable reference divider, a digital phase and frequency detector, lock-detection circuitry, and necessary programmable $\div N$ counters. On-chip options include a choice of phase detector types and reference divider integer values.

In the new family, as a specific example, the MC145156 contains two programmable counters arranged in 10-bit and 7-bit configurations. The on-chip logic circuitry lets it control external, high-frequency, dual-modulus prescalers with values ranging from $-3/-4$ through $-128/-129$. When combined with a prescaler, loop filter, and VCO, the IC can provide all remaining functions required for a PLL frequency synthesizer operating up to several hundred megahertz. Emitter-coupled-logic prescalers can yield a system performance of more than 500 MHz according to Hatchett.

Although the new family is suitable for most general-purpose communications equipment, Hatchett singles out commercial two-way radios, avionics systems, and TV tuning address systems for the highest market priority.

Prices for the first two synthesizers, off the shelf in lots of 100 to 999,

Facts from Fluke on low-cost DMM's

Conductance: What it is, and what it can do for you.

We've often referred to conductance as the "missing function" in DMM's – the capability so many of you have wanted in a DMM but couldn't find until we introduced the 8020A Analyst.

Since its introduction, the Fluke 8020A has become the world's best-selling DMM. And four more low-cost models with conductance ranges have been added to our line. But you'll still find this function only on Fluke DMM's.

Simply stated, conductance lets you make resistance measurements far beyond the capacity of ordinary multimeters. Until the 8020A, there was no way to make fast, accurate readings from 20 MΩ to 10,000 MΩ – ranges typically plagued by noise pickup. Yet, measurements at these levels are vital in verifying resistance values in high-voltage dividers, cables and insulators.

With conductance, the inverse of ohms, which is expressed in Siemens – Fluke DMM's can measure extreme resistances. Simple conversion of direct-reading conductance values, then, yields resistance measurements to 10,000 MΩ (and 100,000 MΩ with the 8050A), without special shielding and using standard test leads.

Here the 8020A is being used to check leakage in a teflon pcb. With a basic dc accuracy of 0.1% and an exclusive two-year warranty, this seven-function handheld DMM has made hundreds of new troubleshooting techniques such as this possible, and more are being discovered every day.

For more details, call toll free **800-426-0361**; use the coupon below; or contact your Fluke stocking distributor, sales office or representative.

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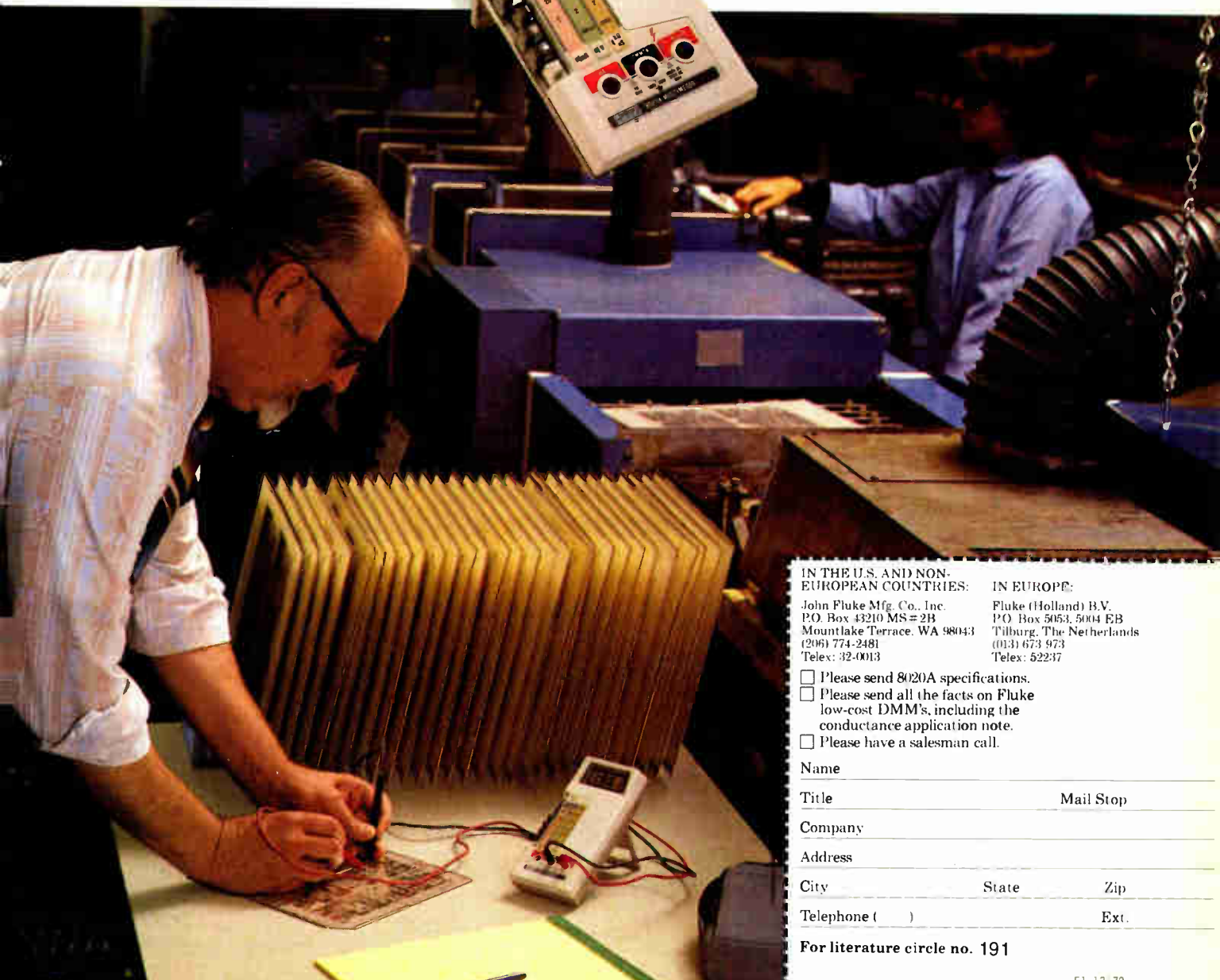

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☐ Please send all the facts on Fluke low-cost DMM's, including the conductance application note.
☐ Please have a salesman call.

Name

Title Mail Stop

Company

Address

City State Zip

Telephone ( ) Ext.

For literature circle no. 191

E1 12/79

are $4.95 each for the single-modulus MC145155 and $5.43 apiece for the dual-modulus MC145156. The parallel-programmed, 28-pin single-modulus MC145151 and 28-pin dual-modulus MC145152 will be available in sample quantities in January at a slightly higher price. Samples of the three 4-bit data-bus programmed chips, in 16- and 18-pin single-modulus and 20-pin dual-modulus configurations are to be ready in February.

Motorola Semiconductors, 3501 Ed Bluestein Blvd., Austin, Texas 78721. Phone (512) 928-6899 [412]

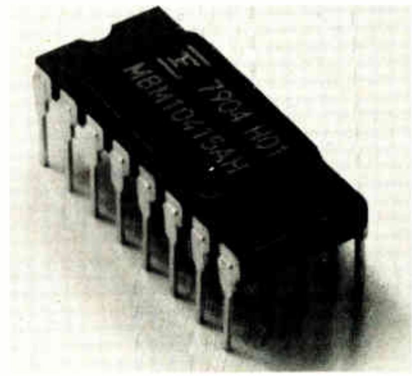
32-K static C-MOS ROMs draw 8-mA operating current

The CM-3200-2 and CM-3200-3 are 32-kilobyte static complementary-MOS read-only memories that require low power and are compatible with the 1802 microprocessor family. The CM-3200-2 has a maximum access time of 800 ns and can operate from a power-supply range of 4.75 to 5.25 V. The CM-3200-3 has a slower access time—1.5 μs maximum—but it has a wider V_{cc} range of 4.0 to 6.0 V. Both versions, which come in dual in-line packages, are organized in a 4,096-by-8-bit configuration that typically requires 8 mA of operating current. Prototypes of both ROMs are available three to five weeks after pattern release. They are priced at $5.45 each in 100,000-piece lots.

Supertex Inc., 1225 Bordeaux Dr., Sunnyvale, Calif. 94086. Telephone (408) 744-0100 [413]

1-k ECL RAM has 12-ns access time

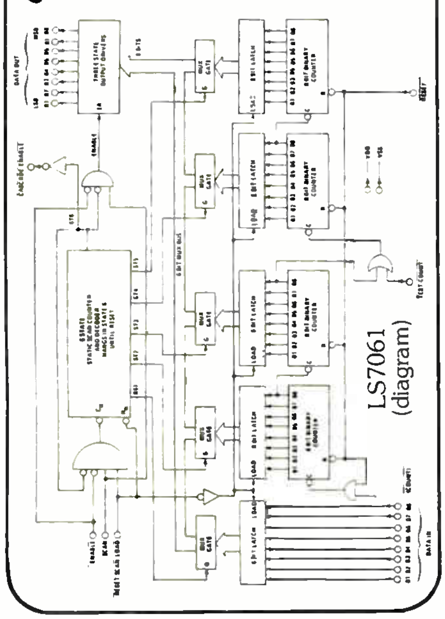
A 1,024-by-1-bit emitter-coupled-logic random-access memory has been designed for high-speed computer scratch-pad, control, and buffer-storage applications. The MBM 10415AH, a read/write memory, is fully compatible with industry-standard 10-K series ECL families. Address access time is typically 12 ns (20 ns maximum), and chip select time is 5 ns maximum. Power dissipation is 0.5 mW per bit. The device is packaged in a frit-sealed 16-pin dual in-line package. It uses patented processes—doped polysilicon and isolation by oxide and polysilicon. The RAMs are available off the shelf for $15.35 each in quantities of 1 to 24 and $11.90 for 25 to 99.



Fujitsu America Inc., 2945 Kifer Ave., Santa Clara, Calif. 95051. Phone Dan Buist at (408) 727-1700 [415]

IC voltage references drift only 1 ppm/°C

A family of integrated-circuit voltage references is claimed by the maker to provide true 12-bit performance over the full military (−55° to +125°C) and commercial (0° to 70°C) operating temperature ranges. The HA-1600, HA-1610, HA-1615, and HA-1620 are designed for use in digital-to-analog and analog-to-digital converters, in data-acquisition systems, in servo and positioning systems, and in signal comparison and detection. The HA-1620 has a 5-V output; the other devices provide 10 V. Each can operate over a wide range of input voltages, typically 12 to 20 V or 12 to 30 V. In addition the references feature outputs buffered by an operational amplifier with an uncommitted feedback loop, which allows the current to be boosted without significantly altering the accuracy of the voltage output. This is useful in



LS7061 (diagram)

Facts from Fluke on low-cost DMM's

Is this any way to treat a $129 multimeter?

In the rough world of industrial electronics, even a precision test instrument can get treated like dirt. You need all the ruggedness and dependability you can get in a DMM for field use.

You'll find these qualities and more in the Fluke line of low-cost DMM's. Our DMM's have been dropped from towers, stepped on, and run over by construction equipment. And they've survived because we never cut corners on quality, even on our lowest-priced, six-function Model 8022A Troubleshooter at $129 U.S.

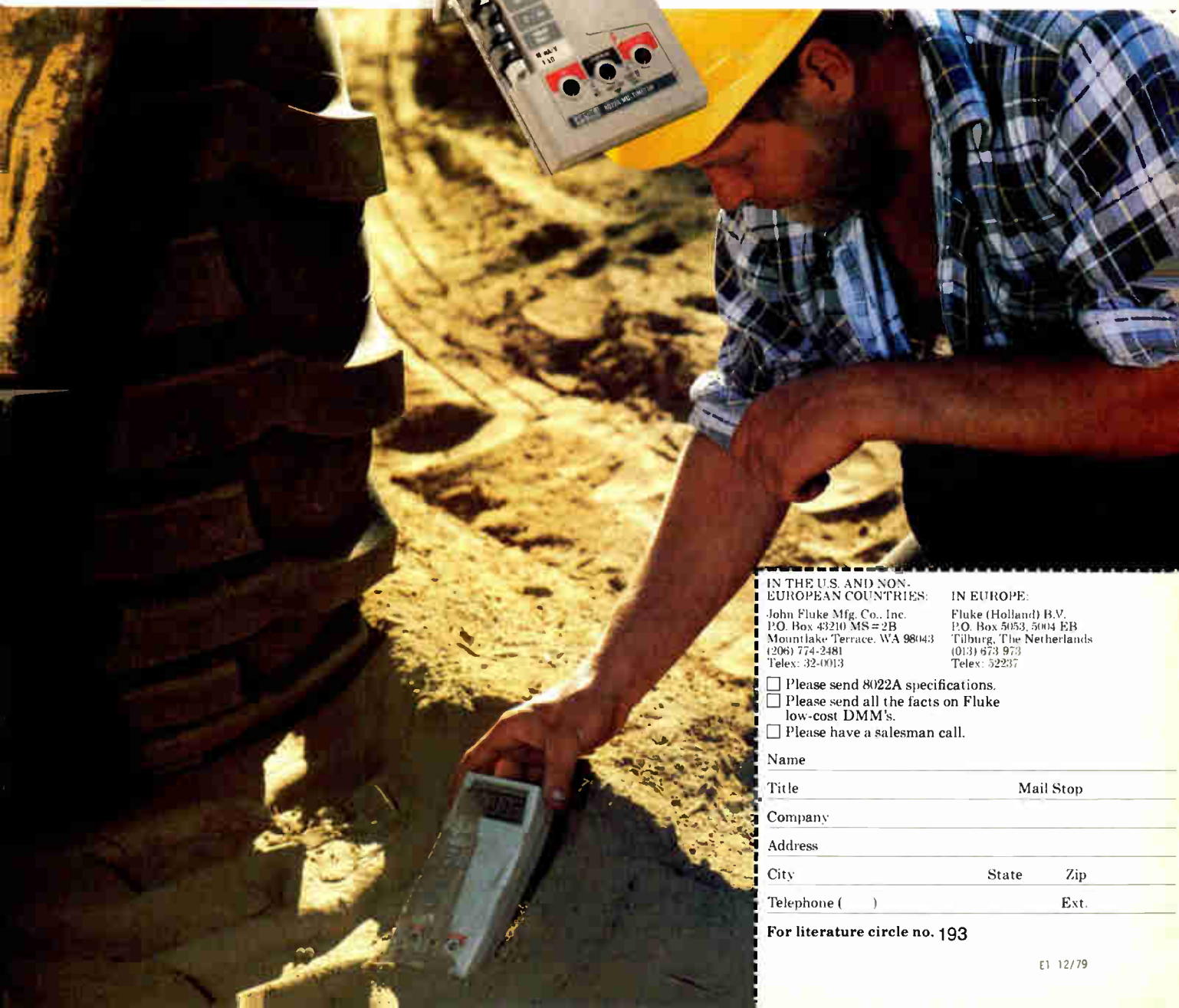
Take a close look at a low-cost DMM from Fluke and you'll notice tough, lightweight construction that stands up to the hard knocks of life. Sturdy internal design and high-impact, flame-retardant shells make these units practically indestructible. Right off the shelf, they meet or exceed severe military shock/vibration tests.

Even our LCD's are protected by cast-tempered plastic shields. We use rugged CMOS LSI circuitry for integrity and endurance, and devote a large number of components to protection against overloading, accidental inputs and operator errors.

We go to these lengths with all our low-cost DMM's to make sure they are genuine price/performance values. You can count on that. Because, that's what leadership is all about.

For more facts on DMM reliability and where to find it, call toll free **800-426-0361**; use the coupon below; or contact your Fluke stocking distributor, sales office or representative.

FLUKE®



IN THE U.S. AND NON-EUROPEAN COUNTRIES:
John Fluke Mfg. Co., Inc.
P.O. Box 43210 MS=2B
Mountlake Terrace, WA 98043
(206) 774-2481
Telex: 32-0013

IN EUROPE:
Fluke (Holland) B.V.
P.O. Box 5053, 5004 EB
Tilburg, The Netherlands
(013) 673 973
Telex: 52237

☐ Please send 8022A specifications.
☐ Please send all the facts on Fluke low-cost DMM's.
☐ Please have a salesman call.

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systems where one reference operates several devices.

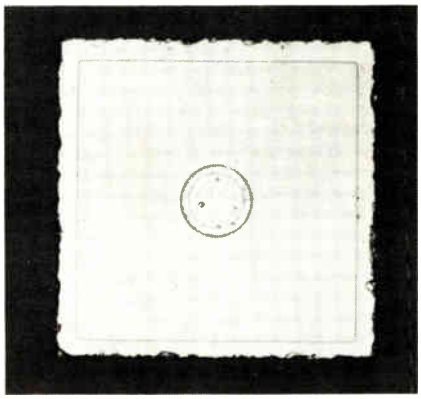
The HA-1600 and HA-1620 are temperature-compensated with an on-chip heating element. They can achieve temperature coefficients of 1 ppm/°C or better. The HA-1610 and HA-1615 provide better than 3 ppm/°C and 5 ppm/°C output voltage temperature coefficients over their full temperature ranges. Thus the HA-1610 is accurate within ±0.6 least significant bit, the HA-1615 to within ±1 LSB. The voltage references are available from stock in prices ranging from $30 for the military version of HA-1600 to $5.25 for the commercial version of HA-1615 if ordered in quantities of 100 to 999.

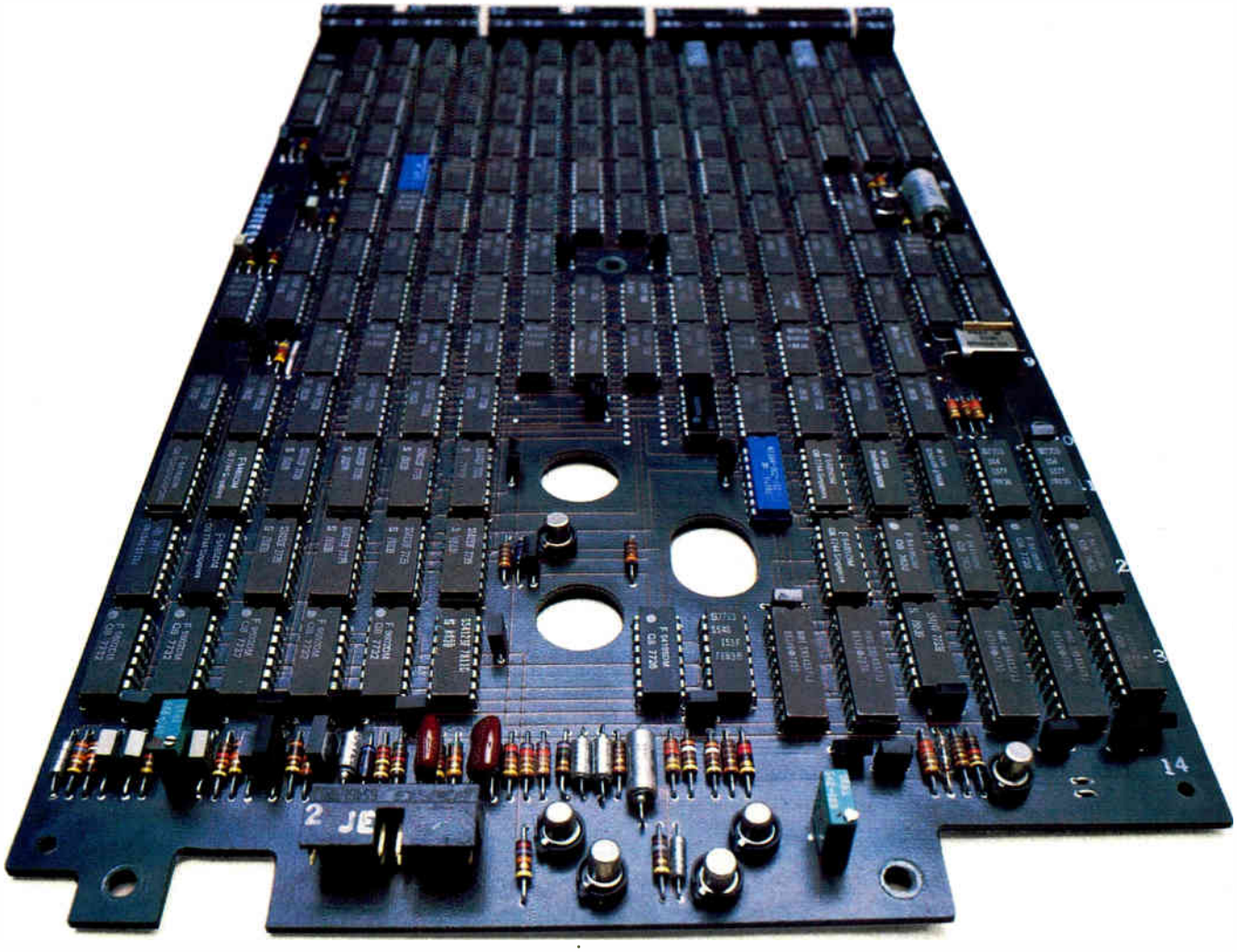
Harris Semiconductor Group, P. O. Box 883, Melbourne, Fla. 32901. Phone Ron C. Pittenger at (305) 724-7407 [414]

Schottky diodes offer 20-V minimum breakdown

Schottky-barrier diode chips for use in manufacturing hybrid circuits have a minimum breakdown voltage of 20 V at 10 μA. They have a maximum forward voltage drop of 1 V at 25 mA, plus a maximum capacitance of 1.2 pF at a reverse voltage of 0 V and a frequency of 1 MHz. Their operating and storage temperature range is −65° to 150°C. They also have a turn-on voltage of less than 0.4 V at 1 mA.

The chips measure 0.014 by 0.014 by 0.008 in. with a pad 0.003 in. in diameter. The anode is of gold for compatibility with ultrasonic and





Don Ende, Director of New Product Development, Miltope Corporation.

"From basic design to first board, we got 30-day turnaround on a militarized floppy disk formatter board."

According to Don Ende, "Getting the formatter board into our DD-400 floppy disk drive was a real shoehorn job. We had to pack 172 IC's onto a board 7 1/4" x 12 3/4" and still leave room for holes in the board through which the drive motor protrudes.

"Preparing the artwork for a multilayer board with such a high packaging density would have been extremely costly and time-consuming.

"Multiwire solved the problem. We provided artwork for the ground and power planes, a net list and a fabrication print. One month later we had our first boards. It also meant freeing our engineers for other work. The board assembly ultimately passed Mil-E-16400 environmental tests with flying colors."

Fast turnaround is just one benefit of using Multiwire. Equally important are such things as meeting military specifications, easy design changes, higher production yields, and lower design cost. We think the choice is obvious. Let us show you why.

Call or write today for details. Multiwire, 31 Sea Cliff Avenue, Glen Cove, NY 11542. Phone (516) 448-1307.

MULTIWIRE

Multiwire is a registered trademark for Kollmorgen Corporation discrete wired circuit boards.

Circle 195 on reader service card

thermocompression bonding; the cathode is of chrome-silver for epoxy or solder die attachment. The chips are priced from $0.25 each, with delivery from stock to four weeks.
Compensated Devices Inc., 166 Tremont St., Melrose, Mass. 02176. Phone (617) 665-1071 [416]

P-i-n diodes have less than 1-Ω resistance at 3 mA

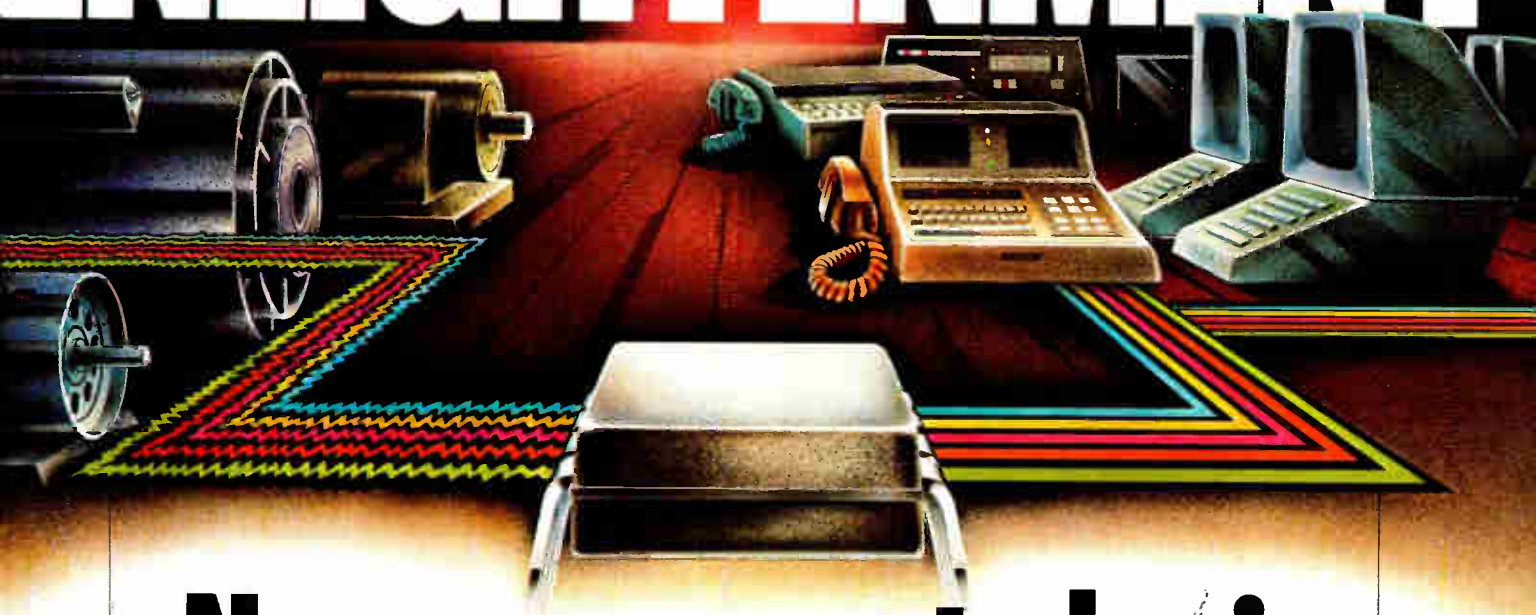
Two p-i-n radio-frequency switching diodes for very- and ultra-high-frequency communications and test equipment applications have resistances of 0.6 and 0.8 Ω at 3 mA of bias current. KS-3542 and KS-3543 have diode capacitances of 0.8 and 0.7 pF at 3 V of reverse bias, which increase by 0.2 pF if the bias is removed. The diodes are packaged in a hermetically sealed DO-34 package that contributes 2 nH of inductance to these products. Leads 2 mils in diameter and over 1 inch long may be inserted manually or automatically. The diodes are available directly from stock and are priced at 39 cents each in quantities of 100 to 999.
KSW Electronics Corp., South Bedfort Street, Burlington, Mass. 01803. Phone Dick Hersum at (617) 273-1730 [417]

325-V transistor has gain of 15 at 2.5 A

A silicon power transistor designed for switching-circuit applications and power amplifiers qualifies for Joint Army-Navy specification MIL-S-19500/414. The JAN-2N5241 is a double epitaxial process npn transistor. It has a collector-to-emitter sustaining voltage of 325 V, a minimum gain of 15 at 2.5 A, and a saturation voltage of 0.7 V at 2.5 A. This device comes in a hermetically sealed TO-3 steel case, priced at $12.45 each in 100-unit lots. It is delivered from stock.
Silicon Transistor Corp., Katrina Road, Chelmsford, Mass. 01824. Call William A. Schromm at (617) 256-3321 [419]

ENLIGHTENMENT

ADVANCED OPTOELECTRONIC PRODUCTS



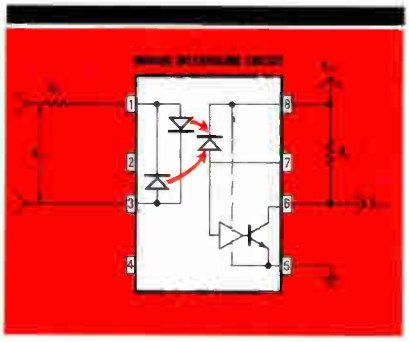
Now, a power to logic optical interface that monitors AC line status

General Instrument's MID400. It's the first optically isolated interface to have direct operation from an AC line current and direct compatibility to TTL and microprocessor systems. Not only do you get a device with direct interface from line voltages ranging from 24V to 240V, but one with externally adjustable time delay and AC voltage sensing. Add to that . . . logic level compatibility and high isolation between input and output.

A system sentry with motor to logic capability. The MID400 is the perfect answer to monitoring AC "line down" conditions. When the power goes, the MID400 can activate auxiliary power control. In industrial control applications, the MID400 is an ideal "closed loop" interface between electromechanical elements such as solenoids, relay contacts, small motors and microprocessors. This closed loop capability may also be utilized in emergency shut down or fail safe applications. And if your system needs an AC current status monitor, a 2 or 3-phase power line status monitor, telephone ring detector or a low speed, high gain optocoupler interface, there's no better device than the MID400.

Low power . . . low current. AC line voltage is monitored by two back-to-back GaAs LED diodes in series with an external resistor. A very high gain detector circuit senses the photodiode current and drives an open collector transistor to a logic low condition.

With a low threshold input current, the MID400 provides energy savings and less heat in your system. Packaged in a UL recognized 8-lead plastic mini-DIP, it's also a space saver.



It's another first from the new name in optoelectronics. For more information on our new MID400, contact General Instrument, Optoelectronics Division **(formerly Monsanto Optoelectronics)**, 3400 Hillview Avenue, Palo Alto, California 94304. Telephone: (415) 493-0400.

GENERAL INSTRUMENT

Circle 197 on reader service card

Whose MCU does 8-bit jobs on a

AMI's S2000 FAMILY, OF COURSE.

With power packed into every square mil of its tiny frame, our mighty microcomputer family is saving the day everywhere you look. From industrial controls on one end of the spectrum to handheld games on the other, our 4-bit wonder is proving to be as versatile as it is cost-conscious.

No other low-end, single chip microcomputer family can handle the jobs Mighty MOS can. Controlling programmable thermostats for industry, pay-TV scrambler boxes, fuel gauges and instrument panels. Running washers, dryers, dishwashers, refrigerators and microwave ovens. And masterminding timers for the home that will turn on lights, sprinkler systems and security monitors.

In one application after another, Mighty MOS is finding more holes in the competition than Swiss cheese.

WHAT GIVES MIGHTY MOS THE EDGE?

It's not only powerful enough to take care of many 8-bit jobs. It's also crafty enough to handle many things other 4-bit microcomputers can't.

Our tiny champion of oppressed engineers has a clear edge in I/O, with a choice of LED or fluorescent drivers; Touch Control; or direct drive of SCR and Triac. It has a 50/60 Hz timer or counter, zero voltage crossing to cut down damaging current surges, and a three-level subroutine stack.

And Mighty MOS is the only 4-bit MCU supported by the Tektronix 8002A development system. That gives it more programming muscle, too.

MIGHTY MOS IS GROWING FAST.

You can order S2000s now with built-in 1Kx8 ROM and 64 4-bit nibbles of RAM. And S2150s, with 1.5K bytes of ROM and 80 nibbles of RAM.

MIGHT

4-bit budget?

In a few months, three more Mighty MCUs will expand the memory even more and include features like analog I/O, interrupts and table look-ups. One of them will be a CMOS version that can do a lot with very little power. When they come flying in, you'll find it easy to upgrade your system, adding even more power and punch without adding much cost. Because all parts of our family software are upward compatible.

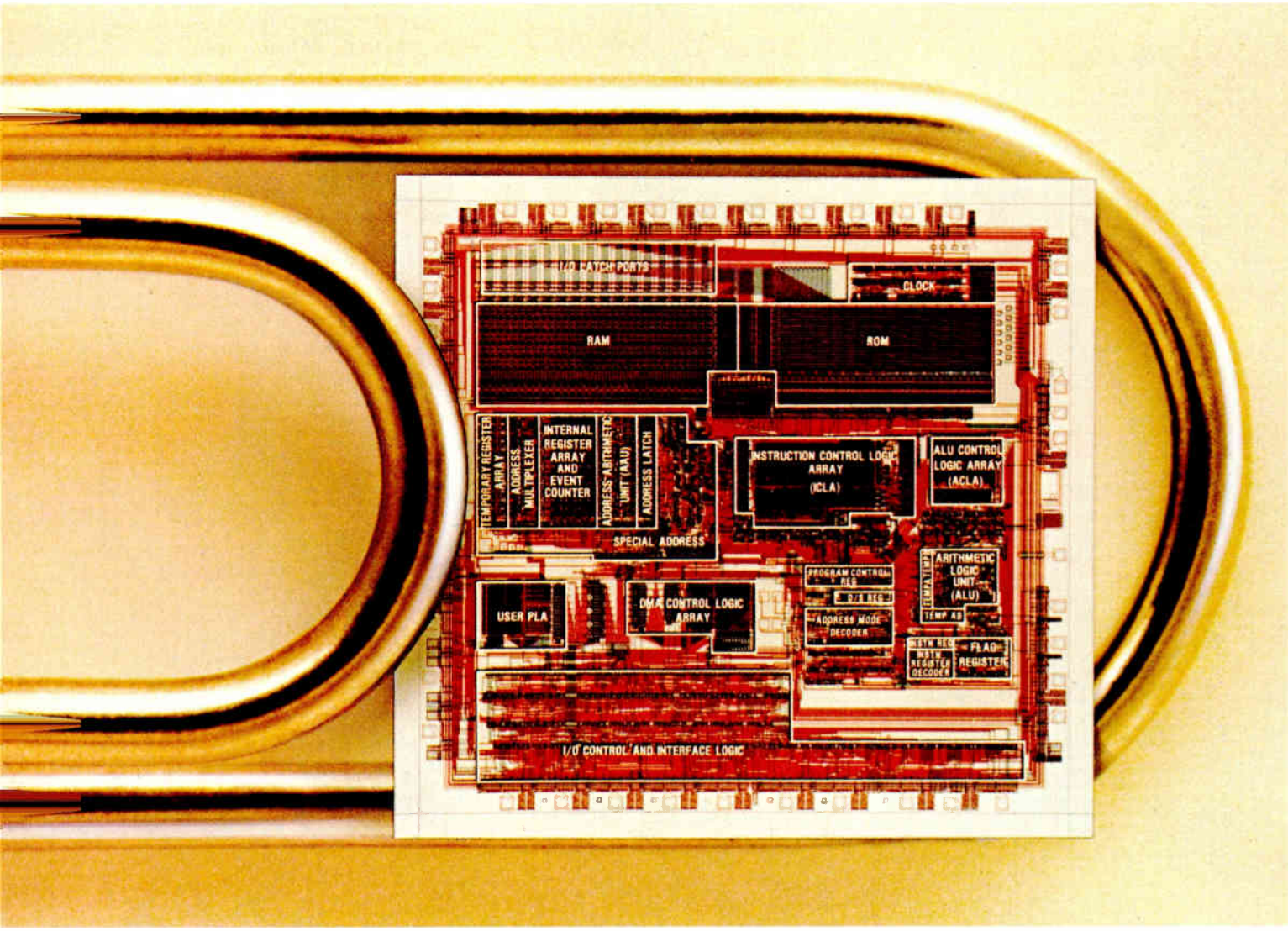
So let Mighty MOS stretch your 4-bit budget. Just get in touch with your nearest AMI sales office. California, (213) 595-4768 and (408) 738-4151; Florida, (305) 830-8889; Illinois, (312) 437-6496; Indiana, (317) 773-6330; Massachusetts, (617) 762-0726; Michigan, (313) 478-9339; New York, (914) 352-5333; Pennsylvania, (215) 643-0217; Texas, (214) 231-5721; Washington, (206) 687-3101. Or contact AMI S2000 Marketing, 3800 Homestead Road, Santa Clara CA 95051. Phone (408) 246-0330.

YOU'LL FIND IT ISN'T HARD TO BE A HERO WITH MIGHTY MOS ON YOUR SIDE.

AMI®
AMERICAN MICROSYSTEMS, INC.

Y MOS

The one-chip computer: offspring of the transistor



The MAC-4 one-chip computer, developed for a variety of telecommunications applications, is compared to a standard-sized paper clip. The chip's numerous functional areas are labeled.

One of the transistor's latest descendants is the Bell System's 30,000-element MAC-4 "computer-on-a-chip." It's another in a long line of microelectronic developments that have come from Bell Laboratories.

The MAC-4 is so efficient that a program written on it takes 25 percent less storage space than that required by most other microcomputers. Its assembler language, C, also developed at Bell Labs, has features that make MAC-4 easier to program, debug and maintain. And the MAC-4 can handle anything from nibbles to bytes to words with its 4-, 8-, 12-, and 16-bit operations capacity.

Like other one-chip computers, the MAC-4 has sufficient memory to support its varied tasks—3000 nibbles of read-only memory and 200 nibbles of random access memory coupled to 34 input/output ports.

Fabricated with the latest CMOS technology, the MAC-4 needs little power. Thus it is well matched to a variety of telecommunications applications.

It started with the transistor

MAC-4 is just one current example of the many microelectronic devices to come from Bell Labs since we started the solid-state revolution with the invention of the transistor in 1947.

Over the past three decades, our advances in materials, processing, and devices have been vital to solid-state technology. These include:

- The Junction Transistor
- Crystal Pulling
- Zone Refining
- Field-Effect Transistor
- Diffusion
- Solar Cell
- Oxide Masking
- Thermocompression Bonding
- Photolithography
- Epitaxial Film Process
- Magnetic Bubble Memory
- Charge-Coupled Device
- Semiconductor Heterostructure Laser Used in Lightwave Communications
- Electron-Beam Exposure System

Today and tomorrow

Today, we continue to make important contributions to solid-state technology. For example, we've developed a rugged 65,536-bit RAM that can tolerate processing faults. Corrections can be made on the chip itself, so we can get more usable chips out of each manufacturing batch—and thus lower unit costs.

In materials processing, we've developed a technique for precisely controlling the growth of successive atomic layers of single crystal materials. This "molecular beam epitaxy" process is finding increasing use within Bell Labs and elsewhere in the electronics industry. We've used it to fabricate a device that permits us to double the speed of electrons by channeling them into crystal layers where they meet less resistance.

Other advances, in X-ray lithography and new resist materials, for example, promise to help place more elements on microelectronic devices and thus enhance their ability to perform important tasks.

As the solid-state revolution continues, these and other developments from Bell Labs will play an important part in it. What's important to us is the promise these advances offer for new telecommunications products and services. Like the transistor, MAC-4 and its solid-state relatives will find more and more applications in the nationwide telecommunications network.

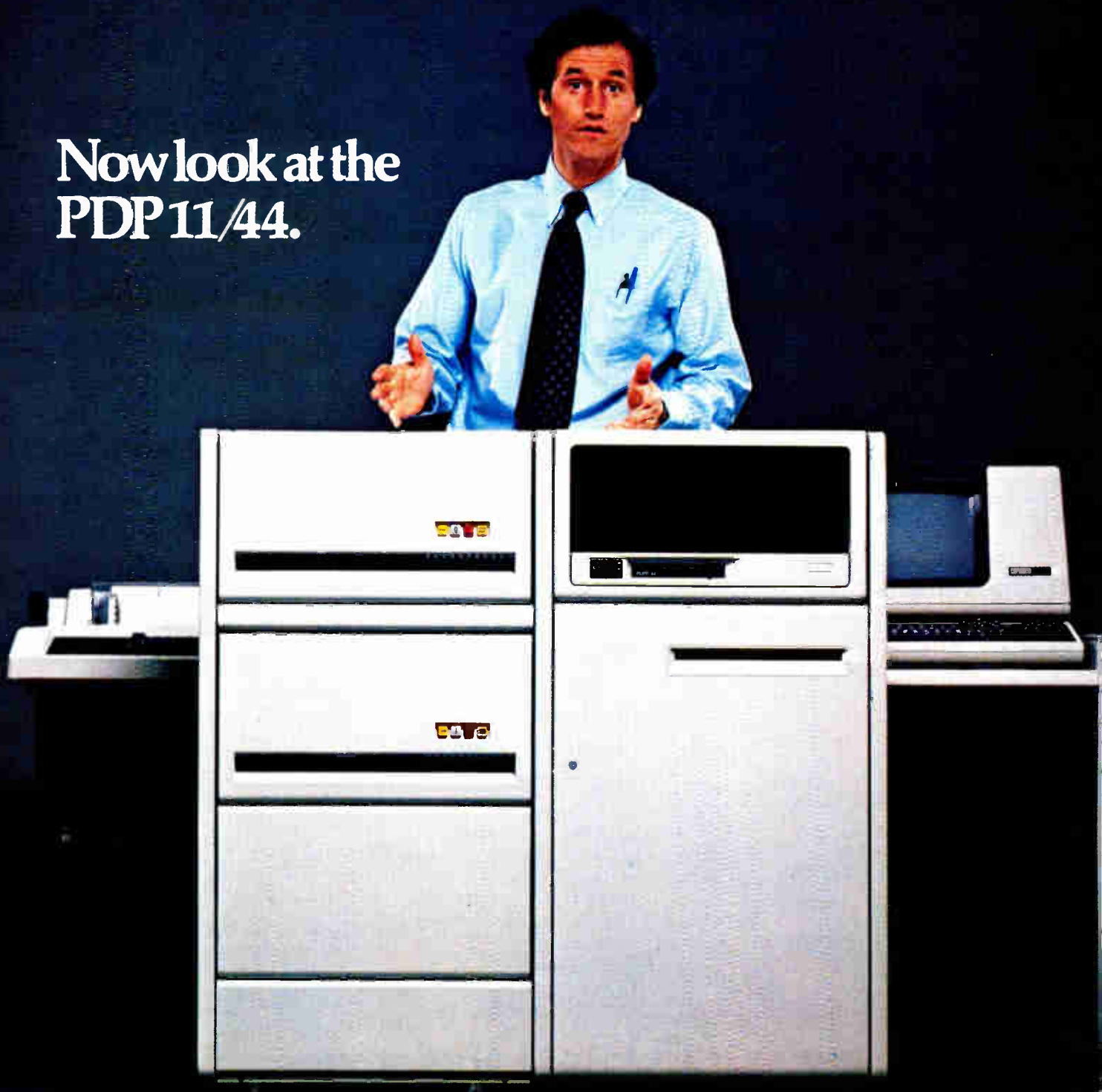
For further information, or to inquire about employment opportunities, write: Bell Laboratories, Room 3C-303, 600 Mountain Avenue, Murray Hill, N.J. 07974.

Bell Laboratories

From Science: Service

You looked at the 11/34 and loved the price.
You looked at the 11/70 and loved the features.

Now look at the PDP 11/44.



Digital introduces a mid-range mini with a megabyte of main memory, decimal arithmetic, and an expanded 11/70 instruction set.

Now for little more than the cost of an 11/34, our new PDP-11/44 gives you features previously found only on superminis. Like PAX, a physical address extension that gives you a full megabyte of main memory for more users, larger programs, greater throughput. A new MOS ECC memory with interleaving for faster access time. 8KB cache memory for faster program execution and greater DMA bandwidth. Sophisticated memory management. And an expanded 11/70 instruction set.

The 11/44 also offers significant performance advancements in two important languages. Our optimized FORTRAN IV-PLUS compiler and run time system, coupled with our floating point processor option, gives impressive performance advantages over conventional FORTRAN. And our enhanced COBOL compiler with our new optional Commercial Instruction Set processor, delivers powerful COBOL performance and data processing capabilities.

To keep the 11/44 on the job, you get plenty of reliability features, including a microprocessor-controlled ASCII console with extensive system diagnostic capabilities. A new built-in TU58 cartridge tape for easier servicing. Plus facilities for optional remote diagnosis for 24-hour-a-day, 7-day-a-week service with an average response time of less than 15 minutes.

Of course the 11/44 shares the design advantages of our entire PDP-11 family. Most importantly, it guarantees software compatibility the way only the world's broadest range of 16-bit compatible computers can. So your software investment remains intact no matter which system you choose. RSX-11M, the most versatile real time system in the industry. The new RSX-11M-PLUS. Or the new enhanced version of our proven general purpose and timesharing system, RSTS/E. You can also tailor the 11/44 to your exact application by choosing from a broad line of interfaces and peripherals, like our new 20 megabyte RL02 disk subsystem.

No matter how you look at it, the PDP-11/44 provides an incredibly powerful base for your interactive and distributed processing applications.

And that's saying a lot for a system that costs so little.

☐ Please send me more information about the PDP-11/44.
☐ Please have a salesperson call.

Name _____

Company _____

Address _____

City _____ State _____ Zip _____

Phone _____

My application is: ☐ Education ☐ Medical ☐ Laboratory ☐ Engineering ☐ Government ☐ Resale ☐ Manufacturing ☐ Other

Send to: **Digital Equipment Corporation,** 146 Main Street, Maynard, MA 01754, Attn: Communication Services, NR-2/2, Tel. 617-481-9511, ext. 6885. Digital Equipment Corporation International, 12 av. des Morgines, 1213 Petit-Lancy, Switzerland. In Canada: Digital Equipment of Canada, Ltd. N-12-6-9

digital

Circle 203 on reader service card

Instruments

Analog multiplexer sells for $585

Unit operates in four modes to ±300 V, joins with DMM to form data-acquisition system

A user with a good digital multimeter is halfway to owning a data-acquisition system, according to Data Precision Corp. All that's needed is the firm's new model 3420 analog multiplexer. Alternatively, the 3420 is a low-cost way of adding to the capacity of an existing data-acquisition system.

The unit has either 16 channels (two wires plus guard) or 8 (four wires plus guard) that combine a low on-resistance (0.5 Ω) with high interchannel isolation (10^9 Ω). Bifurcated relays with gold contacts make these attractive specifications possible.

The 3420 also combines a relatively high voltage capability with low noise; the unit handles ±300-V dc or 300-V ac peaks at currents as high as 100 mA. Noise is essentially that of the device's series resistance—about 1 to 2 μV, according to president Harold Goldberg. Switching noise is not a factor in the multiplexer's performance as its output is disabled during transition from one channel to another.

Goldberg calls the guard that shields each pair or quartet of signal-carrying wires an important aid to reducing electrical noise in the industrial environment. The guard "floats" at the sense end of connections to the 3420, but when the appropriate channel is selected, it connects directly to the guard terminal found on higher-quality multimeters. Aside from noise control in the four-wire-plus-guard mode of operation, the extra pair of wires allows ratiometric measurements at a distance from the multimeter.

The 3420 has four operating modes: manual, scan, remote, and slave. The first two are selected by means of push buttons on the front panel with scan rates of 10 channels/s to one channel/10 s using a front-panel potentiometer. Even slower rates are possible by outboarding an external timing capacitor. In the manual mode, channels are selected using channel-advance and -reset push buttons.

In the remote mode, channels may be selected serially or at random,

Inventory reports

Point-of-sale

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Environmental control

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Computer graphics

Sylvania breaks the color barrier.

Introducing America's first 19-inch color data display tube.

Not just a tube with color.

A tube with gorgeous, glorious, sharp Sylvania color.

Color that provides clearer images and better contrast than anything available anywhere.

Color that makes small characters a breeze to read, with less fatigue.

Crystal clear color created by a high density tri-dot mask.

Color sharpened by a multiple-beam electron gun and enhanced by a Chromatrix dark surround negative guard band, and a rare earth phosphor system.

Sylvania color.

It's completely changed the picture in data display tubes.

Write Product Marketing Manager for our latest catalog:

GTE Sylvania
Data Display Tube Division
700 North Pratt Street
Ottawa, Ohio 45875

SYLVANIA | GTE

Circle 205 on reader service card

SE 7000: Multiband performance – Multi-channel check-out

SE 7000 Series Instrumentation Recorders give you 8 speed recording up to 2MHz Direct, 500 kHz FM and up to 30 k bpi HDDR. The SE 7000 has in addition a unique range of features essential to lab quality recording, with a convenience, simplicity and reliability that no other recorder can offer.

Consider, for instance, the versatile built-in calibrator module with DVM for "set and forget" control, and the unique simultaneous all-channel FM electronics to electronics facility, without tape movement – the higher reliability of hard-wired, all speed active filters, equalisers and other tape speed sensitive components – the proven dependability of co-planer format resulting in more gentle tape handling and lower tape wear.

Don't accept second best. We would like to show you how the SE 7000 can match your requirements in instrumentation recording. Call us or send reader card for details.

SE 7000M – the only wideband portable with built-in 14 channel electronics to electronics FM calibration and pre-record checkout.

EMI Technology

EMI Technology Inc.,
100 Research Drive,
Stamford C.T. 06906.
Tel: 203 356 1300 TWX 710-474-0128

A member of the EMI group. International leaders in music, electronics and leisure.

Circle 206 on reader service card

New products

using control signals applied at an IEEE-488-compatible interface at the back panel. Almost any number of multiplexers may also be slaves to each other, each operating synchronously with its companions. Again the IEEE-488 bus is used for control.

In all operating modes, the selected channel is shown on a front-panel light-emitting diode display. There also are indicators for remote or manual-mode operation.

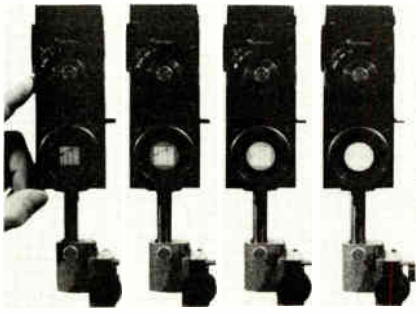
The model 3420 analog multiplexer sells for $585 with delivery from stock to 30 days.

Data Precision Corp., Electronics Avenue, Danvers, Mass. 01923. Phone (617) 246-1600. [351]

Optical test target offers adjustable contrast

The model 26-7567 variable-modulation test target is a precision optical device that offers a contrast ratio adjustable from 0% to 96%. According to Ealing Corp. sales manager Richard M. Anderson, the target, whose contrast control is based on a polarization principle, is the first such unit to offer self-variable contrast. A simple dial control sets the instrument to the high-, medium-, and low-contrast levels specified in Military Standard 150A.

The 26-7567 uses a 15-bar target with a spatial-frequency range of 0 to 1,000 line pairs/mm. With the variable-contrast feature, this lets users insert signals of precisely known frequency and contrast into



New products

any optical system for the purpose of testing such performance characteristics as sensitivity and resolving power. Particular applications cited by Ealing for the target are military reconnaissance, night-vision, and television equipment.

Standard features of the 26-7567 include a mounting pin with a diameter of 13.7 mm, a lamp power control, and visibility calibration tables. The unit, which is available from stock, sells for $5,575.

Ealing Corp., 22 Pleasant St., South Natick, Mass. 01760. Phone (617) 655-7000 [352]

Double bridge measures resistances down to 100 $\mu\Omega$

A lightweight resistance bridge for use in shunt-resistance measurements, low-resistance coil measurements of current transformers, or electrical motor repair shops measures low resistances from 100 $\mu\Omega$ to 11 Ω in five ranges, with a measurement uncertainty of 0.5% of range. Designed for portability, the Thomson's double bridge operates from 120 or 220 v ac and needs no batteries. Zero detection in the instrument is by means of a meter with a taut-band suspension. A logarithmic amplifier provides high sensitivity while protecting the galvanometer from overload. The temperature influence is less than 0.2% for every 10°C.

The bridge (catalog no. 141.100)

abbott POWER SUPPLIES

Our standard products meet MIL specs

Why order "specials" and pay for "options" when you can get an Abbott militarized power module virtually off-the-shelf for fewer dollars per watt? Take our Model C's and W's, for example. They're hermetically sealed, feature superior tracking accuracy for *all* rated conditions, and come in package sizes as small as 2⅛" x 3¼" x 3¼". (The units we put on SKYLAB, except for some special components and testing, were "standard".)

28 VDC to DC Power Modules (Model "C") — feature smaller volume, lower weight, and higher performance. Low peak-to-peak ripple and close regulation meet even the most demanding specs. The standard Model "C" line converts 24-30 volts DC to any output between 5 and 100 volts DC.

For Catalog Circle Card Number 100

400 Hz to DC Power Modules (Model "W") — feature close line and load regulation, low output ripple, and are built to meet the EMI requirements of MIL-STD-461. The Model "W" family provides output voltages from 5 to 100 VDC with current levels from 0.3 to 20 amps. Why waste time and money designing a "special" power supply?

For Catalog Circle Card Number 101

Dual Output Versions — both the C and the W series are available in hermetically sealed, dual output models that feature 1% tracking accuracy, 0.2% regulation, low peak to peak ripple, +100°C operation . . . and we offer CC's and WW's as standards, not "specials."

For Catalog Circle Card Number 102

See Power Supply Section 4000, and Transformer Section 5600, Vol. 2, of your EEM catalog; or Power Supply Section 4500, and Transformer Section 0400, Vol. 2, of your GOLD BOOK for complete information on Abbott products.

abbott transistor

LABORATORIES, INCORPORATED

General Offices
5200 W. Jefferson Blvd., Los Angeles 90016
(213) 936-8185 Telex: 69-1398

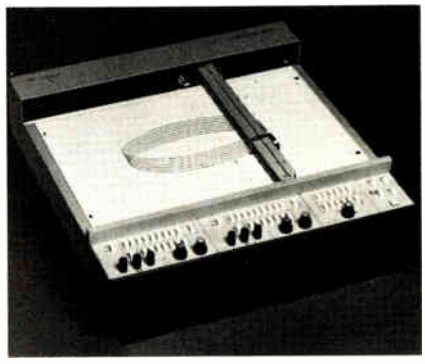
Eastern Office
1224 Anderson Ave., Fort Lee, N.J. 07024
(201) 224-6900 Telex: 13-5332

is available from stock for $531. It is built in a leatherette carrying case that measures 10.7 by 7.5 by 5.2 in. and weighs 5 lb, 6 oz.

AEMC Corp., 729 Boylston St., Boston, Mass. 02116. Phone (617) 266-8506. [354]

Sensitive X-Y recorder sells for $2,350

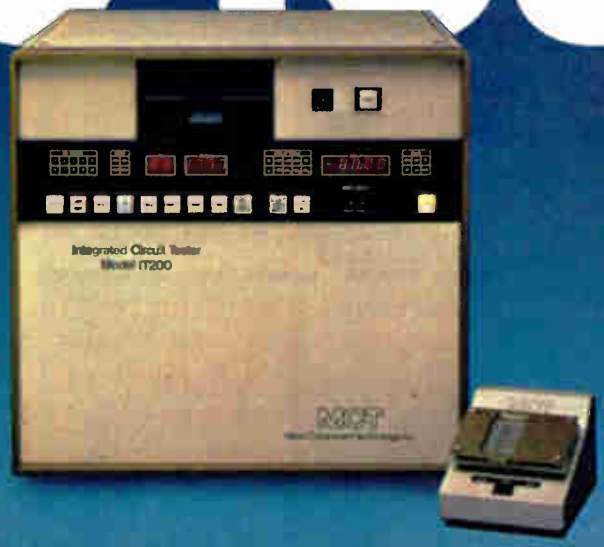
An X-Y recorder priced at $2,350 permanently charts fast-changing signals, which makes it useful for transient signal analysis and destructive testing. The Gould 3054 has a slewing speed of 85 cm/s minimum, Y-axis acceleration of 7,700 cm/s², and X-axis acceleration of 5,100 cm/s². Fourteen sensitivities of 200 μV/cm to 5 V/cm may be selected by push button to accommodate a wide range of input signal amplitudes. The X- and Y-axis preamplifiers include calibrated zero offset in five steps from ±100% to ±500% of full scale, to suppress the static portion of an input signal so that its dynamic portion can be amplified for examination. Also, the preamps have



a low-pass filter that attenuates their outputs by 12 dB per octave starting at 5 Hz, so that any unwanted noise or high-frequency components they contain can be excluded from the recorded traces.

The 12.5-by-17.5-in. writing table of the 3054 holds both 11-by-17-in. and 8.5-by-11-in. chart paper electrostatically. An optional time-base module that supplies six timed ramp voltages can be made an integral part of the recorder for $250 above the base price. Delivery of the 3054

MORE POWER TO YOU.



THE IT200™ TEST SYSTEM FROM MCT.

Power. Capability. Accuracy. That's what you'll get from the MCT IT200™ digital IC test system. In fact, the IT200 has the power to test more kinds of ICs more accurately than any other "bench-top" tester.

If you test a variety of IC types...TTL, CMOS, ECL, and others...the IT200 is right for you. 48-pin testing capability plus total programming flexibility allows the IT200 to keep pace with your growth.

The IT200 has the accuracy you need for complete testing and thorough failure analysis. That translates to fewer component failures and higher quality levels in your end product.

When you specify the MCT IT200 you can be assured you're specifying equipment that's been proven by performance over many years. And you can be assured of the most comprehensive support in the industry.

Before you specify any other IC test system, you owe it to yourself to find out more about the IT200. Write MCT or call us collect at (612) 482-5170. We'll send a brochure that'll show you how to get more testing capability for your money.

MCT

Micro Component Technology, Inc.

P.O. Box 43013, St. Paul, Minn. 55164

Circle 211 on reader service card

New products

is set for the first quarter of 1980. Gould Inc., Instruments Div., 3631 Perkins Ave., Cleveland, Ohio 44114. Telephone (216) 361-3315 [355]

Reliable digital panel meters fit standard cut-outs

Two panel meters that can be mounted easily from the front of a panel are compatible with the Analogic 2570 and 2574 series. Model 379A, with 3½ digits (a 1,999-count), is compatible both pin for pin with the Analogic 2570 and with its panel cut-out. Model 479A is a 4½-digit (19,999-count) meter interchangeable with the Analogic 2574 series. Both are housed in DIN standard cases and have 0.56-in. light-emitting diodes. Large-scale integration allows a choice of four ranges for the panel meters, from 200 mV to 200 V, with optional three- or four-wire ratio operation. Buffered and latched parallel binary-coded decimal outputs are available with or without 500 V of optical isolation between the input and output circuitry, for digital multiplexing or busing; 5-V dc powered units are also available with 500 V of common-mode isolation.

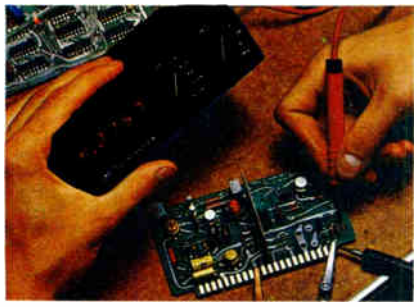
The input of the 3½-digit model may be single-ended or differential, with input power at 110 or 220 V ac ±20%, 50 to 400 Hz. Input offset and scaling are available for displaying directly in engineering units when the panel is connected to current or voltage transmitters. The 4½-digit 479A features ultralow-noise a-d conversion, auto zeroing, and true differential input. The reading error is plus or minus the sum of 0.005% of the reading added to 1 count, with zero stability of ±0.1 μV/°C. The bias current is typically 20 pA. Binary-coded decimal outputs in the 479A are available in either parallel or serial form, or both. The price of the 3½-digit panel meter is $69; the 4½-digit model goes for $139.

Data Tech Division of Penril Corp., 2700 South Fairview, Santa Ana, Calif. 92704. Phone Don Woods at (714) 546-7160 [356]

10μ volt sensitivity, 10 nanoAmp sensitivity, and True RMS measurement in a 4½-digit portable DMM... $295.*

The Model 248's exceptional sensitivity and accuracy is only the beginning. Data Precision has utilized proven circuit design techniques plus LSI/MOS chip economy and dependability to ensure outstanding reliability.

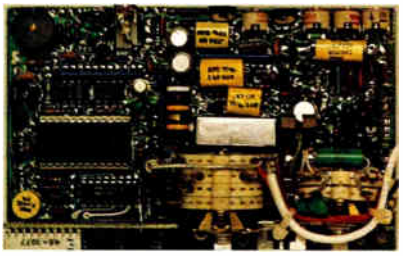
The result: a truly portable, high-performance, full-function instrument that provides sensitivity to 10 microvolts and 10 nanoAmps DC and AC, unsurpassed ±0.05% basic accuracy, and true RMS measurement for AC . . . with all specifications guaranteed for a full year.



Measuring just 5½" x 1¾" x 3½", and weighing only 1.3 pounds, our 248 is the only rechargeable portable, 4½-digit DMM that brings you the advantage of True RMS voltage measurements. And with full 4½-digit resolution on all parameters, you'll have lab performance in the field or on the bench.

Exceptional Reliability

Model 248's sensitivity, accuracy, and portability place it in a class by itself, and its reliability is just as impressive. Its extremely low component count and optimal use of advanced chip technology and design makes Model 248 by far the most dependable True RMS 4½-digit portable



multimeter available (all the way down to 10μ Volts). In fact, it's so reliable we guarantee its accuracy for a full year.

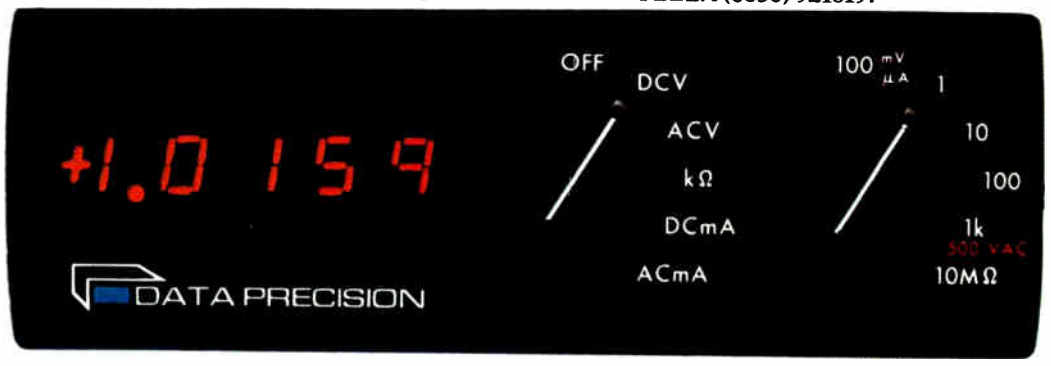
With only two controls—Function and Range—and the bright 0.33" LED display for easy reading in any light, you'll save time on every job. And Data Precision's overload protection

circuits make it forgiving of mistakes on all functions.

$295.* Complete

Charger, NiCd battery, input leads and carrying case are supplied with the instrument. Model 248 is available throughout the world from Data Precision distributors, and service is available from any of our world-wide service centers.

Data Precision Corporation, Division of Analogic Corporation, Electronics Avenue, Danvers, MA 01923, USA, (617) 246-1600. TELEX (0650) 921819.



*price U.S.A.

Sensitivity.

DATA PRECISION®
A DIVISION OF ANALOGIC CORPORATION

CIRCLE #213 FOR DEMONSTRATION CIRCLE #22 FOR ADDITIONAL INFORMATION

"Prove to me that

Seven things managers should know about advertising in the Electronics Technology Marketplace.

1. *Electronics technology advertising works because it must.*

People say to me "I understand why beer advertising works, but I don't really see the necessity for advertising instruments and semiconductors". Actually, *they've got it backwards.* Beer advertising doesn't *have* to work—doesn't *have* to change buying habits. (You are under no obligation to buy more beer or to change your brand.) But the engineer or manager in electronics *must* change his buying habits. To stay competitive in the marketplace, he *must* find new, better, more powerful, less expensive, more efficient products and processes for his company. (When was the last time you got congratulated for doing as well this year as you did last?) So the readers of your advertising *need* what your advertising has to offer. The success of advertising in the electronics technology market is *automatic*—it is *built in* to the business.

Why, then, do beer manufacturers invest a much higher percentage of their selling price in advertising? Because advertising is the only game in town. They must create customer demand through indirect means, because there is no way they can send salesmen out to call on all the beer drinkers. In electronics, sending salesman out to call on all your prospects *appears* to be a viable alternative, but is it? The fact is, as the electronics marketplace broadens, the percentage of prospects you can afford to cover in person keeps dropping. You, too, need to create user demand. All of us in electronics marketing can learn something from the guys who sell beer.

2. *Advertising works in the electronics technology marketplace, either for you or against you.*

Just because your prospect is out there looking for advertised products or services that can help him doesn't mean your advertising will work *for* you. If it's good advertising in behalf of useful products and services, if it offers innovative answers to real problems, if it educates the reader or brings him true value, it will work *for* your company with amazing power. But if there is no value for the prospect, advertising will work *against* you just as strongly. If you have problems of quality, service, pricing, or technology, *don't try to fix them with advertising.* Fix the real problems first—*then* advertise. Otherwise, the disparity between what you claim and what you can deliver will rebound to your discredit.

3. *It's easy to get your money's worth from advertising.*

To make your advertising cost-effective, you only need to do three things:

- *Pick the right objectives* for your advertising, and define them carefully in terms of specific results desired.
- *Invest* the right amount of money in the right media.
- *Measure* the results against the objectives.

The remainder of this advertisement touches each of these points, but before we move on, please notice I did not say anything about advertising copy or style. The content of your advertising, or *what* you say, is *your* responsibility. The techniques of advertising, or *how* you say it, are your *advertising agency's* responsibility. That doesn't mean you shouldn't review their work, but if you as manager have done the three things listed above, your agency's work will be a lot easier—and better.

4. *Good advertising depends on good objectives.*

There are two general categories of tasks (strategic and tactical) that can be accomplished better with advertising, and for less money, and under better control than they can be done any other way. The two categories are:

- *Strategic objectives.* All of these fall under the general heading of "telling your story". They include specific objectives like: company recognition or identification; company or brand preference; positioning; sponsorship of change; getting your message to inaccessible buying influences, etc. An easy way to define these objectives is to write down what you want your customers and prospects to *remember* about where your company and its products fit in the marketplace—and then put numbers on the objective. Thus: "Objective is to increase from 20% to 45% the target readers who believe that our resistors are more reliable than anyone else's, and that this reliability is critical to their equipment". Or: "Objective is to increase from 75% to 85% the target readers who can identify our company as a leading supplier of the following products".
- *Tactical objectives.* All of these fall under the general heading of "getting your prospects to act". They include specific objectives like: turning distributors on; prospect identification and qualification; distributing literature and samples; arranging demonstrations; creating applications; making sales directly, etc. An easy way to define these objectives is to write down what you want your customers and prospects to *do* as a result of the advertising—and then put numbers on the objective. So: "Each ad should result in 400 catalog requests". Or: "The campaign is intended to produce 1300 telephone calls to distributors within a three-week period". Or: "In the first full year of this program, objective is to receive 1500 verified requests for system demonstration".

Notice that nowhere in the foregoing did I mention the objective of "support your salesmen". Everything I *did* list—and a lot more—will, in fact, support your salesmens' efforts, but "sales support" as such is not a rational objective

advertising works"

for advertising. Why? Because you can't write the objective down in a way that permits you to isolate it for measurement.

5. *Advertising is easy to measure.*

In fact, advertising is easier to measure and control than anything else you do in your marketing operation. There's only one trick: you must have the right objectives to measure against. A good rule of thumb is: "if you can't figure out how to measure, you probably have the wrong objective".

• *Strategic objectives.* The best way to determine budgets, decide specific objectives, establish copy themes, and measure results is through *research* among target audiences of interest. You simply do surveys to find out what opinions are now, and then later on do a follow-up to find out what you accomplished to change or shape these opinions. (Did you convince an additional 45%, or only 15%?) Budgeting is a little more judgemental, but it is easy to find out what the "noise-level" is in your markets of interest—you simply add up the competitive dollars and ad pages being invested against you. Then, if you want your own recognition and preference to increase, you know you have to invest enough to make an impression against the noise level. The more you want to move your research scores up, the more you will have to invest in comparison with your competitors—always assuming you have good advertising addressed to sound objectives.

• *Tactical objectives.* These can be budgeted and measured empirically. If your objective is catalog requests, for example, you set up a sum of money to run some specific number of ads, and you *count* the results directly.

Notice that a given advertisement or campaign can have *both* tactical and strategic objectives. Or you can design a series of tactical campaigns so that they will have a cumulative strategic result. But you still must identify *separate* strategic and tactical objectives, and measure against them in different ways. Otherwise, you'll find yourself counting catalog requests to measure brand preference—comparing apples with oranges.

6. *What about media?*

Where should you invest the money? If I give you a one-word answer, I'll be accused of being non-objective. (The curious reader will find the word I have in mind at the bottom of this page.) But here are a few ways to *think about* the media question:

—If you have defined your strategic objectives carefully, the publications whose audiences should receive your message will probably be obvious.

—For tactical objectives, you can easily test media to see which ones give you the best results.

—In general, it makes sense to advertise where you can reach people your salesmen have difficulty seeing.

—Broader audiences make more sense than narrower ones, because you get more comprehensive coverage and you don't miss targets that hadn't occurred to you.

—Look for publications whose quality will *contribute* to your message rather than detract from it.

—If you want to accomplish strategic objectives, choose publications with the lowest audience turnover. It doesn't make sense to invest in readers who disappear halfway through the campaign.

Don't forget that marketing-communications media *include salesmen.* Salesmen can be very effective communicators, but they are also by far the highest-cost media. Whatever you do, don't send your salesmen out to do a communications job you could possibly accomplish with advertising.

7. *You can prove it to yourself*

In my ten years as publisher of Electronics, dozens of electronics executives have said to me—in one form or another: "prove to me that advertising works". It occurs to me that maybe you should demand more proofs from other areas of your business as well—areas that I often see being taken on faith. Thus: "Prove to me your R & D funds are well-invested".

"Prove to me you know and can control what your salesmen are saying about your company and its products." "Prove to me your 5-year plan is not just a ruler job." Get the point? Maybe this is a good time to make sure *all* the functions of our businesses are under control and working. And if you will follow the simple steps outlined in this ad, I will no longer have to prove to you that at least *advertising* works—you will have proved it to yourself.

So long, and thanks for reading this series.

This is the sixteenth—and final—ad in this series, which has spanned six years and has touched on just about every important aspect of advertising in the Electronics Technology Marketplace. This is a convenient place to quit because I've moved to a new job here, just about the same time that I've run out of things to say. Some of the ads were topical, and would become dated if we in the electronics business didn't keep coming up against the same problems. Others are of a longer-lasting nature, and together they constitute a kind of basic training in marketing communications for managers. Complete sets of the series are available from Paul Reiss, the new Publisher of Electronics. Drop him a line, and he'll be glad to send you the series.

Daniel A. McMillan III
Group Vice President

Electronics Magazine

This is the sixteenth—and last—of a series of editorials on advertising, marketing, and planning in the Electronics Technology Marketplace. Your comments are welcome. Electronics Magazine, 1221 Avenue of the Americas, New York, N.Y. 10020.

Power supplies

Dc-dc supplies protect to 8 kV

Series gives flexibility and easy operation in medical, industrial use

Designed for use with medical monitoring systems and for other applications that require high isolation and low capacitance, Intronic Inc.'s DCI series dc-dc regulated power converters feature an 8,000-v dc input/output isolation rating. Input-to-output impedance is typically $10^{11}\Omega$ in parallel with 5 pF. Automatic current limiting to 150% of the rated current protects against short circuits. Should one occur, restarting automatically follows removal of the short. The converters can sustain a short-circuit current of 90 mA for a minimum of eight hours.

The three DCI models allow a choice of operation—from 5, 12, or 28 v dc. The full-load output current is ±60 mA dc. The modules produce floating analog power at ±15 v dc, regulated to within 0.05% for line and load variations.

For the 5-v-input model, the input current ranges from 125 mA at no load to 670 mA under full load. The 12- and 28-v versions have respective no-load current requirements of 50 and 20 mA, while their full-load demands are 275 and 120 mA. Full-load efficiency for the series is, therefore, approximately 54%.

The output temperature coefficient is 0.1%/°C. Reflected input ripple is 1% of the input voltage, and peak-to-peak output ripple is typically 11 mv (35 mv maximum). Settling time is 50 μs to 0.1% of the final value.

In the standard unit, the ±15-v output is accurate to within ±2%. As an option, the output can be factory-trimmed to be accurate within ±1%.

Operations need no derating from −25° to +75°C and require only convection cooling over that range. Storage temperature can vary from −40° to +150°C.

The converters conform to Underwriter's Laboratories UL544 standards for leakage and are yellow-card listed.

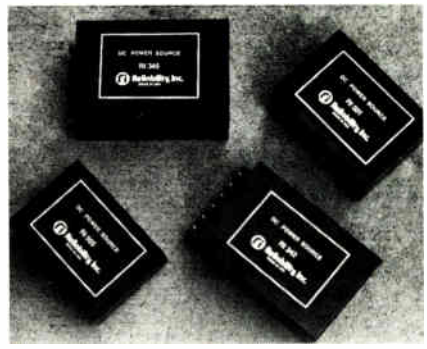
All DCI models sell for $65 each in quantities up to nine units. Mating sockets, if required, cost $133. Delivery takes a maximum of 60 days.

Intronics Inc., 57 Chapel St., Newton, Mass. 02158. Telephone Barry Friedman at (617) 332-7350 [381]

51 ac-dc power sources use 115, 220, or 240 V ac

Fifty-one new ac-dc power sources are available in three different output voltages with inputs of 115, 220, or 240 v ac. They can be packaged for mounting on either printed-circuit boards or chassis. Among the outputs available in the single- and dual-output units are: ±5 V at 500 mA, ±5 v at 2 A, and ± 15 v at 200 mA. Line regulation for units intended for pc boards is ±0.02%; for chassis-mountable units, it is ±0.05%. Load regulation ranges from ±0.02 to 0.15%, depending on the mount and whether the output is 5 v or dual. The same conditions apply to ripple and noise, which varies from 0.5 to 2.0 mv rms. The temperature coefficient for the units is ±0.02%, and the output voltage tolerance is ±2% maximum. The operating temperature can range from −25° to + 71°C, with storage from −25° to + 85°C.

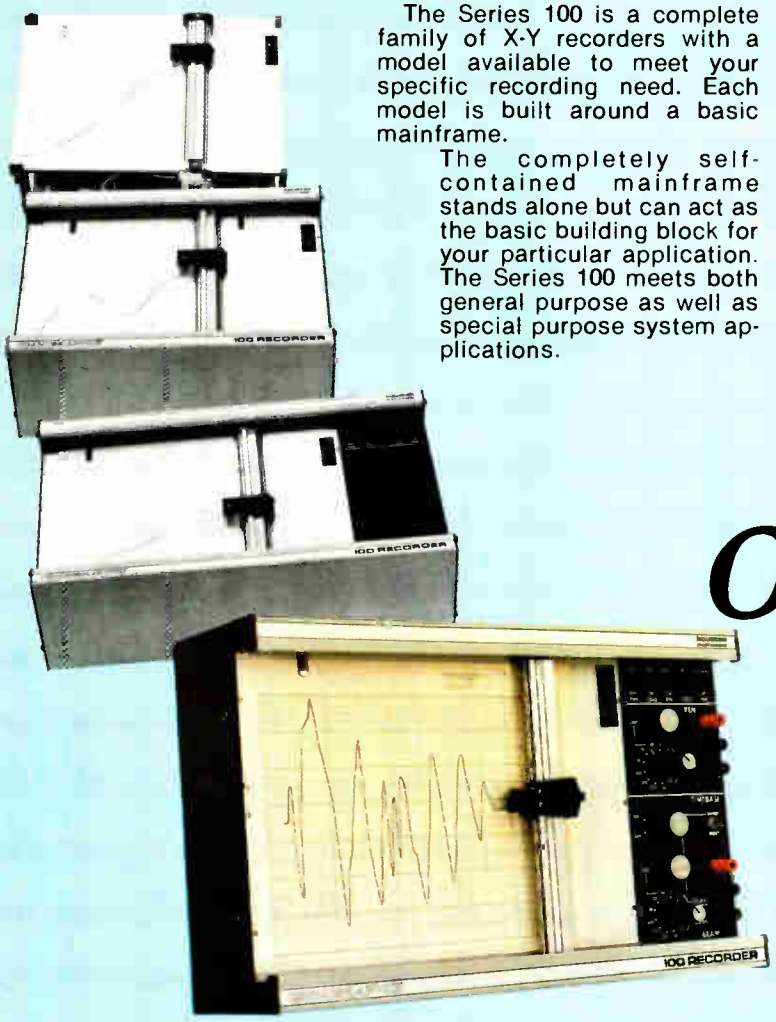
The units vary in price from $61



Select The One That's Right For Your Recording Needs

The Omnigraphic® Series 100

FOR LAB OR FIELD, PRODUCTION OR PROCESS, OEM OR GENERAL PURPOSE

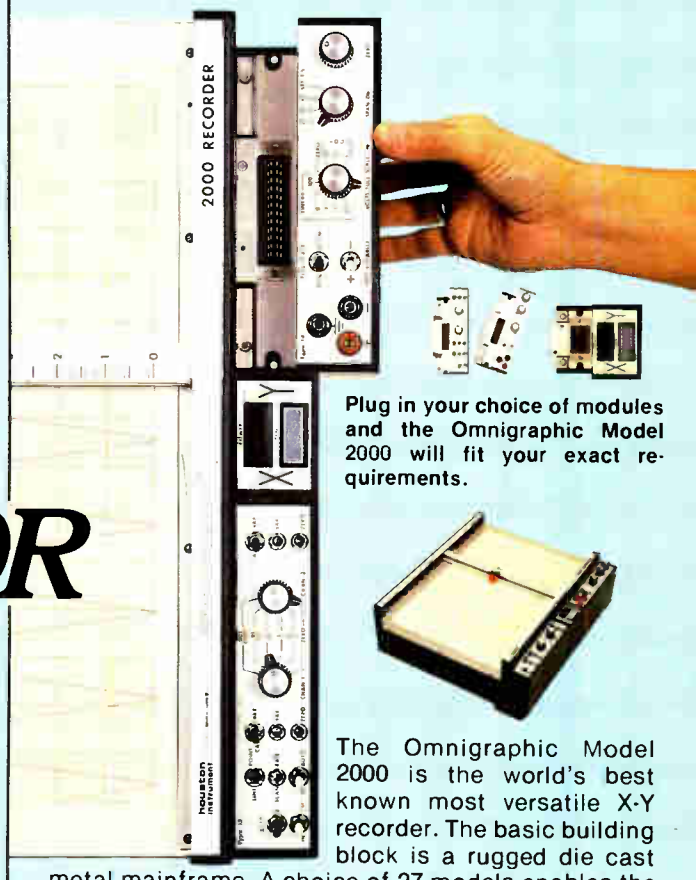


The Series 100 is a complete family of X-Y recorders with a model available to meet your specific recording need. Each model is built around a basic mainframe.

The completely self-contained mainframe stands alone but can act as the basic building block for your particular application. The Series 100 meets both general purpose as well as special purpose system applications.

Prices begin at $970*
Quantity discounts available

When your applications change, this recorder changes with them



Plug in your choice of modules and the Omnigraphic Model 2000 will fit your exact requirements.

OR

The Omnigraphic Model 2000 is the world's best known most versatile X-Y recorder. The basic building block is a rugged die cast metal mainframe. A choice of 27 models enables the recorder to perform in virtually any application

- 30 in/sec speed (40 in/sec available)
- ±0.2% accuracy
- Best commom mode rejection
- Same servo response on both axes
- Modules can be changed in minutes
- Amplifiers interchangeable
- Prices from $1,200*, OEM discounts available

No more slidewire cleaner • No more slidewire lubricant

No More Slidewire!

Houston Instrument's patented non-contacting capacitance feedback transducer replaces the slidewire and potentiometers, neatly eliminating the most troublesome components of X-Y servo systems.

For complete information on the Model 2000 or the Series 100, contact Houston Instrument, One Houston Square, Austin, Texas 78753. (512) 837-2820. For rush literature request and sales office information, outside Texas call toll free 1-800-531-5205. In Europe, contact Houston Instrument, Rochesterlaan 6, 8240 Gistel Belgium. Phone 059/277445.

Circle #217 for Series 100
Circle #24 for Model 2000

houston instrument | DIVISION OF BAUSCH & LOMB

"the graphics - recorder company"

*U.S. Domestic Price Only
® Registered Trademark of Houston Instrument

for the 5-V/500 mA model to $107.42 for the 5-V/2-A model in small quantities. In quantities of 100 or more, the prices are lower. For example, a ±15-V/200-mA unit sells for $84.80 in small quantities but goes for $63.60 in large quantities.

Reliability Inc., P. O. Box 37409, Houston, Texas 77036. Phone Bob Miller at (713) 492-0550 [386]

Laser current supply is totally transient-free

The model LCS-350/R laser current supply is intended for laboratory use to drive and characterize continuous-wave diode lasers and laser systems. It is totally transient-free

and so will not pass any spikes, even when it is initially switched on, says the manufacturer. The supply offers an output adjustable up to 350 mA with a minimum compliance voltage of 6.0 V. Noise and ripple are less than 0.01% of the adjusted output, with a stability of ±1 mA over 8 hours. The supply provides a ramping function that sweeps the current from zero to any preset value. It also provides an output proportional to current for use with an X-Y plotter. The current reading is displayed on a built-in digital readout.

The LCS-350/R is priced at $995 each, with delivery from stock to four weeks.

Laser Diode Laboratories Inc., 1130 Somerset St., New Brunswick, N. J. 08901. Phone (201) 249-7000 [383]

CRT supply boasts five adjustable outputs

A high-voltage power supply has been designed for use with computer-controlled color cathode-ray tubes. The model 10065 has five adjustable outputs: three independent 0-to 625-V dc grid supplies that can be programmed remotely; a 20-kV, 1.5-mA anode supply; and an

CANNON. THE SOURCE.

Cannon KJL/KJ Connectors.

Your ITT Cannon Electric distributor has an in-store supply of Cannon® KJL Series I and KJ Series II connectors for your MIL-C-38999 requirements.

High-reliability connectors with superior contact stability secured by the Super Caesar™ rear release contact retention assembly.

A design variety for temperature environments from -85°F to +392°F with nine shell sizes each series. Fifty-nine contact arrangements from 3 to 128 contacts. All contacts adaptable to AWG wire sizes 16-28 and easily installed by simple and fast customer tooling to lower your total installed cost.

So when you need KJL and KJ connectors, remember the source. ITT Cannon.

For more information contact your local distributor. Or write to: Product Manager, Circular Division, ITT Cannon Electric, 666 East Dyer Road, Santa Ana, California 92702. For 24-hour service, call toll-free (800) 854-3573; in California (800) 432-7063.

For all your Cannon connector needs see the EEM directory.

Six decades on the leading edge of interconnect technology.

CANNON ITT

New products

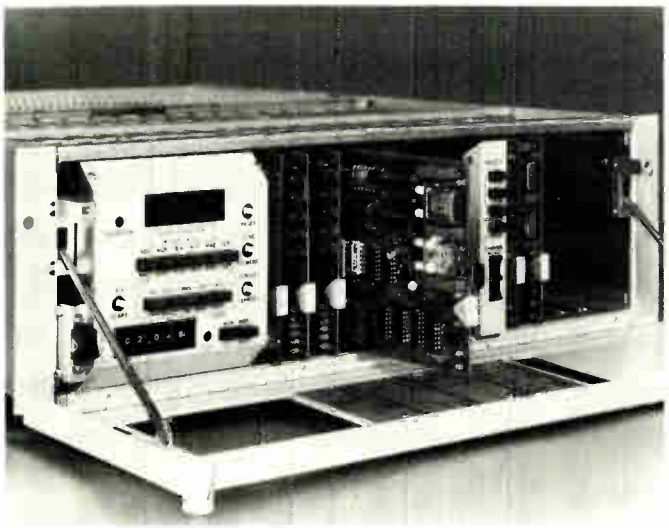
adjustable 5-kv floating supply capable of external modulation to achieve dynamic focus. Input voltage is 28 to 30 v dc. The unit is protected against short circuits. It is convection-cooled and operates at temperatures ranging from 10° to 50°C. Line and load regulation vary between 0.5% and 2.0%, depending on the output, and ripple is 0.5, 6.0 or 20 v peak to peak, depending on the voltage.

Reich Associates Inc., P. O. Box 73, Plano, Texas 75074. Call Ernest Reich at (214) 424-7904 [385]

Ac-dc power supply has 0.02% load, line regulation

A triple-output ac-dc power supply regulates the load and line to within ±0.02 for its dual 15-v outputs and to within ±0.05% for its +5-v logic power output. Model 923 is designed to meet the power needs of data-acquisition systems, as well as of a-d and d-a converters. It provides outputs of ±15 v dc at ±100 mA and 5 v dc at 500 mA and operates from line voltages of 105 to 125 v ac, 50 to 400 Hz. Current-limiting protects against overloading and short circuits. It also prevents start-up and latch-up problems characteristic of current–foldback schemes.

All voltage outputs are accurate to within ±1% maximum of the rated value. Output ripple and noise are guaranteed by the manufacturer to be less than 0.5 mV root mean



NEW LIFE FOR ANALOG RECORDERS IN A DIGITAL ENVIRONMENT

Ampex calls it the *M² Digital Encode/Decode Unit.* You'll call it the most cost-effective modem you've ever seen for high density digital multi-channel transmission applications.

Used in conjunction with an analog instrumentation recorder, the Ampex M² Encode/Decode Unit gives you a digital capability of 5 megabits/second at 120 ips, working in Biphase-L, Miller or M² codes. And you can get as many as 10 channels of record/playback in a package only 5¼ inches high by 19 inches wide.

The built-in test option functions as an error counter with a digital readout to diagnose input rates, and it also serves as both a tape and a total system certification system, displaying number of errors in either 10^6 or 10^8 bits. It can also be used as a frequency counter.

Use this unique unit as a digital recording front end, as a self-standing modem on wideband telephone and a signal circuits, or as a multichannel diagnostic adjunct. Power supply is 115/220V, 47 to 400 Hz, and price ranges from about $6,000 to $12,000 depending upon channel count and installed options.

Rene Chikhani can provide complete technical and performance specifications, and he'll work with you on custom system applications. Call Rene at 415-367-2758, or write to him at Ampex Data Systems, 401 Broadway, Redwood City, California 94063.

AMPEX

Circle 221 on reader service card

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Ailtech's 75 Precision Automatic Noise Figure Indicator (PANFI) can **MEASURE** amplifier and receiver noise figure with accuracy (±0.15 dB) and precision (0.05 dB resolution). To **MONITOR** repeated measurements, there s the 7300 System Noise Monitors. They're available in analog and digital configurations and are ideal for amplifier production tests ***including simultaneous gain measurements*** and on-line radar receiver noise monitoring. Ailtech can **GENERATE**, with a comprehensive line of broadband solid state and gas-discharge devices for laboratory or system requirements; and can **CALIBRATE** RF and microwaves noise sources with the Ailtech 82 Noise Calibration System.

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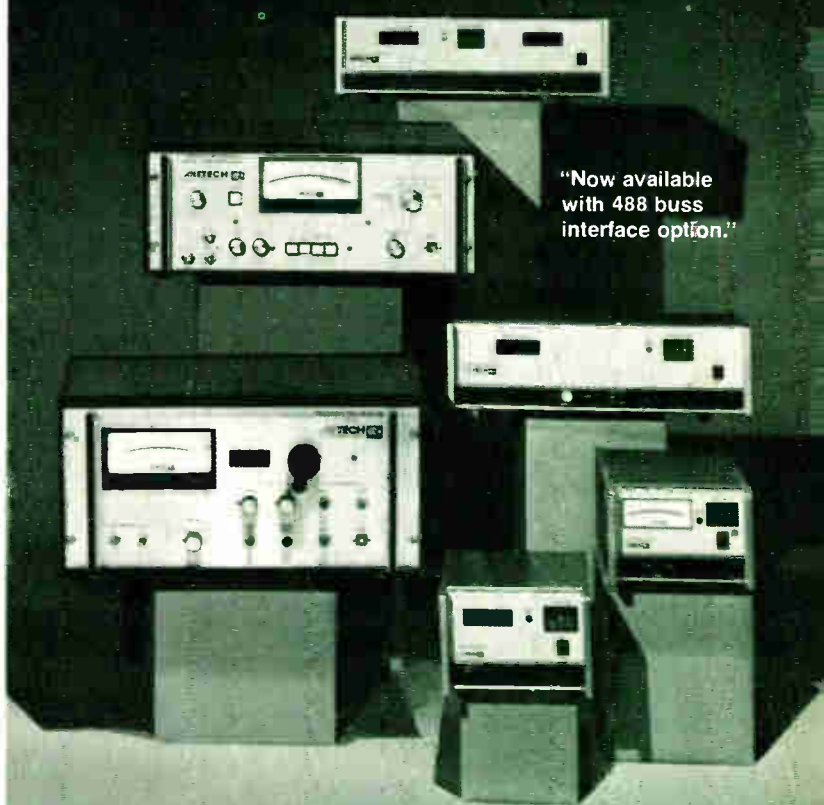

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Circle 26 on reader service card

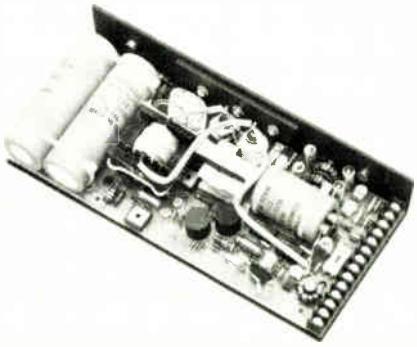
New products

square. The unit, which has been designed for mounting on printed-circuit boards, offers 50 MΩ of input isolation and has a guaranteed breakdown of 500 V rms minimum. The supply measures 3.5 by 2.5 by 1.25 in. and does not require an external heat sink to meet its rated performance specifications over the ambient temperature range of −25° to +71°C. This ac-dc power supply is available from stock for $89 in single-unit volumes.

Analog Devices Inc., P. O. Box 280, Route 1 Industrial Park, Norwood, Mass. 02062. Phone James Conant at (617) 329-4700 [388]

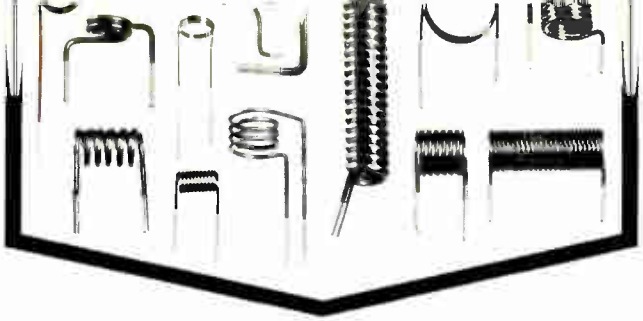
Four-output switcher delivers up to 111 W

A 20-kHz switching power supply produces four output voltages with a total power capability of 111 W. Model 912 delivers 5 V at 15 A, ±12 V at ±1.5 A, and −5 V at 0.5 A. Line regulation is within ±0.1% on all outputs, and load regulation is within ±0.5%. The unit accepts 110, 115, 220, or 240 V ac inputs, selected from a barrier strip. The outputs

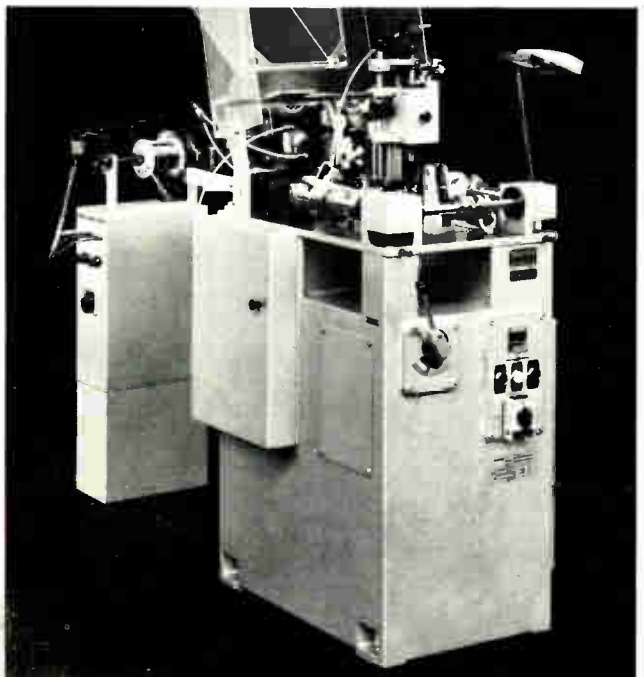


have short-circuit and current-limiting protection. On the +5-V output, self-recovering overvoltage protection and remote sensing are standard. In small quantities, the price is $225, and there are discounts for original-equipment manufacturers. Delivery is from stock to 30 days after receipt of order.

RO Associates Inc., 246 Caspian Dr., P. O. Box 61419, Sunnyvale, Calif. 94086. Phone Richard D. Okada at (408) 744-1450 [387]



WAFIOS



This automatic machine produces up to

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including stripping of both shanks

	FTU 0–97	FTU 1–97
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inside diam. of coil	10 mm	15 mm
coil length	35 mm	45 mm
shank length	30x30 mm	48x50 mm
number of coils	55	70
maximum output	50 coils/min.	40 coils/min.

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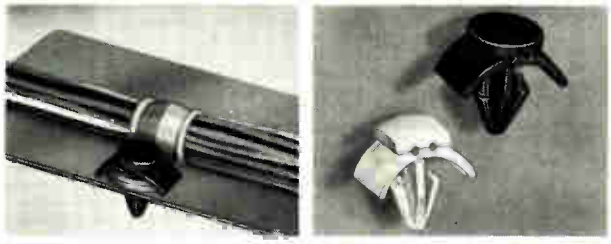
Circle 46 on reader service card

NEW Weckesser NYLON MOUNTING STUD

SNAPS IN



New Weckesser one-piece nylon mounting stud provides easiest, fastest way for fastening cable clamps to hold cable, conduit, pipe, wire . . . even to fasten two pieces of material together.

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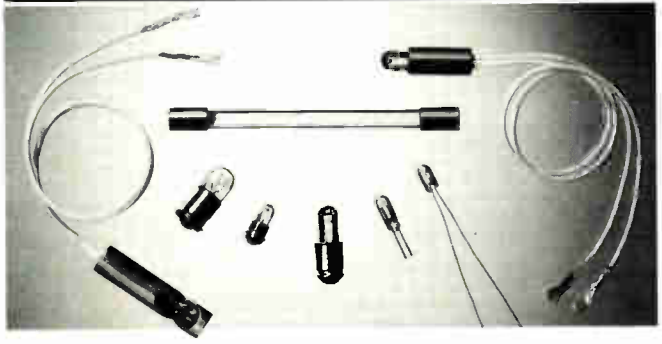

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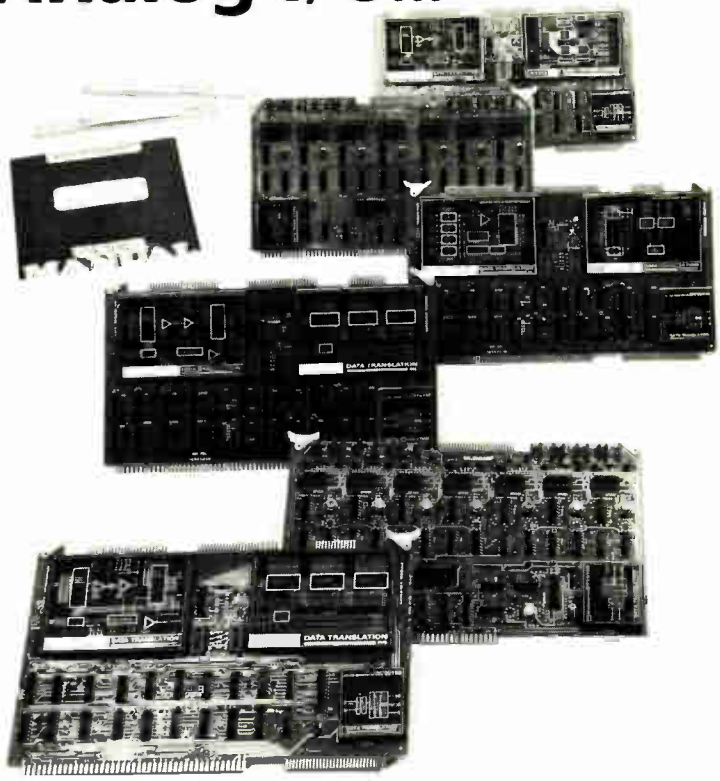
For further information circle #239

Analog I/O...



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D/A systems include: up to 8 analog outputs per slot, with DC/DC converter on-board, fast settling of 3usec to 12-bit accuracy, 20mA outputs for guaranteed cable driving, point plotting capability, and 4 to 20mA current loop outputs.

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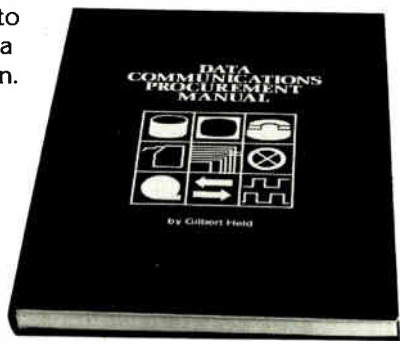
Circle 237 on reader service card

The most important data communications purchase you'll ever make isn't a device or component!

It's a timely, easy-to-follow guide that spells out exactly what you need to know to get the best possible deals on all data communications equipment. To turn data communications procurement into a smoothly running, cost-effective operation. And to **save you thousands** in data communications costs while delivering top-performance service!



Just published, this immensely important resource comes packed with the most authoritative and current information you need to make all your data communications purchasing decisions.

Plus step-by-step guidelines on the procurement process that speeds communications with vendors and assures that you get exactly the equipment you're looking for.

A first-of-its-kind working reference that puts right into your hands...

- an alphabetical checklist of procurement document items to help you determine what's relevant to you and develop clauses or descriptions for the solicitation document
- sample solicitation format plus a compilation of solicitation clauses and forms most frequently used in procurement documents
- specifications for 38 devices, with a complete listing of both general and specific device specifications to consider when developing communications component requirements
- tabulation of Bell System data-set operating characteristics to help you develop a functional modem procurement
- vital facts to determine if special pin cross-connections are required to interface components with existing equipment
- tables of present value interest factors for yearly and monthly periods varying from 6 to 15%. Vital for evaluating proposals for future costs
- yearly energy costs of a continuously operating device in cents per Kilowatt hour
- checklist to develop a schedule of procurement activities
- plus invaluable guidance on the basic construction of a sample solicitation

Before you choose any data communications equipment, choose the DATA COMMUNICATIONS PROCUREMENT MANUAL. The before-you-buy buy for every data communications purchase!

Data Communications Procurement Manual

by Gilbert Held 150 pages

Contents

PROCUREMENT DOCUMENT ITEMS. SAMPLE SOLICITATION CLAUSES AND FORMS. Cover Sheet. Contact Form and Representations, Certifications, and Other Vendor Statements. Instructions, Conditions, and Notices to Vendors. Evaluation and Award Factors. Supplies/Services and Prices. Mandatory Specifications. Preservation/Packaging/Packing. Deliveries or Performance. Inspection and Acceptance. Special Provisions. Contract Administration Data. General Provisions. List of Documents and Attachments. **SPECIFICATIONS.** General Specifications. Specific Specifications (Acoustic Coupler, Analog Extension Unit, Analog Test Set, Automatic Calling Unit, Cable, Channel Service Unit, Code Converter, Concentrator, Controller, Data Access Arrangement, Data Compactor, Data Line Analyzer, Data Security Unit, Data Service Unit, Echo Suppressor, Facsimile Equipment, Frequency-Division Multiplexer, Front-End Processor, Interface Converter, Inverse Multiplexer, Limited-Distance Modem, Line Driver, MIL-STD-188C Adapter, Modem, Modem/Line-Sharing Unit, Multipoint Modem, Multiport Modem, Parallel Interface Extender, Port Selector, Port-Sharing Unit, Remote Batch Terminal, Speech/Data Unit, Speed Converter, Statistical Multiplexer, Switch, Time-Division Multiplexer, Transmission Test Set, Voice Adapter). **APPENDIXES.** Bell System Data Set Compatibility Guide. Modem Options. EIA Terminal/Modem Interface. Modem Interface Description. Present Value Interest Factors. Energy Consumption Cost. Communications Procurement Plan. Sample Modem Procurement.

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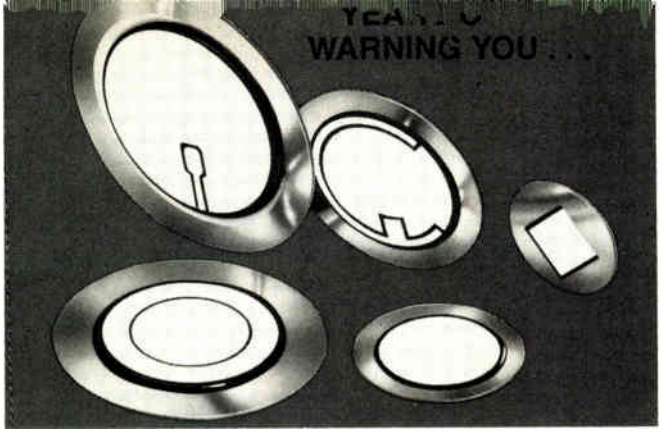

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Projects Unlimited's new line of Piezo Ceramic Benders (Series PCB-1) combine low-cost efficiency with small size, reliable construction and superb performance. These units will sound with as little as 3 VAC applied and are useful over the range of 1.5 to 15 KHz depending on the bender size and model number. High impedance allows the units to be easily driven from conventional I.C. devices.

For more information, write: Projects Unlimited, Inc.,
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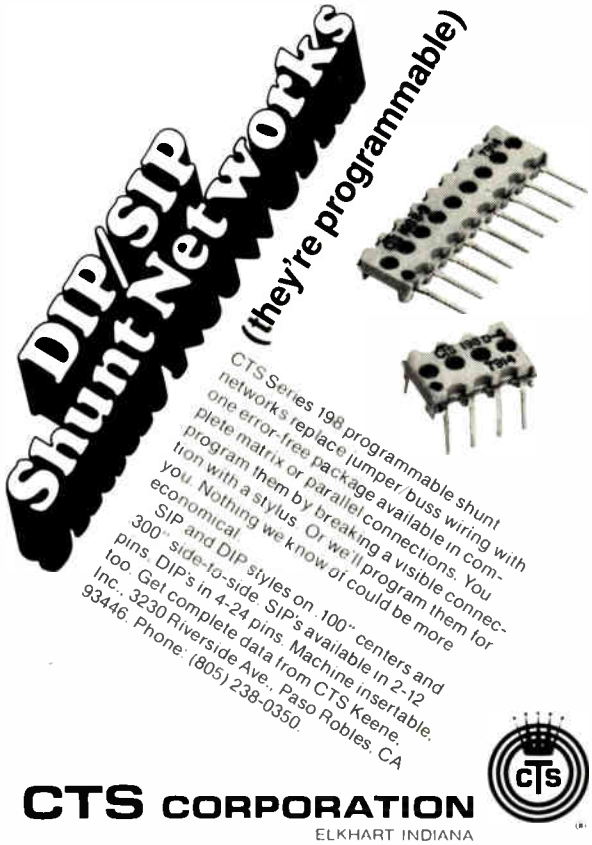
Circle 38 on reader service card



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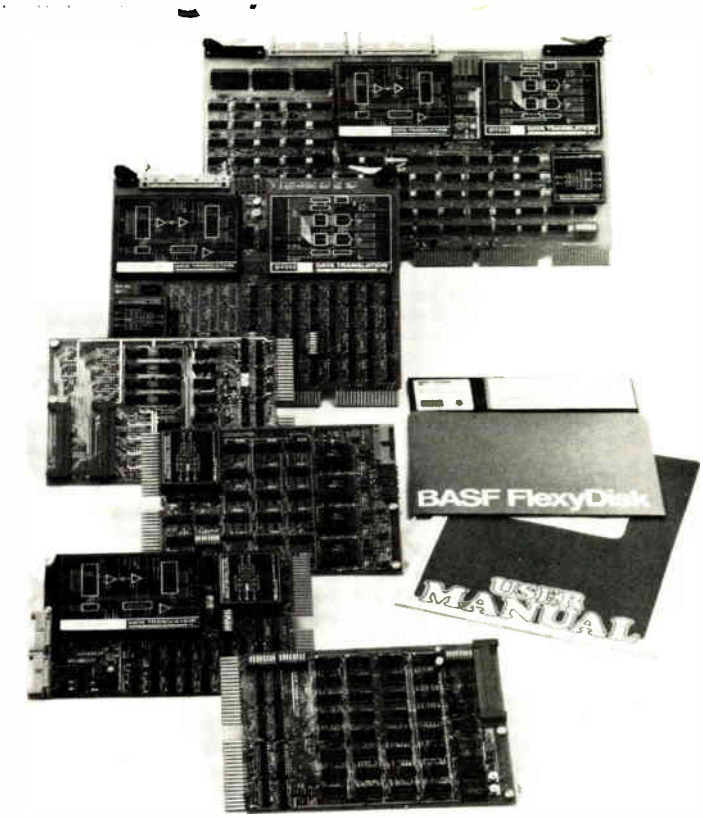

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D/A systems include: up to 8 analog outputs per slot, fast settling of 3usec to 12-bit accuracy, 25mA outputs for guaranteed cable driving, point plotting capability, DMA interface and read/write byte addressable registers.

Digital boards include: Digital I/O, Isolated Digital I/O, and programmable real-time clock.

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Circle 235 on reader service card

lead pins from being bent; no wedge-shaped tools are needed. As the devices are lifted from the board, they pass through a checking station for detection of bent leads. Devices that have no bent pins are passed into an accumulator section or directly into loading tubes. Those with damaged leads are held at a separate station. The good devices are positioned with the leads up for further visual inspection through a clear plastic cover. Between 6,000 and 9,000 devices may be removed per hour by a single operator.

The IC remover machine sells for $6,800 with delivery in four to six weeks. The machine is manufactured by IDEA (for Invention, Design, Engineering Associates) in Torrance, Calif.

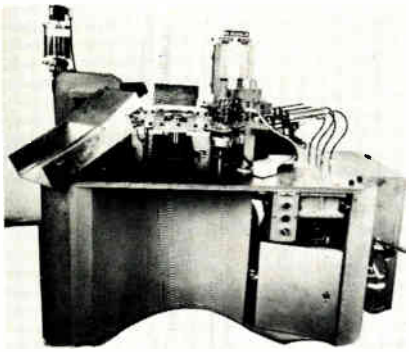
Petlock Associates, 1128 East Chestnut St., Santa Ana, Calif. 92071. Phone (714) 972-4900 [396]

IC sockets and adapter headers operate to 500° F

A series of high-temperature integrated-circuit sockets and adapter headers use thermoset plastic insulation material, making them suitable for continuous operation at temperatures from 425° to 500° F. This insulation is self-extinguishing, Underwriters Laboratory–rated, and meets MIL-14M-14F, Type SDG-F specifications. Well suited for rugged environments or for extended burn-in applications, these sockets and headers use precision-machined brass contacts with either gold or tin plating; the spring clips are gold-plated beryllium copper.

The series HT140 sockets come with mounting holes, whereas the series HT240 sockets do not. Both have 0.3-in. contact spacing and are available with 8 to 24 contacts. The series HT300 adapter headers have 0.6-in. spacing and are available with 8 to 40 contacts. Priced at 30¢ to $1.50 each, the devices are available from stock to four weeks.

Garry Manufacturing Co., 1010 Jersey Ave., New Brunswick, N. J., 08902. Phone (201) 545-2424 [398]



specified point. Any pc board assemblies not meeting these tests are automatically rejected.

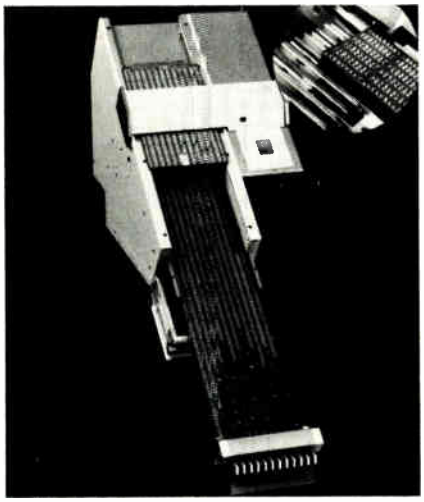
To perform the electronic testing function, the machine makes four connections with the pc board to interface with the user's own computer. After testing, the computer indicates to the machine whether the pc board assembly is accepted, rejected, or in need of reworking.

The desolder and test machine will sell for close to $90,000, with delivery in about a year.

Kahle Engineering Co., 3322 Hudson Ave., Union City, N. J. 07087. Phone Carl Napor at (201) 867-6500 [393]

Unit lifts ICs from burn-in boards without bending leads

The model 6000 integrated-circuit remover enables a single operator to empty a burn-in board in about 30 s. The machine removes the devices in a perpendicular manner to prevent



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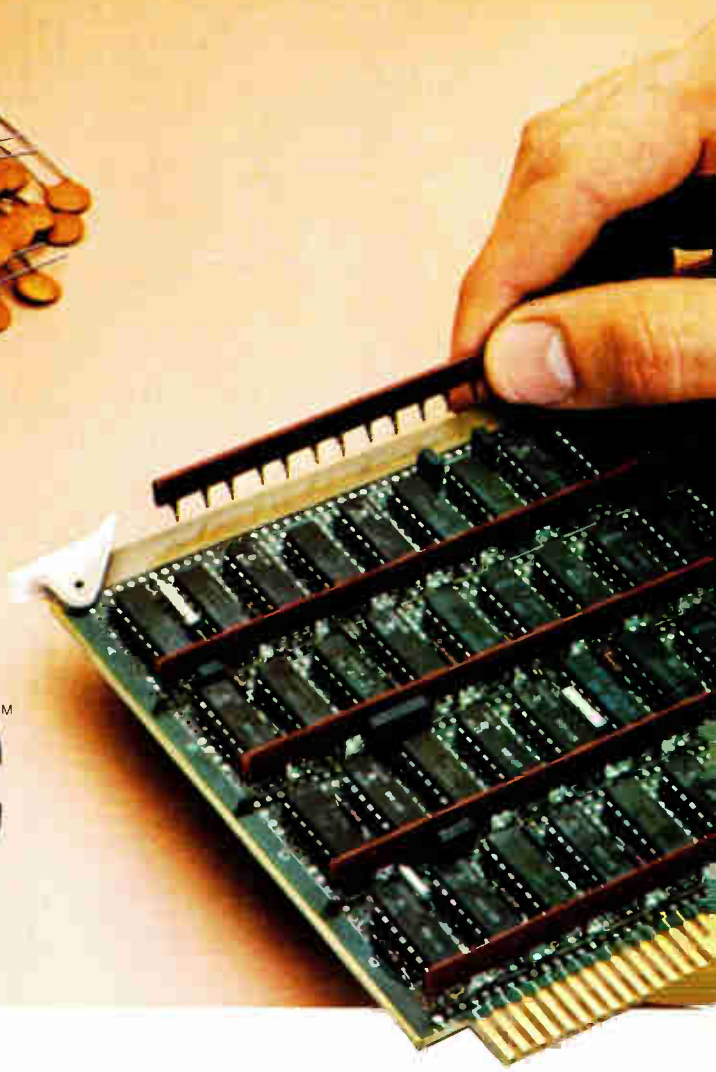

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*Patent Applied For

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FOR IMMEDIATE NEED CIRCLE 229

FOR INFORMATION ONLY CIRCLE 232

This system offers a beam-current density of 100 A/cm² and a spot size as small as 0.025 μm. It can write dimensions as fine as 0.2 μm or as broad as 1.0 μm.

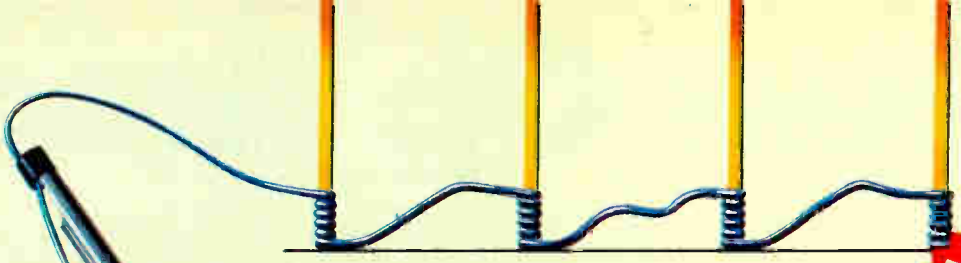
The system uses four back-scatter detectors, giving it a typical stitching error of ±0.1 μm between adjacent scan fields and a typical overlay error of ±0.1 μm layer to layer. Variable clock rates permit variable scanning speeds—to 10 MHz—eliminating proximity effects in writing closely in adjacent areas. The stage or working chamber of the system incorporates drives and coupling in a vacuum, to reduce the possibility of the fatigue fractures often found in systems using bellows. Mounted in the vacuum along with this working chamber and column are interferometers to compensate for differences in substrate height. Because the system uses a dry lubricant, the wear on ball bearings is minimized, as is the risk of column contamination. Isolation valves and automatic pre-pumping controls minimize the time required for changing the filament and the substrate. An advanced pump design eliminates the requirements for liquid nitrogen bafflers.

Currently there is a five- to six-month wait for this system, which, when completely equipped with all available options, will sell for about $2,000,000.

Philips Electronic Instruments Inc., 85 McKee Dr., Mahwah, N. J. 07430. Phone (201) 529-3800 [392]

Machine desolders, tests 1,000 pc boards per hour

A microprocessor-controlled machine for desoldering printed-circuit boards and testing them has been designed to accept printed-circuit board assemblies with waste solder material still attached. The 5062 handles up to 1,000 pc boards per hour. The machine first desolders eight holes, verifying afterwards that this job has been completed satisfactorily and that no soldered connections on the underside of the pc board are protruding beyond a pre-



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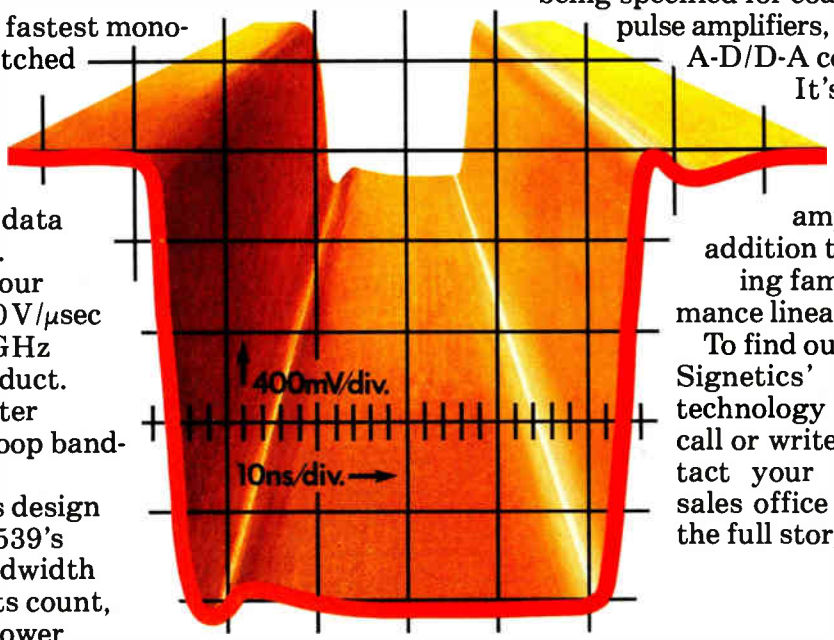
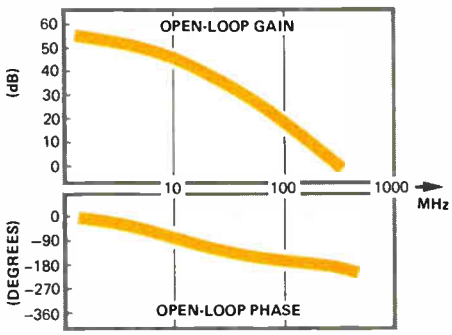
Suddenly systems design is simpler. The NE5539's great speed and bandwidth help you reduce parts count, while an emitter-follower design gives you true differential high input impedance.





This op amp is already making color video systems more reliable. And it's being specified for coaxial cable drivers, pulse amplifiers, RF oscillators and A-D/D-A converter systems. It's a natural for *fast* sample-and-hold circuitry. This high-speed op amp is only the latest addition to Signetics' growing family of high performance linears.

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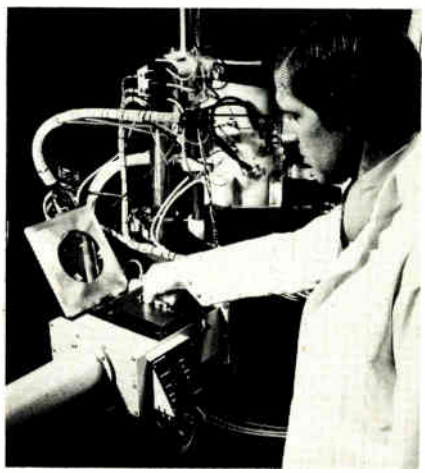
system's vacuum-operated, bed-of-nails test fixture can be adapted to different boards in 1 to 2 minutes. A separate program is needed for each type of board tested, but a "bogie" programming approach makes it simple to write. A known good board is loaded into the machine's test fixture and its parameters measured and stored on a data-tape cartridge for later use in random-access memory. This takes only a few seconds, and the routine can be stored indefinitely. Alternatively, when put into an editing mode, the system can be programmed manually in about 15 minutes.

The 2245 comes with self-testing and diagnostic software, a kit of spare parts, and documentation that includes a video-taped maintenance course. Available options could bring system price up to $30,000 from the basic $18,500. But GenRad sources expect an average system to cost about $25,000. Deliveries will begin in the first quarter of 1980.

GenRad Inc., 300 Baker Ave., Concord, Mass. 01741. Phone (617) 369-4400 [391]

Electron-beam writing system generates 5-in.² patterns

The Beamwriter, a recently introduced [*Electronics*, Oct. 25, p. 33] vector-scanning electron-beam writing system from Philips, has been designed for the faster generation of precision masks and reticles that have pattern areas of up to 5 in.²



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Packaging & production

System tests bare circuit boards

In-circuit tester sells for $18,500, exercises stripped or resistor-loaded boards

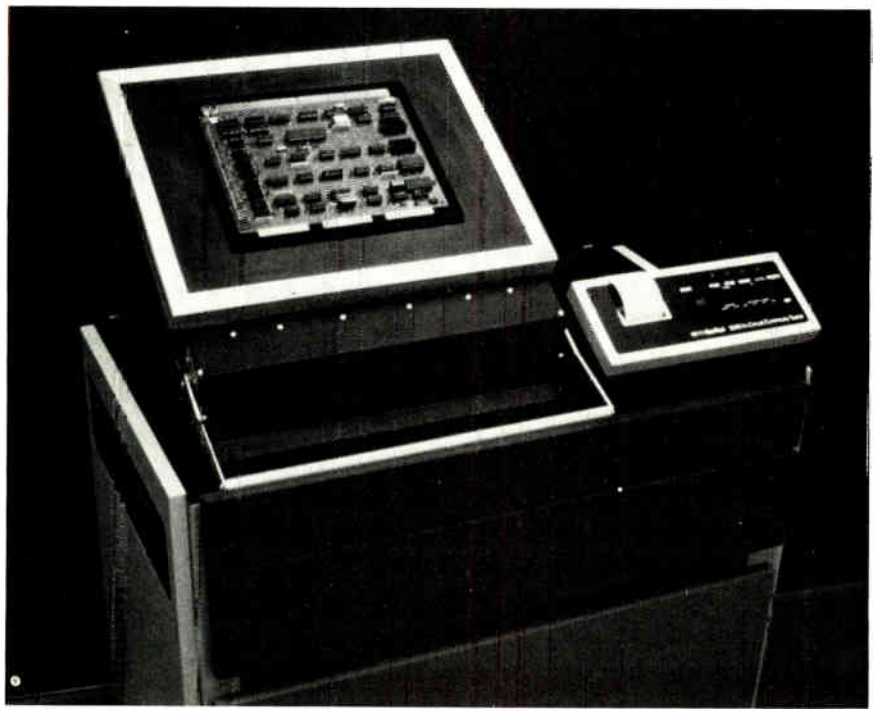
If a company is already in the business of testing incoming components, it makes sense for it to expand into testing bare circuit boards also. GenRad Inc. has introduced what it calls an in-circuit/connectivity test system for just this purpose.

Testing bare boards saves money. The cost of finding an open or short circuit or other defect on a bare board can be measured in pennies—the price of repairing it or throwing it away. But at each point downstream—stuffed board, assembled system, and delivered system—the cost of troubleshooting and repair goes up by about a factor of 10, according to GenRad, until a board failure can cost a firm tens or perhaps hundreds of dollars.

Thus the $18,500 spent on the 2245 could be recouped in a reasonable time in any moderately large assembly operation, say GenRad sources, who claim that bare-board faults, manufacturing-caused opens and shorts, and faulty resistors account for more than half of all board defects. The 2245 tests bare boards, boards with resistors inserted, and (using adaptors) cables and backplanes. It is even said to catch some resistor faults that a functional tester might not—for example, faulty terminating resistors on emitter-coupled-logic boards.

The system may also be used to check fully loaded boards on the production floor, verifying that proper connections have been made. The goals here would be shorter visual inspection time, improved quality control, and, on occasion, the offloading of larger functional testers like GenRad's 2270-class systems. Such an application has obvious appeal for large makers of printed circuits, since it makes outgoing inspection faster and more reliable than visual inspection, especially with multilayer boards.

The 2245 takes 1 or 2 seconds to test a board; its built-in printer presents diagnostic messages at the rate of about one fault every second. The



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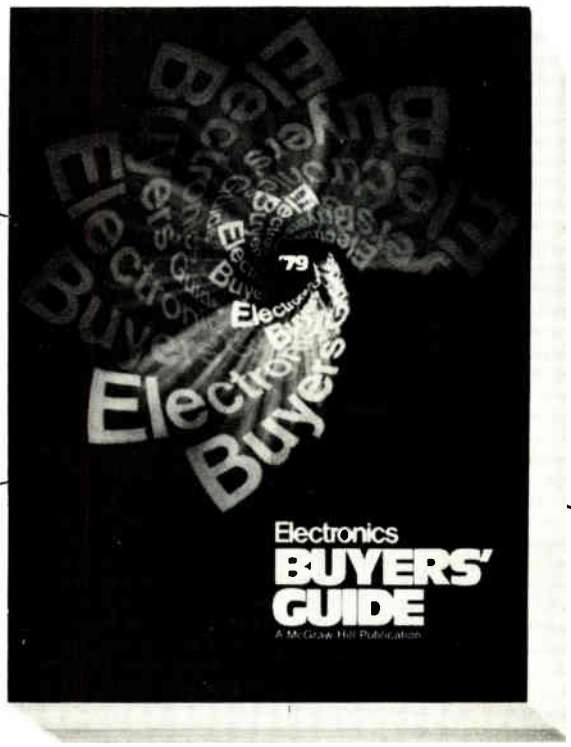

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$199 to $399 switching supplies have five outputs

Five independent dc outputs, with total power of 100, 200, and 300 W and $199 to $399 price tags, are salient features of the ESM series of switching regulated-power supplies. The units have high component density for maximum power per cubic inch. Voltages may be specified for each of the five outputs from 5 to 28 V dc for three regulated outputs and 5 to 50 V dc for two semiregulated ones. Line and load regulation is 0.2% on the first three outputs and jumps to 5% in the last two. Ripple and noise is 50 mV peak-to-peak on the first three and 150 mV p-p on the last two outputs.

For positive brownout protection, the units have a dual ac input of 85 to 132 V and of 170 to 264 V, 47 to 63 Hz. The units also have protection against overvoltage on primary output, overload, short circuit, reverse polarity, and soft start. Remote sensing is standard. The ESM-100 series of 100-W power supplies costs $199 each. The 200-W unit sells for $319 and the 300-W supply for $399.

Power/Mate Corp., 514 South River St., Hackensack, N. J. 07601 [389]

Supply delivers dual outputs between ±18 V and ±24 V

Model HCC24-2.4 is a dual-output dc power supply for semiconductor devices that delivers continuously variable outputs of ±18 V to ±24 V at 2.4 A. It has 115- or 230-V ac ±10% input capabilities and ±0.05% line and load regulation. Maximum output ripple is 5 mV peak-to-peak. Full-load operating temperature is from 0° to 50°C, derated to 71°C. Each unit carries a two-year warranty. The price for each unit is $79.95 in small quantities, and delivery is from stock.

Power-One Inc., Power One Drive, Camarillo, Calif. 93010. Phone Larry Steen at (805) 484-2806 [390]

IR to offer 500-V MOS FET

International Rectifier Corp.'s semiconductor division, El Segundo, Calif., will be bringing out what it says is the **first commercially available 500-V MOS field-effect transistor.** The power device is based on the firm's recently introduced HEX FET technology and will have a pulsed-current rating of more than 6 A, the company says. It should find immediate applications in motor drives and off-line switched-mode converters.

Switching supply meets interference requirements

With an optional internal filter that absorbs electromagnetic interference caused by switching action, LH Research's SM series of regulated power supplies can be made to meet West Germany's stringent VDE 0871 requirements for conducted emissions **and even exceed them by 5 dB.** The worldwide tendency has been to establish requirements similar to the VDE 0871 to keep the high-frequency noises of units that operate above 10 kHz from disturbing broadcast and telecommunications links. The VDE filter will go for $30 as an option on the Irvine, Calif., company's SM series switchers. Without the filter, the switchers, which have power ratings between 750 and 1,000 W with one to four outputs, range in price from $715 to $1,100.

Mylar thins down to 1.5 μm

Previous offerings of Du Pont's Mylar film have been in 16-, 12-, 10-, and 8-gauge thicknesses. The company's Plastic Products and Resins department plant in Circleville, Ohio, **is now manufacturing the polyester film in 6 gauge (1.5 μm) for use as a dielectric in low-voltage capacitors.** The film's high tensile and tear strength lend it to use on automatic production equipment.

Software packages simplify industrial control functions

Eagle Signal Industrial Systems has added the ECL2 and ECL2/P advanced control language packages to the others available for use with its Eptak microprocessor-based controllers. **Programs generated with the ECL/2 combine instructions in Eptak control language (ECL) and Eptak assembly language (EAL); the ECL2/P development package has an analog capability.** Both were designed for complex industrial control applications to simplify the use of control elements such as timers, counters, shift registers, and three-mode controls. The Gulf+Western division based in Davenport, Iowa, plans to sell the software packages for between $140 and $280 each.

Swept-frequency unit gets bus control and flicker-free display

Pacific Measurements Inc. of Sunnyvale, Calif., has enhanced its model 1038 swept-frequency measurement system by adding an interface bus control and a refresh memory. The **refresh memory keeps the display free of flicker regardless of the sweep speed of the generator.** Designated the 1038/D-14, the new model is fully compatible with present 1038 system plug-ins. By using it with the IEEE bus option, the operator can read the contents of two refresh memories or the outputs of two horizontal plug-ins for analysis and data manipulation or scaling. Those who already own a 1038 system may upgrade it and access the bus by simply changing the mainframe for $1,850 and getting the D-14 bus option for $1,275. As with its predecessor, the 1038/D-14 offers dual-channel capability and a built-in feature that the manufacturer says eliminates tracking errors almost entirely.

New products/materials

An opaque alumina composition that combines high electrical resistivity with low light transmission is intended for use as a packaging material for light-sensitive solid state devices. Called A1SiMag 606, the russet-colored ceramic is designed for compatibility with existing thick-film inks. Unlike conventional ceramics, A1SiMag 606's resistivity does not drop with increasing temperature. Patterns printed on it with standard thick-film inks will perform as if they were printed on a white 96% alumina substrate.

3M Co., Technical Ceramic Products division, Dept. Te9-28, P. O. Box 33600, St. Paul, Minn. 55133 [476]

A two-component epoxy adhesive, EP33ST, produces radiation-resistant bonds that are very strong and remain so even after prolonged exposure to temperatures of 400° to 450°F. Cured at room temperature, this material is relatively insensitive to the cleaning of the substrate. In addition to their resistance to thermal cycling, EP33ST bonds resist chemicals including water, oil, and most organic solvents over the temperature range of −60° to +450°F. The material is 100% reactive.

Master Bond Inc., P. O. Box 522, Teaneck, N. J. 07666 [477]

A platinum-gold conductor offers good adhesion and solder-leaching characteristics and long-term adhesion stability. Having an optimum firing range between 850° and 925°C for 10 min, a 1-mil-thick layer of EMCA 7170 has a resistivity of 25 to 35 mΩ/square. The material's viscosity is 180,000 centipoises. A 5-mil line will leach in 2 min at 200°C and in 1 min at 280°C. A 100-by-100-mil pad will sustain a tensile pull in excess of 16 lb and has a peel strength in excess of 10 lb. After 1,000 hr at 150°C, peel adhesion is greater than 5 lb.

EMCA, 605 Center Ave., Mamaroneck, N. Y. 10543 [478]

This solder-salvage liquid, Dross Reclaimer No. 79, can recover solder usually lost to solder-pot dross. For every 8-oz bottle used, 10 to 17 lb of

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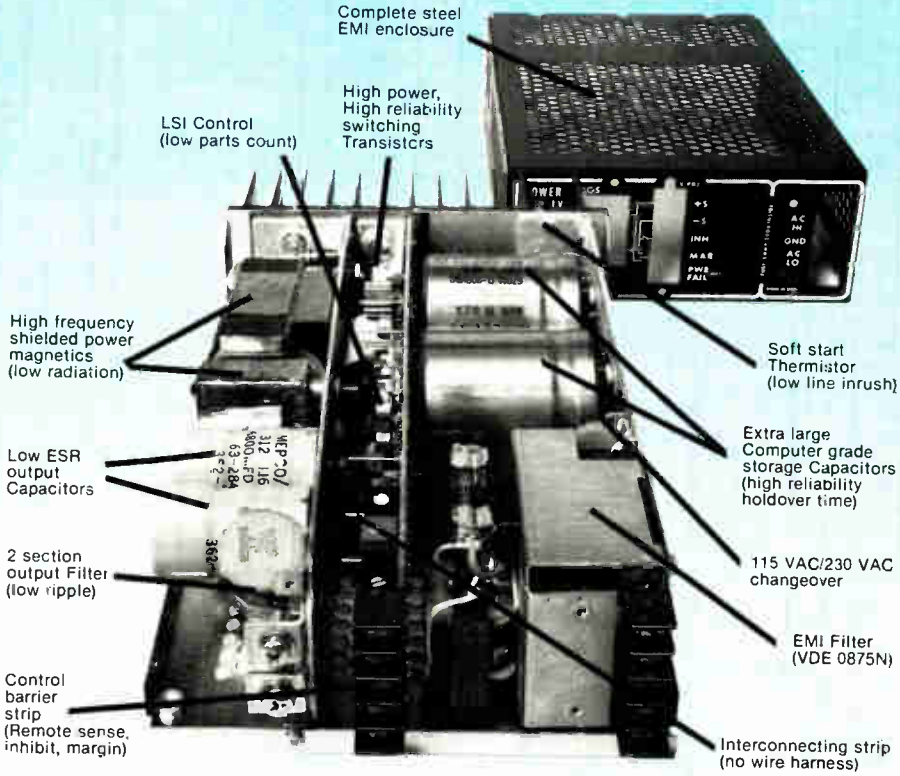

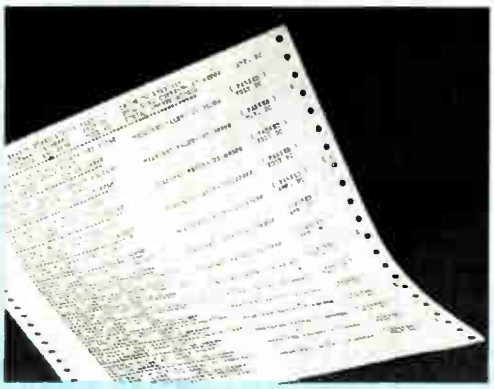

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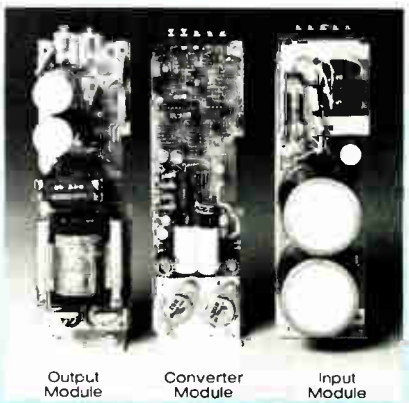

RS Series · Single Output

CASE SIZE	OUTPUT CHARACTERISTICS	VOLTAGE (ADJUSTABLE ±5%)			
		5V	12V	15V	24V
M5	MAX. CURRENT AMPS	10.0	4.5	3.6	2.5
M10	MAX. CURRENT AMPS	20.0	9.0	7.2	5.0
M15	MAX. CURRENT AMPS	30.0	13.5	10.8	7.0
M30	MAX. CURRENT AMPS	60.0	27.0	21.0	13.0

RT Series · Triple Output

CASE SIZE	OUTPUT CHARACTERISTICS	VOLTAGE (ADJUSTABLE ±5%)			
		5V/12V/12V	5V/15V/15V	5V/12V/5V	5V/15V/5V
T10	MAX. CURRENT AMPS	20/2/2	20/2/2	—	—
T15	MAX. CURRENT AMPS	30/5/2	30/4/2	30/5/2	30/4/2
T30	MAX. CURRENT AMPS	60/5/5	60/4/4	60/5/5	60/4/5

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New products/materials

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Unitool Corp., 3740 Skypark Dr., Torrance, Calif. 90505 [479]

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tors printed over the ESL 4901 and 4903 dielectrics show only slight deviations in resistance and temperature coefficient of resistance compared with those printed on bare alumina substrates. The 4901 coating is useful as a material underlying resistors required to dissipate heat.

Electro-Science Laboratories Inc., 2211 Sherman Ave., Pennsauken, N. J. 08110 [480]

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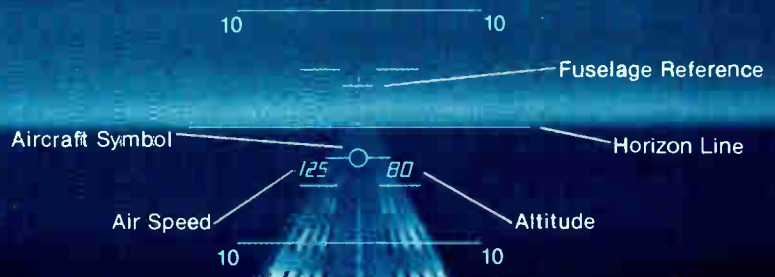

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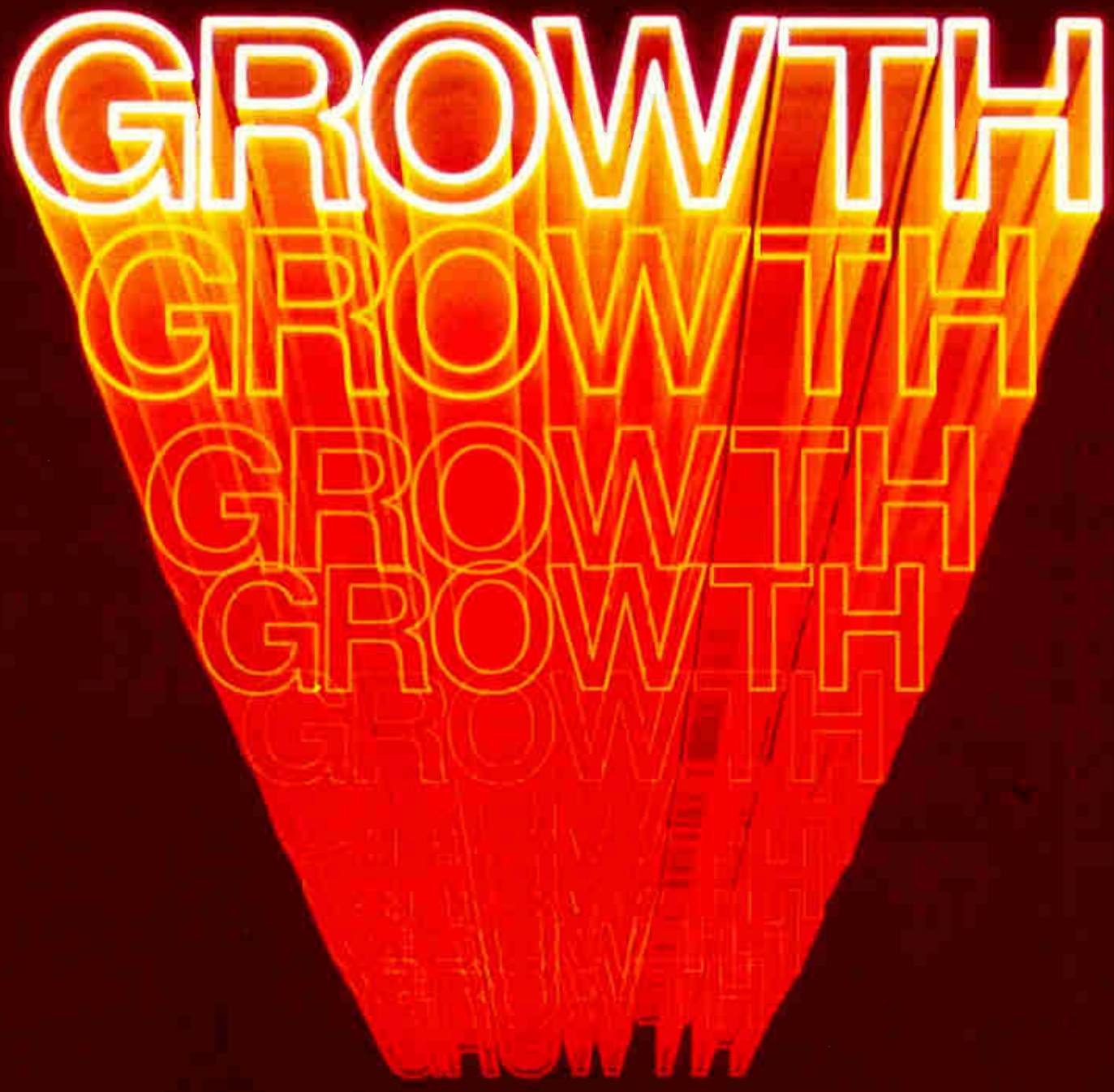

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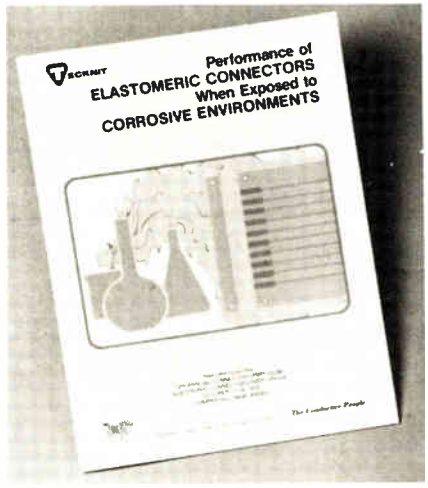
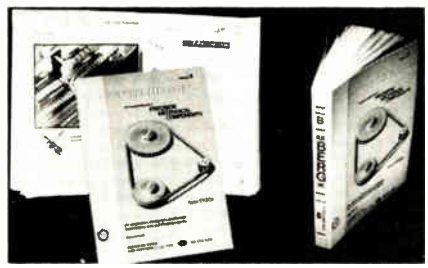
New literature

Connectors. "Performance of Elastomeric Connectors When Exposed to Corrosive Environments" is a six-page brochure describing testing procedures for conductive elastomeric connectors. Tests of a connector called Conmet were carried out to military standard specifications in salt spray and corrosive gas environments and for temperature-cycling



and current-carrying capacity. Tests were also done on printed-circuit boards having tin-lead pads and copper pads. The brochure is a reprint of a technical paper given at the 12th Annual Connector Symposium. Technical Wire Products Inc., 129 Dermody St., Cranford, N. J. 07016. Circle reader service number 421.

Mechanical components. "The Complete Manual of Precision Mechanical Components," a 544-page catalog, contains designs and specifications for hundreds of items such as gears, shafts, linear components, bearings, O rings, breadboard kits, couplings, miniature drive systems, and other products. Also included are design data, reference informa-



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New literature

tion, technical tables, and metric conversions. Winfred M. Berg Inc., 499 Ocean Ave., East Rockaway, N. Y. 11518 [423]

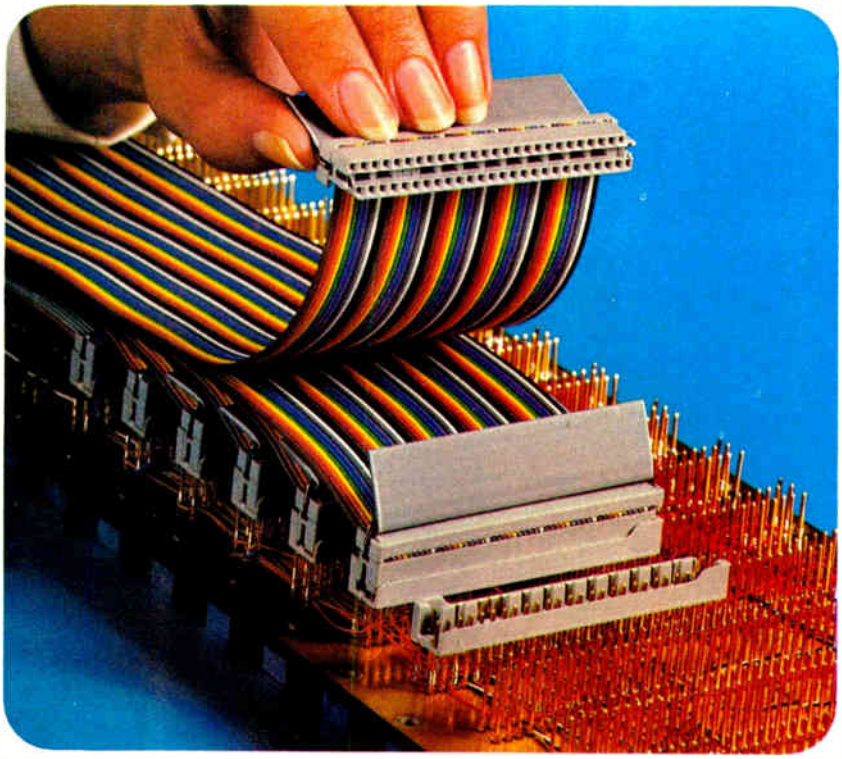
Products galore. Useful for design engineers, industrial plant managers, purchasing agents, experimenters, and hobbyists, the Edmund Scientific 1979 Fall/Winter catalog lists more than 4,000 products. A short description accompanies each item, which include eyepieces, prisms, beam splitters, prism diagonals, projection lenses, mirrors, fiber optics, lenses, fresnel lenses, and camera lenses. Also included in the 100-page catalog are products for optical testing. A price is given for each of the products and special prices can be obtained on quantity purchases. Edmund Scientific, 7082 Edscorp Bldg., Barrington, N. J. 08007 [422]

Optical couplers. The "Complete Guide to Optical Couplers" analyses the 43 optical couplers currently on the market and how they are used in fiber-optic systems. The 48-page guide contains a series of comprehensive tables comparing such operating parameters as design and optical power division ratio. Opinions of the material of both manufacturers and users are given. The guide sells for $95. Probe Research Inc., P. O. Box 251, Millburn, N. J. 07041 [424]

Epoxy smear removal. A three-page product bulletin describes the Chemcut Epoxy Smear Removal System used to clean epoxy during production from the inner circuits of multilayer printed-circuit boards. The bulletin explains why the epoxy smears and then goes on to describe the parts of the removal system and what each does. Specifications are also provided. Chemcut Corp., 500 Science Park, State College, Pa. 16801 [425]

Heat sinks. Two catalogs containing information and specifications for semiconductor heat sinks are available from EG&G Wakefield Engineering. The first catalog (#1) is intended for use with devices that

Want simpler backplane connections? Come to the source.



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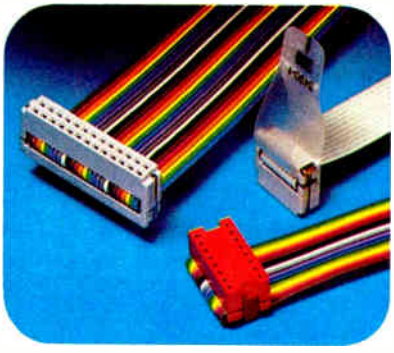

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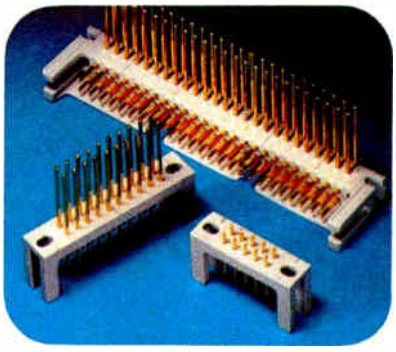

or solder tail headers to suit your specific design problem. Keying capability is also provided.
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generate 10 watts or more of heat. The second (#2) is for use with those that dissipate less than 10W. Complete ordering information for a wide selection of heat sinks and extrusions is provided. Each catalog in addition tells how to select heat sinks and how they perform in both natural convection and forced-air conditions. EG&G Wakefield Engineering, 60 Audubon Rd., Wakefield, Mass. 01880 [426]

Tools and more tools. A 24-page flier, containing information on tools for wrapping and unwrapping wire and inserting and removing connectors for the electronics, telecommunications and aerospace industries, is available from Jonard Industries Corp., Precision Tools Department, 134 Marbledale Rd., Tuckahoe, N. Y. 10707 [427]

Monolithic and hybrid. A 384-page handbook contains information on various types of products such as: analog-to-digital and digital-to-analog converters, data-acquisition systems, analog input/output peripherals, sample-and-hold devices, analog multiplexers, operational amplifiers, power supplies, dc-to-dc converters, digital panel meters, digital panel printers, digital voltage calibrators, and data-logging instruments. These devices are categorized by performance. Data sheets are given on certain key products, and ordering information is also included. Datel Intersil, 11 Cabot Blvd., Mansfield, Mass. 02048 [428]

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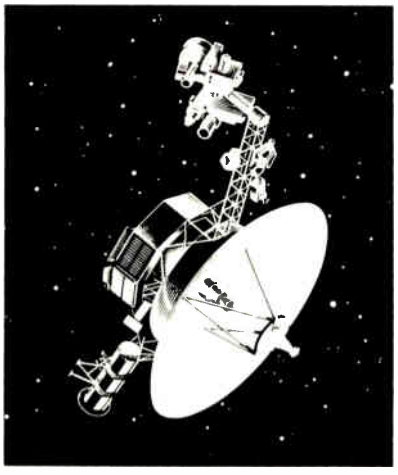

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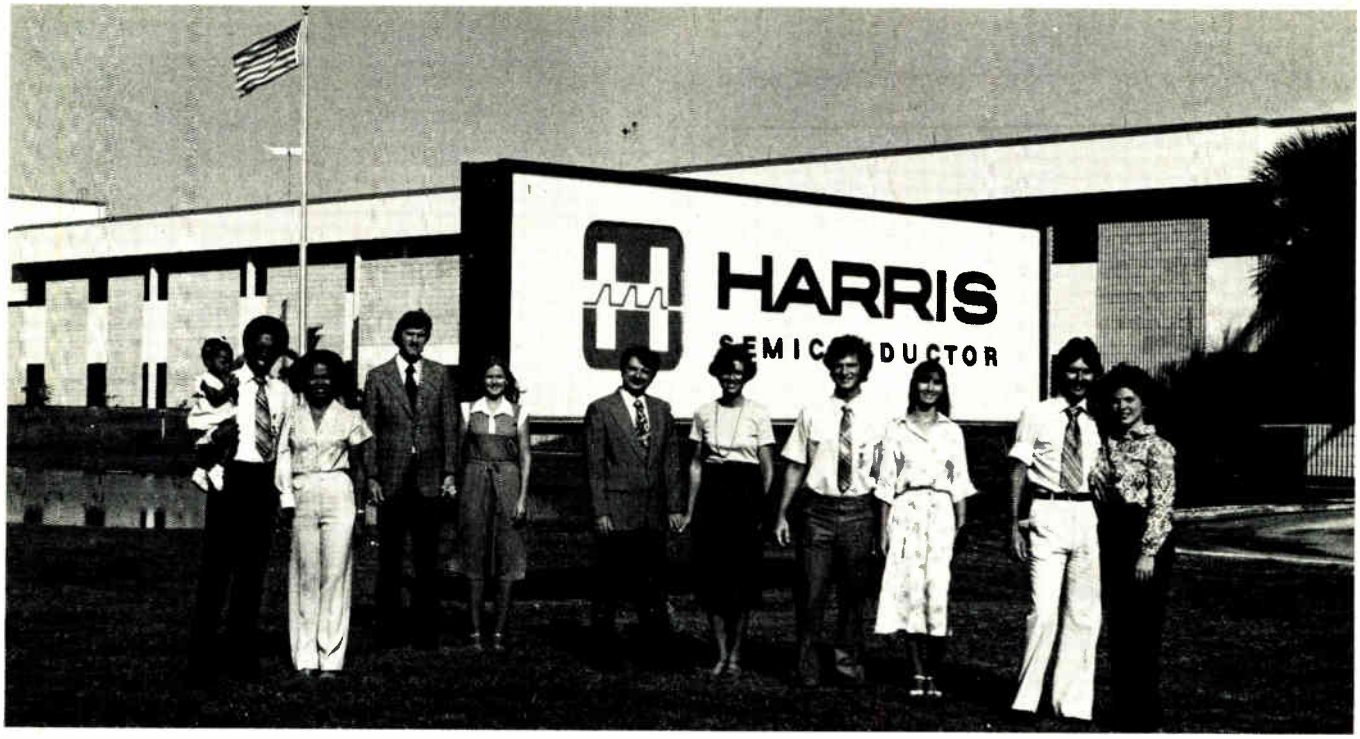

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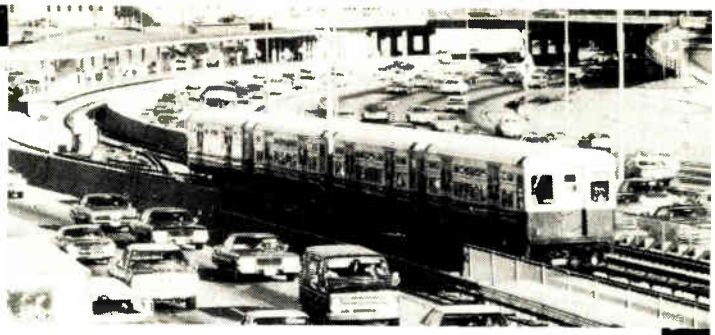

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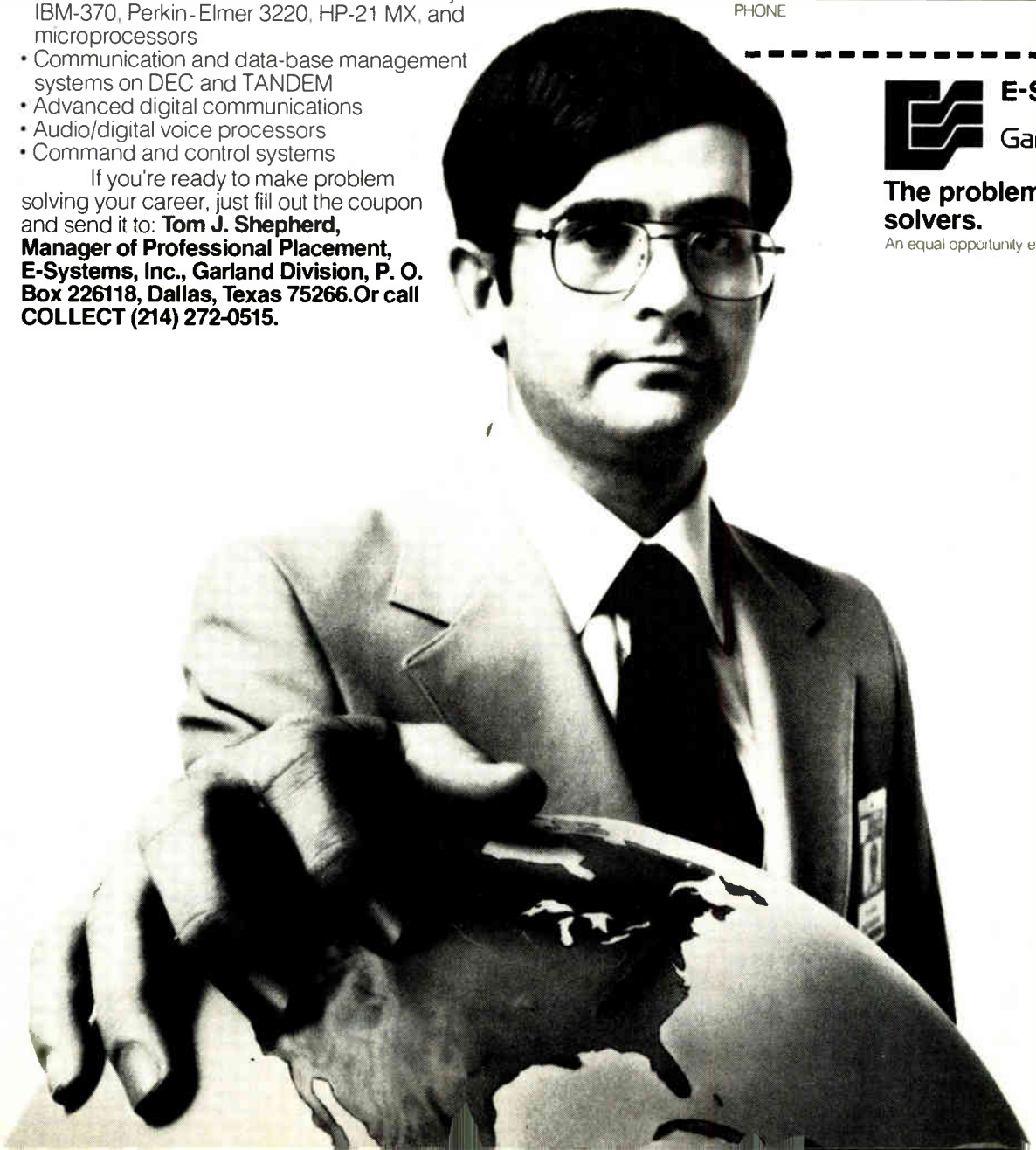

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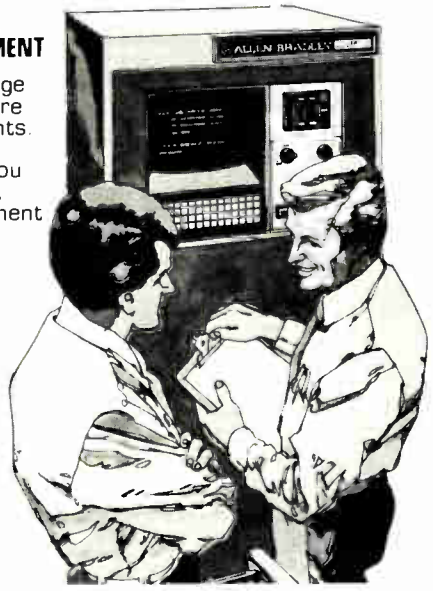

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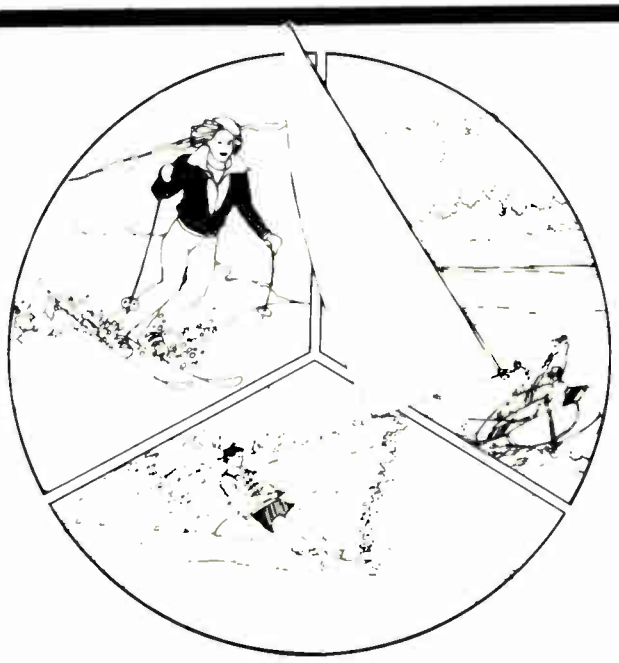

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