NOVEMBER 8, 1979

IEEE MOVES TO POLISH ITS IMAGE/92

Densest bubble memory: meet the family/123

Overlapping operation boosts microprocessor speed/144

50 YEARS

Electronics

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4. Circuit Board Testing Update/No. 4 in a series from Hewlett-Packard.

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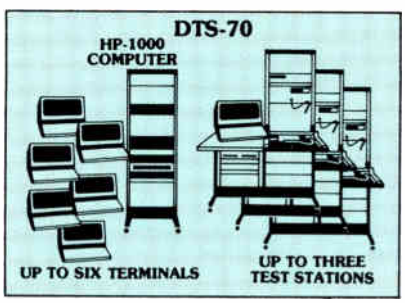
The amount of logic on today's average PC board poses some difficult problems for production test . . . bottlenecks and increasing costs of testing and rework, to name a few. Yet, many of these costs and problems can be minimized with efficient test techniques. Often, that calls for a simulator-based test system.

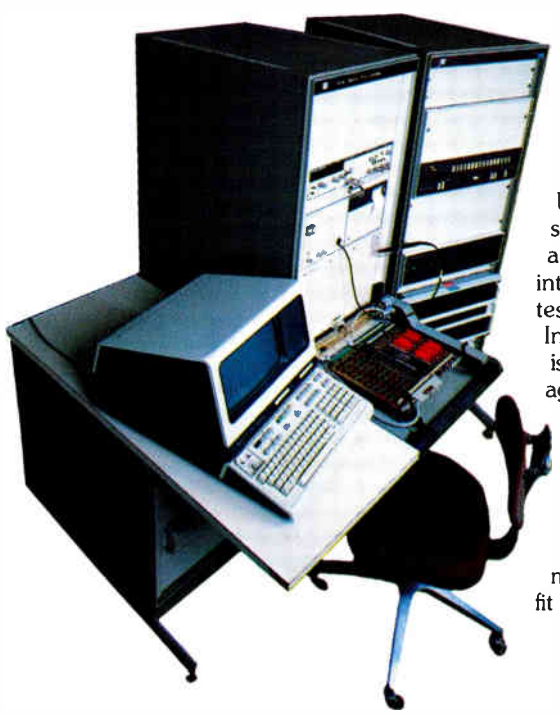
Simulator-based testing defined. Board-test simulation is a technique in which the circuit to be tested is modeled—component by component and node by node—in the test system computer. From this model, the system can calculate the correct response to any input pattern, plus predict failure modes and their responses. This allows only those patterns which identify faults to be used as the test pattern stimulus.

A major benefit of simulation is that it provides an accurate measure of test effectiveness. You know to what extent you're exercising board components. Thus, you can determine test efficiency, and, just as important, you know when to halt test software development.

Another benefit of having the circuit and all of its failure modes stored in the computer is that you then have detailed information to aid in fault isolation. Finally, advanced simulation techniques allow circuit modeling in the test system so that engineering can test designs before they're built and thus eliminate many problems before they reach production.

The advantages of test flexibility. HP's answer to simulation and to the reduction of testing costs and time is the DTS-70 Digital PC Board Test System ($90,350* for standard operating system). It provides the benefits of a simulator and offers other advanced features as well.

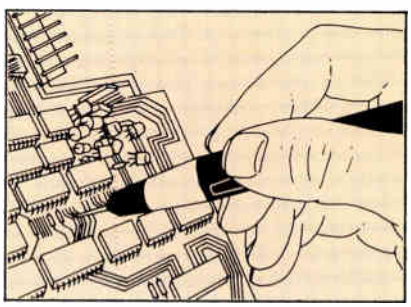




When you expand your production capacity, you can add test stations (to a total of three) without buying additional computing power. Need more test software development capability? Then simply add an inexpensive CRT terminal to your basic system. You can add up to six software development terminals, as shown, and they won't interfere with your 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 store test data and give you reports such as specific board or component failure rates and modes. The DTS-70 will easily fit into your long range computer network plans, too, providing distributed processing and communication to your data processing center.

Simplified troubleshooting. Testing isn't the only problem. You also need a rapid and inexpensive way to locate the specific faulty component or components for replacement. Using HP's FASTRACE software,



the DTS-70 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. And it has zero delay capability, allowing you to detect races and hazards—a critical problem in logic circuit operation.

For more information. There are other benefits to PC board testing with the HP DTS-70. And for analog and hybrid circuit testing, HP offers the 3060A with combined functional and advance in-circuit testing. To get complete details, send for our circuit test system data sheets. Or, contact your local HP field engineer.

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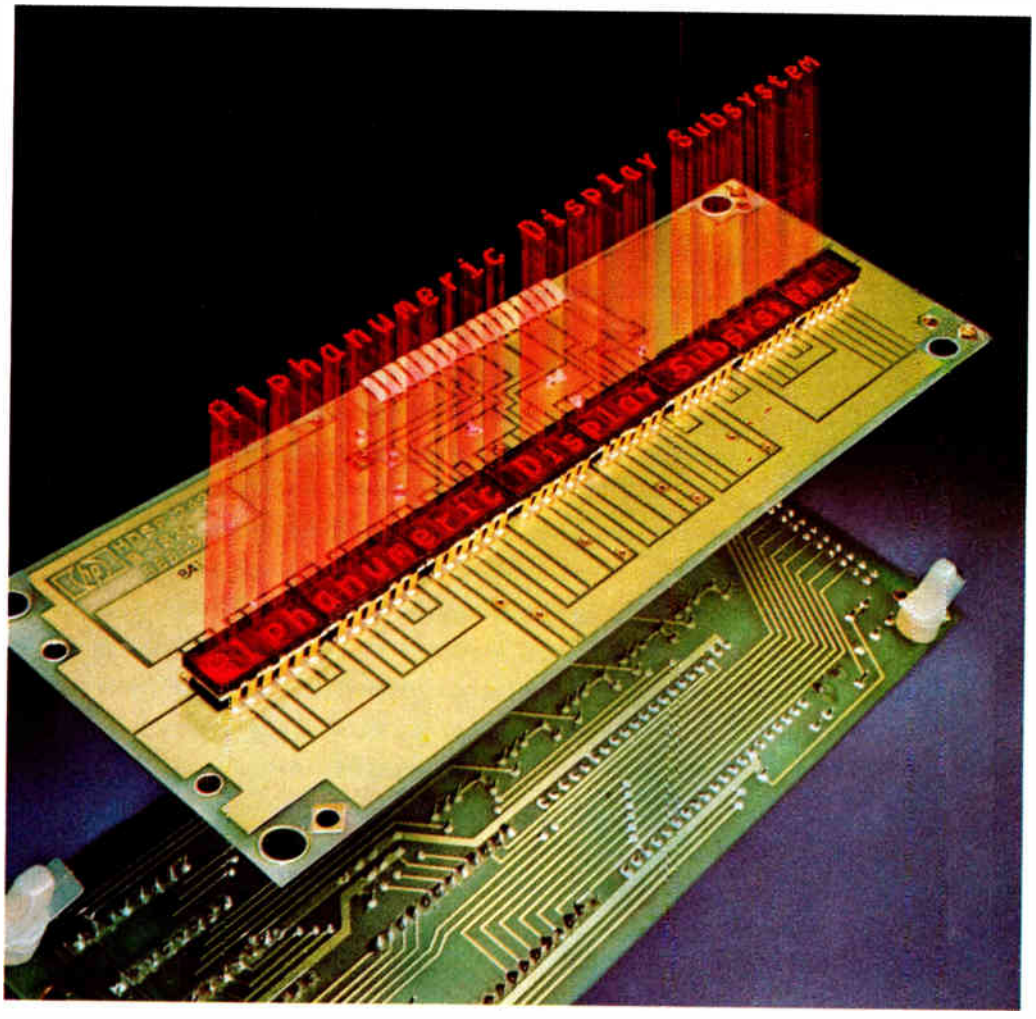

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For more information on the HDSP-24XX alphanumeric system or immediate off-the-shelf delivery, call any franchised HP distributor. In the U.S. contact Hall-Mark, Hamilton/Avnet, Pioneer Standard, Schweber, Wilshire or the Wyle Distribution Group (Liberty/Elmar). In Canada, call Hamilton/Avnet or Zentronics, Ltd.

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Electronics
The International Magazine of Electronics Technology
Vol. 52, No. 23 • November 8, 1979

Highlights

Cover: Uncrating the 4300 mainframe, 109
IBM's industry-shaking replacement for the System/370 preserves software continuity; gains new hardware, architectural improvements, a fault-tracing facility, and horsepower per buck.

Cover is by Robert Strimban.

Europeans join auto electronics race, 94
Car makers in Europe have revved up the effort in electronics research; engine sensors, fuel-injection systems, and dashboard features received attention at a London conference.

Bubble trio well supported, 123
An extensive set of custom chips makes a family of dense bubble-memory devices easy to interface with a computer; error-correction circuitry is optional.

Interface processor thinks twice, 144
Custom board-level processor executes two routines simultaneously to control fast data flow between computer and asynchronous mass memory.

. . . and in the next issue
A new complementary-MOS microprocessor . . . a smart TV prototype . . . Hamming-code error correction for microprocessor memory.

NOTE: Because of the withdrawal of a contributed article on press, page numbers 134 to 141 are missing.

Electronics

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Publisher's letter

Now that deliveries of the IBM 4300 series have begun, users will get their first opportunity to look "under the hood" of this innovative computer series. A detailed look at the new machines is also available in this issue in the three-part article starting on page 109.

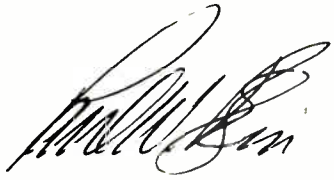
So far, most of the information available about the series has been long on applications but short on the technology inside the computers, which makes this article particularly timely. When IBM announces anything, the electronics world is quick to take note. And in the 4300, it may be said, the giant computer company has once again established a position on the leading edge of technology.

Four authors from two IBM locations describe how the system is put together. Humberto Cordero Jr., manager of processor development at the Systems Products division in Endicott, N. Y., provides an overview of the 4341 hardware. Theodore J. Frechette, project engineer, and Fred T. Tanner, advisory programmer for the Systems Diagnostics section of the division, describe the unique diagnostics designed into the 4341.

To tell the story of the basic architecture there is Hartmut R. Schwermer from the Böblingen Development Laboratory in Böblingen, West Germany. This architecture is called Extended Control Program Support: Virtual Storage Extended, or ECPS:VSE in IBM parlance.

Unlike the Big Three U. S. auto makers, European car manufacturers have tended to depend entirely on their semiconductor suppliers for design work. As countries in Europe prepare tougher exhaust emissions and mileage requirements, the time has come for these semiconductor companies to perform.

Even the European Economic Community is drawing up new requirements, Kevin Smith, London bureau manager, reports. His story about European automotive electronics is on page 94.



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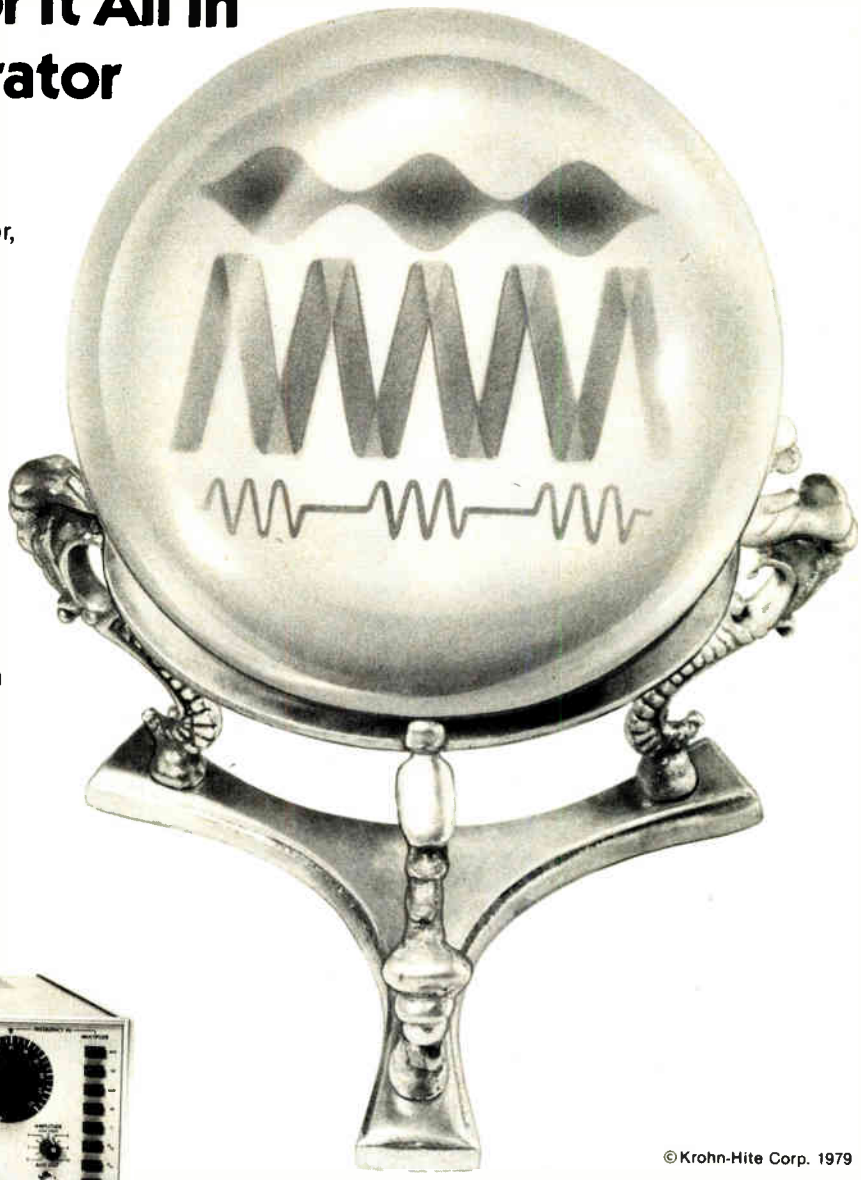

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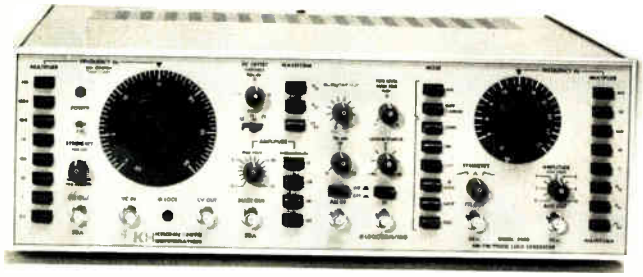

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Readers' comments

Creating more engineers

To the Editor: I recently read "EE shortage threatens growth" [Oct. 11, p. 96] with great interest. I have, for the last few years, been aware of this problem and have anticipated a decline in the electrical engineer population across the country. The problem seems to be acute in the integrated-circuit industry, and because of the attractiveness of salaries in this area it will cause shortages across the entire country.

It seems as though many of these companies spend much on research and development for long-term growth potential but do little to ensure long-term growth in the supply of engineering graduates. Some of the problems could be circumvented by applying some influence at the high school level, as, obviously, quality engineers can only be in supply if we encourage more students to enter the profession. Colleges can only do so much to recruit students, but industry can describe job opportunities and starting salaries and thereby recruit more individuals early on.

The problem will continue to worsen because fewer high school graduates are expected in upcoming years. I would like to see industry begin now to use its influence to lessen the shortage of qualified technical people.

Thomas W. David
Electrical Engineering Department
Milwaukee School of Engineering
Milwaukee, Wis.

More about LEDs

To the Editor: Regarding "Dual light-emitting diode synthesizes polychromatic light" [Aug. 16, p. 130], may I make three points?

First, the LED driver of Fig. 1 has a low output impedance. A current limiting resistor should be inserted between driver output and LED.

Second, the LED driver shown in Fig. 2 is unnecessarily complex. If the right-hand pin of the dual LED were connected to the output of a voltage divider made of two 820-Ω resistors and driven by the supply voltage, the right-hand half of the driver circuit consisting of one sixth of a 74C04, two 20-kΩ resistors, and

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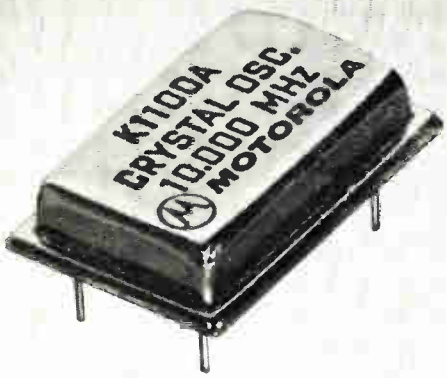

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Circle 7 on reader service card

Readers' comments

two transistors could be omitted, as well as the current-limiting 1-kΩ resistor.

Similarly, the circuit of Fig. 1 could be adapted for a single supply.

Martin Brendle
Tübingen, West Germany

Circuit ambiguities

To the Editor: P. V. Ananda Mohan, in his Designer's Casebook article "Tunable equalizers set amplitude and delay" [Oct. 11, p. 126], shows a simple circuit with two or three operational amplifiers to achieve variable envelope delay or delay and amplitude equalization. But his reference to "roll-off" in an all-pass network is confusing. We assume he means the shape of the delay versus frequency characteristic.

The transfer function shown would be an all-pass function only if the constant term in the numerator and the denominator were the same, but the equation shows an ω term in the numerator and an ω_0 term in the denominator; ω_0 is defined in terms of circuit components, but not ω.

In the formula for phase shift, in which the constant t is not defined, we might assume that ω is the frequency variable contained in the s terms, but the following sentence, as well as the formula in the last paragraph, seems to imply it is a network constant. It would help to clarify these ambiguities.

David C. Bidwell
Boonton, N. J.

■ *The roll-off as defined by the author refers to the change in e_{out} with Q for a given e_{in}. Also, the last term in the numerator of the first equation should be ω_0^2, not ω^2. The term ω is indeed an independent variable. Finally, the formula in the last paragraph should indicate that the null frequency of the filter is $\omega_n = \omega_0/(1-K^2)^{1/2}$.—ED.*

Correction

In "Telephone tester detects line distortion" [Sept. 27, p. 15], the input leads of the optically isolated circuit should be connected across the phone line, not to the same side of the line as shown. Also, capacitor C_2 has a value of 0.47 microfarad.

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News update

■ The highest direct-frequency measurement ever made on an electromagnetic wave has been recorded by Donald A. Jennings, Kenneth M. Evenson, and F. Russell Petersen of the National Bureau of Standards and Kenneth M. Baird and Gary Haines of Canada's National Research Council.

Their feat, accomplished with a cesium-beam frequency standard and a chain of microwave and laser oscillators, is important because measurements based on frequency can be up to 1,000 times more accurate than wavelength checks. They measured 520 terahertz (52×10^{13} hertz), which is in the visible region of the spectrum and is 50,000 times higher than the frequency of the cesium-beam oscillator at present used as the microwave frequency standard.

The 520-THz measurement needs a chain of 14 lasers and six klystrons (microwave tubes) to determine the frequency of a neon laser near 260 THz. When this is done, a helium-neon laser from Canada's research council and a frequency-doubling crystal is used to make the 520-THz measurement.

Mixing known, unknown. The system works by producing beat frequencies. At each step in the chain, a laser or microwave oscillator generates a known frequency that is mixed with a higher, unknown frequency to produce a beat frequency. That frequency is equal to the difference between the known and the unknown frequencies and is low enough to be measured with conventional instruments. Addition of the beat to the known frequency yields the unknown value, which then becomes the basis for the next step in the chain that is needed to produce the highly accurate measurement.

The next project, the researchers say, is to do the whole thing all over again with the best possible accuracy. Only feasibility has been of concern up to now. The lasers will be stabilized to allow the 520-THz measurements to be made with the same accuracy as the cesium frequency standard itself (1 part in 10^{13}). **-Harvey J. Hindin**

Extend your storage capabilities beyond the conventional.

Now Gould offers a range of digital storage oscilloscopes that offer a world of advantages over conventional tube storage technology, beginning with being able to capture transient of "one-time" events and store them indefinitely for display or hardcopy printout. This makes them ideal for electronic, electromechanical, educational, and biophysical applications.

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Other outstanding features include automatic operation, display of stored and real time traces simultaneously and hard copy memory output in digital or analog form. And IEEE488 is available for compatible interfacing.

And, remember that Gould scopes are backed by a two-year warranty of parts and labor, exclusive of fuses, minor maintenance and calibration. For further information, contact Gould Inc., Instruments Division, 3631 Perkins Ave., Cleveland, Ohio 44114. Or Call (216) 361-3315, Ext. 395, for a demonstration.

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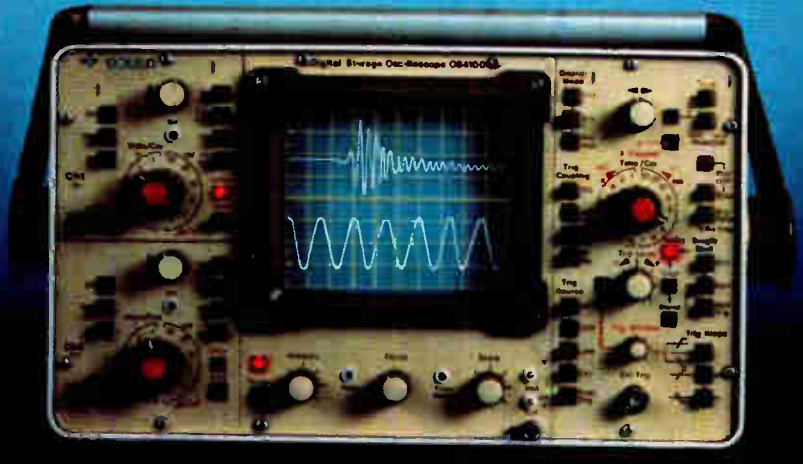

Circle 13 on reader service card

People

Ullrich builds his dream house for International Harvester

Most electronics engineers only dream about being paid to develop state-of-the-art applications in which price is no object. But for John F. Ullrich, recently named vice president for science and technology at International Harvester Co., the dream has come true and it is only part of the deal.

Ullrich, formerly Ford Motor Co.'s executive engineer for powertrain electronic engineering, is not only going to do that but is also now building, basically from scratch, a large technology development center in suburban Chicago for IH, a company with 1978 sales of $4.8 billion. It is in a headlong rush to adopt new technology to increase sales by improving its line of tractors, trucks, and other heavy-duty construction and farm vehicles. And when each tractor has a price tag of $45,000 and up, another $1,000 for electronic controls is insignificant.

IH and its competitors are trying to incorporate microprocessor technology to improve driver monitoring and control of engines and attachments such as combines [*Electronics*, Jan. 4, p. 46]. However, notes Ullrich, "to date, the application of electronics at IH has been minimal."

But that will soon change, he says. The new tech center, which will house several hundred people within the next few years, will be responsible for applying electronic, chemical, hydraulic, and metallurgic technologies to its vehicles and is expected to develop subsystems to be sold to other companies. New applications of electronic technology, though, are expected to have the biggest short-term impact, says the 39-year-old Ullrich, who has several degrees, including a doctorate in nuclear engineering from the University of Michigan.

For example, Ullrich plans electronic dashboard monitoring systems for "across-the-board" applications in a variety of different trucks and other vehicles. An alphanumeric display may be a cost-effective substitute for discrete dials and gages on the instrument panel, he says, in an approach similar to that taken by Ford in its Lincoln Continentals.

Starting from scratch. John Ullrich has gone to IH to build a new technology center.

In addition, cost-conscious long-haul truck drivers could save 50% of their fuel bills if an electronic module were available to sense and display the optimum moment for switching gears, Ullrich notes. But crucial to the development of such systems are better sensors and actuators, he adds.

Kravitz keeps Dionics on top by thinking small and fast

Take a 60-employee semiconductor company whose plant includes just 10,000 square feet and make it the top supplier in its market segment. That's what president Bernard Kravitz has done with Dionics Inc., a Westbury, N. Y., manufacturer of high-voltage driver integrated circuits and hybrid-circuit chips.

Kravitz, a modest 46-year-old with a master's degree in metallurgical engineering, attributes his company's success to the good fortune of being in the right place at the right time. Still, someone had to have the foresight to blend talent and innovative thinking into a leadership position. In fact, Dionics has had to make good twice—when it was started in 1969 with $400,000 put up

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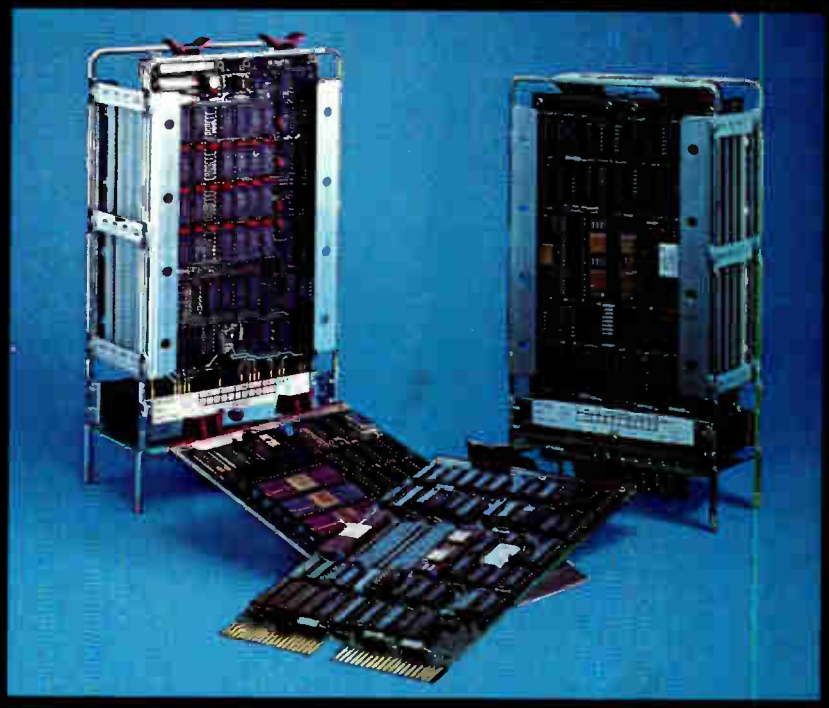

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People

Right combination. Bernard Kravitz has parlayed skill and know-how into top spot.

by a group including Kravitz and operations vice president Sherman Gross, and again after the 1975 economic slump.

"We're not doing something that cannot be done by others," insists Kravitz. "IC manufacturers could easily compete with us if they wanted to, but they usually look for large mass markets to get into." However, he says, "a small manufacturer like us has some advantages over larger firms. We can respond to customer demands faster. Customers don't even mind that we are a small, sole-source manufacturer—after all, we've been around for a number of years and have a good reputation."

All that is fine and necessary, but the bottom line is technology—and that's where Dionics shines. Of key importance is the company's ability to supply dielectrically isolated high-voltage ICs in a hurry. And, as Kravitz points out, it takes more than just expertise in dielectric isolation to be in the high-voltage IC business: "One also has to know how to make high-voltage components within the dielectrically isolated chips, and for that fabrication task we have a number of patents."

Also, a small company like Dionics—it will do close to $3 million in business this year—must sometimes live by its wits. In one case, it was unable to supply enough drivers for one customer. So it studied the product's applications and found that the driver was underutilized. The solution: halve the driver chip's area and thereby double production capacity. It's that kind of thinking that keeps Dionics small but big. □

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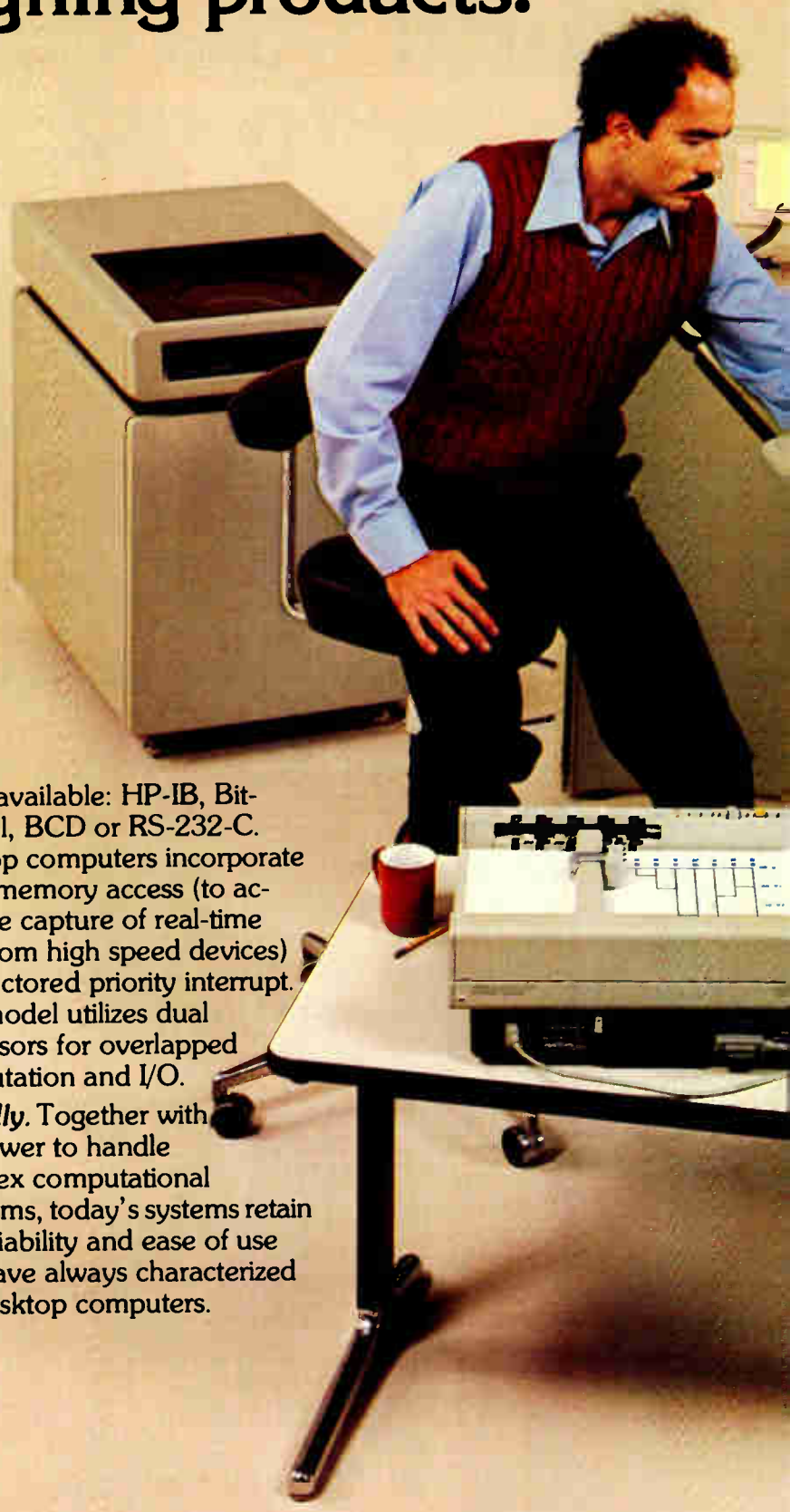

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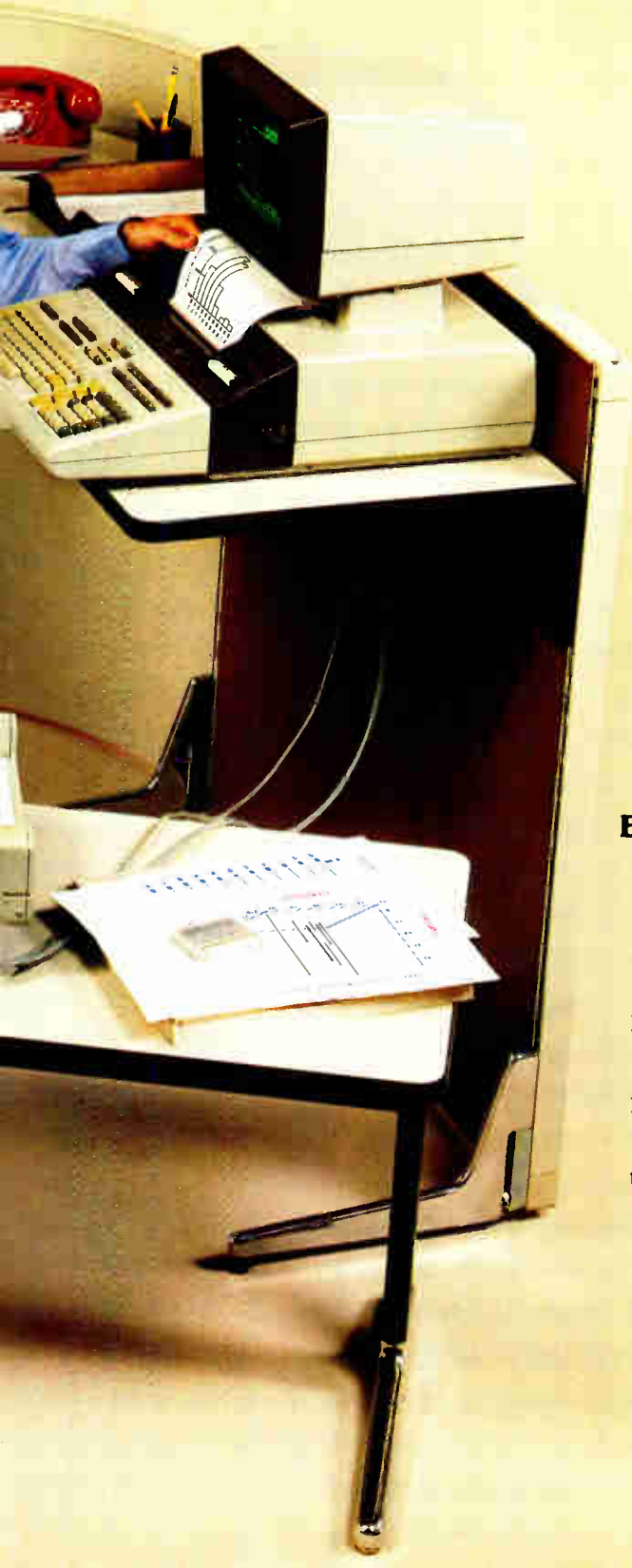

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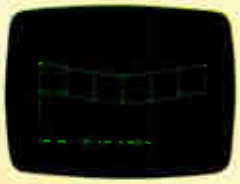

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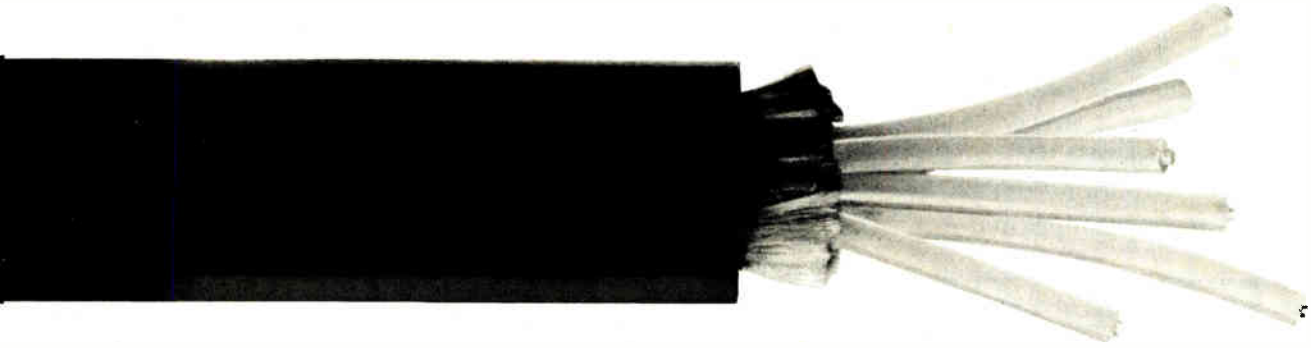

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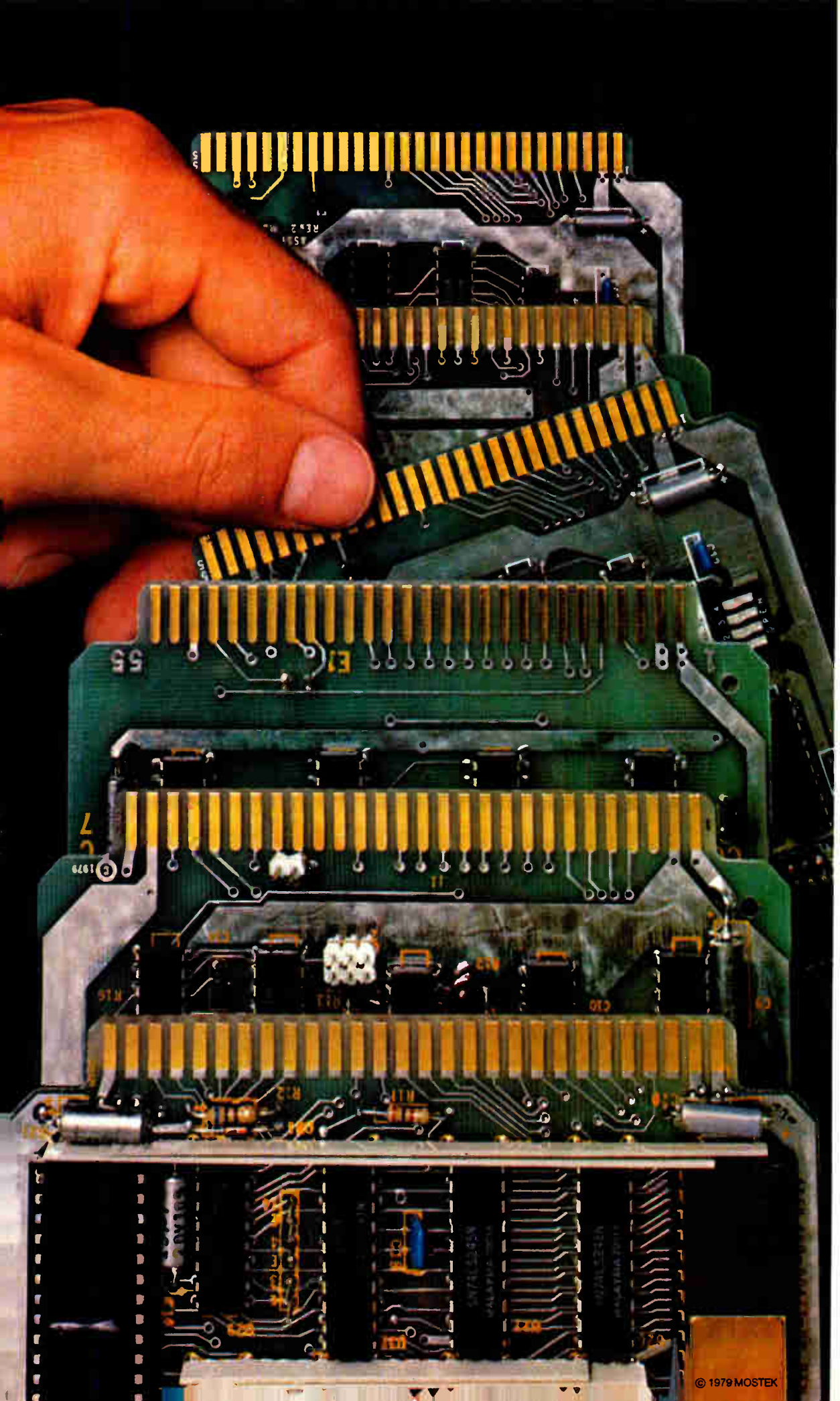
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Editorial

Polishing the engineer's image . . .

The decision of the Institute of Electrical and Electronic Engineers to put some real muscle, and money, behind an effort to improve the image of the engineer could prove a good thing (see p. 92). The effort to educate the public, as well as Congress, as to what technology and the engineer both can and cannot do is welcome.

The decision to go to professional public relations people is to be applauded, too. Volunteer and part-time public relations staffs, though well-intentioned, would be hard put to get the job done.

If there is a word of caution to be said to the institute, it is to remember that it is the engineer, and the role the engineer plays as a contributor to society's good, that is important here. Neither the IEEE as such nor any of the individuals who lead it is important in this context. And the public relations program should not in any way be viewed as a substitute for continuing efforts in professional activities to improve the IEEE members' working conditions and benefits. Creating a true image of what technology and the engineer do to contribute to the well-being of the nation should be uppermost in the minds of those in charge of the new program.

. . . and paying for his research

"Products are the end result of technology, and are not technology in themselves." That's a good perspective, and it comes from J. Fred Bucy, president of Texas Instruments Inc., one of the United States' canniest executives.

Unfortunately, Bucy's point must be less appreciated outside TI. According to some industry observers, the U. S. is underfunding research and development and by so doing risks a technology gap—and therefore a product and an eventual trade gap.

To their credit, many industry executives recognize that more money should be spent on R&D to boost technology, efficiency, and productivity. So do key academics and many Government officials. But there are obstacles.

First are those peculiar to Washington. The best intentions of the Federal agencies are often foiled by the paralytic influences of single-issue politics, punitive tax laws, the gamesmanship of legislators like Sen. William Proxmire, and national priorities that favor exporting technology (which many in industry feel simply fosters stronger overseas competition) while putting research funding near the bottom of the list.

And the impossibility of obtaining patents for Government research irritates both academic researchers, who would like some return from their research, and universities, which would like to supplement shrinking endowment and tuition income.

So Government, industry, and academe share a problem. But they are beginning to recognize it and talk about it. In Seattle last month the Association of Graduate Schools held its annual meeting with the theme of industry, academe, and governmental partnership. Unfortunately, Government and industry types were outnumbered four to one by academics, so the possibilities for problem solving were limited.

And at the Massachusetts Institute of Technology last month, a symposium on technology, innovation, and industrial development drew a broader audience. Again, though, there was some feeling of like talking to like within each group and sniping between the three groups rather than a bridging of their gaps in understanding.

But these conferences are good first steps, even if they are shorter steps than some might wish. What is needed now is more pressure from industry for increased Federal spending.

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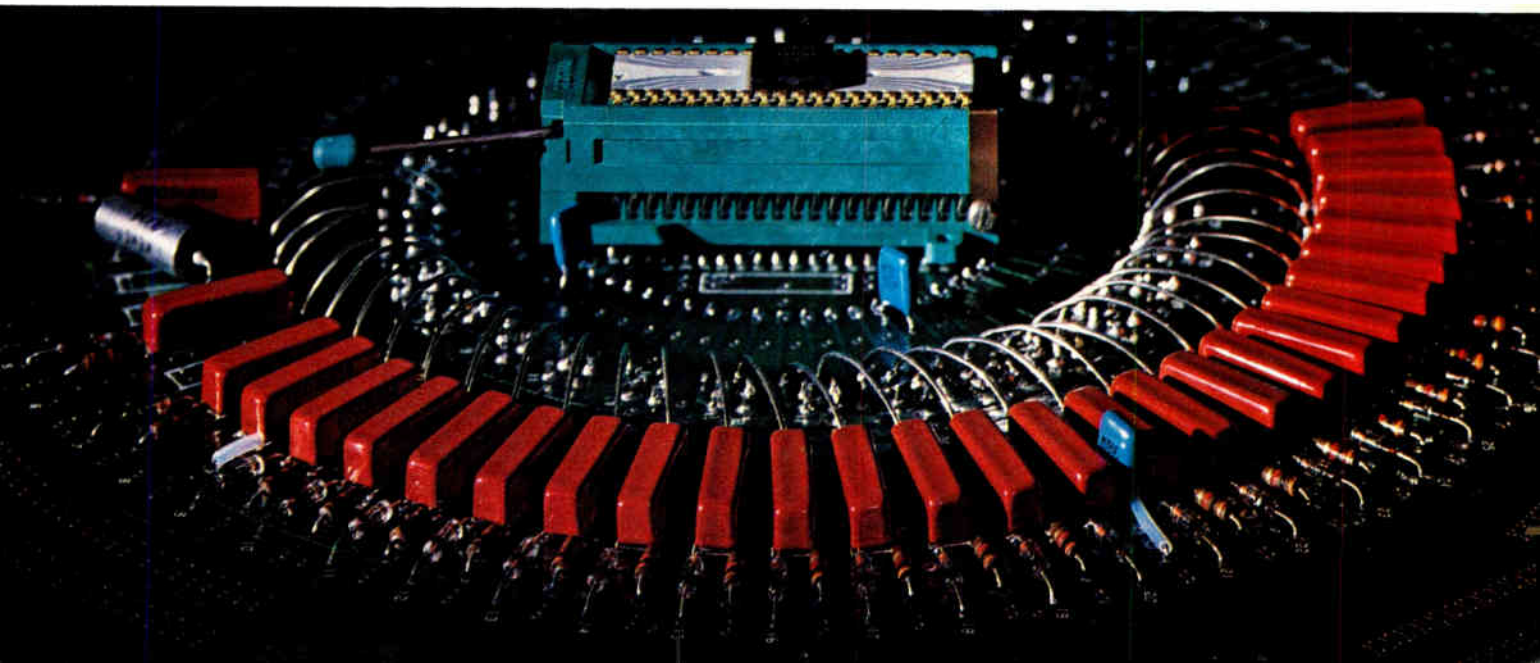

Meetings

Non-Ionizing Radiation Symposium, American Conference of Governmental Industrial Hygienists (2205 South Rd., Cincinnati, Ohio 45238), Capitol Hilton Hotel, Washington, D. C., Nov. 26–28.

Intelec '79—Second International Telecommunications Energy Conference, IEEE, Sheraton Park Hotel, Washington, D. C., Nov. 26–29.

National Telecommunications Conference, IEEE, Shoreham-Americana Hotel, Washington, D. C., Nov. 27–29.

Sixth Data Communications Symposium, Association for Computing Machinery *et al.*, Pacific Grove, Calif., Nov. 27–29.

Measurement Science Conference, IEEE *et al.*, California Polytechnic State University, San Luis Obispo, Calif., Nov. 30–Dec. 1.

High Temperature Electronics and Instrumentation Seminar, IEEE *et al.*, Marriott at the Astrodome, Houston, Texas, Dec. 3–4.

International Electron Devices Meeting, IEEE, Washington Hilton Hotel, Washington, D. C., Dec. 3–5.

Future Shock—Computers in the 1980s, American Institute of Aeronautics and Astronautics (Box 91295, Dept. Comp80, Los Angeles Calif. 90009) *et al.*, Ramada Inn—Rosslyn, Washington, D. C., Dec. 3–5.

VHSIC—A New Era in Electronics, American Institute of Aeronautics and Astronautics (Box 91295, Dept. VHSIC, Los Angeles, Calif. 90009), Washington, D. C., Dec. 6–7, and Boston, Jan. 21–22.

First Electronic Component and Telecommunications Apparatus Industry, Ente Fiera—Mostra di Componenti Elettronici (Viale degli Scaligeri—C.P. 805, 36100 Vicenza, Italy), Vicenza Fairgrounds, Dec. 8–10.

Second International Symposium on Mini- and Microcomputers in Control, International Society for Mini- and Microcomputers (P. O. Box 248, Anaheim, Calif.), Galt Ocean Mile Hotel, Fort Lauderdale, Fla., Dec. 10–11.

Distributed Data Processing, Data Communications and Networks, and Minicomputers Conference, American Institute of Industrial Engineers, (P. O. Box 3727, Santa Monica, Calif. 90403), Jack Tar Hotel, San Francisco, Dec. 10–12.

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, EIA, Convention Center, Hilton and Jockey Club Hotels, Las Vegas, Nev., Jan. 5–8.

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

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.

Short courses

Structured Analysis, Design, and Testing of Computer Systems, Dec. 10–14, George Washington University, Washington, D. C. Write to the Director, Continuing Education Program, George Washington University, Washington, D. C. 20052.

Programming in Pascal, Mondays and Wednesdays, Dec. 3–19, and Tuesdays and Thursdays, April 8–24, 1980, Toronto. Write to Human Computing Resources Corp., 10 St. Mary St., Suite 401, Toronto, Canada M4Y 1P9.

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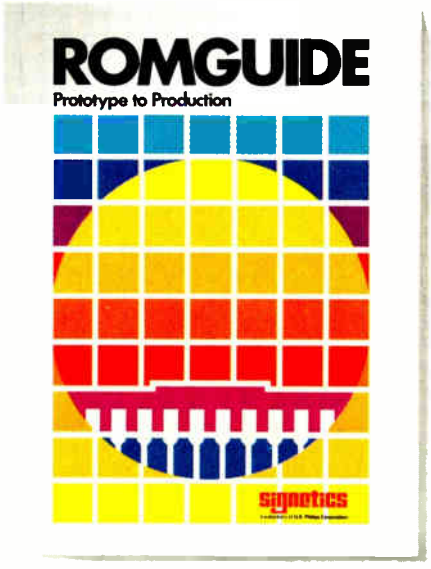

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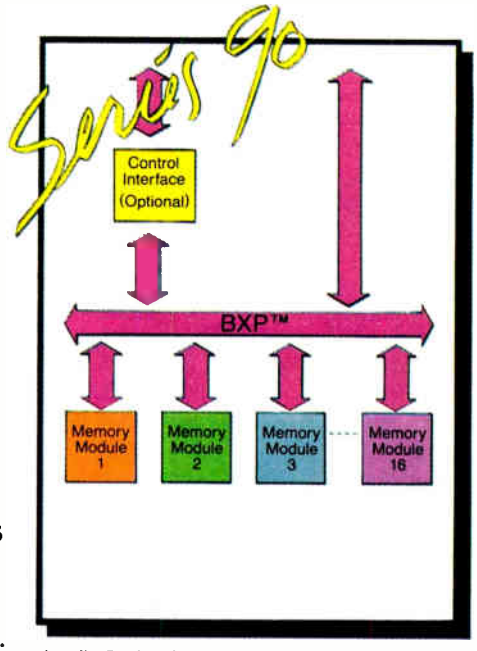
Whether you're adding more of today's memory technology or upgrading to higher density components of the future, our BXP bus stays with you. It has addressing space already allotted for up to 2 billion bytes.

ECC for unimpeachable data integrity

A primary function of Series 90's optional control interface is our ECC feature. With single-bit error correction and double-bit error detection, it gives your system the highest data integrity available. The controller also supports an optional error logger and display.



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Series 90 memory modules and controllers are available now, so you can start designing today. For complete information, plus our convenient Configuration Guide, contact your local Intel sales representative. Or write Intel Corporation, Literature Dept., 3065 Bowers Avenue, Santa Clara, CA 95051.

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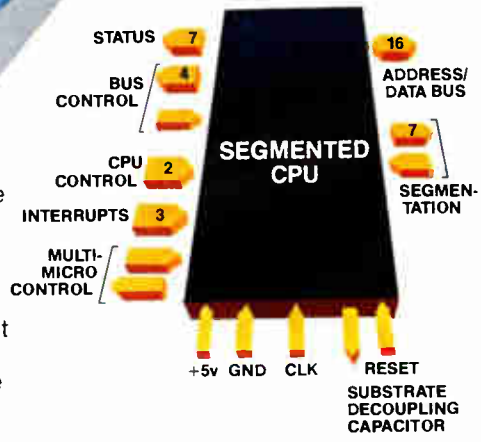

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Circle 31 on reader service card

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Electronics newsletter

IBM offers system to process and transmit documents

International Business Machines Corp. is moving to tie together the components of its office of the future with its newly announced 5520 Administrative System, **a shared-logic system that combines advanced text editing and electronic document distribution via phone lines.** The 5520 comes from IBM's General Systems division in Atlanta and further blurs the boundaries between the computer giant's divisional product lines, with each now selling at least one product in the office-automation area.

The new 5520 can stand alone as a word processor or be attached—for document distribution ranging from one-page memos to entire manuals—to another 5520, the System/6, the 6670 information distributor, the 6640 document printer, the Mag Card II-Communicating, the 6240 Mag Card Typewriter-Communicating, the Word Processor/32, or the System/370. The system is available in four models. The shipments will be in two stages: advanced text-processing portions starting in February and the document-distribution portion beginning in November 1980. The 5520 will be made up of a system unit, two printer options, a magnetic-card reader, two display choices, and a licensed program.

Entry-level scientific computer due from Data General . . .

Watch for mid-November introduction of a new scientific Eclipse computer from the Data General Corp., Westboro, Mass., bearing an entry-level price. The S/140 will have a base price of about $16,000 with 128 kilobytes of memory, built-in error detection and correction, and a cache-like pre-fetch memory port to speed throughput. Many other features like hardware floating-point processing will be optional. Similarly equipped, the new S/140 would have about the same price as the firm's existing S/130, but greater performance: Data General sources even say that the S/140 would have **about 70% of the performance of the much more costly Eclipse S/250.**

. . . as firm announces its networking strategy for 1980s

Data General is announcing what it calls its computer networking strategy for the 1980s this week, based on Xodiac, a communications package fully compatible with the X.25 packet-switching system. Company sources note that Decnet, the communications approach offered by Digital Equipment Corp., Data General's fiercest competitor, is not X.25-compatible, and they feel that **this gives Data General a network market edge that could last for up to a year.**

Zenith to become maker of computers for small businesses

Zenith Radio Corp., the last of the big consumer electronics companies to rely on virtually only one product—television sets—is diversifying. Now that it has acquired the Heath Co. of Benton Harbor, Mich., it plans to become a manufacturer and marketer of small-business computers. That move takes on added significance in the light of the resignation of chairman John Nevin after Zenith increased its market share but netted less profit this year.

For the $64.5 million that Zenith paid Schlumberger Ltd. for Heath, it received, among other things, a line of **intelligent video terminals that will be the new Zenith Data Systems division's first products.** The company plans to become a broad-based supplier of small-business computers and peripherals and is recruiting design engineers.

Electronics newsletter

Exxon's Kylex ready to market dense LCD display

Exxon Enterprises Inc. is about to unleash yet another tiger into the electronics marketplace. Its Kylex Inc. affiliate in Mountain View, Calif., formed in January 1978 to investigate the development of large liquid-crystal displays with high information density, is in the process of transferring its first product out of research and development and into production. The initial offering, due later this month, is understood to be a complete LCD system producing a **40-character line (5-by-10-dot matrix per character) that can interface with microprocessor systems.**

Energy search triggers big sale of array processors

One of the largest single purchases by an original-equipment manufacturer of array processors is to be announced this week by Seismograph Service Corp. of Tulsa, Okla., and CSP Inc. of Billerica, Mass. The buyer is a division of Raytheon Co. Neither firm would detail the dollar or unit amounts involved in the transaction. However, Seismograph is expected to sell its new seismic data-processing system—based on CSP's MAP-300 and Digital Equipment Corp.'s VAX-11/780—into its existing customer base, as well as using it internally. **Seismograph is said to have more than 200 seismic data-processing systems in place worldwide,** all seemingly candidates for replacement.

Mostek, SMC in licensing and second-source deal

Mostek Corp. of Carrollton, Texas, and Standard Microsystems Corp. of Hauppauge, N. Y., have agreed on a second-source and cross-licensing arrangement **that puts the New York firm into the market for standard telecommunications devices.** The deal covers SMC's CRT-5027, -5037, and -5057 Video Timing and Control (VTAC) cathode-ray-tube controllers and the FDC-7003 floppy-disk controller. Mostek products are the MK 36000 64-K read-only memory and a line of complementary-MOS telecommunication chips: the MK5116, 5116-1, 5150, 5151, and 5156.

Electronics stars in defense budget, says EIA forecast

Electronics spending by the Department of Defense will rise from $19.2 billion in fiscal 1980 to $26.6 billion in fiscal 1989, measured by total obligation authority in constant fiscal 1980 dollars, according to a 10-year forecast by the Electronic Industries Association. **Hot technology areas include software, large-scale integration, night vision, millimeter-wave communications, signal processing, fire control, sensing, and friend or foe identification** (see p. 57).

Addenda

Selected as the winner of a benchmark evaluation, Computer Automation Inc.'s Industrial Products division says its Capable 4000 series of logic board testers **will be the preferred test equipment for all International Telephone & Telegraph Corp. divisions.** The estimated worth of sales of the digital test systems by the Irvine, Calif., firm to ITT is more than $4 million over the next three years. . . . Set for signing is a second-sourcing agreement for Siemens AG of West Germany to build Western Digital Corp.'s six-model FD179 floppy-disk controller line. The Newport Beach, Calif., firm expects this licensing arrangement **to expand into its data-communication chips and specialty 16-bit processor line.** . . . National Semiconductor Corp. will become a **second source for Motorola Inc.'s Macrocell family** of emitter-coupled-logic array circuits.

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Reliability spells the difference between "just another commodity RAM" and the EA 2114 1K x 4 static NMOS RAM. Reliability built-in with extra heavy lead frames that shunt more calories of heat away from your chip. Or IC circuitry painstakingly designed to provide ±10% power supply tolerances. It's this kind of reliability that gives you more usable parts at incoming inspection, and measurably fewer field problems in your finished products.

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Part Number	Access Time
EA 2114L	450 nsec
EA 2114L-30	300 nsec
EA 2114L-25	250 nsec
EA 2114L-20	200 nsec
EA 2114L-15	150 nsec

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8085A	✓		✓		✓		✓		✓		✓	
8049	✓		✓		✓		✓		✓		✓	
8039	✓		✓		✓		✓		✓		✓	
8039-6	✓		✓		✓		✓		✓		✓	
8035	✓		✓		✓		✓		✓		✓	
8021	✓		✓		✓		✓		✓		✓	
8048	✓		✓		✓		✓		✓		✓	
6802	✓		✓		✓		✓		✓		✓	
6800	✓		✓		✓		✓		✓		✓	
F8	✓		✓		✓		✓		✓		✓	
3870	✓		✓		✓		✓		✓		✓	
3872	✓		✓		✓		✓		✓		✓	
Z80A	✓		✓		✓		✓		✓		✓	
TMS9900	✓		✓		✓		✓		✓		✓	
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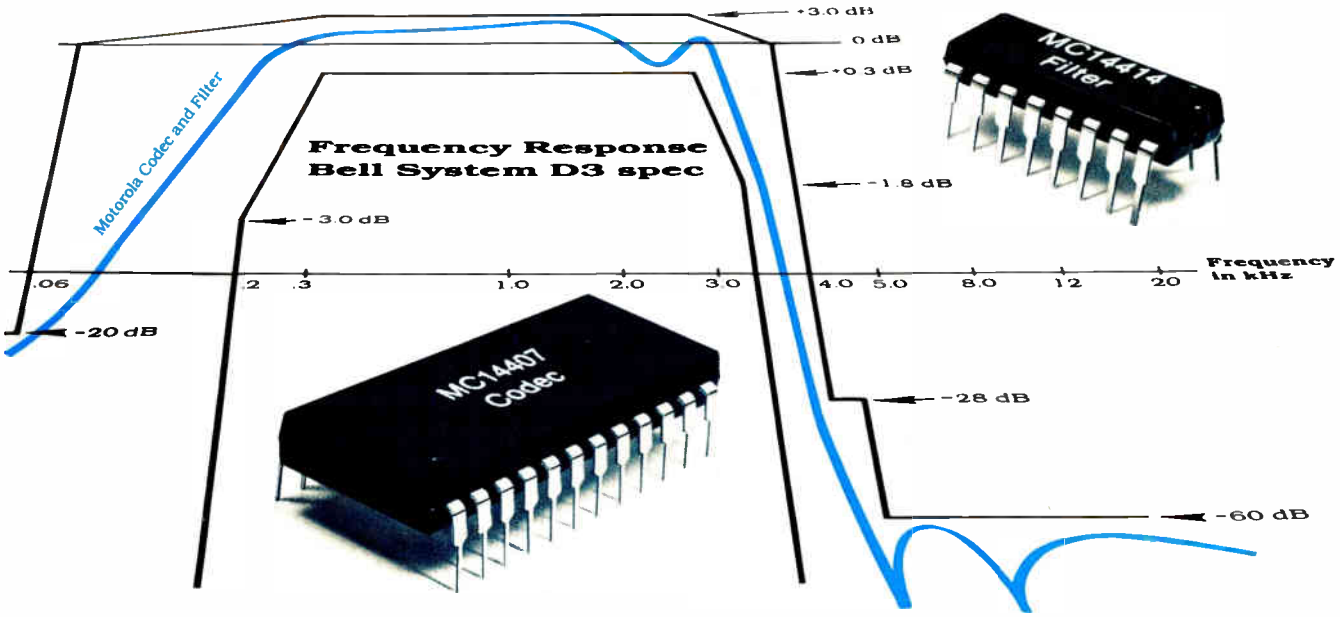


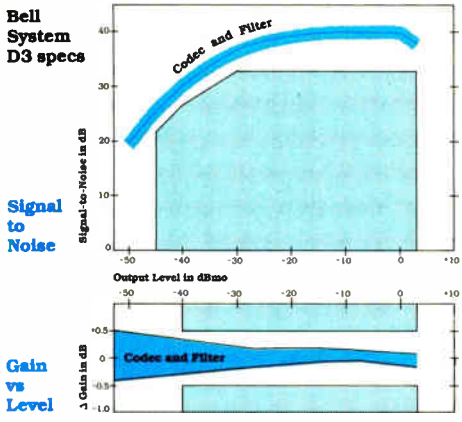
Motorola's LSI codec and filter team up to meet system specs.

Motorola's MC14406/7/4 PCM codecs and MC14414 PCM filter together meet or exceed all Bell System D3 voice frequency requirements and objectives*, and are compatible with G. 712 CCITT recommendations. *See Bell System technical reference PUB 43801

They're available from the factory now, so don't let your customers down. With Motorola codec and filter, they'll never again need to risk missing channel objectives.

Both the technologically advanced codec and filter are mass produced on our established, reliable metal-gate CMOS line, one of the most prolific and dependable CMOS manufacturing operations in the world. You know we'll be able to meet schedules with the quality you depend on. You know we'll be able to keep costs down. We're Motorola. You know we'll be here.

The 24-pin MC14407 codec provides pin-selection of A-law or Mu-law companding with D3 digital format, and the MC14404 does the same with CC1TT digital format. The 28-pin Mu-law MC14406 offers transmit and receive LSB signalling. All three are designed for 8K samples per second, and no other codec challenges the low on-hook power drain of just 1 mW.



The MC14414 filter has both transmit and receive low-pass filters on-chip, and on-hook power use is only 1 mW.

Later, when our MC3419 line feed and 2-to-4 wire conversion circuit is available, you'll be able to do the complete low-power, up-to-spec Subscriber Channel Unit including Subscriber Line Interface with reliable, space-saving, low-cost monolithic circuits.

In the meantime, see that your customers get what they have to have: systems that meet specs, including the sensitive idle noise spec of 23 dBrnCO. Motorola's codec-filter team is typically 17 dBrnCO.

For product data, write to Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, AZ 85036. To inquire for products, contact your Motorola sales office.

State-of-the-art LSI for the telecommunications industry is just one of the many aspects of Motorola's commitment to providing components for

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Circle 38 on reader service card

Ternary gates support three logic states

by John G. Posa, Solid State Editor

Scheme fits all three levels into 5-V swing, as well as saving real estate and power and halving propagation time

A ternary logic scheme from Signetics Corp. provides a way of achieving the throughput of very large-scale integration without shrinking device dimensions to VLSI sizes. Using standard n-channel depletion-load MOS processing, the company has developed circuits that operate on three logic states at a time—that is, in base 3 arithmetic instead of base 2.

Of course, ternary logic has a tough row to hoe in the binary-dominated solid-state world. But the Sunnyvale, Calif., subsidiary of the Netherlands' NV Philips Gloeilampenfabrieken is convinced of its future and is designing its first chips with the new logic gate.

Contrast. National Semiconductor Corp. also recently introduced a three-level logic scheme that it calls Tricode [*Electronics*, Sept. 27, p. 38]. Tricode's first two levels are the usual binary digits, represented by 0 and +5 volts respectively, and the third level comes from a chip's high-impedance state. The setup is primarily intended to reduce the pin count required to address a device.

In contrast, Signetics' approach squeezes all three logic states into a 5-V swing (see figure) and is used at the gate level rather than just at the chip level. Thus, the high-impedance state remains available for the usual application of driving a single bus from multiple sources.

As the table shows, for a hypothetical 16-bit arithmetic and logic unit, Signetics' scheme does more than just reduce the number of input and output pins. It also lessens internal circuitry and interconnections so that chip area is minimized.

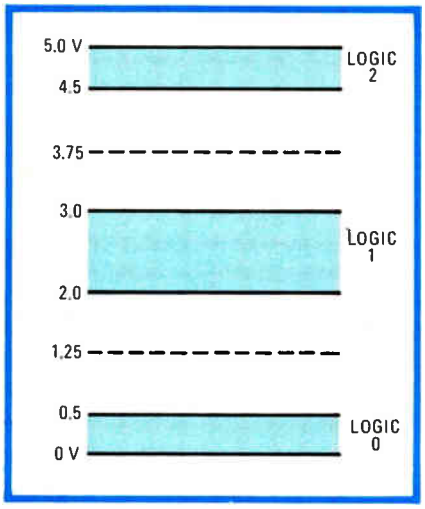
Power consumption is reduced because "only half of the voltage range switches 66% of the time," that is, from 0 to 1 or 1 to 2 (or vice versa), according to John Woodman, electronic data-processing applications manager. Also, because the three logic levels are spaced within the same 0-to-5-V swing as binary logic uses, rise and fall times are cut short and propagation times are roughly halved. With cost proportional to chip area, I/O pins, and power usage, the upshot is more performance for the money.

National's Tricode requires a rather complicated encoder and decoder to recognize the three states, but Signetics engineers designed a gate that actually senses different threshold voltages between 0 and 2.5 V and between 2.5 and 5 V. Similarly, the gate's push-pull output stage can latch at three voltages.

With these gates, three different kinds of inverter can be built. One lets the 0 level pass right through while levels 1 and 2 are interchanged. Another inverter changes 0 to 2, 1 to 0, and 2 to 1; and the third type turns a 0 into a 1, a 1 to a 2, and a 2 to a 0. Thus, design of a chip can be further optimized simply by employing the inverter type suited to a particular logic problem, according to L. Keith Russell, manager of circuit research.

Signetics plans to exploit the ternary gates in at least two upcoming LSI devices. One will be a binary-to-ternary converter. "Until we can get transducers that can produce three levels, we'll use the two-to-three-level converter," Russell says. With the addition of a three-to-two-level converter, ternary chips could work in binary systems, and such a design is coming.

The other coming device will be a



Ternary. Signetics' new depletion-load p-MOS gate can sense and drive three logic levels. The dotted lines at 1.25 and 3.75 V represent dividing lines between levels.

BINARY VS TERNARY LOGIC FOR A 16-BIT ARITHMETIC AND LOGIC UNIT

Item		Binary	Ternary
Circuits		400	307
Wire interconnections		2,000	1,334
Input/output pins		40	28
Speed	6-μm dimensions	2.5 – 5 ns	1 – 3 ns
	4-μm dimensions	1 – 4 ns	0.5 – 2 ns

multiplier capable of efficiently processing complex numbers. "This is exceedingly important for signal processing and real-time map reading and will help make fast Fourier filters and things of that ilk," Russell explains, adding that the lower cost will also make the innovation attractive to the word-processing, data-entry, and consumer markets.

Other schemes. This is not the firm's first bout with multilevel logic. Back in 1977, it designed a family of basic gates that used four-level integrated injection logic.

The idea did not go over so well, admits Russell, because "I^2L was slow back then." Another problem with multilevel bipolar logic like I^2L is that, being controlled by current rather than voltage, each gate needs a replicator that senses the output current and feeds a control signal back into the input to keep that current constant, thereby making current latching work.

However, Signetics is eyeing a high-performance version of I^2L developed by Philips called integrated Schottky logic, or ISL [*Electronics*, May 25, 1978, p. 42]. For fast four-level logic, ISL might do.

Trade

Effect of RAM imports into U. S. disputed; shortages may trigger increases in prices

Charges that Japanese makers of 16-K random-access memories have invaded the U. S. market with prices much lower than in Japan are reverberating in the markets of both countries. Moreover, supply in the U. S. is so tight, some U. S. manufacturers are considering raising their prices.

At the heart of the controversy are the per-unit prices for the 16-K RAMs in the two countries. Sources in Japan, including a representative of a U. S. semiconductor maker and others, say they are lower there for products from both countries, whereas Mostek Corp. chairman L. J. Sevin claims the Japanese charge more at home than in the U. S. [*Electronics*, Oct. 25, p. 40].

One Japanese distributor of integrated circuits reports that domestically made 200-nanosecond RAMs sell there for between $3.43 and $4.29 each in lots of 10,000 or more, with slower parts from Motorola and Texas Instruments going for about the same price. Mostek's asking price is about double that, he says.

Origins. The controversy began last month in Washington, D. C., where Sevin, representing the Semiconductor Industry Association, told a congressional committee that Japanese prices in the U. S. range from $4.85 to $5.40, whereas prices in Japan for American parts range from $6.90 to $8.10. The U. S. parts would not have sold there unless Japanese parts were going for comparable prices at home, the SIA argued. Prices in Japan may have

Exports up, but . . .

It looks like another good export year for U. S. electronics firms, with total exports rising 30% to $6.9 billion in the first half, while imports increase by only 17% to $5.6 billion, the U. S. Department of Commerce reports. The $1.3 billion trade surplus was 162% higher than in 1978's first half.

However, some Government analysts see disturbing signs in the trade data, notably that imports in categories like computers and telecommunications equipment are increasing faster than exports. "In computers, the U. S. is still way out in front,' says one trade specialist. "But in telephone equipment, imports are catching up as the U. S. market opens to competition. If imports keep growing by more than one third, while exports expand more slowly, imports are going to surpass exports in a few years."

-Ray Connolly

U.S. EXPORTS AND IMPORTS, JANUARY THROUGH JUNE (millions of dollars)

	Imports			Exports			Trade balance	
	1978	1979	% change	1978	1979	% change	1978	1979
Computers and related equipment	343	490	+42.9	1,877	2,549	+35.8	+1,534	+2,059
Calculating and accounting machines	254	256	+0.8	138	179	+29.7	−116	−77
Consumer electronic products	2,240	2,344	+4.6	341	374	+9.7	−1,899	−1,970
Telephone and telegraph equipment	102	141	+38.2	166	212	+27.7	+64	+71
Radio and TV communication equipment	383	443	+15.7	761	858	+12.7	+378	+415
Electronic components	1,238	1,631	+31.7	1,423	1,874	+31.7	+185	+243
X-ray apparatus, etc.	116	129	+11.2	255	347	+36.1	+139	+218
Electronic measuring and test instruments	152	192	+26.3	348	492	+41.4	+196	+300
Totals	4,828	5,626	+16.5	5,309	6,885	+29.7	+481	+1,259

SOURCE: BUREAU OF THE CENSUS, U.S. DEPARTMENT OF COMMERCE

dropped as a result of his testimony, he says. He and observers in both countries report that Japanese pricing is subject to much fluctuation.

Confusing the pricing issue are the variety of specifications available, which affect prices. For example, it is not always clear if two identical prices refer to the same specs.

An official at Nippon Electric Co., one of the firms singled out by Sevin, would not give prices. "But I can at least say that the price of 16-K RAMs is 10% to 15% lower in Japan than in the U. S.," said Keisuke Yawata, general manager of the International Electron Devices division, in Tokyo.

Nor would Hitachi Ltd., another of the companies singled out, comment on prices. However, Hiroshi Asano, executive managing director of the Electronic Devices group, Tokyo, said that the supply-demand gap is so great that any protectionist measures would hurt U. S. users of the 16-K RAMs.

An example of the problems created by the gap comes from Data General Corp., which recently posted its first-ever losing quarter. The Westboro, Mass., company said one of the two reasons was inability to deliver Nova 4 computers as planned and attributed the lag to a shortage of 16-K parts.

In fact, the Japanese pricing tempest is submerged by the high U. S. demand for memory bits. Demand will exceed supply by a factor of 4 in 1980 and of 2.5 in 1981, taking 1980 production capacity increases into account, says Bruce Threewitt, product marketing manager for Fairchild Camera and Instrument Corp.'s MOS Products division, in San Jose, Calif.

Hike. It is no wonder then, that some U. S. firms are thinking about price increases on their 16-K lines. Threewitt acknowledges that Fairchild is considering such a move.

Another company considering such a move is Motorola Inc. David Ford, MOS memory strategic marketing manager in Austin, Texas, says stable or rising prices are necessary to finance needed capacity increases. -*Electronics* **staff**

Industrial

New language simplifies coding

Convinced that the world of electronic industrial control needs a new language, Analog Devices Inc. has brought still another to the Tower of Babel. Its new A$^{PL\mu S}$, standing for "a programming language for microprocessor systems," is intended to simplify software writing in the field.

There are plenty of languages available, but, says the Norwood, Mass., company, none has the right mixture of high- and low-level features needed by industrial controllers. The firm now derives about 35% of its revenues from its line of industrial controllers, and A$^{PL\mu S}$ is being introduced along with a versatile new controller, the Macsym 20. The unit talks to anything from Teletype to mainframe with its wide variety of interfaces, including RS-232-C, RS-422, and IEEE-488.

Commands. Working in a variety of configurations, from stand-alone measurement control to complex, interactive networking, the Macsym 20 comes with a basic command set that lets the user make high-level control statements easily in IF . . . THEN form and simple commands like WAIT T, halting the program for interval T. The set includes two-character alphanumerics for data storage or indexes.

The upshot is simpler communication between a host computer and the Macsym 20 network modules, since control strings may be initiated with a simple two-character label. In addition, the command set unburdens the host.

Users who want to put together more intricate, interactive networks can buy the $13,990 development system shown in the photograph. Its software aids include compiler, text editor, and utilities.

Once the program is generated, the development system will burn it into a 2716 programmable read-only memory, which may be substituted for the PROM containing the command set. Making this possible is the fact that the Macsym 20 is built around an A$^{PL\mu S}$ interpreter.

Extensions. It also means that Analog Devices will extend the product line toward both the high and the low end, since it makes programs system-independent. If, for example, the present Z80 system microprocessor is upgraded to the Z8000, the programs written for the original board could still be used. Similarly, the programs could be transported to multi-user, multitasking systems as they become available.

The $3,250 Macsym 20 can oper-

Partners. Development system for Macsym 20 industrial controller works with A$^{PL\mu S}$ programming language, which is machine-independent, block-structured, and infinitely extensible.

ate as a stand-alone controller without a display or keyboard. It can measure analog or digital inputs and provide analog and/or digital control outputs.

To enhance its use in networking, the system configuration is user-determined. He or she can plug any of a number of different analog/digital input/output cards into the chassis's 16 slots. **-Richard W. Comerford**

Telecommunications

Microcomputer fills many phone roles

Seeking a single-chip microcomputer that could be put to work in equipment ranging from individual telephones to huge central-switching systems, Bell Laboratories first set about to find a commercially available unit. But the search was scrapped because the general-purpose devices on the market do not fill the bill. So the MAC-4 was born: a special-purpose low-power microcomputer dedicated to telephony.

Its instruction set has many low-level bit-manipulation facilities, but is compatible with the labs' well-regarded high-level C programming language. On-chip random-access and read-only memories can be configured for the job at hand, and 34 of the chip's 40 pins are used for input and output.

C-MOS. To hold down telephone-loop power consumption, the 4-bit chip [*Electronics*, Aug. 30, p. 32] is cast in silicon-gate complementary-MOS technology. The chip consumes only 200 milliwatts during operation, but upon activation of a special halt instruction everything except the RAM is turned off and consumption plummets down to microwatts.

Thus this microcomputer can run on the power available on a telephone line, and a battery can run the device for extended periods of time. Even a charged capacitor can keep information like phone numbers alive for days in RAM.

As the simplified block diagram shows, the MAC-4 has a 4-bit data bus. However, it can also process operands 8, 12, and 16 bits wide. Also, like the 9900 microprocessor from Texas Instruments, the chip has no accumulator. Instead, four addressing modes, one direct and three indirect, allow any RAM location, two memory-pointer registers, and a group-pointer register to function as accumulators.

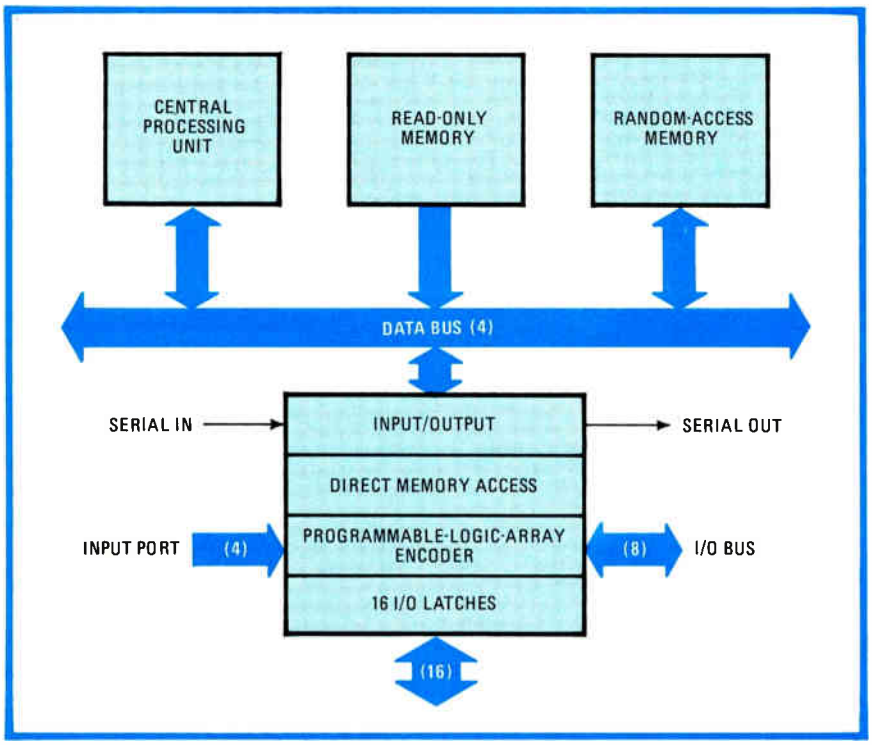
The MAC-4 instruction set has 43 instructions arranged in four groupings. Two cover single- and double-operand data manipulation, one is for program transfer, and a fourth is for miscellaneous commands.

The microcomputer has a 12-bit internal address bus, so on-chip RAM, ROM, and register space can total 4,096 locations. The ROM can vary in size from 1,024 to 3,840 4-bit nibbles, and the RAM's size can range from 80 to 192 nibbles. The respective memory sizes can be set at layout time.

Lots of software. "The MAC-4 has been supported by tons of software aids," says Lee Thomas, head of the microprocessor systems department at Bell Labs in Holmdel, N. J. One of them, he says, takes the output of the assembler and generates a tape to make masks for a proper complement of RAM and ROM on the chip "without human intervention." The tape also configures the MAC-4's programmable logic array, which "can be used for all kinds of high-speed combinatorial logic," he says.

Bell has already designed an 8-bit microprocessor called the MAC-8, but Thomas stresses that the MAC-4 is in no way intended to compete with or supplant the older chip. In fact, the new chip is intended to work with the MAC-8, in multiprocessor configurations, for example.

As for the future of the MAC-4, Thomas says that its dimensions will be shrunk for more speed and a smaller die. He also admits that the 12-bit, 4-K addressing range has already proved to be too restrictive, so a future version will provide for a wider internal address bus. Ironically, one commercial semiconductor company has approached the labs with the intent of producing the microcomputer. But that would require complicated in-house approval, says Thomas, and possible legal



Adaptable processor. Bell Labs' 4-bit C-MOS microcomputer includes configurable memory and a programmable logic array. It will serve many functions in the phone system.

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	DM-3100N	±2V, balanced differential	Low Profile	.56" High LED	+5 Vdc @ .28A	Optional off-set pot	$50 (1-9) $34 (100's)
	DM-3100B	±2V, balanced differential	Short Depth	.56" High LED	115/230 AC, pin-selected	Low cost AC power	$68 (1-9) $48 (100's)
LIQUID CRYSTAL DISPLAY	DM-3100X	±2V, balanced differential	Short Depth	.6" High Liquid Crystal	+5V, 6mA or 9-15V	Battery Powered	$66 (1-9) $43 (100's)
	DM-3100U1	±2V, balanced differential	Low Profile	.5" High Liquid	+5V, 6mA or 9-15V	Programmable Descriptors	$76 (1-9) $51.50 (100's)
	DM-3100U2 DM-3100U3	±2V, balanced differential	Low Profile	.5" High Liquid Crystal	115AC(U2) 230AC(U3)	Programmable Descriptors	$76 (1-9) $51.50 (100's)

4½ DIGIT DPM'S

LED DISPLAY	DM-4100L	±2V, single-ended	Short Depth	.56" High LED's	±5Vdc @ .4A	Low cost 4½ digit	$87.50 (1-9) $62 (100's)
	DM-4100N	±2V, single-ended	Low Profile	.3" High LED's	+5Vdc @ .4A	Low cost, 4½ digit	$87.50 (1-9) $62 (100's)

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battles because the telephone industry is government-regulated at the state and Federal levels. But, he smiles, "I would love to see the things sold at K-Mart." **-John Posa**

Speech synthesis

Module starts 990 family talking

That low murmur from the speech-synthesis corner of integrated circuitry is working its way up to a shout. Texas Instruments Inc. is adapting its talking chip set to a variety of products, including a new module aimed at manufacturers of industrial control, test, and security systems. Also, other IC houses are planning to add their voices to the marketplace soon.

Complete products. In introducing its TM990/306 speech-synthesizing module at this week's Midcon show in Chicago, TI is continuing to offer complete products, rather than the synthesizer IC and associated chips. Houston-based MOS microprocessor marketing manager Jim Huffhines notes that the TM990 16-bit microprocessor family provides modules that are much easier than chips to assemble into systems.

The 306 module [*Electronics*, Oct. 25, p. 33] will offer a basic vocabulary of about 180 words, including letters A to Z and numbers 1 to 12. As the figure shows, the board comes with eight 2716 erasable programmable read-only memories, in which the vocabulary is stored.

Huffhines says the 128-K TM0350 p-channel MOS read-only memory will eventually store the vocabulary code, once the final word list is set. Then some or all of the E-PROM sockets may be used for chips with added words. Also, TI points out, words can be created by compounding sounds—for example, preceding "crease" with the sound of the letter N or D.

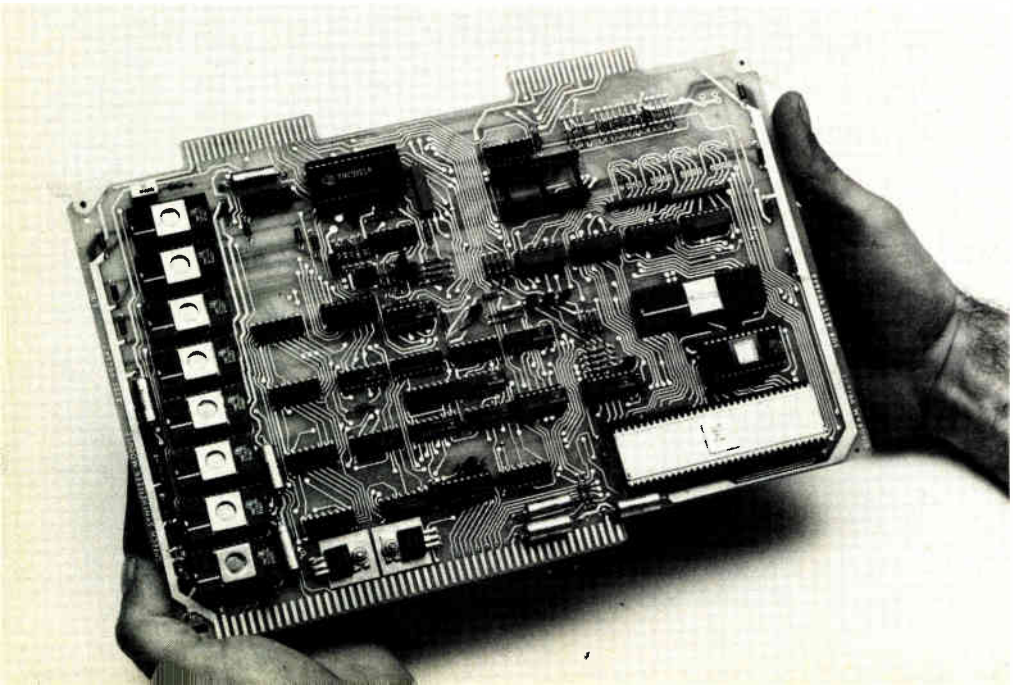
Circuitry setup. Priced at $1,280 for one unit and available in production quantities early next year, the 306 module incorporates the TMC0280 synthesizer chip. It has a TMS1099 4-bit controller and other circuitry necessary for overhead-free interface with the control processor in a 990 system. Huffhines says the module will work with other microprocessors, but not on the same plug-in basis.

The first product to use the synthesizer chip was the highly successful Speak & Spell educational game introduced last year [*Electronics*, June 22, 1978, p. 39]. It also is in use in a language translator [*Electronics*, May 24, p. 44] and in a speech-synthesis peripheral for the 99/4 home computer [*Electronics*, June 21, p. 93].

Other chip makers are working on synthetic-speech ICs. National Semiconductor Corp. plans to introduce a chip set early next year. The company is believed to be pursuing a different synthesizing technique from the linear predictive coding TI uses. There is, also, the two-chip programmable synthesizer from Telesensory Systems Inc. [*Electronics*, Oct. 11, p. 41].

Other competition will be coming from abroad. Intermetall GmbH, the Freiburg, West Germany, unit of the ITT Semiconductors Group, is readying a very large-scale IC with a 20-word vocabulary for consumer applications [*Electronics*, Oct. 11, p. 74]. In Japan, Hitachi Ltd. has designed a three-chip set in conjunction with the Nippon Telegraph and Telephone Public Corp [*Electronics*, Oct. 25, p. 63]. Like the TI chip set, it employs p-MOS technology and consists of a synthesizer chip, a 128-K vocabulary ROM, and a 4-bit microcomputer. **-Wesley R. Iversen**

Speak to me. TI's speech synthesis module includes synthesizer chip and vocabulary ROM, control processor, and E-PROM that also is used for vocabulary.



Components

Bipolar op amp takes on FET parts

Most design engineers equate field-effect-transistor operational amplifiers with the ultimate in low bias current. But a new bipolar op amp from National Semiconductor Corp. could change that.

The LM11 precision instrumentation amplifier, with few exceptions, is an electrical equivalent to the industry-standard LM108. Notable among those exceptions, the input currents have been reduced by more than a factor of 10, and offset voltage and drift have also been improved (see figure on p. 46) over the full operating temperature range.

According to Robert Widlar, the renowned bipolar specialist who designed the part for National, FET op amps have been popular because of their low input bias currents, "but

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MJ4361	1.5 A	400 V	40 W	$1.15
MJ4380	4.0 A	300 V	75 W	$1.45
MJ4381	4.0 A	400 V	75 W	$1.80
MJ4400	5.0 A	300 V	100 W	$1.80
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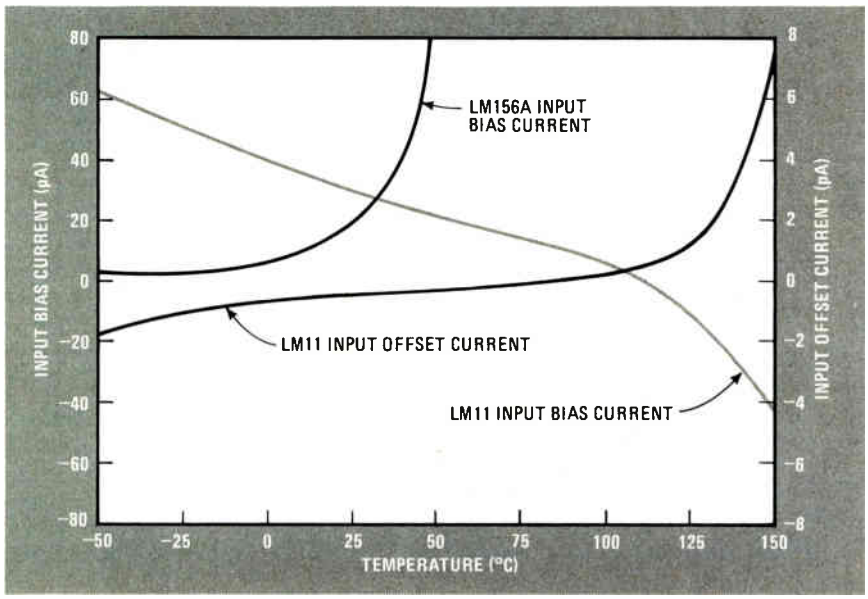

Best of both. New National op amp design has inherent bipolar stability, along with low input bias current usually associated with FET parts. Performance also is less heat-sensitive.

those currents tend to double with every 10° to 11°C increase." What's more, he claims, even if the offset voltage of a FET is trimmed, "drift does not come into line, and long-term stability is much worse than bipolar designs."

Stable bias. In contrast, the 20-picoampere bias current of the LM11 "doesn't double every 11°C. In fact, it is typically less than 50 pA over its rated −55° to +125°C operating range." In a FET op amp, such bias-current performance comes with large errors in input offset voltage, but with the new bipolar part, "think again," says Widlar. The LM11's offset voltage starts at around 100 microvolts and drifts only about 1 μV/°C. Long-term stability—about 10 μV a year—is at least an order of magnitude better than for FET op amps, he claims.

Although the offset current of the LM11 is usually under 10 pA from −55° to +125°C, the 150-pA maximum bias current may still be a nuisance, he points out. "But the bias current is well behaved with temperature," he says, noting that National has on-chip circuits that can give maximum bias currents of 15 pA over a −55° to +100°C range "if a trim or two is allowed."

Widlar notes that the development of the LM11 was something that should have been done a long time ago. "It's a matter of containing the leakage currents," he explains. "But that means understanding the leakage phenomenon."

Since leakage currents are proportional to how hard a transistor is driven, Widlar operates the devices in the input stage of his amplifier at very low levels. Bias currents for the differential input transistors are provided by a double-emitter punch-through transistor. This type of device is diffused for super-high gain, but it also has a dangerously low breakdown voltage.

This potential is regulated by cascoding; that is, its collector and emitter are connected to the base and emitter of another device. This scheme keeps the collector-emitter voltage to that of a diode drop, or near 0 volt. In addition, Widlar operates the punch-through device in a reverse-active mode for temperature compensation.

Manufactured with standard bipolar processing using super-gain transistors and zener-zap trimming, the LM11 is a redesign of the older LM112, a fully compensated version of the LM108 that includes offset balancing. Thus it is internally compensated, but external compensation can be added for improved frequency stability, particularly with capacitive loads, Widlar notes.

As such, "it makes a good plug-in replacement for most op amps, as it can eliminate adjustments in most circuits along with improving performance, especially with large source resistances," Widlar says. Production quantities will be available later this month, but prices are not set yet. **-Bruce LeBoss**

Medical electronics

Device will aid deaf in reading lips

A microprocessor-run device that can analyze and display spoken words symbolically for deaf persons may one day fit into a pair of glasses. Prototypes, using Data General minicomputers for speech analysis, have improved syllable identification to an accuracy of 75%, compared with 25% for the trained lipreader.

The miniature Autocuer will be programmed to identify, analyze, and display only the tricky "look-alike" sounds that frustrate the lipreader, says Robert L. Beadles, project director for the Research Triangle Institute, Research Triangle Park, N. C. It will project the sounds as nine simple visible symbols, or cues, appearing in air alongside the speaker's face. The symbols, which represent syllables, are formed with two seven-segment light-emitting diodes.

LED display. RTI's earlier speech-cueing systems have used Data General Corp.'s Nova 210 and 820 minicomputers. Eventually, Autocuer will probably use a microcomputer to drive the pair of LEDs located on the bow of a pair of eyeglasses. An optical relay element in the lens of the glasses projects the LED-transmitted symbols to focus at a distance of about 4 feet, where they can be read along with a speaker's lips.

The Autocuer could increase comprehension to about 90%, at least in clinical settings, says Michael C. Peck, project director for the National Aeronautics and Space Ad-

Current sensing resistors for multi-range instruments.

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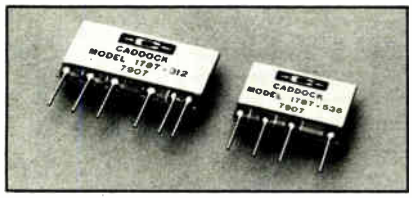

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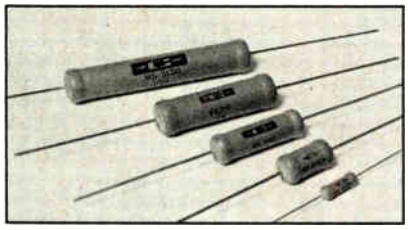

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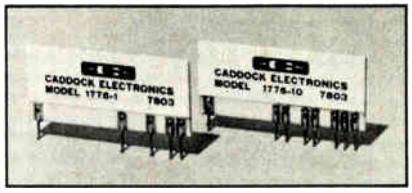

Caddock's Type 1776 Precision Decade Resistor Voltage Dividers.

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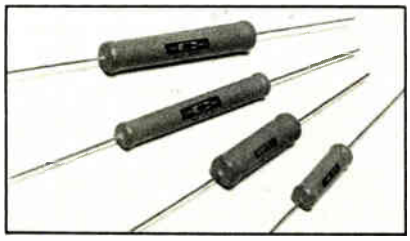

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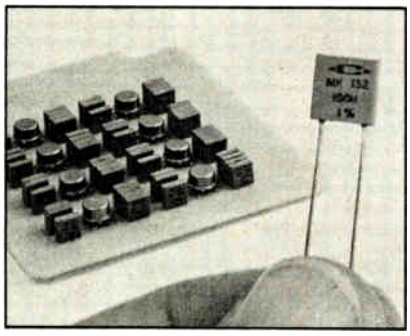

Caddock's Type MK Precision Film Resistors.

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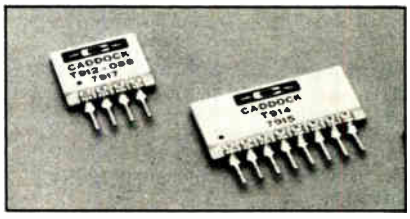

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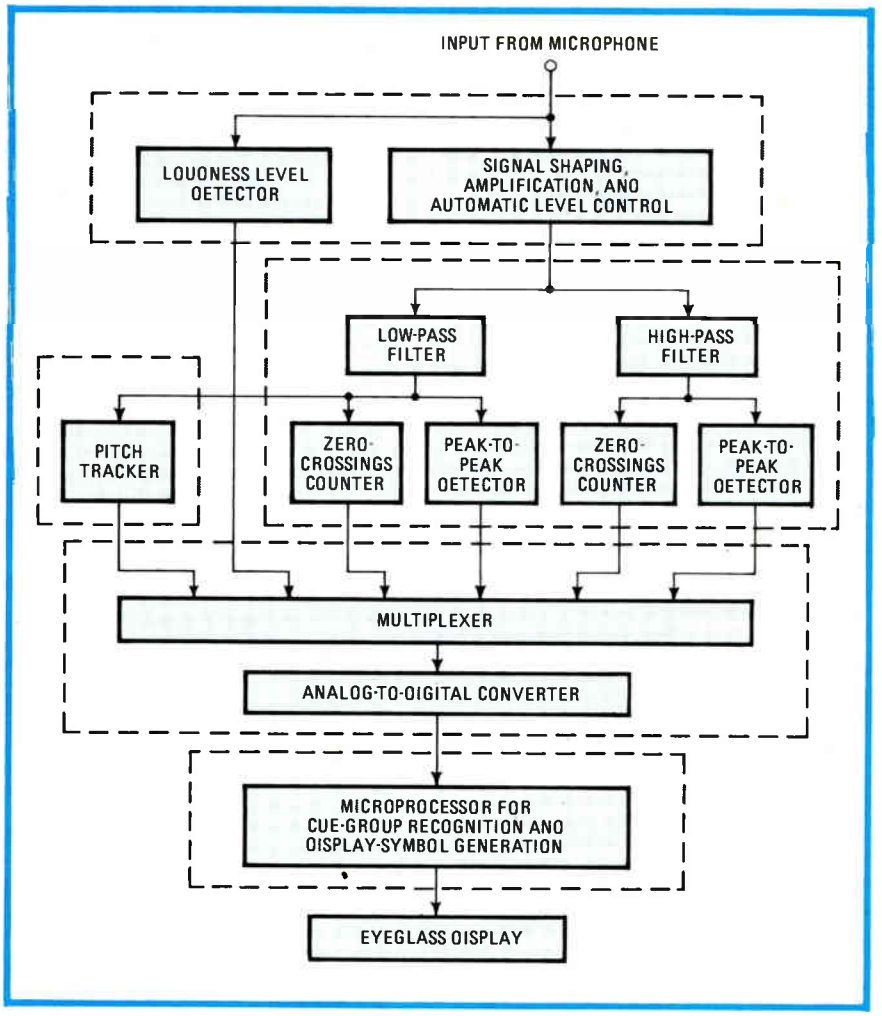


Hear, hear. Four custom LSI chips and a standard microprocessor may make up a speech-analysis device for the deaf. Block diagram is tentative.

ministration, which is supplying $500,000 jointly with the Veterans' Administration for the project.

NASA will develop most of the hardware, using RTI's research results, and Gallaudet College, a Washington, D. C., school for the deaf, will test the equipment. The college and RTI have been developing computer models for mechanically cued speech since 1971.

According to Peck, Autocuer will use linear predictive coding. LPC allows algorithms applied at a very low data rate to simulate vocal-tract movements in speech. NASA is developing front-end LSI chips with capacities of 10 to 12 algorithmic coefficients each to handle the process (see figure). Beyond that, NASA and RTI are looking at new ways to implement Autocuer's other functions, such as the relay element to project the image.

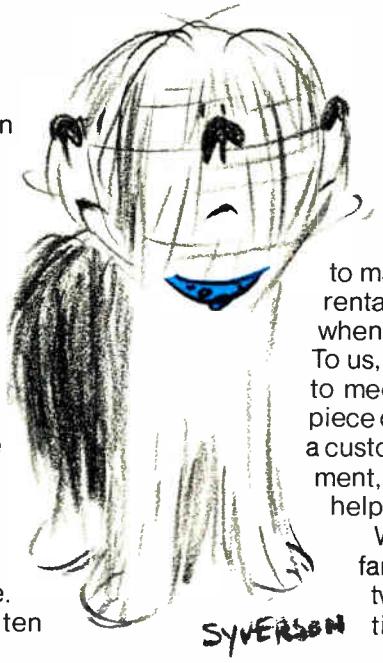
Beadles thinks a mass-produced Autocuer could cost about $1,000 to buy. And, he says, once the system design is in place, it can easily be shrunk, all of it eventually fitting into eyeglass frames. **-Linda Lowe**

Packaging & production

Polyurethane gives solderless connection

The familiar soldered interconnection of components may be going the way of the vacuum tube, at least in the consumer electronics field. Helping to usher it out is a new interconnecting mechanism based on a cellu-

If All Rental Companies Look Alike, How Do You Choose?



Need an oscilloscope or logic analyzer in a hurry? Do you have a short term need for a microprocessor development system? Chances are you've already discovered that renting the electronic equipment you need makes sense. But which rental company?

When you call Rental Electronics, you're tapping a multi-million dollar inventory of electronic equipment from Hewlett-Packard, Tektronix, Intel and every other major manufacturer. So we're sure to have what you need—even the newest equipment.

Our on-line real-time computer lets us give you immediate availability information while you're still on the phone. Even if what you need is at another of our ten stocking centers across North America.

Renting from Rental Electronics makes good economic sense, too. We're big enough to be as flexible as you need us to be, with competitive short term rates, lower rates for extended periods, even a selection of rental/purchase plans.

But there's an even better reason to make Rental Electronics your equipment rental company. It's called service. It starts when our rental experts answer your phone call. To us, service means going that extra step to meet your particular needs—for a special piece of equipment, a tight delivery schedule, a customized rental or rental/purchase arrangement, or just straight answers and a helpful attitude.

When it comes to service we're positively fanatical. And it pays off. During the past twelve months, for example, 92% of our first-time customers have come back for more.

Next time you consider renting, consider Rental Electronics. Give us a shot at your business. We're confident we'll turn you into a repeat customer.

Test and Measurement Instruments

Here is just a small sampling of the test and measurement equipment available today from Rental Electronics. For a complete list, use the coupon opposite.

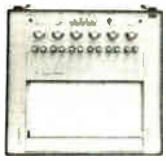
Hewlett-Packard 1640A Serial Data Analyzer. Identifies and locates failures to the component level; RSC 232C; 2048 characters, monitor buffer, plus 1024 characters transmit message buffer; Sync or Async.

Biomation K 100 D Logic Analyzer. 16 channels; 1024 word memory; clock rates up to 100 MHz; signal timing resolution to 10ns; built-in display and keyboard control.

Honeywell 101 Recording System. 7 or 14 tracks depending on head assembly; ½ in. (7 tracks) or 1 in. (14 tracks) tape; 8 tape speeds from 0.937 ips to 120 ips; direct bandwidth to 2 MHz (wide band) and to 600 kHz (intermediate band); FM bandwidth to 80 kHz (wide band) and to 40 kHz (intermediate band); reel size 10½ to 15 in., coaxially mounted.

Tektronix 465 Oscilloscope. BW 100 MHz; display 8 x 10; 5 mV/div to 5 V/div sens.; sweep rate 50 ns/div to 0.5 s/div; x10 magnifier; dual trace; delayed sweep; x-y operation.

Hewlett-Packard 8565A/100 Spectrum Analyzer. 0.01 to 22 GHz with internal mixer; 14.5 to 40 GHz with 11517 external mixer; 100 Hz and 300 Hz resolution bandwidth; Absolute Amplitude Calibration: −110 dbm to +30 dbm.



Brush 260 Strip Chart Recorder. 1 mV to 500 V; chart speeds 125 mm/sec. to 1 mm/min., incl. four event markers; pressurized ink; response: DC to 100 Hz.

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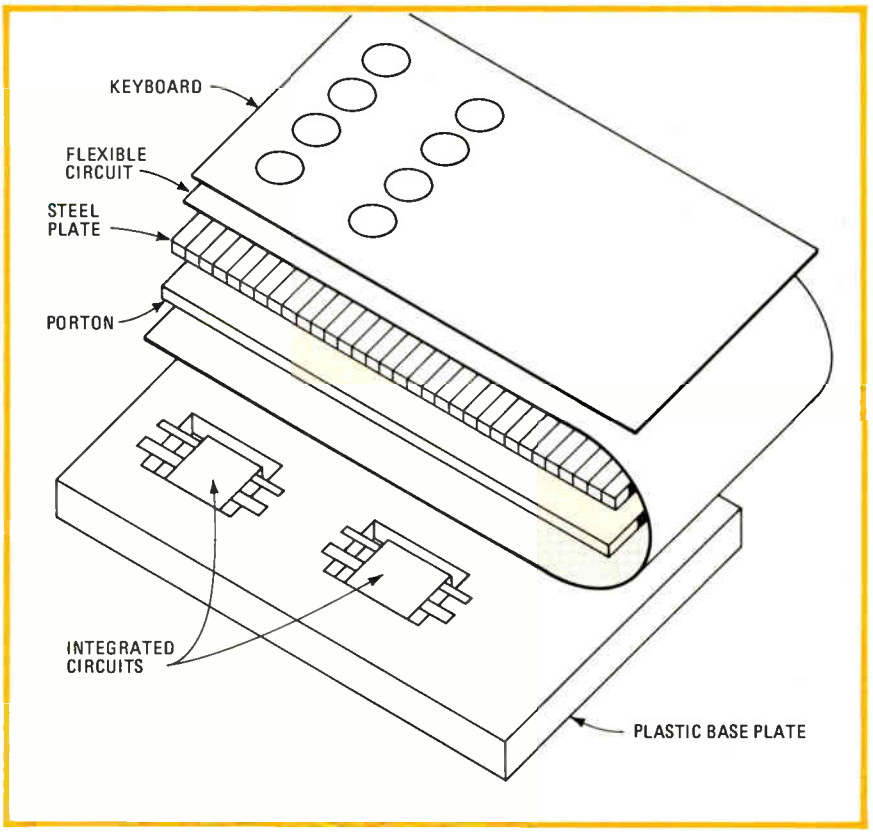

No movement. Portron holds flexible-circuit traces and component leads in place in a solderless package. In this keyboard application, the circuit is three-dimensional.

lar polyurethane material.

The material, called Portron, comes from Rogers Corp.'s Poron division in East Woodstock, Conn. It provides a uniform and long-lasting mating force in a sandwich of compressed layers.

The Rogers, Conn.–based corporation supplies a variety of industries with a wide range of plastic-based components and related materials. It says that its new scheme will cut assembly costs, increase reliability, and improve serviceability.

In the Rogers Solderless System, Portron is put to work with flexible interconnection circuitry from Rogers' Circuit Systems Group in Chandler, Ariz. RSS provides a structure that presses together circuit leads from the components and the electrical traces of the flexible circuit, with the Portron providing the uniform compressive force that maintains the contacts.

In a typical RSS structure (see figure), the bottom piece is a rigid plastic base with cavities that hold and align the various components. The leads of the components are in a flatpack configuration and extend just beyond the edges of the cavities.

The flex circuit on top is aligned to provide the required interconnections, and a thin Portron layer and a rigid top pressure plate back it. The assembly is completed by compressing the four layers and holding them together with screws or spring clips.

"The idea of a solderless system clamped under pressure is not new. Lack of a material like Portron held it back," says Stephen Etzel, assistant product manager at Poron. Unlike other plastics, Portron will not lose resilience over time and so continues to exert a spring force over the entire compressed area. The company cites one test of 50% compression for 48 hours at 149°F and 95% humidity, in which resilience loss was under 10%. These severe conditions are, of course, unrepresentative of consumer-electronics operation.

As it stands, the company

sees consumer products as the most likely candidates for RSS, first because it recommends a maximum constant-use temperature of 50°C to ensure that there is no long-term compression set to degrade contact integrity. Also, it is best suited for high-volume applications, where the design and tooling costs can best be amortized.

RSS is a bit tricky to adapt to production lines, but Portron already is used in several products, including a Milton Bradley game called Microvision. It holds an elastomeric connector against the game's large liquid-crystal display.

Potential savings in cost are considerable, Etzel contends, since there is no soldering equipment and no need for materials resistant to the high temperatures of soldering. Also, RSS is designed to provide automatic alignment of interconnections and simple mechanical assembly, further cutting production costs.

Portron is a good absorber of energy, he says, so it increases reliability by providing shock resistance for components and interconnections. Serviceability improves because the testing and replacement of bad components require no desoldering, he says. **-Jerry Lyman**

Astrocommunications

Sun would be part of space radio scope

How about a giant millimeter-wave radio telescope using the sun's gravitational field as a focusing element and strategically placed satellites as the transmitter-receivers? Such a system could reach far into the universe, seeking, among other signals, coherent radio communication from other planets.

That is the claim Stanford University's Von R. Eshleman presented at a recent St. Louis meeting of the American Astronomical Society. He developed the idea for the Planetary Atmospheres Program of the National Aeronautics and Space Administration as a result of studying the focusing of radio signals using the planet Jupiter's atmosphere.

"The gravitational field of the sun

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10 MHz: □(a)80 kHz □(b)100 kHz □(c)1 MHz

2. FM distortion (100 kHz deviation at 100 MHz)

□(a) 4% □(b) 3% □(c) 0.5%

3. Incidental AM (100 kHz deviation at 100 MHz)

□(a) unspecified □(b) 1% □(c) 0.2%

4. AM distortion

At 30% AM: □(a) 3% □(b) 1% □(c) 1%
At 70% AM: □(a) 3% □(b) 3% □(c) 2%
At 90% AM: □(a) unspecified □(b) 5% □(c) 3%

5. Incidental FM (30% AM at 1 MHz, 1 kHz mod.)

□(a) unspecified □(b) 150 Hz □(c) 50 Hz

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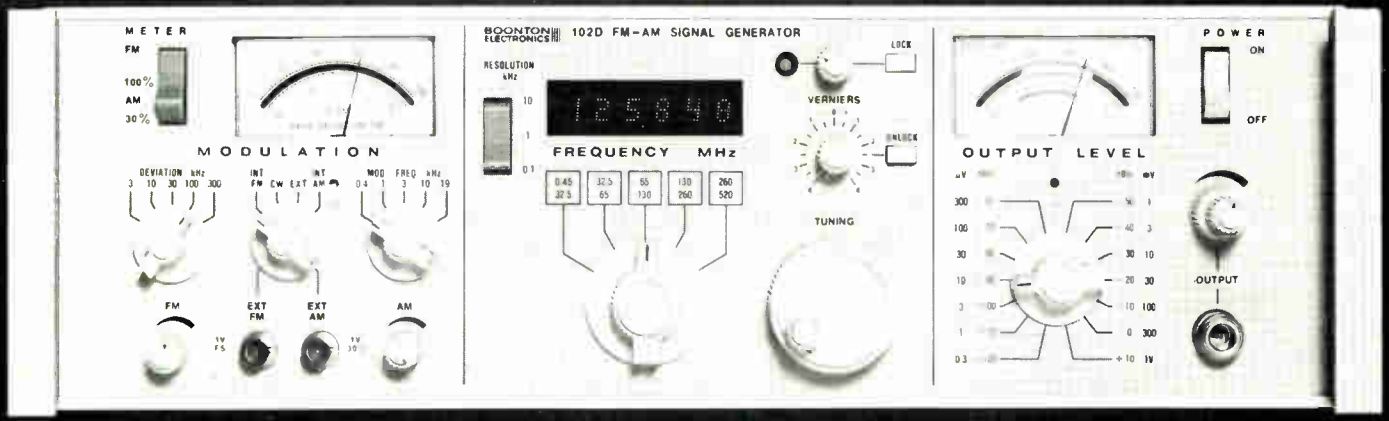

acts much like a spherical lens, magnifying the intensity of radiation from a source an extended distance away," he explains. This magnification effect allows the satellites to pick up much weaker signals than a comparably sized earth-based system and sharply reduces the power of the signal required to reach deep into space.

"Using only equipment with present-day capabilities, a spacecraft, if it were positioned properly, could pick up interstellar signals," he claims. The focusing requirements mean the distance from satellite to earth would be about 550 times the distance between earth and sun.

The focusing of electromagnetic radiation by a gravitational field is no new concept, remarks Eshleman, an electrical engineer at Stanford's Center for Radar Astronomy. "Einstein wrote that light could be focused by the gravitational field of a star if the positions were right."

Problems. Some formidable technical problems arise, he admits. For example, a separate spacecraft would be needed for each direction to be observed.

Moreover, the immense distances involved mean that signals would take two weeks to travel between satellite and earth, compared with the 90 minutes it takes Pioneer II to send information back to earth from Saturn.

In addition, the sun's gaseous corona degrades electromagnetic radiation and, at wavelengths greater than a millimeter, would seriously distort the signal and reduce the magnification effect. The magnification factor is inversely proportional to the operating wavelength (10^8 at 1 mm), but the submillimeter radio telescope equipment necessary to take advantage of the preferable lower wavelength is extremely costly to purchase.

"The great potential is obvious," says Eshleman. "We could, with current shortwave technology, detect coherent sources and communicate with a neighborhood of thousands of stars." He plans to continue to study the technical feasibility of his proposal. **-Harvey J. Hindin**

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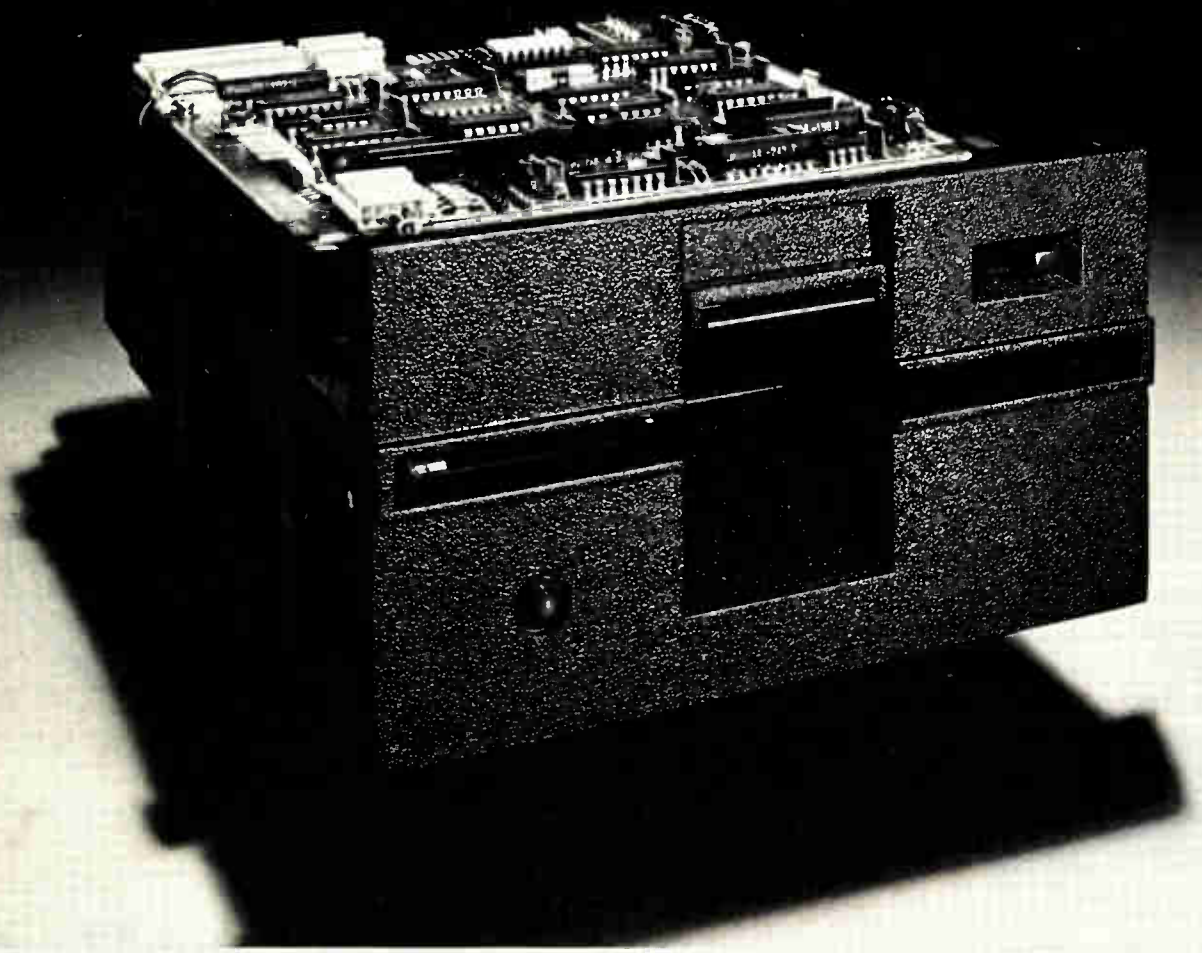

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Circle 56 on reader service card

Washington newsletter

Electronics RDT&E to lead military budget growth

Fiscal 1981 military electronics money for production and research, development, test, and evaluation will be scheduled to increase at a far greater rate than other weapons systems when President Carter previews his new budget for Congress later this month. Overall spending for all weapons production and R&D are expected to be in the range of $42 billion to $43 billion. In his election-year drive to get Senate ratification of his SALT II strategic arms limitation treaty with the Soviet Union, Carter's early defense budget outline for the fiscal year beginning next October is expected to strike a **compromise between his 3% goal of "real growth" (discounting inflation) and the demands of Senate hawks.** Led by Sam Nunn (D., Ga.), they want a 5% growth rate in each of the next five years.

Office of Management and Budget sources say choices are now being made between "a straight 4% compromise in each year" or "3% next year and 5% in the years after that." The 4% option is believed the leading candidate at this point, supported by political arguments that a supplemental Pentagon budget for fiscal 1980 may be used to pump more money quickly into the economy if the recession deepens next year. **Growth rate of electronics outlays could jump between 10% and 15%,** officials say, because of the need to improve communications, command and control systems, satellite reconnaissance, all-weather aircraft fighting capabilities, ground and airboprne tactical radars, and optical detection systems, as well as all-weather tactical weapons targeting and antisubmarine warfare systems (see p. 34).

Airliner pay phones proposed to FCC . . .

Pay telephones in airliners? That is a new service proposed to the Federal Communications Commission by Airfone Inc., a wholly owned subsidiary of Goeken Communications Inc. in Washington, D. C. The company is headed by John D. Goeken, who broke new telecommunications ground in 1969 by winning FCC approval after a 10-year fight to establish the nation's first specialized common carrier (now MCI Telecommunications Corp.) to compete with the Bell System. Airfone wants the FCC to release the 896–898-megahertz and 941–943-MHz frequencies for the up link and down link, respectively, of its proposed single-sideband service, **which would connect the in-flight telephone with one of 51 ground stations** for interconnection with American Telephone & Telegraph Co. lines. Goeken says AT&T has agreed to make interconnections.

. . . three carriers reportedly interested

Three air carriers, including Eastern Air Lines, have expressed interest in the Airfone service proposal, says Leo I. George, the company's counsel before the FCC. Airfone, he says, would acquire and pay for all aircraft equipment, including the antenna attached to the airframe and the airline's installation costs. Each plane would have two telephones—one in first class and another at the rear of the coach section. The proposed frequencies, now held in FCC reserve for "innovative services," **could also be used by other land-mobile servies without interference.** The automatic full-duplex system would have a 6-kHz voice channel, a 20-W power output, and use a 200-kHz ground channel. Proposed charges, to be paid by telephone credit cards, would be $5 for the first three minutes plus $1 for each additional minute. First Capital Corp., the equity investment arm of the first National Bank of Chicago, said in a letter to the FCC that it saw no problem raising capital. Goeken says 2,000 airborne units are planned and that sites for the ground stations have already been lined up.

Washington commentary

Air Force fires back at its industry critics

What began this summer as just one more flap between the Air Force Systems Command and its aerospace contractors over some procurement rule changes is escalating into a real fight. An AFSC letter to the Aerospace Industries Association claims the AIA's earlier protest "misrepresented the purpose and intent of AFSC policy" is designed "to set the record straight," according to its author, Maj. Gen. James W. Stansberry, AFSC deputy for contracting and manufacturing.

Stansberry's response, made available at the end of October, is in defense of his boss, AFSC commander Gen. Alton Slay, and his new "acquisition initiatives," which are designed to lower electronics and weapons program costs by increasing competition and developing second sources, stressing the use of standard components and modules, and substituting simpler commercial market practices where possible for mammoth Government documentation. Gen. Slay was not surprised when contractors did not applaud his initiatives at first, says one Air Force staff member, since "they represent a big change in the way we have been doing business." But the general did become upset when the AIA wrote him at length to protest that his plan would do more harm than good.

Contracts as 'auctions'

The AIA claims that overemphasis on price competition would lead to contract "auctions and result in product compromise and more cost overruns, as well as inadequate profits." Increases in standardization, the AIA contends, would inhibit competition and contribute to technological obsolescence. As for adoption of commercial practices, the AIA believes that these will not work without accompanying sharp reductions in paperwork. Moreover, the trade group is concerned that the Air Force underfunds early development work on programs.

The AFSC chief has already rejected an association proposal to establish an industry group to review his proposed changes in procurement practices on the ground that he lacks the authority to do so. But, "as General Slay has stated many times, he, his product division commanders, other members of AFSC staff, and I are willing to discuss our contracting practices with you at any time," Gen. Stansberry wrote. The AFSC deputy also rebutted the industry complaints one by one.

On profits: the AFSC "is not depressing profit nor forcing risk on industry without providing an opportunity for a commensurate return. Quite the contrary. Our negotiated profit rates show a definite upward trend over the last two years." This is a result of the AFSC's effort to use firm, fixed-price contracts, with their higher profits, where costs are predictable, he says.

On the charge of underfunding development, Stansberry comes on strong. "I must note that contracts are two-party instruments, and we emphatically do not, as a matter of policy, engage in auctioneering. Competition for development is characteristically weighted most heavily toward the contractor's technical approach, not price." As for evaluating bids against independent estimates, "we assume corporate management attaches the same degree of importance to cost realism as we do."

The competitive 4%

Concerning price competition, he says: "Four percent of our business is accomplished under this method and we do not anticipate further increases. Thus, we believe your concern in this area is overdrawn." As for second-sourcing, Stansberry notes that "we will not attempt to develop second sources unless there will be an adequate payback," but reminds the AIA that "the reasons for competing programs are rooted in law and Federal policy." He adds that "increasing competition is AFSC policy and our track record is showing a modest improvement."

On introducing commercial market practices, Stansberry suggests that AIA concerns are exaggerated here, too. "We anticipate the ultimate result will be a blending of commercial and Government practices derived through frequent, open dialogue between the Air Force and its major suppliers," he says.

If generals Slay and Stansberry are correct, then why are the AIA's members uptight? They are uneasy because many of them see a decline in new military aircraft market opportunities in the years beyond 1980 despite the certainty of defense budget increases. Much of the new money is expected to go for electronics that will be used in large part to improve the operational readiness of U. S. tactical forces and their North Atlantic Treaty Organization counterparts. As a result, the demand for new aircraft platforms is expected to decline after several years of a high-volume business. And the increases in military satellite business will not begin to take up the slack.

Faced with those uncertainties, the aerospace industry is not eager to begin learning a new set of rules. Nevertheless, Gen. Slay's AFSC seems determined to make the change. How well he succeeds in the face of determined industry opposition remains to be seen. **-Ray Connolly**

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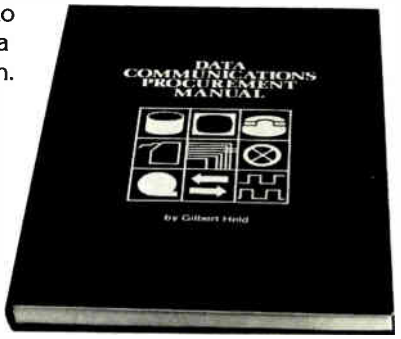

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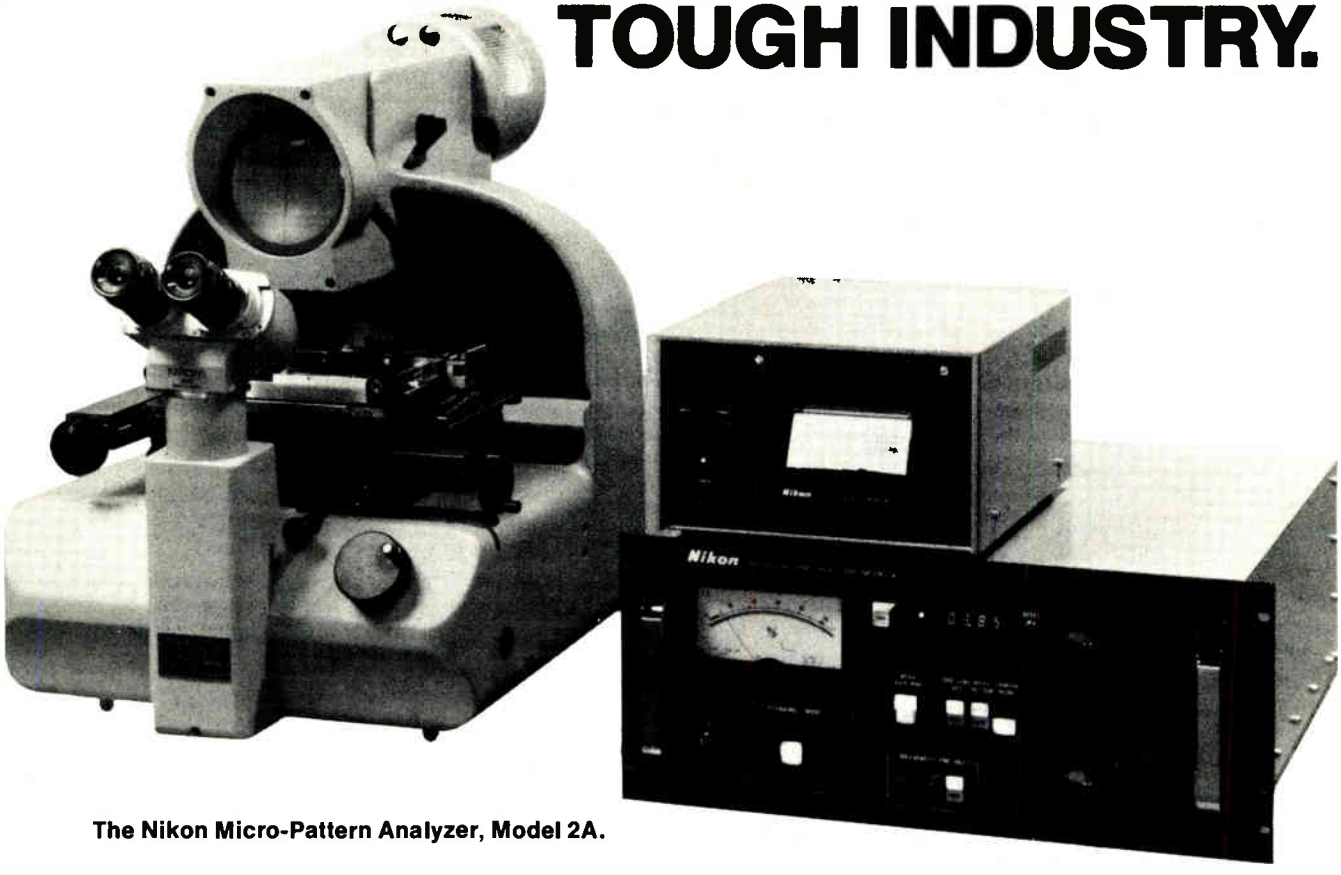

The Nikon Micro-Pattern Analyzer, Model 2A.

SCIENCE/SCOPE

A new ring and moon around Saturn were among the discoveries made by NASA's Pioneer 11 spacecraft during the historic first flyby of the giant planet in September. The spacecraft's electronic camera, an imaging photopolarimeter, also supplied close-up pictures of Saturn's banded cloud structure. Another instrument, an infrared radiometer, found atmospheric temperatures from -279° to -288°F on Saturn and its largest moon, Titan. The readings for Titan reduced the possibility of biologic activity in the organic gases of the moon's reddish smoglike atmosphere. The polarimeter and radiometer were built for NASA's Ames Research Center by the Santa Barbara Research Center, a Hughes subsidiary.

Secure and nonsecure voice communications can be handled simultaneously by an advanced radio-telephone switching system that provides channel-to-channel crosstalk isolation above 100 dB. The system, developed by Hughes for U.S. Navy shipboard use, eliminates the need for separate equipment for plain and secure voice channels. Hughes' advanced microcircuit technology, including extensive use of large-scale integrated circuits, has given the system a high packaging density, high reliability, and low power consumption.

An advanced goggle that allows soldiers to see at night has been developed by Hughes for the U.S. Army's Night Vision Laboratories. The device, called a holographic one-tube goggle, employs thin-film diffraction optics and advanced electronics. It amplifies dim visual light and near-infrared radiation, then superimposes the enhanced image over the wearer's view. Aided by studies on how the brain overlaps the field of view of each eye, human engineering specialists designed the goggle so that the image intensifier tube, which extends from above the bridge of the nose, would not block any portion of a person's view.

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How a fighter aircraft's radar performs during exercises can be determined from data gathered by a new recording system. Hughes devised the equipment for use with its AWG-9 weapon control system on the U.S. Navy's F-14 Tomcat. The recorder stores up to an hour of data, pilot and voice communications, and a time base. The information is sufficient to analyze the radar's performance from search and detection through missile launch. In the past, only highly modified test aircraft could provide this data because tactical aircraft have little or no room for additional electronics. Space was found on the F-14 by removing an electronic countermeasures unit that goes unused on training missions.

International newsletter

British software runs 16 Intel 8086s as one

A system that allows up to 16 Intel 8086 16-bit microprocessors to work together as if they were a single machine is to be launched by Scicon Consultancy International Ltd., a London software house. **A version of the Demos multiple mini/microcomputer system** [*Electronics*, Sept. 14, 1978, p. 92], it was developed in collaboration with the National Physical Laboratory to provide a progressive expansion in computer power and a high level of fault tolerance in process control, transaction processing, communications, and interactive information systems. Up to 16 processing nodes can be connected by one main and one standby 16-bit parallel data bus, each with an effective data rate of 2 megabytes per second. At each node are two 8086s, one handling bus communications, the other executing segments of the compiled program. The operating system is written in Concurrent Pascal and applications programs in sequential Pascal. Demos was recently chosen by the European Space Agency for its experimental multiprocessor system. This version will initially be based on three Texas Instruments 990 minicomputers, but eventually up to 32 mini- or microcomputers will be able to be interconnected.

Roessle makes plans for ITT Europe's components makers

A consolidation of the passive components mix, a stronger orientation of such devices toward European needs, and more streamlined manufacturing operations—these are some of the strategies that industry observers expect Heinz Roessle to pursue as **the newly appointed group gen ral manager in charge of all European component producers affiliated with the International Telephone & Telegraph Corp.** Roessle, who retains his position as head of ITT's worldwide semiconductor activities, will keep adhering to a policy of producing solid-state devices, including memories, for worldwide appeal, however. He will continue to work out of Freiburg, West Germany, the site of Intermetall GmbH, headquarters company for the ITT Semiconductors Group, and will report to John Chluski, ITT senior vice president, based in Brussels.

Mostek to sell aggressively in Japan through new firm

Mostek Corp. of Carrollton, Texas, is giving notice that it intends to be a strong competitor in the Japanese market by starting a wholly owned subsidiary, Mostek Japan KK, there. Initially the company will provide the expert sales help needed to sell advanced products; it plans to build a test facility in two or three years to ensure high reliability, which will make its devices more competitive with domestic ones. **Mostek's policy will be to emphasize leading-edge memories,** including its 64-K random-access memory, first commercial samples of which will be distributed worldwide late in the first quarter of 1980. (For a related story, see p. 40.)

Mostek has been selling in Japan since 1971 through two agents, which will continue to distribute its products. But sales have been well below expectations because of a 1970 decision to emphasize mature products.

Liquid-crystal-display addressing schemes vie for French approval

Two different techniques for addressing liquid-crystal displays are being proposed to the Direction Générale des Télécommunications, the telecommunications arm of the French post office, **for use in the small interactive terminals to be distributed to all French telephone subscribers over the next 12 years** [*Electronics*, July 5, p. 85]. Thomson-CSF's Electron Tubes division, located in the Paris suburb of Boulogne-Billancourt, suggests a display in which thin-film transistors are placed at each point making up

its grid, a technique developed in the U. S. by Westinghouse Corp. [*Electronics*, Oct. 31, 1974, p. 32]. The second proposal, from Sintra, a subsidiary of the Compagnie Générale d'Electricité in Asnières, outside of Paris, and the government's Laboratoire d'Electronique et de Technologie de l'Informatique (LETI) in Grenoble (see p. 67) involves multiplexing points on an X-Y grid made of wire 35 μm in diameter. Sintra may buy LETI's license for the technique, or it may form a joint subsidiary with the lab to develop and produce the LCDs, perhaps as early as 1982.

Britain gets fourth channel; transmitter sales boom

A fourth television channel for British viewers, scheduled for 1982, means big business for Marconi Communications Systems Ltd., Chelmsford, and Pye TVT Ltd., Cambridge. They will split equally a $33.6 million dollar contract for a total of 48 high-power transmitters from Britain's Independent Broadcasting Authority. Delivery is spread over four years, with 30 transmitters, providing coverage for 80% of the population, to be operational on the first day of the new service. **The 15-kW transmitters feature new klystrons (microwave tubes) having an efficiency of 45%,** compared with the 25% to 30% efficiency of conventional klystrons. Microprocessor-based transmitter control will allow unmanned control from new regional operational centers. The use of surface-acoustic-wave filters as a passband-shaping device in its design, says Marconi, contributes to both stability and reliability.

France, Canada to cooperate on teletext research

France's Secrétariat d'Etat aux Postes et Télécommunications and Télédiffusion de France, the government broadcasting agency, have signed a memorandum of understanding with the Canadian Department of Communications on joint research into their common problems in designing a teletext system. However, the cooperation between the two countries seems unlikely to lead to any standardization at the system level, since the memorandum says that **the specific characteristics of the two systems—France's Antiope and Canada's Telidon—"will be respected."** "High-priority" areas of mutual interest include coding, visual characteristics, transmission systems, human factors to be considered in designing the terminals, and network architecture.

IBM Japan continues to add kanji input/output

Kanji (Chinese-character) displays and line printers for its System/34 follow those recently announced by IBM Japan Ltd. for its mainframes as the company strives to catch up with Japanese manufacturers in the race to bring Japanese-language capability to electronic data-processing equipment [*Electronics*, Oct. 11, p. 73]. Deliveries of the $6,850 displays, which include a keyboard similar to those used with mainframe displays, will start next August. The displays are actually work stations and replace those without kanji capability—up to a maximum of 16 for the System/34; **they have a capacity of 480 kanji characters or 960 kana or alphanumeric characters.** The two line printers, which can be used as either work-station or system units, will be delivered starting February 1981. One, having a speed of 85 lines per minute of text, including kanji, or 300 lines/min excluding kanji, sells for about $17,200. The other, with rates of 140 and 475 lines/min, respectively, sells for some $20,000.

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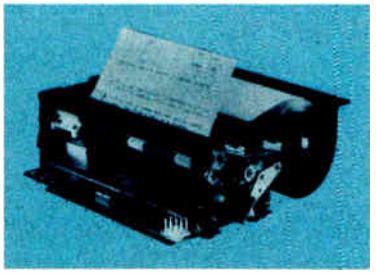

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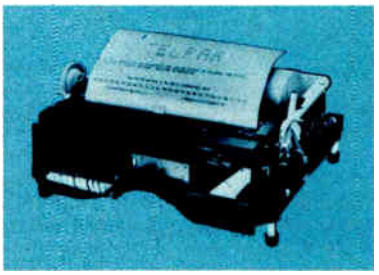

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French lab crams 256 by 256 dots on 2-by-2-cm LCD

by Kenneth Dreyfack, Paris bureau

Continuing research enables LETI to quadruple the number of elements and slim down the crystal

Having decided that in liquid-crystal displays as in electronics in general, denser is better, France's Laboratoire d'Electronique et de Technologie de l'Informatique (LETI) has made a 256-by-256-dot LCD measuring only 2 centimeters square. And since with LCDs the thickness of the crystal determines the speed with which images can be changed, the lab has gone in for thinness as well: the liquid crystal is a mere 5 micrometers thick.

The new display [*Electronics*, Oct. 11, p. 73] is a continuation of LETI's work for the Centre National d'Etude des Télécommunications, the research organ of the French postal and telecommunications administration [*Electronics*, Dec. 22, 1977, p. 55 or 5E]. The lab uses a 100-watt bulb behind the LCD and a lens to project the images onto a viewing screen.

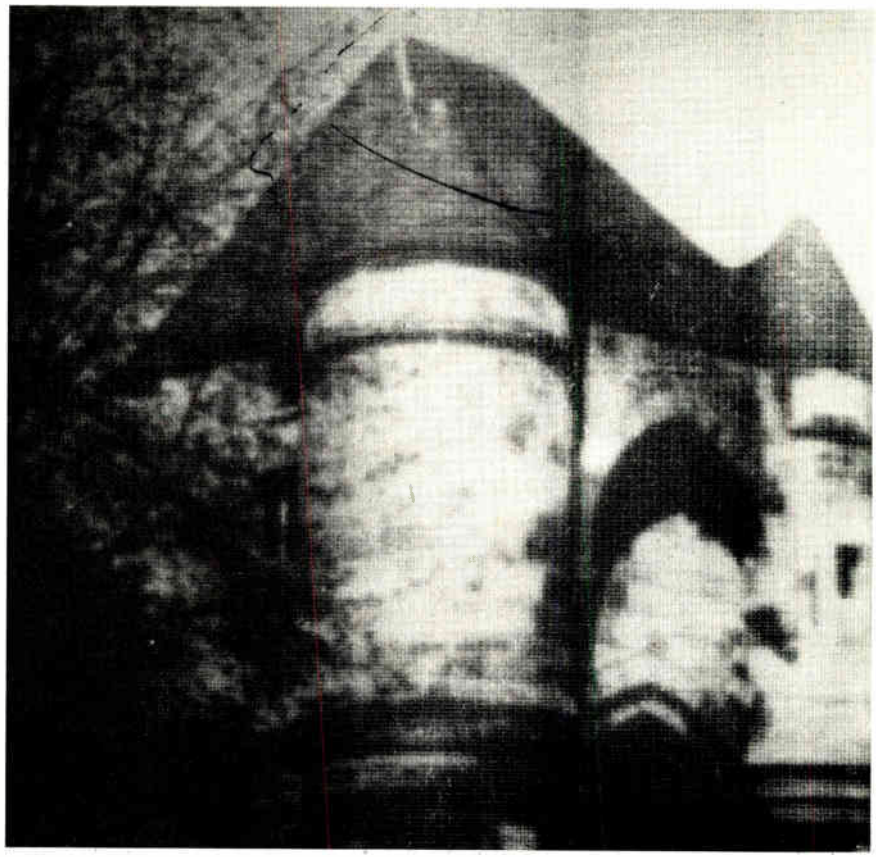
Alignment. LETI's LCD technique is known as deformation of aligned phases. It uses crystal molecules that have large polarized heads and small, thin tails. The polarized heads attach themselves to the walls of the sheets of glass between which they are sandwiched. As a result, all the molecules line up perpendicular to the glass and not parallel with it, as in other techniques.

To produce images, an alternating electrical field is applied to the molecules to shift their orientation: 50 volts is applied sequentially to each of the rows of the matrix, and 6.5 v is applied simultaneously to all the columns at once.

When the row and column voltages are completely in phase, the molecules prevent light from passing through; hence the display is black. When the voltages are exactly out of phase, light passes through and the display is white. Degrees of phase difference produce shades of gray. The 32 possible variations thus yield 32 shades of gray.

In driving the display, the row and column voltages are multiplexed at a rate of 25 images per second—the largest LCD grid to be multiplexed thus far, LETI says.

Borrowings. To place the 35-μm-diameter electrodes on the glass, the researchers have borrowed a sputtering technique from semiconductor processes. Heated indium is placed in a medium consisting of argon and oxygen and an electric field is applied to the gas, causing oxygen ions to combine with the indium to



Denser. Grenoble-based LETI has managed to place a 256-by-256-element matrix on a liquid-crystal display only 2 centimeters square. The LCD produces 32 shades of gray.

form the indium-oxide electrodes.

Another semiconductor technique deposits a 5-μm-thick silicon-dioxide "wall" around the display surface on one of the two glass sheets. The wall is precise to within 0.1 μm, helping to ensure a uniform layer of liquid crystal.

Epoxy resin bonds and seals the two glass sheets together, and the crystal is then inserted between them in a simple vacuum. The seal is especially important, as liquid crystals—in this case a mixture of metoxybenzylidene butyl and etoxybenzylidene butyl—are extremely sensitive to contact with water or solvents. MBB-EBB crystal was chosen, LETI says, because it has a relatively low viscosity, it is inexpensive, and its properties are fully documented.

Like its predecessor, the LCD displays up to 10 images per second. That is more than ample for alphanumeric applications, but too slow for television images, which generally change at the rate of 25 per second (the multiplexing rate). A crystal layer of 3.5 μm, though, would give the speed for satisfactory TV images, and that is one of the targets for which LETI is shooting. 'We know how to go about it—it's a question of the time and means available to us," says Jacques Robert, head of the research team.

Great Britain

Statistical multiplexer based on microprocessors cuts data exchange costs

By making extensive use of microprocessor technology, one small British company, Computer and Systems Engineering Ltd. (CASE), has come up with a low-cost statistical multiplexer that can be upgraded to provide an inexpensive data exchange. With it, minicomputer users can assemble switchable data networks with facilities and features that have hitherto only been enjoyed by large-mainframe users.

Explains David Brown, systems support manager at CASE: "Statistical multiplexers brought the advantages of error-free transmission and a new level of economy to low-cost data networks." However, with very few exceptions they were limited to point-to-point usage and lacked a network switching capability. The new DCX series, Brown says, allows hubbed networks to be assembled in which a central station controls several remote sites, each with its own network.

Low-priced. Admittedly, agrees Brown, big mainframe companies, like IBM with its 3705 front-end processor or Digital Equipment Corp., have been able to create switched data networks of any complexity. But these systems can cost up to 10 times more than the networks that can now be devised with switching statistical multiplexers. A typical price for hardware modules in the DCX series is $12,000 for a 20-channel system.

Adds Nick Samuel, CASE's technical director: "With our previous 670 multiplexer, complex networks could be built up, but they were hardwired. If a user wanted the network changed because of a line outage or because of system growth, we had to send out an engineer to change the network PROMs at each node. Now a user can dial up each switching node in turn through the network and switch channels around."

Finding fault. Extensive diagnostics are built into the system, too. If there is a fault, each node can be accessed through the network and a test microprocessor instructed to enter a test routine.

"That way we know whether to send out a line, multiplexer, or modem engineer," Samuel says. "When a node cannot be raised through the network, our engineers have provided a standby line of defense. We can dial up the network control center over a public telephone line and access the diagnostic processor via an external modem."

The DCX range is itself fully modular and can be built up to the required complexity from a set of five basic cards, each with its own microprocessor. The system starts with a simple four-channel point-to-point multiplexer and is expandable to data networks with almost 4,000 channel ends. Each DCX node in a channel can support up to 240 channels ends with up to 12 high-speed composite links.

To provide the needed flexibility, CASE engineers exploit microprocessor technology in a big way. They use Texas Instruments 9900 16-bit microprocessors on all the building-block cards except the buffer card. In that case, for speed they use Advanced Micro Devices bit-slice processors to create a 12-bit microprocessor. (A fully developed system, says Samuel, uses over 70 microprocessors.) As each of the constituent software modules is relatively small, the engineers were able to work in assembly language and thus write very efficient routines.

The DCX range extends from the 820 through the 850. The 830 is an intelligent statistical multiplexer system expandable up to 60 slow channels. Conventional multiplexers share time equally among channels. But in the 830 and rival products, the multiplexer adapts to the data rate on individual channels and since all channels are never working at full capacity simultaneously, leased lines of lower data rate than are conventionally employed can be used.

The 830 can handle a composite data rate of up to 19,200 bits per second and is assembled from up to 12 low-speed channel cards. Microprocessor-controlled, it works by checking the presence of data on all channels in turn and writes any data character into the buffer queue, together with appropriate channel address bits.

Cooperative. The 830 competes with products from companies like Micon Inc. and Codex Corp. Alone, it would have a hard time in a tough competitive market. But its ability to work with the DCX 840 network multiplexer and 850 switching multi-

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Flexible. DCX 840's network control panel allows user to reconfigure switchable data network as needed. Systems built with DCX series multiplexers can handle up to 4,000 lines.

plexer have created an as yet untouched market, the Rickmansworth, Herts., firm says.

The 840 incorporates a user switching option card that provides a hubbing and onward-linking capability, local and remote supervisory control, additional diagnostics, and statistical reporting. The switching microprocessor carries two network maps in its memory.

The 850 requires an additional microprocessor-based card. It provides facilities so that a specified user can dial up lines on the network by typing in a short address code. It also provides port-contention facilities. **-Kevin Smith**

West Germany

Etching process for pc boards reuses solution, retrieves copper

Production engineers engaged in printed-circuit-board fabrication will soon have a new etching method at their disposal: a continuous electrochemical method that is more economical to run than the conventional wet-etching processes used to remove copper from pc boards. Furthermore, it retrieves waste copper at no extra cost and etches more accurately, all but eliminating the problem of undercutting.

The process, called Elo-Chem, for "electro-chemical," was developed at the Institute for Applied Physical Chemistry at West Germany's nuclear research establishment, Kernforschungsanlage Jülich GmbH—KFA for short. It is based on an electrolytic solution described as "permanent" because it is used over and over again. There is no poisonous waste water, no accompanying pollution, and none of the cleanup problems encountered with other wet-etching processes.

What's more, the etched-off copper can be retrieved immediately at no extra cost. In contrast, in conventional wet etching the removed copper either is lost or is recovered from the waste by expensive chemical processes. Copper retrieval and waste water cleanup can cost hundreds of thousands of dollars.

After years of government-supported development, KFA has built a pilot system. Laid out to handle pc boards 15 inches (about 36 centimeters) wide, the system has a throughput of some 65 square feet (6 square meters) of boards per hour. Smaller experimental systems for processing 5-in. boards (roughly 12 cm wide) have recently been shipped to potential licensees in the U. S., Japan and Europe, according to Wolfgang Faul, who has been instrumental in developing the new process.

Now that the technology is all worked out, KFA has turned it over to a small firm, Elo-Chem Ätztechnik GmbH, formed to exploit the process commercially and negotiate licensing deals with other companies. The Meersburg firm is demonstrating the process at this week's Productronica in Munich.

Continuous. As Faul explains it, the process takes place in a system of pipes, nozzles, and vessels in which the electrolytic solution constantly circulates. Consisting of diluted sulfuric acid at 50°C, the solution contains microscopically small, activated carbon particles at a concentration of about 15% by weight.

In an electrolytic cell, the 10-micrometer-diameter particles flow past a graphite anode and take on a positive charge. The solution then goes to the etching chamber, where nozzles squirt it onto a masked pc board. (Any normal type of mask can be employed.) The charge on the carbon particles is transferred to the copper, and the resulting copper ions enter the solution.

Ions and particles then return to the electrolytic cell, where the former pass through an ion-exchange membrane and are deposited on a copper cathode in the form of directly usable 99%-pure copper plates. The carbon particles, on the other

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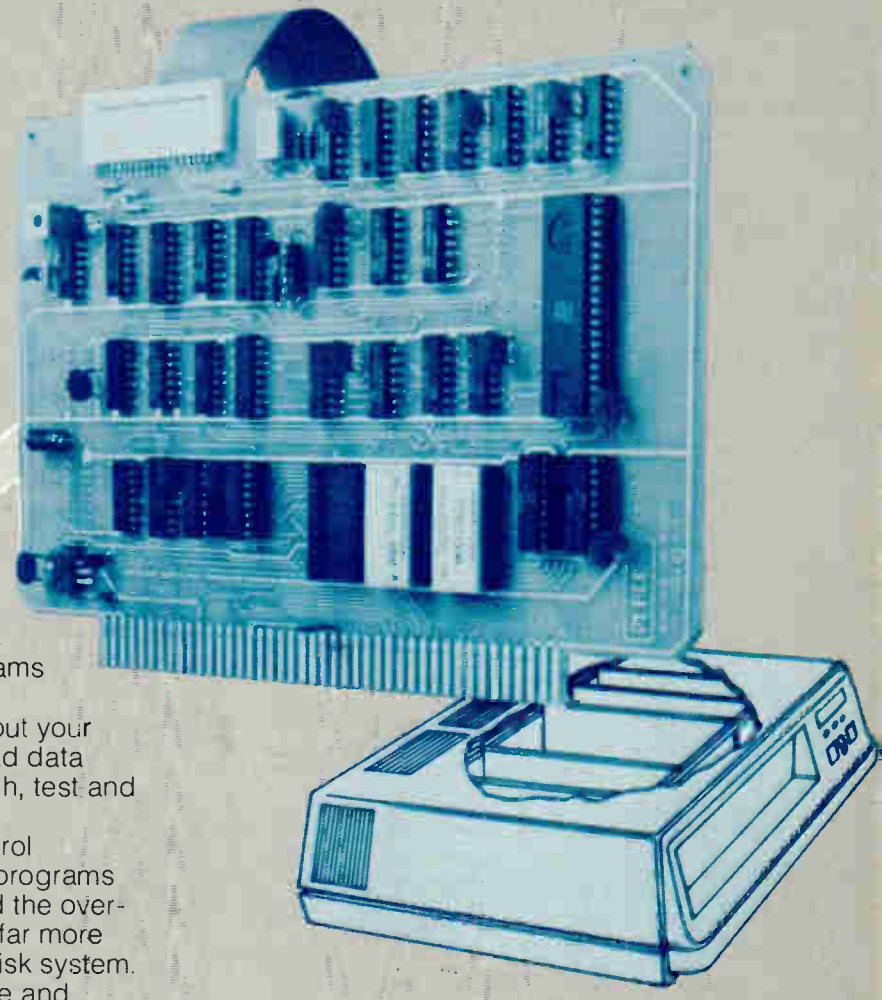

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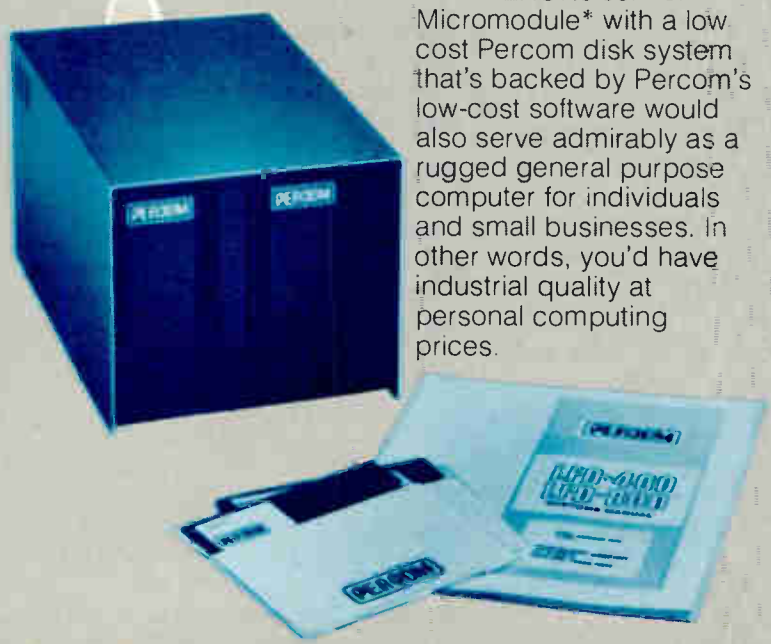

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hand, again flow past the graphite anode, take on a positive charge, and repeat the etching process. Thus the boards are continuously etched.

The solution does not change its chemical composition during the process, Faul says. As a result, the etching conditions are the same for an entire production run.

To ensure uniform etching, the potential of the etchant must be constantly controlled. This control is achieved simply by regulating the output of the system's dc generator.

No problem. Undercutting, a serious problem with conventional methods, is hardly encountered, Faul continues. The reason is that the solution with its charged carbon particles is squirted from the nozzles in a straight and sharp stream, removing the copper with great accuracy only from the desired areas. Narrower and more closely spaced paths on the boards can therefore be etched—lines as fine as 70 μm, spaced 70 μm apart, are possible.

As for the savings, tests at the Jülich facilities show that with conventional wet-etching methods the chemicals and the energy needed to etch away 1 kilogram of copper cost about $1.40. With the Elo-Chem technique, however, there is only the energy cost (beyond the initial cost of the chemicals), which comes to about 56¢ per kilogram of removed copper. To this savings, Faul notes, must be added the sales value of the regenerated copper—about $1.40/kg—for a total savings of approximately $2.24 per kilogram of etched copper.

An Elo-Chem system is expected to cost 10% more than a conventional system. **-John Gosch**

Japan

Single-mode-output laser diodes go for the long and short wavelength

Mitsubishi Electric Corp., Tokyo, is readying a short- and a long-wavelength laser diode that will provide engineers with improved performance in two very different applications. One, an aluminum-gallium-arsenide transverse-junction-stripe laser, provides a single-mode output at 780 nanometers for video disks and laser printers. The other, a conventional stripe device supplying a single-mode output at 1,300 nm, is designed to transmit hundreds of megabits of information per second over fiber-optic cables tens of kilometers long.

Although 780-nm light is near infrared, it is visible to the human eye (the beam, though, must be diffusely reflected to prevent damage to the retina). A visible laser-beam spot greatly simplifies the adjustment of optical systems. Also, the 780-nm light can be focused into a spot about 20% smaller than the usual 850-nm beam, providing higher information density. Furthermore, the sensitivities of many photosensitive coatings increase greatly at the shorter wavelength.

The device has a threshold current of about 30 milliamperes and supplies a 3-milliwatt output at a forward current of about 40 mA. Its junction-up diode structure is similar to that of earlier Mitsubishi devices [*Electronics*, July 6, 1978, p. 39], except that the active stripe consists of $Al_{0.15}Ga_{0.85}As$ to shorten the wavelength. The two AlGaAs stripes that sandwich it contain a higher percentage of aluminum—$Al_{0.40}Ga_{0.60}As$—to provide the higher index of refraction for the waveguide effect and the higher forward voltage that forces the current to flow through the active layer.

Close to optimal. Since even shorter wavelengths are desirable from the applications standpoint, Mitsubishi researchers will try for them in the future. But the present wavelength of 780 ± 15 nm may be near optimum: below 750 nm, efficiency decreases rapidly with decreasing wavelength, and the higher input powers are apt to shorten diode life.

The diode has been designed for maximum life and reliability. A silicon submount, which has a temperature coefficient of expansion similar to that of the GaAs, is mounted between the device and the package. It greatly reduces thermally induced strain on the laser chip. Furthermore, passivation with a silicon-nitride film applied by chemical vapor deposition after lead bonding to prevent degradation of the cleaved mirror surfaces by oxidation also protects the entire device; however, because the coating is precisely one-half wavelength thick, it has negligible effect on the optical characteristics. The guaranteed operating time will be about 10,000 hours, but Mitsubishi is confident that the average device will operate approximately 10 times longer.

The 780-nm ML-4001, in a TO-46 package, will initially be available in sample quantities in December for $220 ($260 in the U. S.); the price in large quantities will probably be about one tenth as much. Included in the package is a photodiode to provide a dc output for automatic power monitoring. The same laser without the power-output-monitor diode will be available mounted unpackaged on a heat sink as the ML-4307 at double the price.

Mitsubishi's long-wavelength laser diode is a more conventional stripe device in which the junction is mounted against the heat sink. It has a threshold current of 150 mA, with an average operating current of 170 mA for a 3-mW output. It comes in a pill-type package having a threaded stud, with a light guide extending through the stud to provide a monitor-light output. The ML-7205, which emits its beam through a window in the front of the package, will sell for $1,760 each ($2,100 in the U. S.) in sample quantities, also starting in December.

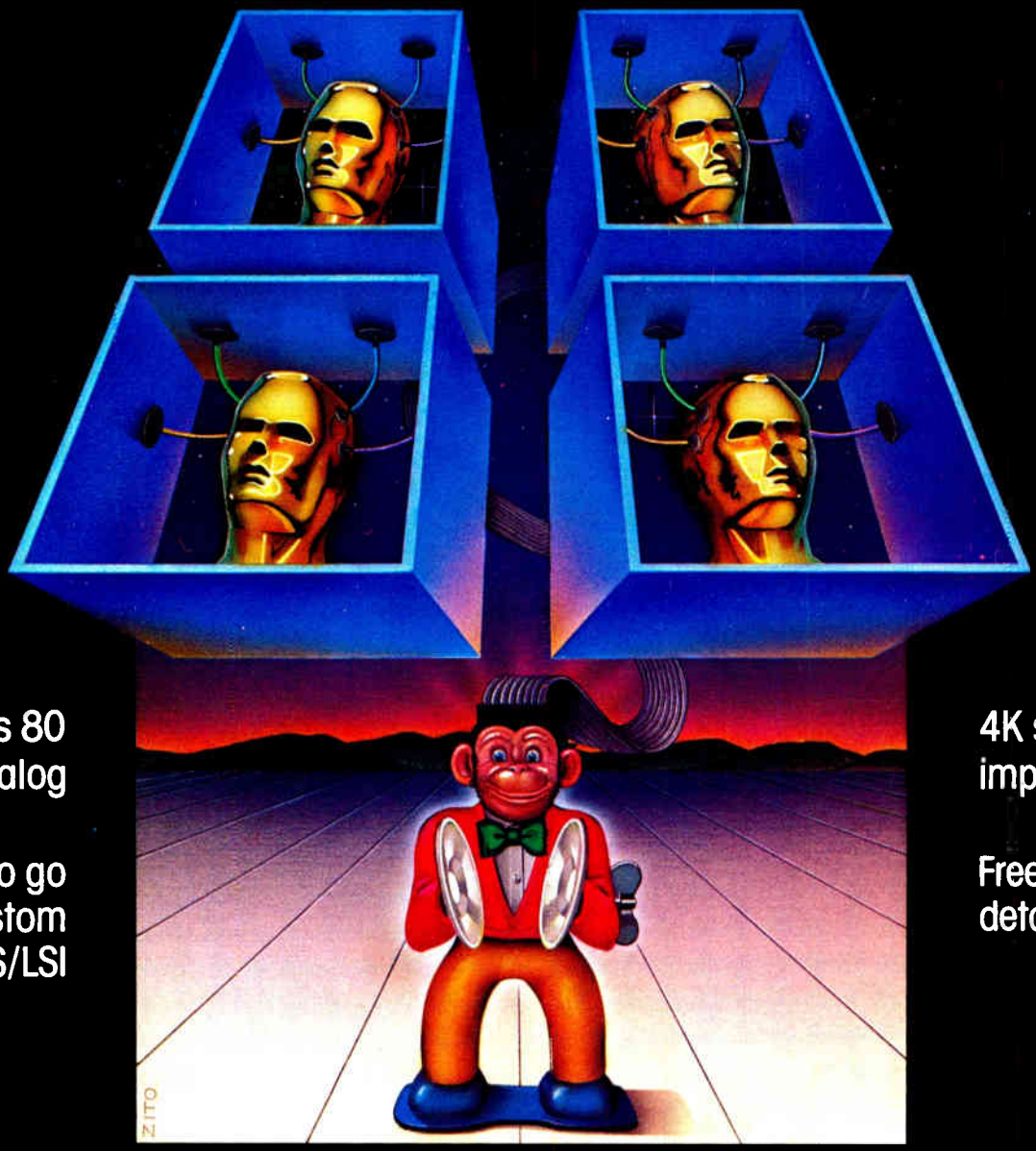
The ML-7205F has an optical fiber attached for connection to a fiber transmission line. Its output is only one quarter that of the 7205 as the coupling efficiency is 25%. Samples will cost $2,200 ($2,600 in the U. S.). **-Charles Cohen**

NO. 1

NATIONAL ANTHEM

Curing microprocessor overkill.

MICROCONTROLLERS THAT DO A LOT WITH A LITTLE.



Series 80 goes analog

Where to go for custom MOS/LSI

4K static RAMs improved.

Free literature—details inside

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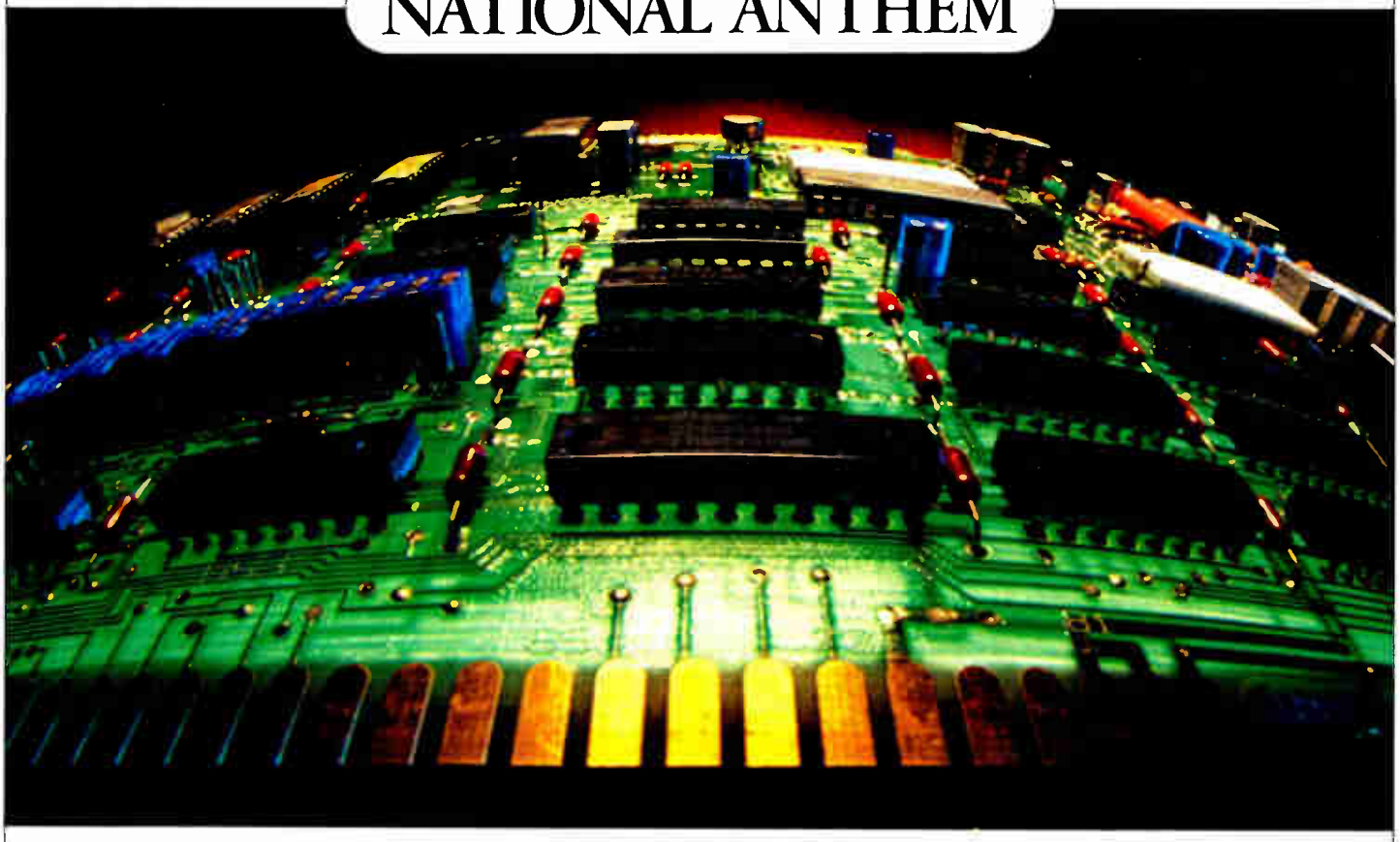


The BLC-8737. The analog I/O board they'll think of next.

The real world is analog. And National's new BLC-8737 analog I/O board gives you easy interface with that real world. The BLC-8737 is very easy to use because its built-in intelligence takes care of the analog functions automatically.

Onboard intelligence handles the complete analog conversion and scanning control. So you don't have to spend time writing conversion routines, for example, and run the risk of messing them up. You save considerable time, not to mention aggravation. Perhaps the best part, however, is that it saves you considerable development cost and gets you to market quicker.

It may be simple, but it handles a lot. Thanks to the BLC-8737's simplicity, the programmer need only tell the board what gains he wants for each channel. In fact, the BLC-8737 strongly resembles a simple memory board, with each input channel behaving very much like a memory address.

In addition, the BLC-8737 can handle a lot of data because it gives you 12-bit resolution. And it only requires a single 5 volt power supply.

With this new MULTIBUS-compatible board, National has simplified the design of microcomputer systems even further.

When you get right down to it, the BLC-8737 represents impressive capability for designers of analog system applications such as industrial/process control, energy management, testing and instrumentation, to mention just a few.

The BLC-8737. Just part of a very large family. But the BLC-8737 is only the newest addition to National's broad board line. The fact is, National offers over 75 different products in the family, all of them MULTIBUS compatible.

And National also makes a number of unique boards (such as the BLC-8737) that design engineers find very useful. That's because National is putting more and more intelligence on the board. And taking more and more of the tedious board design work off of you. The BLC-8737 is but one example among many.

National provides a broad spectrum of boards, including CPU's, memories, controllers, analog and digital I/Os, peripheral controllers, rack-mounted systems, a full complement of card cages, power supplies, cables, and other accessories.

A warranty four times as long. National knows how to build products that work. And they also know how to test their products, at the chip and board level.

That translates into better reliability. And explains why they're able to back this claim up with a warranty four times as long as the competition's: a full 12 months.

In addition to their guarantee, National maintains inventory levels that let them quote very competitive delivery schedules.

The bottom line is simple. If you're looking at MULTIBUS-compatible boards, you should be looking at National.

The COP 402 cures microprocessor overkill.

For those millions of repetitive tasks that don't need too much thinking capacity, National Semiconductor has come up with a timely solution.

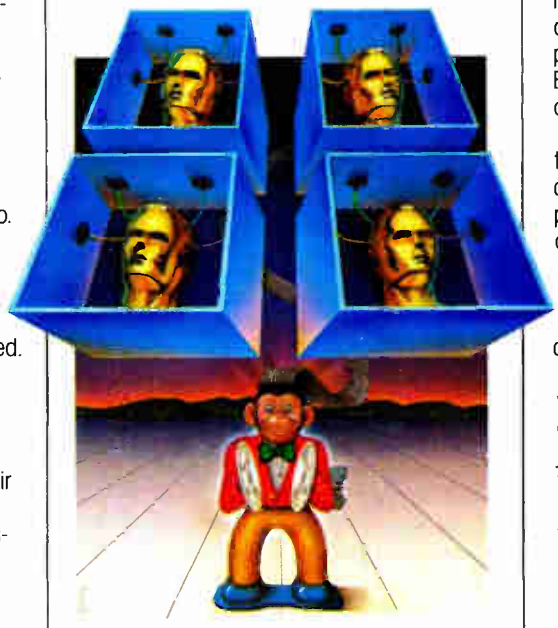
Their COPS™ microcontrollers actually improve upon the performance of the microprocessors most people use in their place. That's because most microprocessors can do a lot very well, but they can't really do very little very well. Many repetitive jobs applications that are being handled with microprocessors are really cases of overkill.

National Semiconductor recognized the situation and took steps to fill an obvious gap.

Being single-minded has its advantages. The fact is that these many jobs being done by multiple discrete circuits and overly complex microprocessors require a lot of headaches before they're accomplished. Shoe-horning a complicated circuit into a situation that is in fact too simple can be more trouble than it's worth.

So, for under $10, National is introducing two additions to the COPS family: their COP402 and COP402M. Both designed to handle simple tasks in an efficient way. Customers not only get devices that control little things, they get devices that control them inexpensively.

Introducing another microcontroller that handles little control processing jobs better than complex microprocessors.



Benefits haven't been forgotten, either. The COPS alternative, though simple in theory and action, actually has quite a lot of thought behind it, as well as on it.

For example, each model features a RAM right on the chip, direct I/O instructions, direct LED drive, easy interface to COPS peripherals (like the COP470), binary and BCD operations, direct KBD scan, and built-in address decoder.

But National didn't stop there. In addition to the above benefits, the entire line can scan switches, maintain real time, display in LED or VF, use external data from a read/write memory, and even function as a computer peripheral. When you consider all the COP402 does, you begin to wonder why you ever thought you needed a complex microprocessor.

The COP 402. Simply competent. If you're currently handling tedious, repetitive, or single-minded tasks with a circuit that's just too over-qualified, you should look into this new National alternative. The bottom line is that the COP402 could be handling your chores for you with a lot less hassle, and a lot less money.

Practicality is the National philosophy.

SEE SPECS ON BACK.

No one puts more manufacturing muscle and engineering talent into custom MOS/LSI.

"Custom MOS/LSI gives you proprietary features that signify a competitive edge – which gets you the market sooner, with a better product, at less cost.

"When it comes to custom MOS/LSI, National Semiconductor offers the lowest cost solution for volume production. We also have dedicated production lines for custom products, so that you always have guaranteed capacity.

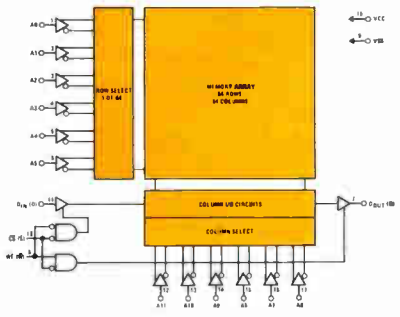
"National's capability in custom MOS/LSI is reflected in three key areas. First, we've got the necessary manufacturing capability. Second, our engineering talent cuts across virtually all electronic design disciplines. And third, we've been in the custom business for years and intend to stay there as long as customers have needs.

"In terms of customer benefits, custom MOS/LSI is the best solution for minimizing system costs. It's the best solution for maximizing system reliability. It makes your product unique.

"And from design through production capability National Semiconductor is your best source for Custom MOS/LSI."

William Sanderson
Group Marketing Manager,
Custom MOS/LSI

Working wonders on the 2147 4K static RAM.



National's new MM2147 static RAM is a 4096-word by 1-bit random access memory that uses National's XMOS™ N-channel silicon-gate technology.

All of the 2147's internal circuits are full static. And they therefore need no clocks or other refreshing for operation. All data is read out non-destructively, and has the same polarity the input data has.

The 2147's separate chip select input automatically switches the part to its low power standby mode when it goes high. And the output is held in a high impedance state during write in order to simplify your common I/O applications.

The 2147 has other impressive features as well. All its inputs and outputs are directly TTL compatible. It has automatic power down, and high speed – down to 55 ns cycle time. It has a TRI-STATE® output for bus interface, separate Data In and Data Out pins, and a standard 18-pin dual in-line package.

In addition to all this, the 2147 is available.

National Semiconductor

COP402/COP402M ROMless N-Channel Microcontrollers

General Description

The COP402 and COP402M ROMless Microcontrollers are members of the Control Oriented Processor (COP) family, fabricated using N-channel silicon gate MOS technology. Each part contains CPU, RAM and I/O, and is identical to a COP420 device, except the ROM has been removed; pins have been added to output the ROM address and to input ROM data. In a system, the COP402 or 402M will perform exactly as the COP420; this important benefit facilitates development and debug of a COP420 program prior to masking the final part. These devices are also appropriate in low volume applications, or when the program may require changing. The COP402M is identical to the COP402, except the MICROBUS™ interface option has been implemented.

The COP402 may also be used to emulate the COP410L, 411L, 420L or 420C by appropriately reducing the clock frequency.

Features

- Low cost
- Exact circuit equivalent of COP420
- Standard 40-pin dual-in-line package
- Interfaces with standard PROM or ROM
- 64x4 RAM, addresses up to 1k×8 ROM
- MICROBUS™ compatible (COP402M)
- Powerful instruction set
- True vectored interrupt, plus restart
- Three-level subroutine stack
- 4.0μs instruction time
- Single supply operation (4.5V to 6.3V)
- Internal time-base counter for real-time processing
- Internal binary counter register with serial I/O capability
- Software/hardware compatible with other members of COP400 family

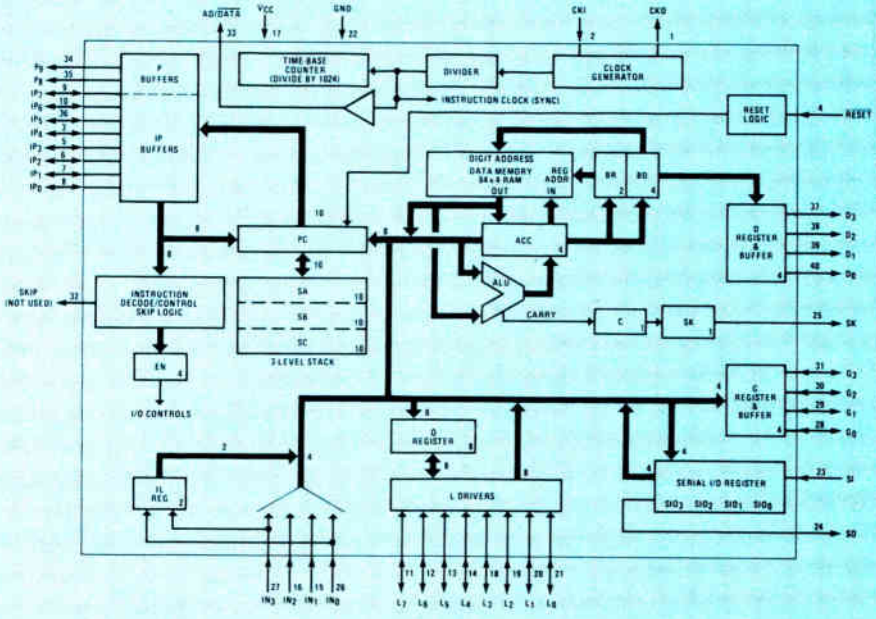


Figure 1. COP402/402M Block Diagram

What's new from the National archives.

001 ☐ BLC 8737 Data Sheet
002 ☐ COPS 402 Data Sheet
003 ☐ MM 2147L Data Sheet
004 ☐ The National Story
005 ☐ Additional Custom MOS/LSI Information
006 ☐ Special Functions Data Book ($6.00)
007 ☐ Interface Data Book ($6.00)
008 ☐ Pressure Transducer Data Book ($3.00)

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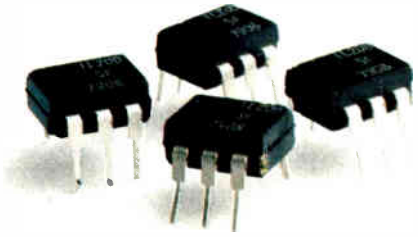
OPTIMUM OPTO-ISOLATORS.



Not everyone needs specs like these. But for those who do, we got 'em.

5KV Opto-isolation

The new Litronix family of high voltage opto-couplers offers 5,000 volts of protection.

That's enough to isolate patients from x-ray machines...or delicate equipment from surges in high voltage power lines.

But what really sets these new products apart is their long term performance specs.

Long term stability

Typical 1,000 hour degradation is less than 20% (Competing products are closer to 50%).

Up to 450% CTR

Our IL-200 series is a 6-lead single coupler offering 5KV isolation at 10 mA IF. It's available in three current transfer ratios: 75 to 150%, 125 to 250%, and 225 to 450%.

Unusually low driving current

All IL-200 opto-isolators feature minimum CTR at 1 mA driving current. They are also guaranteed to operate over a temperature range of 0 C to 70 C. Currently there are three models in the new line.

Part Number	Current Transfer Ratio @ 10 mA	Current Transfer Ratio @ 1 mA	Isolation Breakdown Voltage	1000 Piece Price
IL-201	75 to 150%	10% min.	5000 volts	$1.00
IL-202	125 to 250%	30% min.	5000 volts	$1.08
IL-203	225 to 450%	50% min.	5000 volts	$1.20

Improved Duals and Quads too.

Updated dual and quad optoisolators with the same high range specifications as the single channel IL-1.

Part Number	Channels	Current Transfer Ratio	Isolation Breakdown Voltage	BV_{CEO} @ 1 mA (V) Min	I_{CEO} (Dark) V 10V (nA) Max	1000 Piece Price
ILD-1	2	20% min.	2500	30	50	$1.36
ILQ-1	4	20% min.	2500	30	50	$2.90

For samples call or write Litronix, 19000 Homestead Road, Cupertino, CA 95014. Phone (408) 257-7910.

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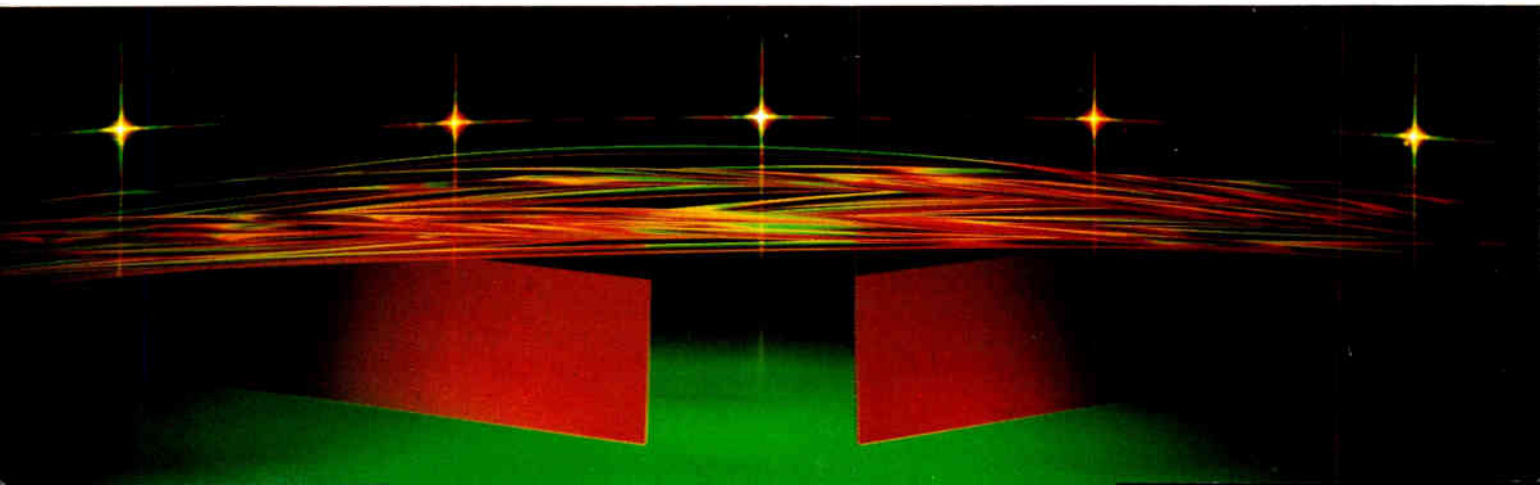
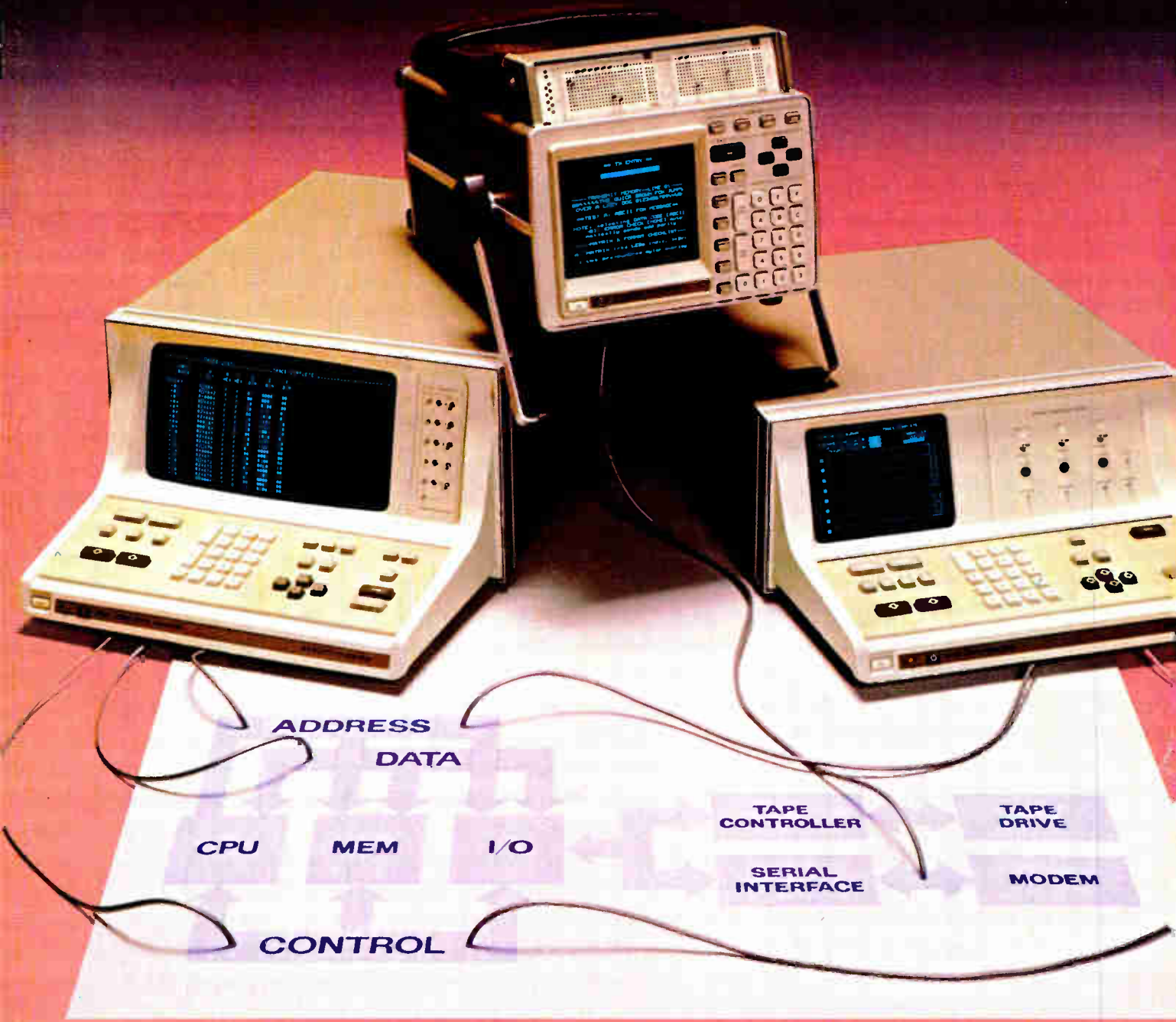
THE LIGHTS FANTASTIC



IN MINICOMPUTER SYSTEMS DEVELOPMENT

See how they run.



Design Production Service

HP—When you depend on logic

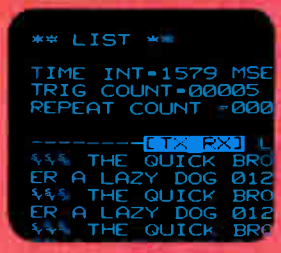
Or see what happens when they don't.

HP Logic Analyzers: The fast, easy solution.

These three HP Logic Analyzers get you on minicomputer buses quickly and easily with improved results.

They're powerful measurement tools that let you probe into the heart of operating systems. Monitor I/O transactions. Identify and isolate state flow problems. View logic circuits in action. And more. With a degree of user-convenience previously unavailable in systems design and debugging.

Our menu concept with simple keyboard entries and plug-in interfacing reduces set-up time to a minimum. Add the advantages of better insight and faster debugging and, chances are, you'll make the transition from hardware assemblies to operating systems more rapidly.



With simple matrix programming, the 1640A Serial Data Analyzer ($5,800*) monitors RS-232C interfaces, measures time intervals and simulates network components. It's flexible triggering lets you trap on data errors, time-interval violations or invalid protocol sequences. For subtle problems, or loopback tests, it simulates a CPU, terminal or modem. And you can operate with any combination of standard transmission modes.

Now you can capture state, timing and glitch information simultaneously with the 1615A Logic Analyzer ($6,800*). It acts as a 24-bit state analyzer or an 8-bit timing analyzer. You can also combine the two modes to trigger on timing while viewing program flow. And vice versa—at your choice of specific points in address flow.

Save both debugging and development time by relating parallel data transactions to handshake protocols; verifying time sequences; detecting and triggering on glitches; and evaluating system performance at the time of a glitch.

Solve state flow problems on data and address buses quickly with the 1610A Logic State Analyzer ($9,500*).

Its sequential triggering allows you to directly locate sections of branched or nested loops for complex software analysis. And you can define up to seven words for selective trace capture to simplify data examination and program debugging.

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Find out more about how HP Logic Analyzers can get you on your minicomputer bus. Simply send for a *free* copy of the **HP Guide to Selecting Logic Analyzers.** Or, for immediate assistance, give your local HP field engineer a call today.

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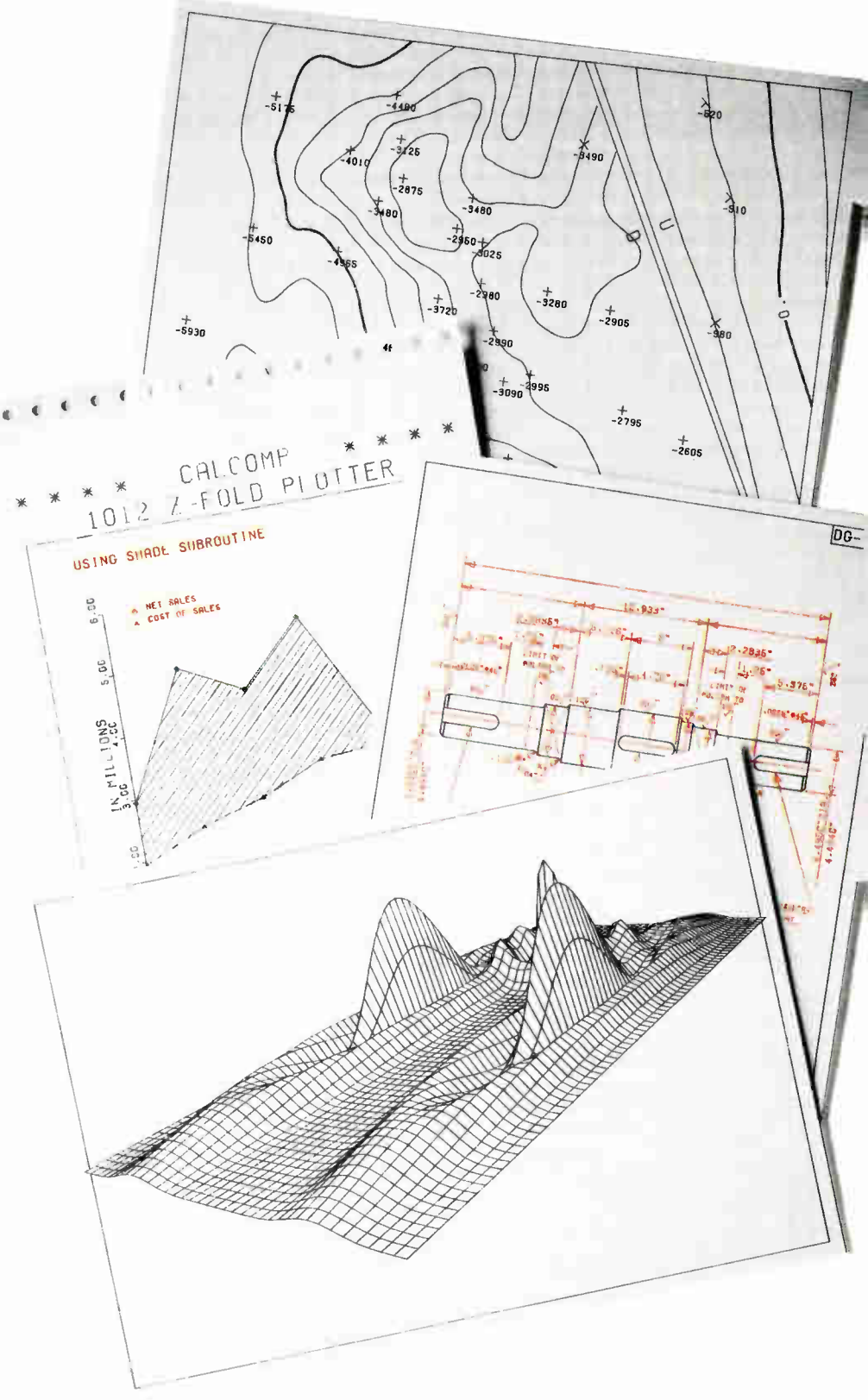

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Looking at the broadest line of computer graphics systems in the world may still present a problem to you.

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representative is really a consultant. In every sense of the word.

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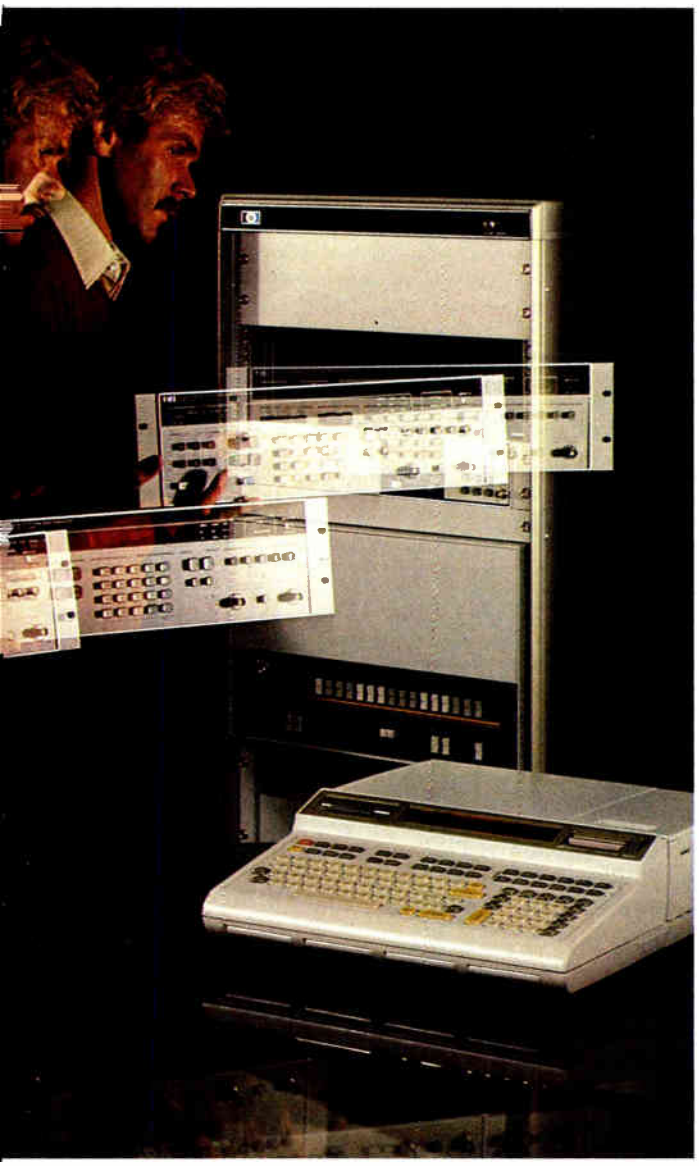

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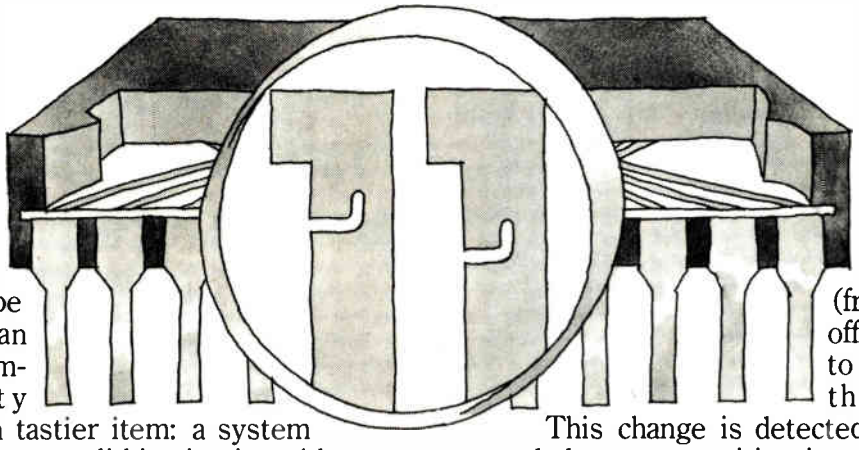
Laser trimming of monolithic circuits

Silicon valleys



No sooner have we swallowed the fact that 86,000 thick-film resistors can be laser-trimmed in an hour than the trimming fraternity serves up an even tastier item: a system capable of trimming monolithic circuits with a laser beam only 6 micrometers in diameter.

Now, to put a spot size of 6 micrometers into focus (so to speak), the new trim system can very easily write your name inside the period at the end of this sentence, with room left over for a troupe of dancing angels.

Producing a spot this small is basically an optical feat, accomplished by lensmanship of the highest order. To be useful in monolithic trimming, however, beam reduction must be accompanied by equally remarkable positioning accuracy, there being no known application for a wandering 6-micrometer laser kerf.

Teradyne's closed-loop galvanometer beam positioner, used for some time on the W411 Laser Trim System, had already wiped out hysteresis and greatly reduced nonlinearity. That left geometry errors in the step-and-repeat table and registration errors from die to die as the principal error sources to be dealt with.

The solution to these problems is a new technique for nondestructive edge sensing, called "Laser Eye." Before the laser beam starts trimming, it is attenuated and brought to the leading edge of the circuit. When it encounters the circuit edge, there is an abrupt change in the amount of laser energy reflected (from high reflection off the light substrate to low reflection off the dark circuit). This change is detected by a photodiode, and the exact position is passed along to the computer, which adjusts the stored trim coordinates and the focus of the laser beam accordingly. The edge-sensing is typically repeated on every die to ensure positioning accuracy, with focus adjusted every inch or so to compensate for any wafer warp.

As further insurance against positioning errors, the entire mechanism is shock-mounted against the effects of vibration. The trim system is, after all, designed not as a laboratory instrument but as a machine to grind out parts on a factory floor.

The combination of closed-loop galvanometer positioning, Laser Eye, and solid systems engineering yields a bottom-line, no-strings positioning accuracy of 2.5 micrometers. That means that, on any given circuit, the laser beam will be within 2.5 micrometers of where it's supposed to be, period.

Monolithic trimming is currently of principal interest to makers of monolithic 12-bit D to A converters. But now that lasers have broken the IC, who knows what uses may be found for 6-micrometer holes, coming thousands per second, right on the money every time?

The first 12 essays in this series are now available in booklet form. For your copy, write to Teradyne, Department E, 183 Essex Street, Boston, MA 02111.

TERADYNE

Standards key to fax's future

CCITT to decide on data-compression code to be used on digital networks by future machines

by Ana Bishop, McGraw-Hill Publications Co.

After many years of lackluster performance, facsimile equipment may regain the spotlight as a component of the all-digital electronic office of the future. But the industry's future is hanging on whether an international committee, meeting this week in Kyoto, Japan, can decide on standards for the digital transmission of facsimile images.

A study group of the Consultative Committee on International Telephony and Telegraphy is preparing to promote standards for facsmile transmission to the CCITT plenary session in Geneva next spring. The study group has pretty much agreed on a one-dimensional data-compression code—the modified Huffman code (see "Getting to the point")—that will make all high-speed digital facsimile machines transmitting over conventional analog telephone lines (Group 3 machines) compatible.

However, a second data-compression code, this one two-dimensional, would be available on machines that meet the Group 3 CCITT recommendations, and there is no consensus on that one. Why all the fuss over an option? Whichever algorithm is chosen may become the precedent for a future generation of digital facsimile machines that would transmit over all-digital communications networks (Group 4 units).

For the option, seven algorithms have been proposed to the study group. Japan, the United Kingdom, and West Germany have one apiece, and the other four come from American firms—3M Co., IBM Corp., Xerox Corp., and American Telephone & Telegraph Co. But the U. S. has only one vote, and the decision must be unanimous.

Facing the unenviable task of uniting the American companies on this issue is Western Union Corp.'s vice president of corporate planning, Roy K. Andres, who heads the U. S. preparatory group. He says that the committee recommendation on the optional data-compression technique "has to be solidified six months before the plenary session." Since the CCITT holds its standards-setting plenary sessions only every four years, the issue would wait until 1984 if there is no accord this week.

The manufacturers cannot wait another four years. Andres says time is of the essence: "The quicker the standards come out, the quicker the manufacturers can settle into the market." But a compromise on the algorithm has not been reached at other study group meetings because each company has been looking out for itself. The attitude has been that the firm that already has the hardware to implement whatever optional algorithm is recommended will have a head start on Group 4 machines. In fact, companies that already have sub-minute machines on the market are promising their customers that their units will meet

Getting to the point

In terms of data content, images are highly redundant. So, in a facsimile system a lot of information transmission can be eliminated with little or no effect on received picture quality. The basis for this redundancy reduction is proper coding of the symbols that represent the transmitted information. In the picture itself, transitions from black to white and vice versa appear with unequal frequency.

There are actually few transitions, with what amounts to runs of black or white of varying lengths. And the number of transitions in a typical scan of one document line by a raster scan system is smaller still. Therefore, encoding black and white run lengths between transitions and converting the run length and its position into a digital code seems to be a good idea if the code words are chosen to take far less transmission than raw informa

This can be done in many different ways and is the basis for the one-dimensional codes, such as the Modified Huffman, that have been developed. Depending on the coding scheme used and the ratio of white to image space on the document, these codes are capable of a wide range of compression ratios.

It is possible to expand the coding concept to take into account more than one line at a time. For example, the contents of two adjacent lines can be encoded so that additional compression is gained. But two-dimensional coding is capable of the most compression. Here, the data is also compressed on the basis of transitions occurring from one scan stroke to the next. The principle for the coding is the high probability that a transition occurring at one point in one scan stroke will be repeated at approximately the same point in the next scan stroke. Thus, if all the transitions in the first stroke are encoded, only the differences in the position of the transitions in the next stroke need to be encoded. And since difference codes are shorter than position codes, further compression results. **-Harvey J. Hindin**

future CCITT standards, so the makers face a large retrofitting bill if the machines they are installing now use a nonstandard algorithm.

Compromise in all. An Electronic Industries Association committee has "worked very hard to come up with an American position and alternative compromises which all could accept," says Andres. The chairman of that committee, Chuck Jacobson, engineering manager for facsimile at the Xerox Office Products division in Dallas, says that "the majority of U. S. companies are going to the Kyoto meeting with an attitude of compromise" because "most are interested in reaching a standard as soon as possible."

According to Jacobson, most manufacturers feel that the two-dimensional algorithms in question "probably will be extended" to machines that would transmit over proposed public data-communications networks such as AT&T's Advanced Communications Service or Xerox's Xten [*Electronics*, June 7, p. 94].

Like most standards, these facsimile recommendations are expected to have a major impact on the market because they portend faster and more efficient machines. Some manufacturers break up the facsimile market along analog-digital lines; others go by transmission speeds. The Japanese companies have been transmitting digitally at high speed for years because their telephone system has a broader bandwidth, but U. S. companies have stayed in the mid-speed analog market.

Some contend that the market for medium-speed analog machines—those that transmit an average letter in 2 or 3 minutes—has reached a peak and that the market for subminute machines—those that do so in less than a minute—is just taking off. The manufacturers of medium-speed machines have aimed their marketing strategies at medium-sized companies that want the machines for convenient use at what Jack E. Cochran, president of Exxon Enterprises Inc.'s Qwip Systems, Orlando, Fla., calls "the point of need"—the desk and phone.

But some in the industry argue that special digital common carriers are needed to make the big, expensive, fast units cost-effective. So 3M and others in the facsimile business are keeping close tabs on such systems as ITT Domestic Transmission Systems Inc.'s forthcoming Faxpak. Faxpak, which combines a computerized store-and-forward capability with packet-switched data-communications technology, begins operation throughout the continental U. S. on Dec. 3. 3M, for one, sees such technologies, rather than other firms, as the major competition.

Although Faxpak and other proposed communications networks would make the facsimile machines of different manufacturers and of different speeds compatible, they would not solve compatibility problems on international transmissions. For example, in order to serve its international Q-Fax customers, RCA Global Communications Inc. has to use machines made by six firms. □

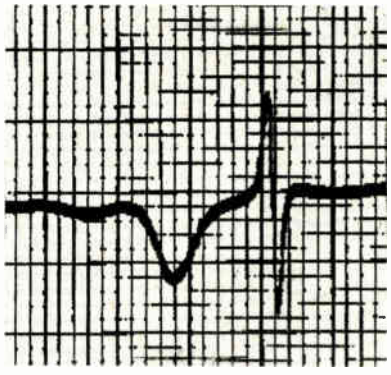
Getting the picture

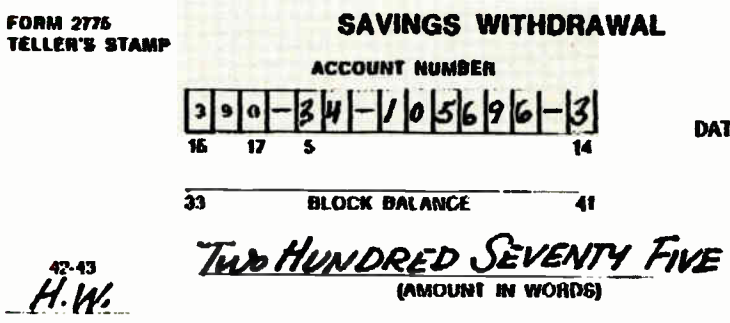
One of the major problems that facsimile faces is the quality of the copies. Use of voice-grade lines means that the transmission can be affected by noise, causing echoes of other distortions to appear on the transmitted copy. As the samples below show, facsimile machines can have problems, even transmitting over demonstration machines at company display sites.

The Qwip copy (top left) was transmitted interoffice at a rate of 2 minutes over telephone lines on a demonstration model. Even over such a short distance and at a speed that in theory offers better resolution, noise interference patterns were a serious problem.

The 3M copy (top right) was transmitted interoffice at 9,600 bits per second over telephone lines. Most of the copies from this machine were clear, but a graph reproduction revealed that the relatively few bits not being transmitted—which did not seriously affect the legibility of alphanumeric transmission or large diagrams—did cause significant distortion when transmitting a grid pattern. The vendor claimed that this was a malfunction of the particular machine and could be easily corrected by a repairman.

The cleanest copy (bottom) came from a Xerox 200 Telecopier transmitting from one terminal to another in the same display room at a rate of 2 minutes over analog telephone lines. The 200 uses a laser beam for scanning and reproduction and produces xerographic copy on plain bond paper. Even better resolution is possible with the 3-minute rate.





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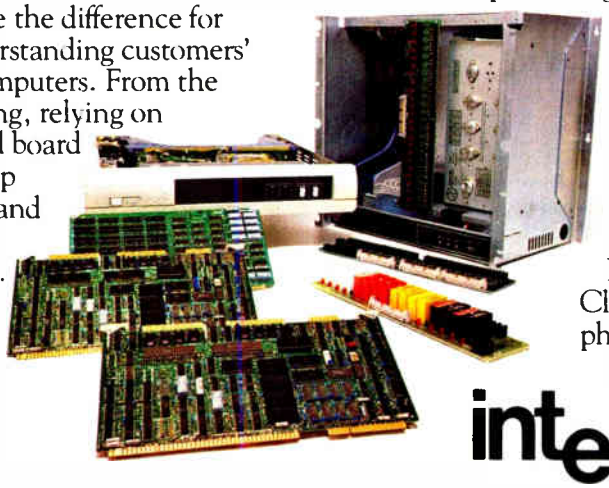

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Companies

Born-again GenRad roars into '80s

$2 million in the red in 1972, the company has bounced back by capitalizing on in-house capabilities and new markets

by James Brinton, Boston bureau manager

In the late 1960s, General Radio Inc.'s future was behind it. Its product introductions were sporadic, often unplanned, and sometimes unsuccessful. Its offices were musty, its management fusty. Lines on graphs showing earnings projections drooped and were to sag further in the next few years.

But things have changed. Now it's GenRad Inc., and there is an upbeat atmosphere about the Concord, Mass., firm's plant, people, sales, and its financial statement.

In mid-October, GenRad reported a record third-quarter net income of $2.531 million on $31.7 in revenues—increases of 48% and 45%, respectively, over 1978's third quarter. For the year, net income is up 52% to $6.139 million and revenues have increased 34%, reaching $82.079 million. That is almost what GenRad made in all of 1978.

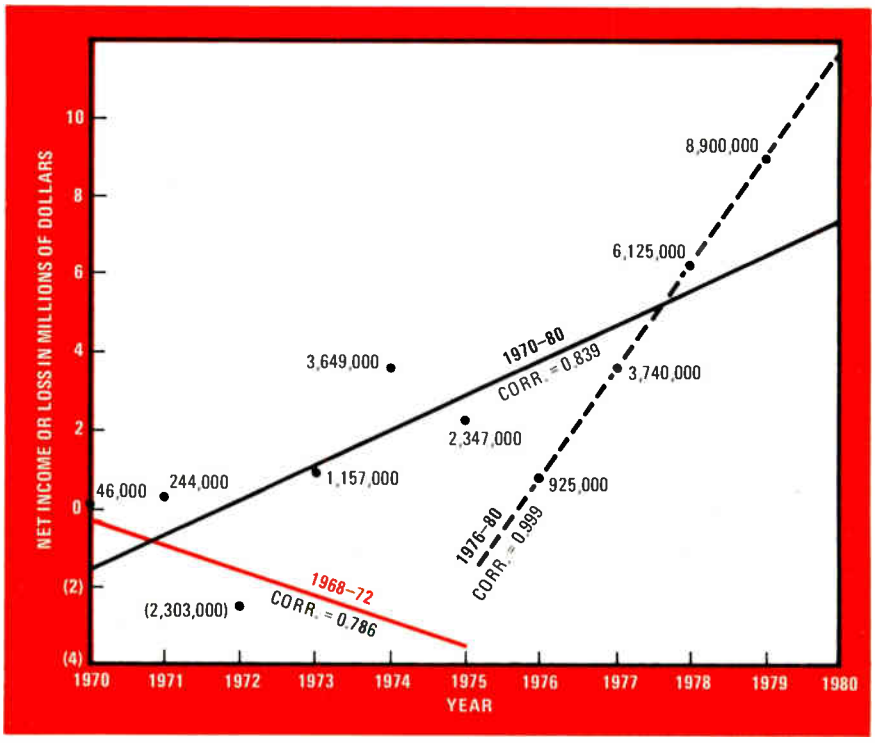
Estimates vary, but GenRad could finish 1979 with net revenues of $105 million to more than $120 million, according to company spokesmen and financial analysts. Thus, it is performing more like a highballing young company than one of the country's oldest electronics firms. In fact, it is both.

The resurrection dates from 1972–73 when it lost its shirt and then gained William R. Thurston as president. The company lost $2.303 million in 1972 on a net of $33.35 million, and though 1970 and 1971 had theoretically been profitable, a small accounting change would have been enough to throw GenRad $100,000 to $200,000 into the red despite $26 million to $30 million in net revenues. Outwardly, the company was moribund.

But beginning in 1973, Thurston dumped its committee management system, wrote off a costly internal computer development, restructured top management, began weeding out marginal operations, and eventually started scouting for acquisitions [*Electronics*, July 20, 1978, p. 96]. Insiders, though, say his greatest effect has been on what is called GenRad's hit ratio—the ratio of successful new products to unsuccessful ones. Lately, some of them have not so much arrived as detonated in the marketplace.

Announced this spring, the microprocessor-based 1731 tester of linear integrated circuits allows unskilled operators to test 3,000 to 5,000 different IC types [*Electronics*, March 29, p. 136], and it has been selling fast enough, say company spokesmen, to have already captured much more than 30% to 40% of 1979's benchtop-tester sales. By expanding the market and offering an attractive price-performance ratio, the $22,900 product now is expected by GenRad to capture 80% to 90% of its market by year's end. It is selling at about 120% of the planned rate, deliveries have been stretched from 12 to 16 weeks, and plant capacity is being reserved for increased production next year.

Low figure. Product marketing manager G. Roy Rondeau admits to a classic case of underestimation: "Our research showed a total market of $4 million to $5 million." That



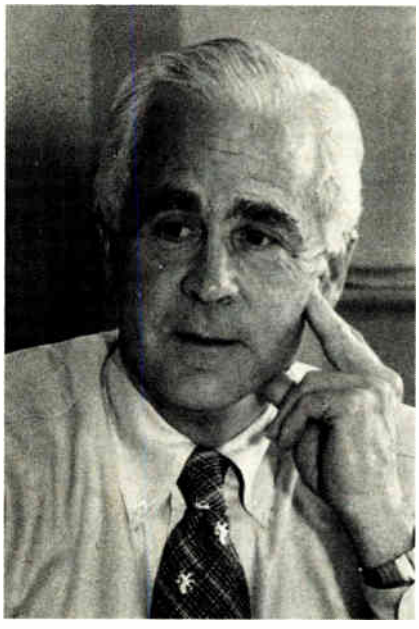
itself was low, but then the 1731 began selling in unexpected areas, too. Aimed at the incoming-inspection market, half the 1731's sales have come from semiconductor manufacturers instead, with a number going into offshore assembly operations and others backstopping large Sentry-class IC testers at firms like Fairchild Camera and Instrument Corp., Advanced Memory Devices Inc., and Signetics Corp.

The 1731's success story and Rondeau's reasoning both are supported by independent observers like Galen W. Wampler, vice president of market research firm Dataquest Inc., Cupertino, Calif. "Even GenRad's competition agrees that the 1731 is a very capable machine at the price," he says, adding that "it also was announced just as the growing sophistication of linear ICs had outmoded many existing testers. Finally, the 1731's competition is concentrated at the ends of the price-performance ratio spectrum while the 1731 is in the middle."

Treading the boards. GenRad's board tester business also is booming. Its line of functional test systems, launched in 1960 with the model 1790, logged $17.5 million in sales in 1976 for 32% of net revenues. In 1977, the figures were $31 million and 44% of net. Thurston breaks out 1978's figures, noting that GenRad sold $42 million in board testers, taking about 48% of the worldwide market (reckoned at $88 million) and accounting for 49.6% of net revenues. "Our next five largest competitors combined had $42.5 million," he says, claiming that GenRad's share is steadily growing: "GenRad's systems business grew 38% in 1978 while our competition's grew less than 21%."

F. Eberstadt & Co., New York, manager of two mutual funds and broker for institutional clients, expects the growth to continue. 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. The rest of the major firms in the test and measurement field are expected to grow at 17% to 30%.

Eberstadt's estimate is probably conservative; analyses made nearer the end of 1979 by Dataquest and Morgan Stanley & Co., the New York investment firm, forecast 1979 growth between 28% and 37% for firms like Teradyne, John Fluke Manufacturing Co., Tektronix Inc., Hewlett-Packard Co., and GenRad. And even these two market analysts are factoring in a mild recession for the first half of 1980.



Turnaround leader. William Thurston arrived at GenRad to find a $2 million loss.

Eberstadt estimates that the 1979 board tester market will grow by about 30%. Thus, if GenRad simply grows in proportion, it will have sold about $55 million in board testers by year's end. Inside betting is that the figure will be much higher.

Looking ahead. Entrenched in the incoming-inspection and functional-board-test markets, GenRad is looking toward equipment servicing and the design process as future targets.

Its approach to servicing is characterized by the 2225 portable functional board tester; using software generated for GenRad's large in-plant systems, it moves board test (and repair) into the field, helping to cut the floating inventory of printed-circuit cards.

GenRad's investment in Los Angeles-based Futuredata Computer Corp. may yield a larger payoff, though. GenRad/Futuredata makes multi-user, universal microprocessor software development systems [*Electronics*, April 26, p. 40], and market research figures put it in a good place at a good time. According to Dataquest, the microprocessor development system market is in for a 31%-compounded annual growth rate between 1977 and 1982. That's an increase from $74 million in 1977 to $285 million in 1982.

Further, by the end of 1978, there were some 32,000 such systems in use and Dataquest foresees 100,000 installed by 1982—a 212% increase. That means shipments, and Dataquest plots an increase from 8,900 in 1977 to 21,000 in 1982, for a 20%-compounded annual growth rate.

Finally, in 1978, the price of a development system averaged $9,300; Dataquest figures the price will be $11,200 in 1980 and $13,000 by 1982. GenRad/Futuredata estimates that peripheral equipment raises average price about 50%.

Futuredata seems less an acquisition than a marriage. "Futuredata wanted some capital, but more specifically, they wanted our systems test software know-how," says Thurston. "GenRad wanted Futuredata's logic and microprocessor systems development expertise—we wanted to get a lead on testing the microprocessor-based products of the 1980s."

Bruce E. Gladstone, vice president of GenRad/Futuredata, estimates that the market for universal development systems (versus the dedicated types sold by semiconductor houses) will be about $23 million in 1979, up from nothing in 1976. Semiconductor makers rang up about 85% of all development system sales in 1978, he says, but he foresees a switch by users away from dedicated to universal systems. And right now just a few companies offer universal systems in competition with GenRad.

Thurston says that GenRad/Futuredata already is exceeding the growth plan laid out before the acquisition, in both volume and profit, and "we want them to learn and grow as fast as possible"—which sounds like what the rest of the company is doing. □

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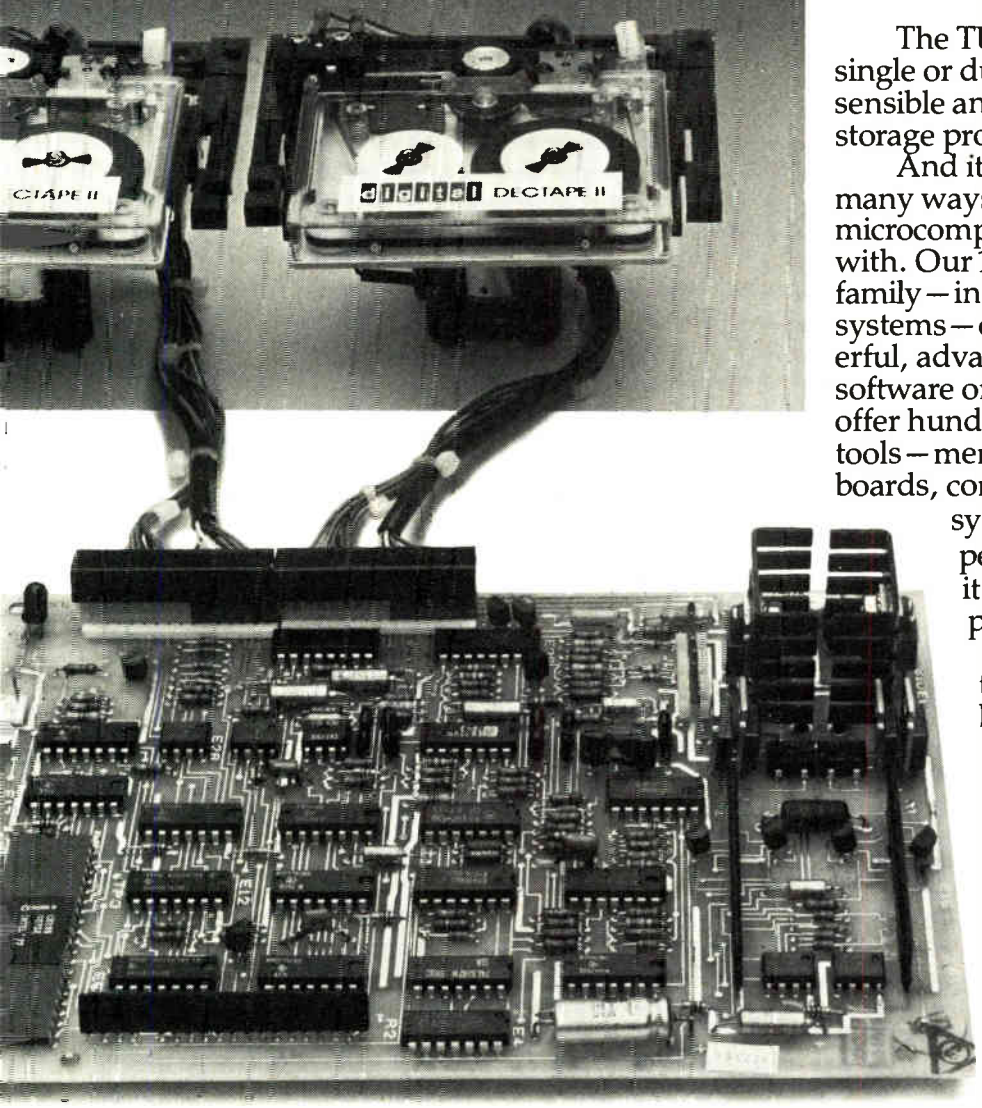

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Shinier image sought for the engineer

Long-term IEEE effort under way to clarify role of engineers and electronic technology

by Alfred Rosenblatt, Managing Editor

If doctors have Marcus Welby, M. D., to enhance their image, why can't electronics engineers have a TV series built around a friendly Joe Engineer, as sympathetic and knowledgeable about the real-life problems of modern technology, like Three Mile Island and public transportation, as Welby is about gastroenteritis and cancer?

The possibility of such a series is far-fetched, as Eric Herz, general manager of the Institute of Electrical and Electronics Engineers, after a decades-long career as an electrical engineer, is quick to admit. But the idea behind it excites him.

Why not a more sympathetic image for engineers in the mind of the general public, he asks, one that would counteract the negative attitude he perceives that it has toward engineers and technology? Why not a counterbalancing image of the engineer as a source of good for society, rather than of danger? as a respected professional contributing to the community?

Spending money. Herz and the other top-level members of the IEEE think the institute can change the engineer's image. It is spending $200,000 for the effort in 1979 and has earmarked $216,000 for 1980. The money has, in part, brought Joseph J. Codispoti to the institute in September as its new staff director for public relations and allowed it to retain an outside public relations counsel, the well-known New York firm of Ruder & Finn Inc. Still to be hired is a public relations staff member for the IEEE's Washington office to deal with members of Congress and their staffs. (In 1978, in contrast, the institute spent $46,000 on public relations, working mainly with an outside consultant.)

Codispoti, 35, comes to the IEEE from eight years as the public relations manager of Analog Devices Inc., the maker of converters and other electronic components. "I have no biases, no allegiances," he says. "I can bring a fresh approach to public relations."

So far, perhaps the most important role in the new program has been played by Ruder & Finn. For one thing, it helped select Codispoti from among several applicants responding to newspaper advertisements for the job. It also drafted a public relations program, drawing largely on interviews with IEEE staff and committee volunteers.

Broad target. According to Herz, the targets of the program "are the institute's members, Government opinion leaders, the technical press, and, through the general press, the public." For Codispoti, this translates into promoting the public's understanding of technology and, in particular, of the role played by the electrical engineer. At another level, Codispoti will focus on internal communications within the organization itself to increase the membership's awareness of the activities being undertaken in its behalf.

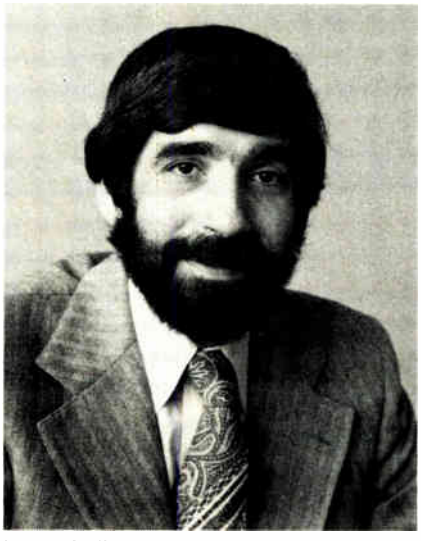


Image builder. Joseph Codispoti has joined IEEE as staff director for public relations in effort to upgrade public's view of EE.

All involved are agreed things will not change overnight. "I see this as a sustained, long-term effort," says IEEE president Jerome Suran. He is particularly concerned about working to influence Congress to pass laws of benefit to IEEE members. He points to laws that would seek to halt wage-busting efforts by certain companies and establish better pension rights for engineers. If the public regards engineers in a more favorable light, such legislation, and other issues as well, may have a better chance of being decided in favor of institute members, he points out.

To reach the public, Codispoti sees a lot more effort being made to inform the general press about IEEE activities, particularly about conferences and testimony before Congress. A lot more technical stories will be sent out to the press, he says. "We also want our conference organizers to concern themselves with the general press," he continues. "We want to have press people meeting with our technical experts who will explain difficult things in ways they can understand. It will help them to report technical events better."

Use experts. Off in the future, both Herz and Codispoti hope that members of both the technical and general press will come to regard the

IEEE as a source of information. "We'll have people on call who can answer questions in a whole range of technical disciplines," says Herz. "That way, the reporter will have the benefit of someone who is technically able." He hopes, too, that Congress will learn to call upon the IEEE for unbiased technical opinions.

As Henry Morgan, president of T-Bar Inc., Wilton, Conn., and chairman of the IEEE's all-volunteer public relations committee, points out, "We have a lot of renowned people in the organization who could provide background and explain the fundamentals. This need have nothing to do with taking a public stand on an issue."

It was Morgan's committee that formulated the plan to enhance the engineer's image. And it was he who brought Ruder & Finn, which also acts as a consultant to T-Bar, to the attention of the executive committee that engaged the firm and agreed to its fee (believed to be about $60,000 from April through the end of the year).

Morgan stresses that Ruder & Finn will not be used to do the work the IEEE staff can do by itself but will do that for which it is uniquely qualified. "They won't do something like set up a press conference," he says. "Rather, they'll tell us whom we ought to invite, or how we might best approach the chairman of a congressional committee."

Fee questioned. However, some do question retaining Ruder & Finn and paying its monthly fee. "I don't understand why they need both a professional like Codispoti and Ruder & Finn," says a former member of the IEEE public relations committee, himself a public relations man. "They could put a little more in Joe Codispoti's budget and get the same things done for a lot less money."

Strong misgivings about the IEEE's new program are held by Irwin Feerst, long-time critic of the IEEE hierarchy. "This looks like a coat of PR paint they're trying to give us, when they should be carrying out positive actions," Feerst says. So disgruntled is Feerst that he filed suit in New York City's small claims court on Oct. 22 for $1.13—"about the portion of my dues to the IEEE going to pay for the program." □

Automotive electronics

Europe races to catch up

Car makers lag behind U. S. counterparts in placing controls under the hood but are feeling the pressure of oil crises

by Kevin Smith, London bureau manager

Though European automotive manufacturers were left at the starting line by U. S. rivals in the race to electronic engine-control systems, they are beginning to make up ground. According to one of Europe's most successful manufacturers, Volkswagenwerk AG, a technology with a distinctly European flavor is emerging.

This opinion was expressed by K. Ehlers in an overview of European automotive electronics at the Second International Conference on Automotive Electronics held at the Institution of Electrical Engineers in London Oct. 29 through Nov. 2. Without the bludgeon of government-legislated emission and fuel-consumption standards, Europeans have been freer on economic and technical grounds to choose at which point new electronic car systems should be introduced.

Consequently, Volkswagen, for one, takes a more cautious view than its U. S. or Japanese counterparts on the rate of growth of automotive electronics. By 1988, Ehlers says, electrical and electronics systems will represent about 15% (7% for electronics) of the car's manufacturing cost, compared with 10% (about 2% for electronics) today, and in absolute terms will mean a market of several billion dollars. By then, he adds, there could be between 5 and 10 microcomputers in a production car. And one of those—to control the car's route-guidance system—may not have its counterpart in an American car, although it has been talked about in the U. S.

Unlike the U. S., Europe has been forced all along—by fuel prices and congested urban centers—to design light, compact cars with small-displacement engines having low fuel-consumption and carbon-monoxide emission figures. But tougher regulations are on the way.

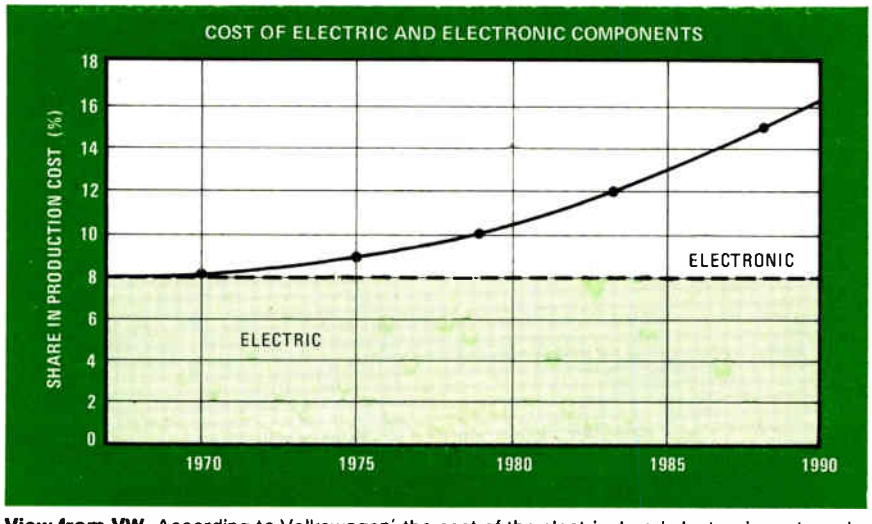
Even without them, successive oil crises are concentrating European automotive design engineers' attention on efficiency. For example, in addition to phased European Economic Community emission-control standards, West Germany is considering the possibility of taxing cars according to their fuel consumption. Also, limits on top speed and obligatory fuel-consumption gages are being considered. Says Ehlers, "Electronic fuel- and air-metering systems will find mass application in Europe during the period from 1982 to 1985 and onwards."

Another difference is the relationship in Europe between the semiconductor suppliers and the car manufacturers. Few car makers have their own electric and electronics divisions. A result is that almost all the major semiconductor manufacturers in Europe have set up automobile engineering departments to develop electronic systems.

Motorola SA in France, for example, worked with Citroën to develop a completely electronic ignition system for its two-cylinder Visa introduced in 1978. The goal of the collaboration remains to develop a similar system for four-cylinder engines that eliminates mechanical breaker points and high-voltage spark distributors.

Freedom from in-house development groups, claims Ehlers, gives manufacturers greater leeway in selecting the right semiconductor technology. Various technologies could be tried initially, he says, and only in the second phase would one be selected. For Ehlers, the choice is complementary-MOS.

However, European semiconductor firms have contributed few



View from VW. According to Volkswagen, the cost of the electrical and electronic systems in cars will be about 15% of the total manufacturing cost by 1988.

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process innovations, but one significant development in nonvolatile memories comes from SGS-ATES (UK), whose polysilicon metal-nitride-oxide-semiconductor technology looks ideal for odometers and other car applications.

Unlike previous technologies that have been tried, says R. C. Ambrose of SGS-ATES, the technology is process-compatible with n-channel MOS technology, provides an access time comparable with that of read-only memories, and a fast erase-and-write time of 100 milliseconds. Thus memory can be integrated on a chip together with logic functions and can be erased and written into by conventional chip voltages.

Display technologies for the new generation of driver information and instrumentation systems will also be of crucial importance to success in the automotive market, says Ehlers. With the automotive market heading for stagnant sales, and as cars look increasingly alike in pursuit of aerodynamic efficiency and fuel savings through weight reduction, "the battle for customers will take place in the car interior with particular attention focused on the instrument panel," he says.

Active displays such as light-emitting diodes are not suitable because they wash out in bright light. Ehler believes the choice, then, is liquid-crystal and electrocolloid technologies. But opinions expressed in several papers at the conference were sharply divided. Smiths Industries Ltd., for example, figures that dc electroluminescent displays are bright enough. It aims to introduce its first product using the technology next year [*Electronics*, Sept. 27, p. 75].

Sensors around the world. Though the impetus for the proliferation of electronic engine control has come from the U. S. and has been fueled by developments in microcomputer technology there, sensor development is in a state of rapid change worldwide, according to William G. Wolber of Bendix Corp.'s research laboratories in Southfield, Mich. Wolber singled out the development of the hot-wire anemometer used to measure air flow in fuel-metering schemes.

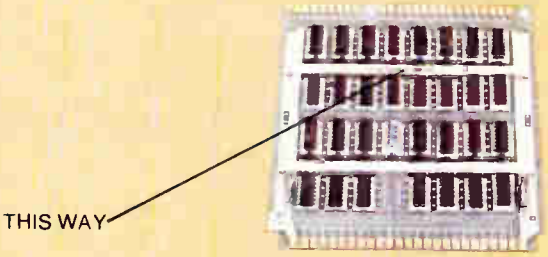
Conference papers confirmed his assessment by describing a flurry of new sensor and transducer systems. One of the most striking was an ultrasonic fuel injector from Plessey Automotive Products Ltd. in Ilford, England. The system has been under development for 12 years, according to Plessey's Bill Martin. In its present form it would cost less than half the price of a conventional electromagnetic valve system, though more engineering still has to be done. The design is based on a ball valve that, under ultrasonic vibration, allows the passage of accurately metered atomized fuel. Martin maintains that most other efforts to produce an alternative, and less expensive, version of electromagnetic fuel-injection systems have thus far been accompanied by a deterioration in performance.

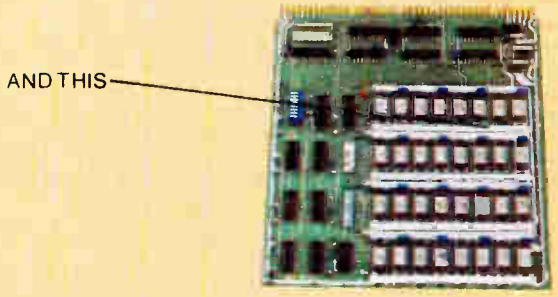
An alternative approach from Philips Research Laboratories in Redhill, Surrey, England, replaces the electromagnetic solenoid actuator with a piezoelectric rod fabricated from piezoceramic disks. It offers a 100-microsecond response time and a high degree of mechanical stiffness.

Multiplexing schemes. Several papers pointed to the technical feasibility of vehicle multiplexing sysems. One of the most advanced is the Salplex system developed by England's Ward & Goldstone Ltd. in collaboration with the University of Salford. The system contains a coaxial cable linking several transmitter-receiver units, each capable of switching local loads and sending and receiving multiplexed data. The outer conductor carries the power, the inner conductor the signals. The system has been operating for a year in a test car without any failures.

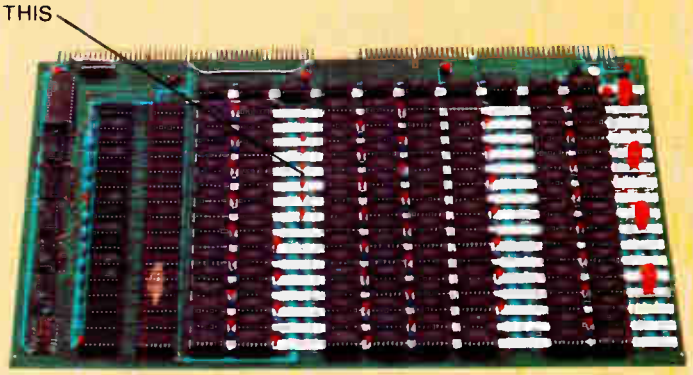
It remains to be seen whether European car manufacturers will be perpetually struggling to catch up with their U. S. counterparts, as in the semiconductor or computer industries, or whether they can develop a brand of technology that is distinctly their own, as in the television field. On the evidence of this year's conference, the leading car exporters will not fail through lack of effort. □

How the smart companies





distribute power



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Testing

How are bubble memories to be tested?

Makers of devices and testers get together to find the answers at the first such session to be held at the Annual Test Conference

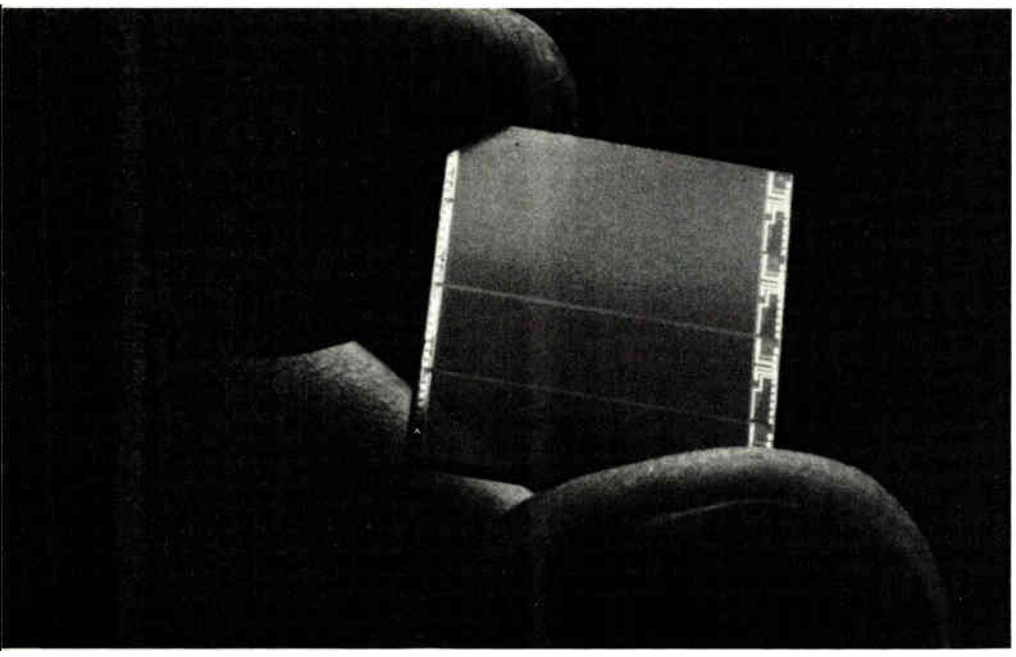
by Richard W. Comerford, Test, Measurement & Control Editor

Now that magnetic-bubble memories are emerging for commercial use, the creators of both chips and testers are working to smooth the road to new products. At last month's Annual Test Conference held at Cherry Hill, N. J., the first formal session on testing such memories was held in a direct effort to expose the accumulated knowledge of those with the most device experience: the manufacturers and test system designers. What experience has taught them is that although the means to ensure bubble device reliability is different from that for semiconductor devices, it can be accomplished without a lessening of yield. Further, the technology has defined what is needed in test systems to keep pace with bubble innovations.

"The fact that you can mask loops to improve reliability without decreasing yield is very important," says David Cheng of Intel Magnetics Inc., Santa Clara, Calif., developer of the first 1-megabit bubble memory. The fact that block replicate and major-and-minor-loop devices are made with redundant loops gives the manufacturers this capability, he points out. "They can not only eliminate propagation loops that have outright defects, but also find weak loops, which may pass tests initially but do not have as good a longevity as the others," Cheng explains.

The way to find such loops is to test the packaged chip with the maximum and minimum drive fields and temperatures specified and to inspect individual loops. Within the loop is a worst-case pattern of bubbles whose rotation is stopped and started so that the effect on it of nearby bubbles can be observed. Although start and stop testing does make it easier to find weak loops, in one instance increasing the error rate to 1 in 10^4 from 1 in 10^8, Cheng admits that it drags out production test time. But both he and Farooq Quadri, chairman of the session and product engineering manager for National Semiconductor Corp.'s magnetic-bubble memory group also in Santa Clara, stress that it is now particularly important that manufacturers provide users with extremely reliable devices. So the extra test time represents an investment in the device's future.

Test objective. Based on their experience with semiconductor memories, makers of bubble memories and of test systems are talking about test techniques. Shown is Intel's 1-Mb device.



The question of pattern sensitivity, a sore point for semiconductor memory, has a different significance for the magnetic devices. "I think the overall problem is easier to condense because of the localized nature of pattern sensitivity," Cheng states. He notes that semiconductor memories are matrix devices, so that what happens on one line of interconnected cells can conceivably affect other points in the matrix. Magnetic bubbles, on the other hand, affect only three or four sites in their vicinity. "Thus, at any given moment, the effect is localized to a group of sites in the neighborhood of the bubble," says Cheng. This localization applies to both propagation loops and the read gates and write gates.

Quadri cautions that design rules for the magnetic-bubble memory are not established, as they are for random-access memories. "In the

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magnetic-bubble memory field, everybody has a little bit of innovation. Any change you make in the input or output gates can change the pattern sensitivities of those gates."

To Phil Burlison, product marketing manager of bubble test systems for Fairchild Camera and Instrument Corp.'s Xincom Systems division, Chatsworth, Calif., this points to one aspect of the way testers must go. "It simply says that you have to have an easy way of generating and programming an arbitrary pattern and changing it interactively," he says. What complicates this, he adds, is that the results of parameter variation do not appear until much later and that the pattern in which data is written is not directly related to the pattern in which it is stored. The result, he says, is a tremendous emphasis on flexibility in structuring the programming.

Approaches vary. There are some differences in the way the tester manufacturers have gone about providing this flexibility, notes Steve Bisset, president of Megatest Corp., Sunnyvale, Calif. Having gained much experience in microprocessor testing, his company designed its tester with a parallel structure that Bisset says "takes into account the whole concept." The pattern processor allows the user to program a model of the architecture of any device into it. "The model is such that you can keep track of the status of all the internal locations in parallel during each field rotation cycle, rather than trying to unwind all the test sequences," Bisset says.

The approach taken by Xincom in its tester architecture is more serial in nature. With its background in testing memories at high speed, Burlison explains, the company found that "even at data rates of 1 megahertz, you still have one whole microsecond, which is years compared to semiconductor testing." So the approach taken was to design a pattern generator that, rather than perform one instruction per data cycle, had much more computing power so that it could do preprocessing of information before spitting it back to the controller. □

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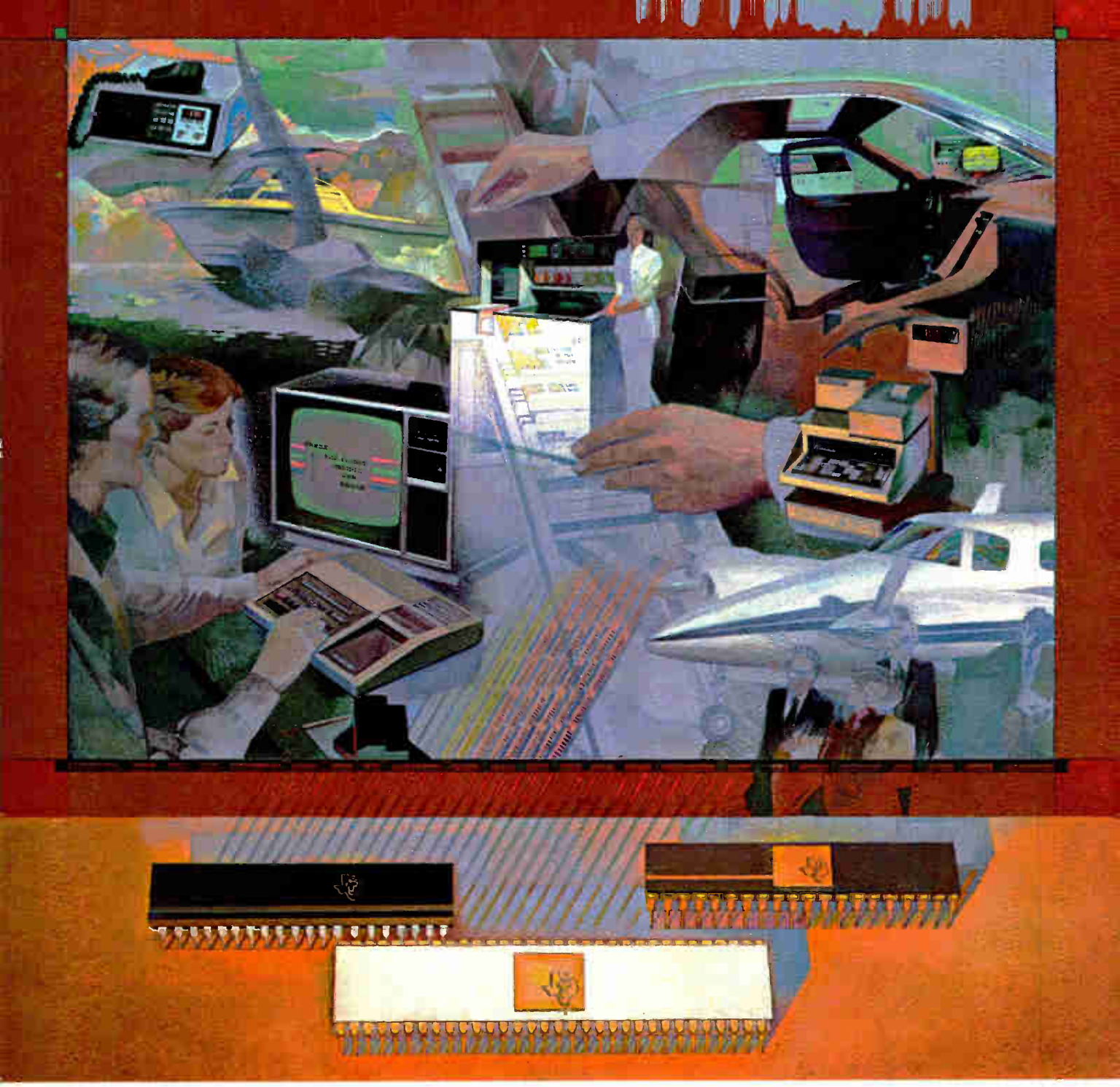

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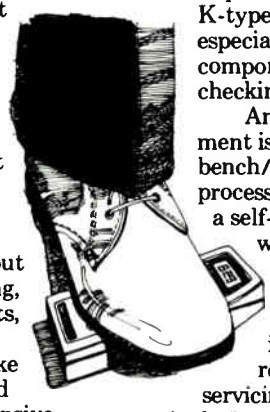
When you're looking for genuine value in a low-cost DMM you have a lot more to consider than price. You need information about ruggedness, reliability and ease of operation. Accuracy is important. And so are special measurement capabilities. But above all, you must consider the source, and that company's reputation for service and support.

Fact is, as electronics become more a part of our daily lives, dozens of new manufacturers are rushing to market their "new" DMM's. In theory, this is healthy; but in practice, crowding is confusion.

To help you deal with this flood of new products, here are some facts you should know about low-cost DMM's.

The economics of endurance.

Even the least expensive DMM isn't disposable. Accidents happen, and test instruments should be built to take the abuses of life as we live it.



Look for a DMM with a low parts count for reliability, and rugged internal construction protected by a high-impact shell. Make sure the unit meets severe military tests for shock and vibration.

Another feature to check out is protection against overloading, whether from unexpected inputs, transients, or human errors.

Just for the record, all Fluke low-cost DMM's meet or exceed military specs, and feature extensive overload protection.

The importance of being honest.

Just because a multimeter is digital doesn't mean it's automatically more *accurate* than a VOM – even though the LCD might give you that impression. The benchmark for accuracy in DMM's is *basic dc accuracy.* The specs will list it as a percentage of the reading for various dc voltage ranges.

Of course accuracy is more critical in some applications than others, and increasing precision and resolution in a DMM usually means increasing price. In the Fluke line, you can choose a model with a basic accuracy of 0.25% (the 8022A), others rated at 0.1%, or the new 8050A bench/portable at 0.03%.

Special measurements: getting more from your DMM.

Actually, for all the variations in size, shape and semantics, most DMM's perform five basic measurements: ac and dc voltage and current, and resistance. Prices vary according to the number of ranges and functions a DMM delivers.

	PRODUCT	FUNCTIONS	RANGES	DIGITS	BASIC DC ACCURACY	CONDUCTANCE	OTHER SPECIAL FEATURES	PRICE
HANDHELD MODELS	8022A	6	24	3½	0.25%		Basic six-function DMM; lowest-priced	$129
	8020A	7	26	3½	0.1%	X	High accuracy ; pioneer in conductance; exclusive two year warranty.	$169
	8024A	9	26	3½	0.1%	X	Direct temperature readings; continuity/ input level detector with selectable audible signal; peak hold capability.	Available soon
BENCH/PORTABLES	8010A	7	31	3½	0.1%	X	True RMS; extra 10A range.	$239
	8012A	7	31	3½	0.1%	X	True RMS; two extra low resistance ranges.	$299
	8050A	9	39	4½	0.03%	X	True RMS; selectable reference impedances with direct readouts in dBm; offset feature.	$329

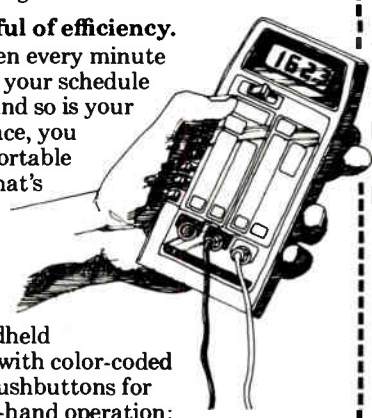
The Fluke line includes DMM's with from 24 to 39 ranges, 3½ and 4½-digit resolution, and some unique functions you won't find in any other DMM. Additional measurement capabilities like temperature, dB, conductance and circuit level detection.

If your work involves temperature measurements, the new 8024A delivers direct temperature readings via any K-type thermocouple. This is especially useful in testing component heat rise and checking refrigeration systems.

Another talented instrument is our new 8050A bench/portable. The microprocessor-based 8050A features a self-calculating dB mode in which dBm readings are displayed automatically referenced to one of 16 selectable impedance ranges – a real timesaver when servicing audio equipment.

And of course no discussion of DMM's is complete without considering conductance – a Fluke exclusive featured on five of our low-cost DMM's – which allows you to make accurate resistance measurements to 100,000 Megohms. You can't do that with any ordinary multimeter, but it's a must for checking leakage in capacitors and measuring transistor gain.

A handful of efficiency.



When every minute matters, your schedule is tight and so is your work space, you need a portable DMM that's fast and easy to operate. We designed our handheld DMM's with color-coded in-line pushbuttons for true one-hand operation: no need to hang onto the meter with one hand while twisting a rotary dial with the other.

But there's more to convenience than fingertip control. The 8024A, for example, is also designed to function as an instant continuity tester, with a selectable audio tone to indicate shorts or opens. It also has a peak hold feature to capture transients.

A word about warranties.

Last but not least, look closely at the company that manufactures a low-cost DMM. Their service is just as important as their product. Look for no-nonsense warranties, a large family of accessories, an established network of service centers and technical experts you can rely on.

That's how you'll recognize a knowledgeable supplier of low-cost DMM's, a company with experience, resources and a commitment to leadership in the industry.

Incidentally, you'll find it all at Fluke.

Look for more facts from Fluke in future issues of this publication. Or call toll free **800-426-0361**; use the coupon below; or contact your Fluke stocking distributor, sales office or representative.

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EL 11/79

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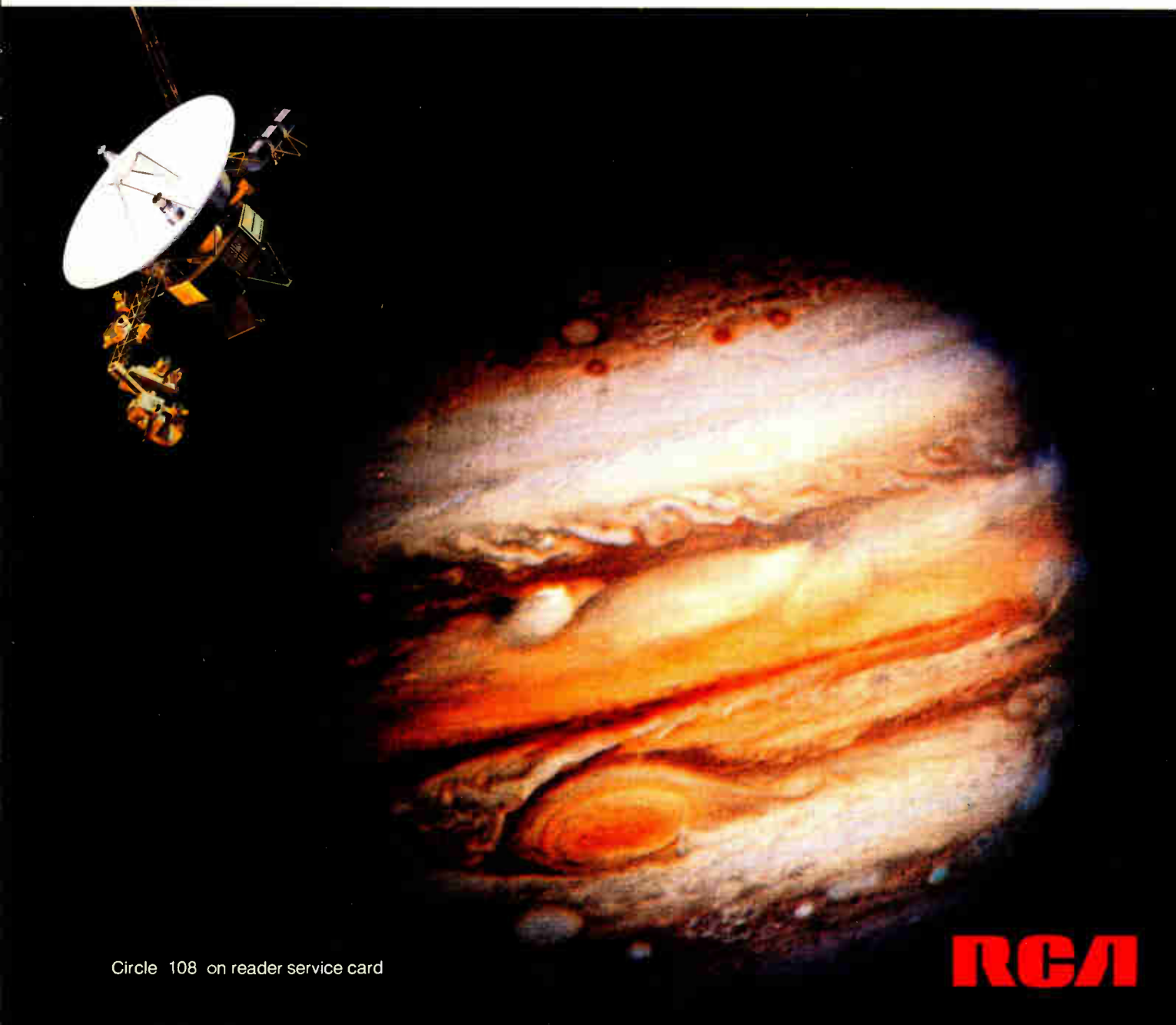
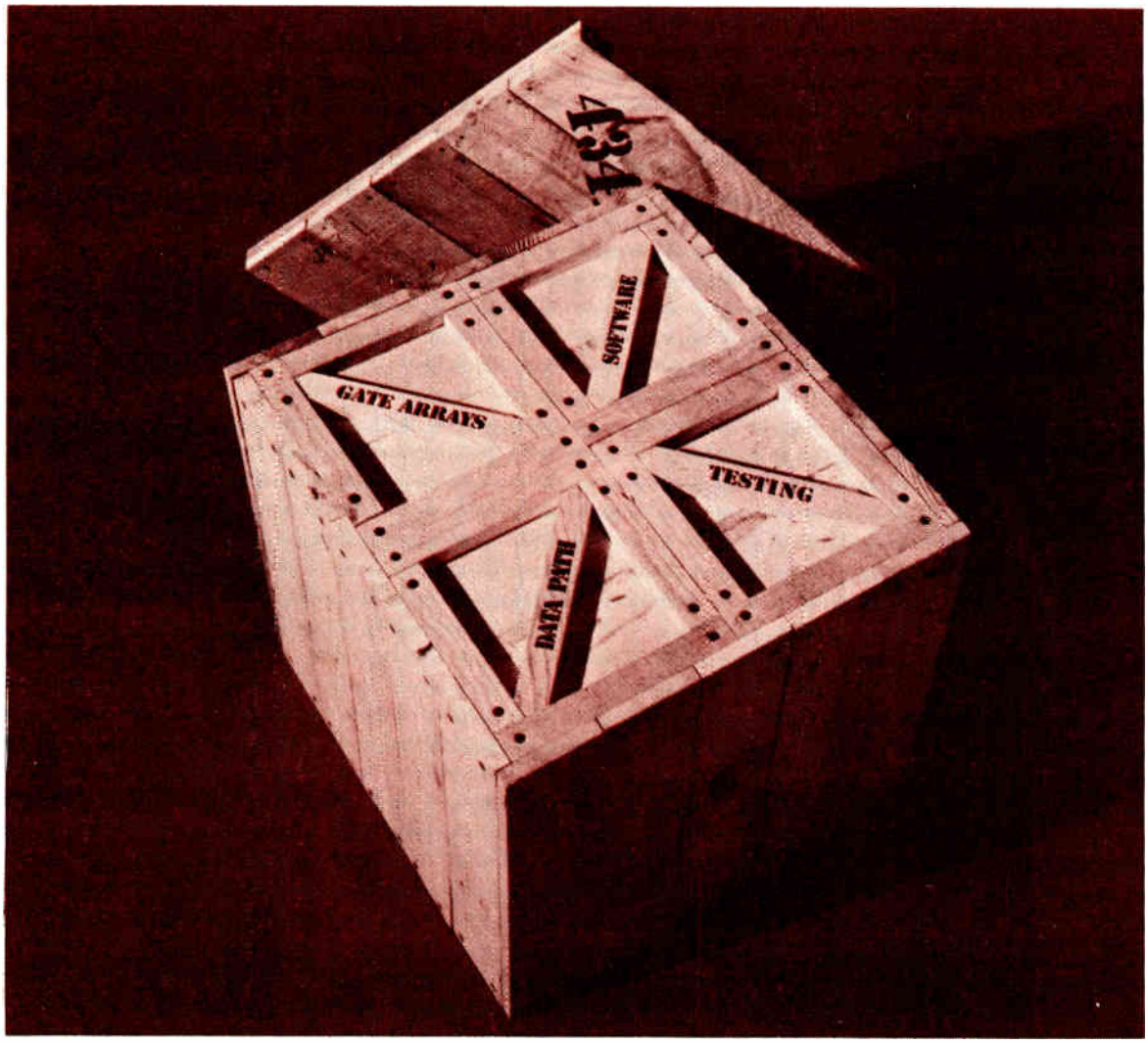


Circle 108 on reader service card

RCA

Putting together the new IBM mainframe



Error-catching latches and fast virtual memory give the 4300 a big edge over the System/370 while retaining compatibility

☐ *When International Business Machines Corp. introduced its 4300 computers in January, it upgraded its mainframe computer line with the first new designs and technology it had developed since the System/370 almost nine years ago. Long discussed in industry circles as the E-Series, the new computers established a surprising new level of price and performance by which the rest of the industry will measure itself. IBM also set new standards for functionality, reliability, and maintainability. At the same time it assured both its customers and its competitors that it will continue to support the computer architecture introduced in the System/360 back in 1964. The System/370 uses almost the identical architecture, and the 4300s make only slight modifications.*

This set of articles provides a view of the unique hardware and software design of the 4300s and includes some just-released photographs of the 4341 processor. In particular, they discuss the hardware design of the 4341, the larger of the two machines that IBM began delivering late last month, its new maintenance concepts, and its new architectural concepts.

-Anthony Durniak

4341's infrastructure is new from the substrate up

by Humberto Cordero, Jr.
IBM Corp., System Products Division, Endicott, N. Y.

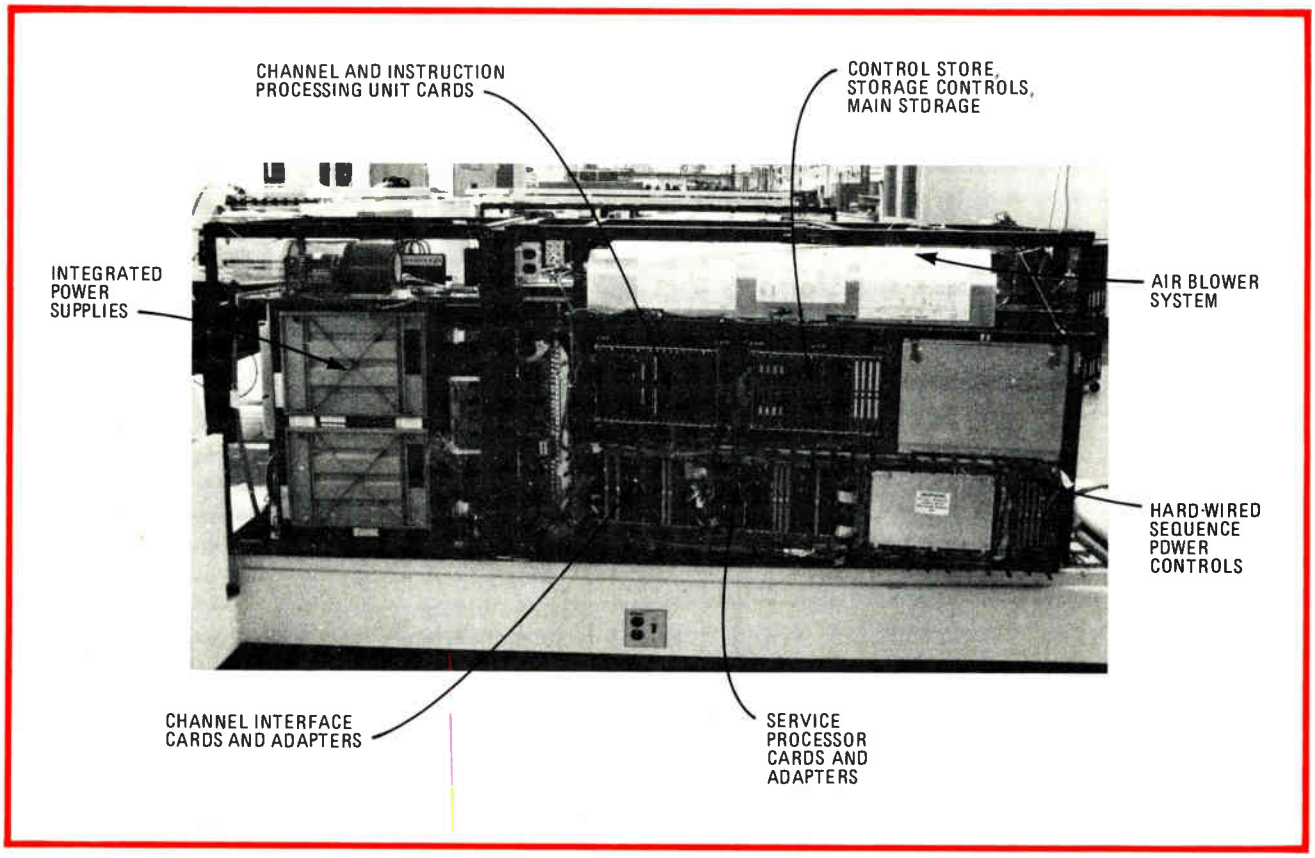
The design objectives considered by IBM Corp. during the development of the 4300 processors were similar to those of many other computer manufacturers: to provide customers with growth opportunities for their current computers, with an improved price/performance ratio, and with higher reliability. IBM achieved just these goals with a highly innovative design based on unique high-density semiconductor technology that it dovetailed with improved microcode control, advanced data flow and buffering techniques, and an entirely new maintenance approach.

The larger of the two new intermediate-performance mainframe computers, the model 4341, is a good illustration of the new design. Available with 2 or 4 megabytes of main memory, the 4341 offers four times the memory capacity and 3.2 times the performance of the older System/370 model 138 it replaces—and all for a lower price. Logic and storage densities are so increased with a master-slice logic chip and 64-K memory chips that the entire 4341, with its full complement of memory and six input/output channels, is contained on just 35 circuit cards. Furthermore, IBM is able to fit this entire computer, with its channels, power supplies, system diskette drive, and separate maintenance and support processor into a compact cabinet that measures only 60 inches long, 29 in. wide and 38 in. high (Fig. 1). The older model 138 was not only about twice as large, but also required a separate power supply cabinet. The new 4341 also needs only half the electrical power and cooling required by the 138.

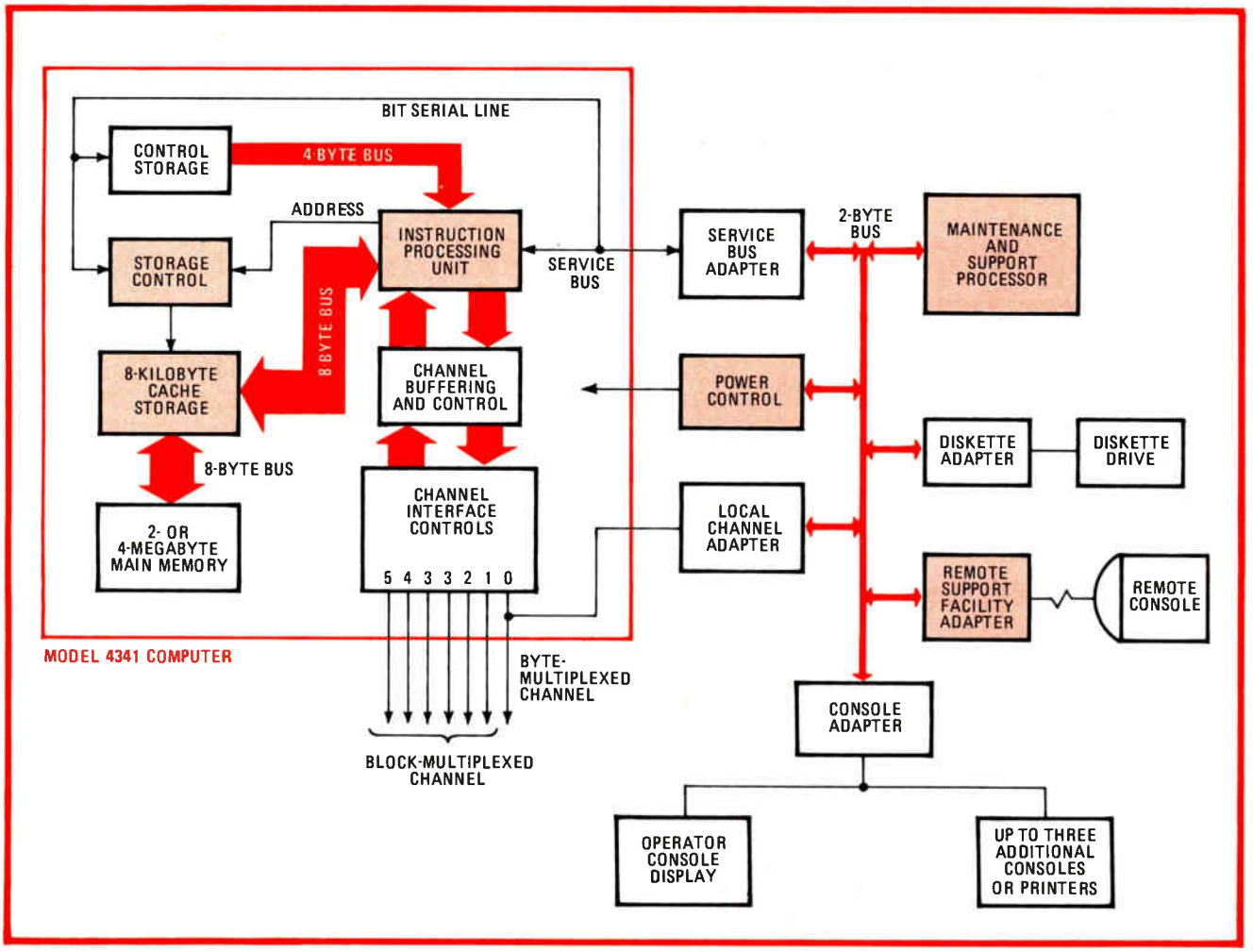
Speed above all

More important even than reducing the size, electrical power consumption, and heat dissipation of the computer, the new semiconductor technology adds to speed by facilitating a new and expanded hardware organization (Fig. 2). Central to this new organization is an 8-byte-wide bidirectional data bus that replaces the unidirectional 4-byte-wide buses used in previous intermediate-scale IBM mainframes. Also new to this class of machine is a cache memory—an 8-K-byte cache is standard on the 4341. Especially innovative is the fact that IBM placed two additional 8-bit buffers directly on each 64-K memory chip. To control this cache and the enlarged main memory, the storage controller was made more sophisticated through the addition of the directory look-aside table and cache directory.

A fifth block multiplexer input/output channel not available before can be attached to the 4341. The full complement of five block-multiplexer and one byte-multiplexer channels have an aggregate data transfer



1. Petite package. This photograph of the model 4341's interior (the first released by IBM) shows how the entire computer with its full complement of 4 megabytes of memory, six channels, and power supplies fits into a cabinet measuring 60 by 29 by 38 inches.



2. Wide. Most noticeable in the new 4341's hardware configuration is the use of 8-byte-wide data paths, instead of the 4 bytes used before, and the additions of a cache memory, extra channel, more main memory, more powerful support processor, and separate power controller.

rate of 10 megabytes per second, some 3.5 times that of the model 138. Furthermore, the channels were designed to have more circuitry in common than previously.

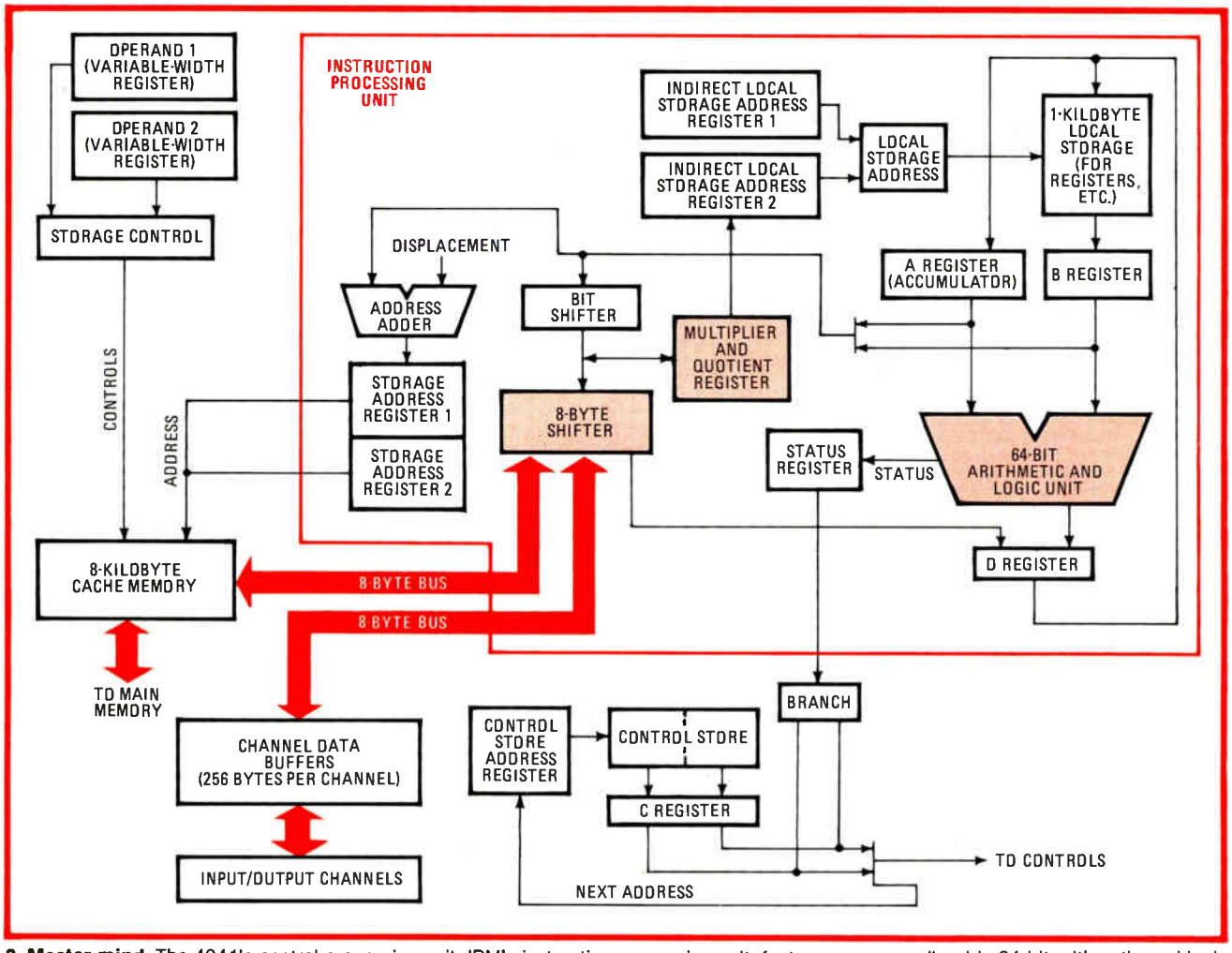
A new power controller, not used before, not only controls the distribution of electricity to the various circuit cards in the system, but on command of the maintenance and support processor can vary those voltages to aid the diagnostic process. The separate microprocessor-based support processor is also more powerful than its predecessors, primarily because of a new semiconductor design that makes previously inaccessible circuits available for testing.

As the second of this series of articles explains, this support processor also has the ability to log for later analysis both the condition of the central processing unit and environmental factors such as input voltages and temperatures. Instead of just the serial data link with the central processor used previously, the 4341's support processor has a high-speed parallel link through the local channel adapter. And because of the new remote support facility, a service technician can diagnose the machine from a remote site over telephone lines.

Last, but not least, the central processing unit, or instruction processing unit, has been improved both through the use of 8-byte-wide data paths and through the addition of an 8-byte shifter. The new storage controller hardware automatically performs the virtual address translation needed by the virtual memory system and performed by software in earlier models. A new console adapter lets more consoles be connected to the system than before and gives each of them more control over the system.

Because of the wider data paths, decimal and floating-point arithmetic operations are now handled 8 bytes at a time instead of 1 or 2 at a time. Besides performing faster in business applications, the enhanced CPU also does scientific calculations more rapidly—as much as four times quicker than the System/370 model 148 computer in such applications. Because the time-consuming memory accesses can be performed in advance and the results stored in either the unique on-chip buffers or the 8-kilobyte cache, the system overhead during storage operations is reduced and the response time of memory is improved. In addition to being faster, the new channels with their common hardware offer greater configuration flexibility.

Another achievement of the new hardware is the improved reliability and serviceability of the computer. Intermittent problems that either went undetected or plagued a system but could not be found are now



3. Master mind. The 4341's central processing unit, IBM's instruction processing unit, features an unusually wide 64-bit arithmetic and logic unit, 8-byte wide accumulator, and special multiplier and quotient register. An 8-byte shifter adds to the unit's power and flexibility.

captured as they occur, to be traced by the more sophisticated diagnostic microcode in the separate support processor.

The model 4341 makes more extensive use of microcode control than previous intermediate-scale IBM processors. In addition to controlling both the execution of software instructions by the CPU and the operations of the channels and main memory, a portion of this control microcode is dedicated solely to controlling the maintenance and support processor and performing the error-logging and diagnostic functions.

How microcode helps

An advantage inherent in such reliance on microcode control is architectural flexibility. The current architecture—that is, the instruction set and operational characteristics as seen by the programmer—can remain the same while new instructions and architectural features that take advantage of the improved hardware can be added. The 4341 processor can operate in one of two architectural modes: one identical to that of earlier System/370 computers, and a new mode that simplifies and improves on that popular architecture, but remains basically compatible.

The computer can operate in only one mode at a time which is selected at the time the machine is turned on and the control microcode is loaded. Once a mode is picked, it cannot be changed by the operating system, only by starting the machine over.

The first of these modes, the IBM System/370–compatible mode, has Extended Control Program Support for the Virtual Machine or Virtual Storage operating systems. This program support for VM/370 is similar to ECPS:VM/370 offered previously on the model 138 and 148. The only functional difference between these program supports is the inclusion of new fixed block input/output devices. This software support can reduce the portion of the computer's time spent on supervisory software tasks by as much as 84%.

The Extended Control Program Support for VS/1 on the 4341 is similar to the same feature on the large-scale System/370 model 158, except for the addition of the Page Measurement instruction (which is on the models 138 and 148) and a new instruction called Set Direct Translate Limit. This software can reduce CPU busy time by up to 14%.

These improvements in this software's performance are primarily due to the speedy hardware execution of certain control program functions, such as first-level interrupt handlers and dispatching. When they are

carried out in software, more slowly, these functions require large percentages of the system's execution time.

The second architectural mode, called the Extended Control Program Support:Virtual Storage Extended (ECPS:VSE) is unique to the 4300 series processors. It is tailored to speed the execution of the new Disk Operating System/VSE and support its new features—primarily its new memory management scheme.

As described in the third of this set of articles, ECPS:VSE architecture substitutes a new single-level address translation scheme for the more complex two-level technique used on the System/370. This single-level memory uses a uniform set of virtual addresses in both the CPU and the input/output channels where the System/370 uses indirect addressing to reference the channels. Since the channels' virtual addresses no longer have to be translated separately, the operating system software can run faster. In fact, ECPS:VSE will yield up to a total reduction of 13% in the CPU busy time, making more machine execution time available.

A versatile processing unit

The heart of the hardware controlled by this microcode is the central processing unit, or instruction processing unit (Fig. 3). Operating with a cycle time of 150 to 300 nanoseconds, the model 4341's CPU is as much as five times faster than the model 138's CPU (which has a cycle time of 275 to 1,485 ns). The chief difference in its design, when compared with earlier intermediate-scale processors, is that its data paths are all 8 bytes wide.

The arithmetic and logic unit (ALU) is an unusually wide 64 bits—it accepts 8-byte inputs from the A and B registers and generates an 8-byte output. The main advantage of this 8-byte data flow through the ALU is that the unit can handle an entire 64-bit floating-point register at one time for faster scientific calculations. The ALU can, however, operate on smaller, variable-width data. It will perform binary and decimal operations equally well, with any invalid decimal format result being detected. Automatic decimal sign handling is done by hardware by means of operand sign testing and dynamic selection of the required ALU function. In addition, the ALU can perform floating-point or logical arithmetic and automatically set condition codes.

Inclusion of an 8-byte accumulator (the A register) with an 8-byte extension (the multiplier and quotient register) allows the implementation of a hardware-supported algorithm for multiplication and division instructions. This is because the accumulator plus its extension provides a 16-byte register that can be used to retain an entire product from a multiplication or a quotient with remainder from a division operation.

Another significant part of the instruction processor's design is the 8-byte shifter that controls access to and from the system main storage and channels. Unusually powerful for this class of machine, the shifter has logic features that allow a full 64-bit shift range as well as extended shift, the automatic alignment of storage data or op codes, sign propagation, and data formatting through operations such as wrap, padding, and decimal pack and unpack.

The model 4341's main storage, in addition to being larger (up to 4 megabytes), has been redesigned to improve its performance. To begin with, the use of the high-density 64-K chip semiconductors in the 4341 processor increases storage packaging density to 72 chips, or 512 kilobytes, per card where previous models had only 64 kilobytes per card. But more importantly, this chip is unique in that it contains two 8-bit data buffers to hold the transient data output of the chip's field-effect-transistor storage array. Up to 32 selected bytes of data may be buffered on each card for movement in 8-byte blocks to other areas of the system via the 8-byte-wide data path. This buffering eliminates the need for multiple memory accesses to obtain large quantities of data.

Cache storage

In addition to these on-chip buffers, improved storage operation is provided by making 8-kilobytes of cache storage immediately available for the processor's use.

To manage these new buffers, the storage controller has been improved to decrease the processor and channel overhead due to the time-consuming storage operation (Fig. 4). The most important of these is the directory look-aside table (DLAT) that is available for both processor and channel storage accesses. This contains pretranslated virtual addresses and is interrogated during storage read-and-write operations to see if the desired virtual address has already been translated into a real address. This can alleviate the burden of translating a virtual address for each access. Control of the DLAT has been designed to ensure that the probability of finding the required address in the DLAT is quite high, thereby improving system operation by reducing address translation overhead.

To control addressing of the cache, a cache directory, whose operation is similar to that of the DLAT, is used. Once a storage address has been obtained by a translation operation, the cache directory is checked to see if the data is immediately available from the cache. If not (a situation called a cache miss), the storage control hardware loads the required data into the cache.

The cache directory control has also been designed to provide a high hit ratio—that is, a high probability that the required data is in the cache. This further reduces system overhead due to storage accesses.

Other improvements designed to increase system throughput include the addition of special storage read-and-write instructions that let the channels move data directly to and from main storage without first placing the data in the cache. During these channel data transfers, the instruction processing may continue.

Finally, a new 64-byte swap buffer temporarily holds data being moved to main storage from the cache or the channels. This permits the processor to use the cache during the time that data is being written into the main storage buffer from the swap buffer, further speeding its operation.

The common hardware design of the input/output channels of the new processor allows increased flexibility in configuring the channels. Six channels are available. Channel 0 operates only in a byte-multiplexer mode,

while channels 1 through 5 can operate in either block-multiplexer or -selector mode.

The mode of operation for channels 1 through 5 depends on the type of devices connected to each channel. This information is contained in a channel directory, which is modified from the system console and is used by the control microcode to set up channel Unit Control Words (UCWs). The channels are serviced by the channel control hardware in a predefined rotational cycle.

Servicing the channels

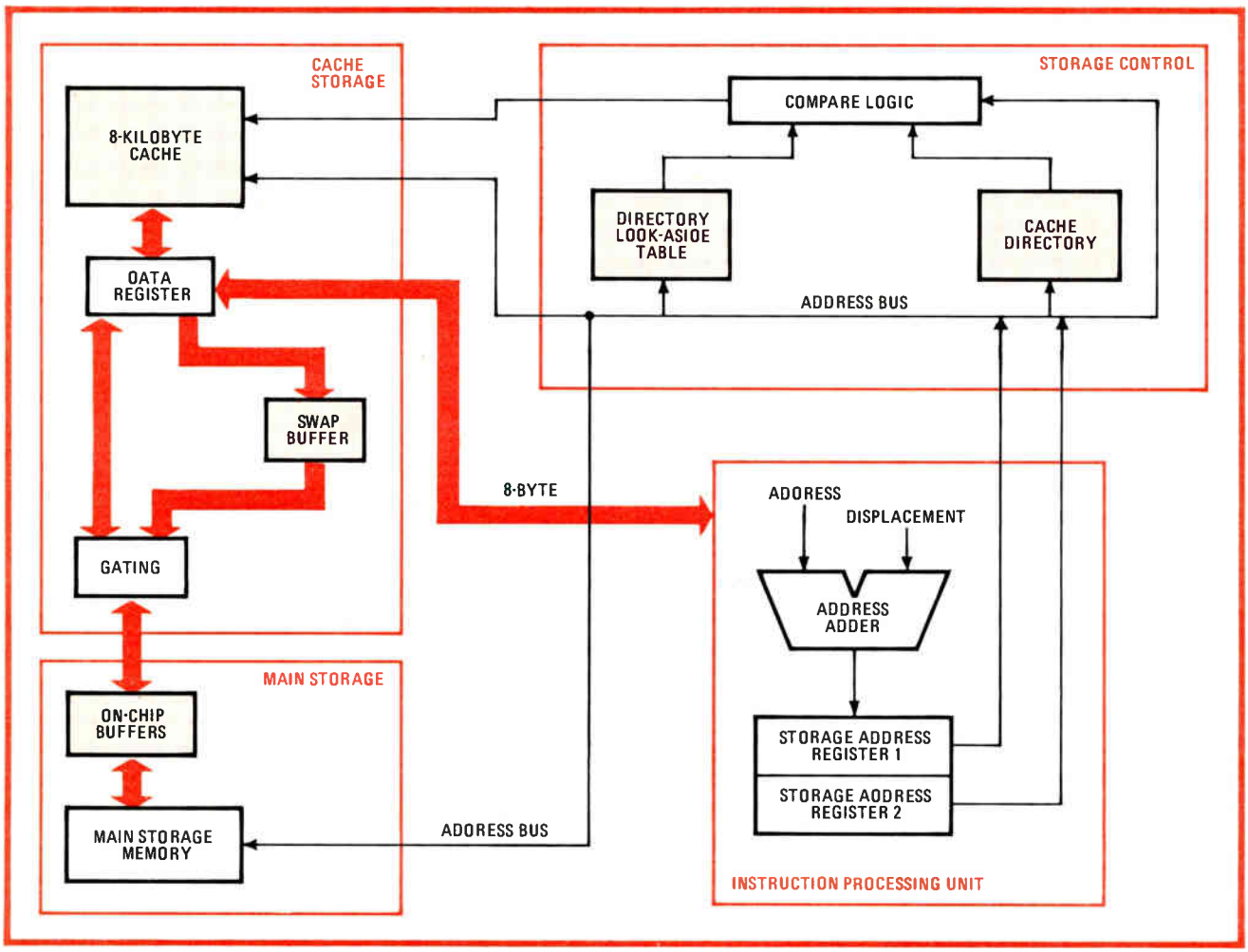
The order is set with channels 1 through 4 permitted two services per cycle and the remaining channels receiving only one processor service per cycle. The extent of the service allotted to each channel essentially predefines the maximum operating data rate. Nominal maximum channel date transfer rates are 1 megabyte per second for channel 5, 2 megabytes per second for channels 1 through 4. The byte-multiplexing rate of channel zero depends upon both the connected devices and the number of block-multiplexed channels that are active. The maximum rate for single-byte transfers is 8 kilobytes per second with no active block-multiplexed channels and 2 kilobytes/s, if all five block-multiplexed channels are active.

Providing access to and control over the entire 4341 computer is the operator's console. As with the rest of the system, the console features several improvements over System/370 models 115 through 148. Most obvious is the fact that up to four of the latest model 3278 cathode-ray-tube terminals can be connected as consoles to the 4341—previous systems had only one. This allows the operator, the system programmer, and the service engineer each to have a separate console.

For the operator there are more fixed-function keys to make life easier than were available on the previous machines. These keys handle functions like: insert characters; delete characters; scroll a display of storage ahead or backwards; and change the screen back and forth between system mode and operator mode without losing either display.

The system can be operated from any one of the four consoles. The various manual controls are now selected from these consoles, not the front panel of the machine as on the models 138 and 148. It is important, however, to show the status of these controls on the display. For example, the operator can always determine by a glance at the CRT the status of the address match controls regardless of the console used to operate the system.

Previous consoles required the entire screen contents



4. Hierarchy. A hierarchy of on-chip and cache buffers improves memory access, and the directory look aside table and cache directory eliminate redundant address translation. The swap buffer returns data to main memory while the cache is also in use.

to be redisplayed for any character change. However, with the model 3278 display, only one character at a time need be changed on the display. This also eliminates flicker.

Because the operator, system programmer, or service engineer can be at any of the four consoles, or at a remote site through a remote support facility, it is important to reflect the system-wait state not only through an indicator light on the Operator Control Panel at the primary console, but also on the display in the system status area (the last line of the screen).

Two extremely powerful additions have been made to the Address Compare function of the console that help the operator to manually control the computer and to debug software problems. The first of these is an instruction-trace command that traces all instructions that cause a reference to a given main-storage address. A data-compare command results in a match stop, which occurs when the data at the given address matches the given data; this power is increased by commands that yield matches on the not-equal case, on bit-level comparison, or on given characters (including "don't care" characters). These two functions can also be combined—so a request can be made for a data-compare trace.

Nearly all the functions can be selected by reading a displayed menu and entering the indicated character. This greatly reduces the time normally needed to look for the functions in a separate reference manual.

It is possible to display storage contents not only in hexadecimal notation but in Extended Binary-Coded Decimal Interchange Code, as well. This feature makes certain textual information more readily identifiable.

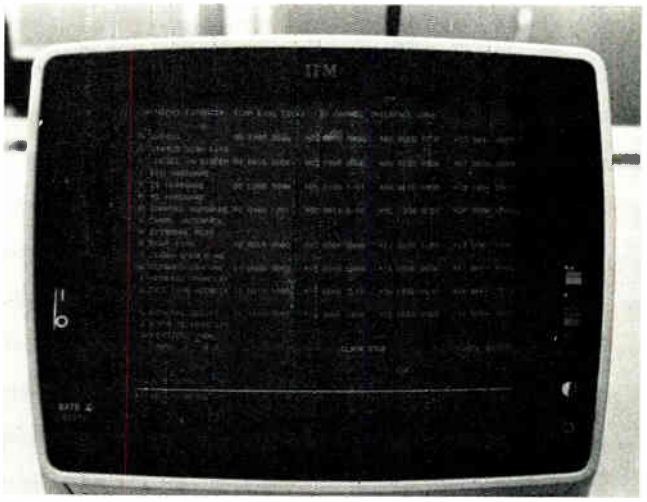
Among the other features of the 4341 console, which are unique when compared to previous IBM processors, are several that are specially intended for maintenance and service. For instance, the maintenance display formats have been tailored to reflect the new LSI chip technology (Fig. 5). The displays show individual strings of latches, called scan rings, that help the support processor to detect errors. Once an error is detected, specialized displays have been formatted to help in the analysis of a problem in a given area of the machine, such as storage.

To coordinate all of these new and old functions, a very powerful block function is included to permit all of the console commands to be entered into a file on the diskette and called out at a later time. This function is particularly useful to IBM in applying temporary or trial microde fixes, in repeating several tedious commands, and in setting up monitoring tasks where specific information is recorded only if a given event occurs.

Many maintenance features

The on-chip diagnostic features of the new logic semiconductors, coupled with Level-Sensitive Scan Design and a separate microprocessor-based maintenance processor, give the 4341 processsor a greater degree of control over error conditions than prior IBM systems had.

The separate maintenance processor performs self-diagnosis and assists in locating faults that cause both continuous and intermittent errors. The maintenance processor also monitors such environmental factors as input voltage and temperature both inside and outside the processor mainframe, controls automatic retry of failing instructions, and creates error logs to be stored for use by error-analysis microcode. These will be discussed in the following article.



5. Show and tell. By displaying the contents of the scan rings (in this case in a channel interface) on the system console the 4341 helps the service engineer locate problems in the machine. Other new console features assist the operator.

In addition, the microcode for the support subsystem measures and displays logic input voltages. Power faults are identified by monitoring special points in the system every 500 milliseconds and comparing the monitored values with stored fault criteria. Digital and analog sensors help monitor the condition of circuit breakers, circuit protectors, over- and under-voltage conditions, thermal switches, and other information such as voltage and thermistor resistance values. Analog voltages are converted into appropriate digital values in the power adapter circuitry.

Other modules of the control microcode are designed to support the Level-Sensitive Scan Design operation used in the processing unit. Upon detection of an error, the maintenance processor interrogates the status of the Central Electronic Complex, consisting of the processing unit, storage, and channels, via a special support bus. Pertinent error information is loaded into the support processor, analyzed, and stored for future use by the error-handling routines or maintenance personnel.

The new Remote Support Facility (RSF) developed for use with the 4300 provides an added level of system maintenance support via the telephone network. The RSF is implemented using the support processor connected through an adapter and modem to the telephone network. To secure the computer's data and programs, RSF service can be initiated from the customer's location only when the system is in the maintenance mode. Once connected, the RSF permits the remote facility to have full console capability (except power control), but it also gives the local service personnel access to a data bank containing the latest maintenance information.

The author thanks the following for their contributions to this article: W. Campbell, D. G. Cate, T. I Foster, J. T. Moyer, J. W. Rossier, E. M. Shimp, L. K. Terry, and F. A. Zurla.

Support processor analyzes errors caught by latches

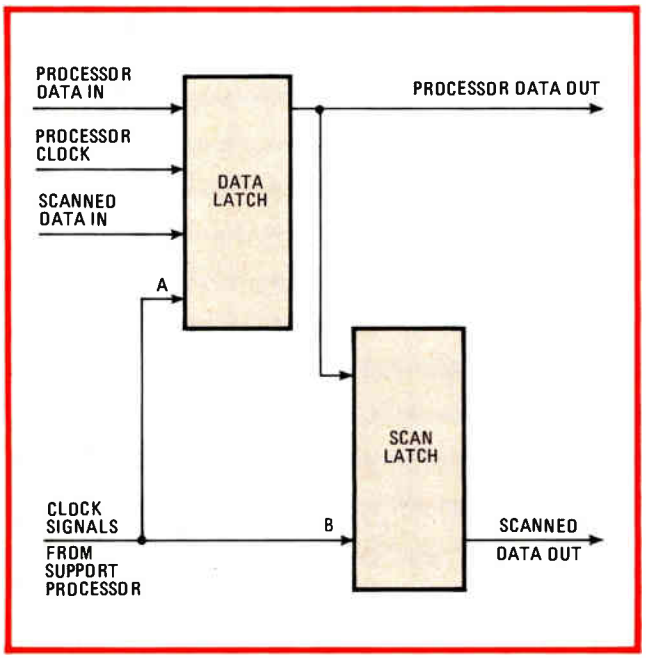
by Theodore J. Frechette and Fred Tanner
IBM Corp., System Products Division, Endicott, N. Y.

Tracking down the source of intermittent problems in digital computers is often difficult and time-consuming, especially as most diagnostic programs are more suited to locate and correct continually occurring errors.

The IBM 4341 processor overcomes this problem by employing several new maintenance concepts. First, a special type of latch design has been added to the central processor logic. This design permits an external and independently clocked maintenance and support processor—another new feature—to capture the state of the logic when a failure occurs. This separate support processor also logs environmental factors such as the voltage and temperature. Finally, there also is innovative microcode that runs in the support processor and analyzes this error log information to isolate the problem to a circuit card. It will do this either automatically or under control of a service engineer.

In previous computer systems, isolating problems requires the service engineer to use diagnostic microcode that runs at machine speed and uses a building block testing technique. The technique tests function A, then uses A as a basis for testing function B, and continues thus through all the functions to be tested—a procedure that has little trouble finding continuous, or solid, failures but may not isolate intermittent problems correctly.

For example, if the intermittent fault with function A does not appear (and hence is not detected) until function B is under test, the diagnostic program will be unable to correctly determine which function is failing. If the fault is also infrequent, the diagnostic program may not detect any failure, even though one is known to exist. One service approach that can be used in this case is to replace circuit cards on a best-guess basis and return the system to operation on the assumption that the fault has been corrected.



1. Split personality. A pair of polarity hold latches is the basis of IBM's Level-Sensitive Scan Design. The first latch can be used for both system design and testing requirements, hence its two signal and clock inputs, while the second is used solely for testing.

If the problem persists, more extensive diagnostic techniques must be used. These include "freezing" the system when an error occurs, trapping suspect signals, or tracing through failing customer programs. Other techniques deliberately provoke the reappearance of the problem by putting worst-case physical stresses on the system—for example, varying input voltages or cooling or heating circuit cards and boards. All such activities, however, interrupt customer operations and require much extra time.

Capturing faults

The IBM 4341 processor, in contrast, may be described as capturing faults the first time they occur. It does this by logging the state of the system when a failure arises. All data pertaining to the failure is recorded on the system's diskette for later analysis, the results of which are displayed on the system console and dictate the repairs to be made.

This diagnostic approach makes repair faster because there is no need to recreate the failure. In addition, it tells the service engineer what spare parts to bring to the customer's site.

IBM calls its use of special latch circuits for diagnostics its Level-Sensitive Scan Design. These are actually shift-register latches consisting of a pair of (type D) polarity-hold latches connected to form a single stage of a shift register. These pairs are scattered throughout the logic to allow the state of the various circuits in the chip—many otherwise inaccessible—to be captured and read out by the separate support processor.

The first latch in a pair, or the data latch, is used for both system design and testing requirements. It therefore has two data inputs—processor-data-in and scanned-data-in—as well as two clock inputs—one from the CPU and one from the support processor.

The second, or scan latch, is used primarily for testing purposes. It has its input permanently connected to the output of the first latch and can be clocked only by the support processor. Figure 1 illustrates the relationship of the latch pair.

There are approximately 5,000 of these latch pairs in the central processing unit's logic. But only about 300 of them function solely as error checkers to aid diagnostics. The rest serve a dual purpose, doubling as storage elements like registers or accumulators or to retain the state of selected control lines. Because of their dual role, these latches are able to enhance maintainability without becoming overhead.

In this role the first latch has data moved into or out of it through the processor data-in and -out lines in time with pulses of the CPU clock. In the diagnostic role, the state of the first latch is transferred to the second latch

by pulsing the support processor clocks. That state can therefore be captured by the support processor, which sends a clock pulse to the second latch and shifts its information out through the pin for scanning data out.

These latch pairs are linked serially into several long shift registers called scan rings; the scanned-data-out line of one scan-ring latch pair is connected to the scanned-data-in line of another, and so on (Fig. 2). The support processor can now clock all the scan latches and shift their contents out as a serial bit stream through a single line. Since each bit in this serial bit pattern corresponds to a latch pair, the state of each latch in the string can be determined.

Thus, when any type of error occurs, the support processor can obtain the exact machine state at the time of failure. The state of each machine latch when an error occurs is then used by the error analysis microcode in the support processor to locate the defective component. The support processor can also scan a specific machine state into the central processor through the scanned-data-in line on these latch pairs so that if other diagnostic programs are needed, they can begin from a known starting point.

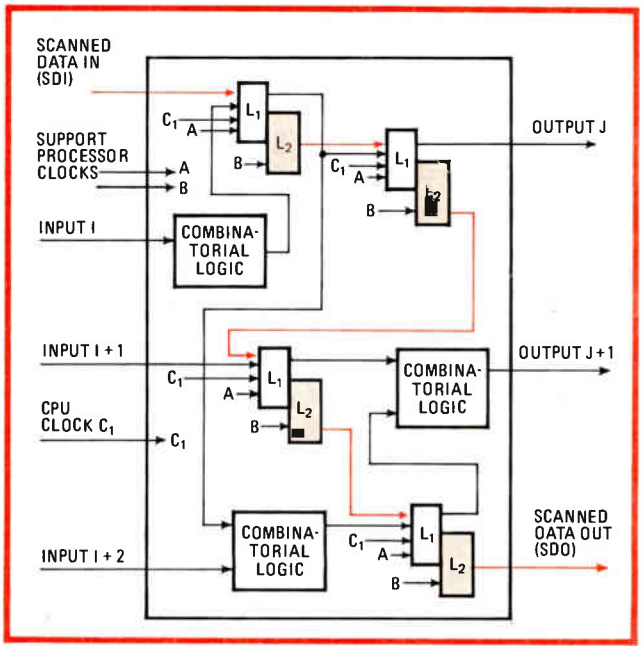
The actual monitoring of the CPU's data flow, control lines, timing circuits, and cables for errors is performed by combinatorial logic, also in the CPU, using parity, duplex, validity, and other error-checking techniques. When this logic detects an error, it activates one or more of the 300 scan-ring latches that are dedicated to functioning as error checkers, causing a condition called a machine check that stops the central processor. The machine check also signals the support processor in order to start CPU recovery or else, if required, to analyze the error log.

Divide and diagnose

These 300 dedicated error-checking latches are strategically placed so that they divide the computer logic into distinct portions called error domains. An error domain is composed of an error checker, the arithmetic or logic function being checked, and all of the circuitry associated with that function.

When an error is detected and a machine check signaled, the support processor begins the recovery procedures. Its recovery microcode initially reads the data in selected scan rings into the support processor and checks it to determine the type of failure. All scan-ring data pertinent to the failure is formatted and recorded on the system diskette as an error log. Also used with this log is environmental data like electrostatic discharge and power line voltage transients, internal machine temperatures, and time and date information. Whenever possible, a standard instruction retry is then attempted—the processor is returned to a known state and the failing instruction is executed again.

When an intermittent failure is involved, the retry usually succeeds and the main computer can resume operations. The error log is saved, however, so that during the next service call the service engineer may be made aware that intermittent problems are occuring—conditions that went unreported in previous systems. The new maintenance techniques really excel when retry is



2. Ring around the data. By connecting the scanned-data-out line of one latch pair to the scanned-data-in port of the next a long shift register, called a scan ring, is created, allowing the state of each latch in the ring to be shifted out for analysis.

unsuccessful, however. Then the special Error Log Analysis diagnostic microcode is invoked in order to analyze the information contained in the error log.

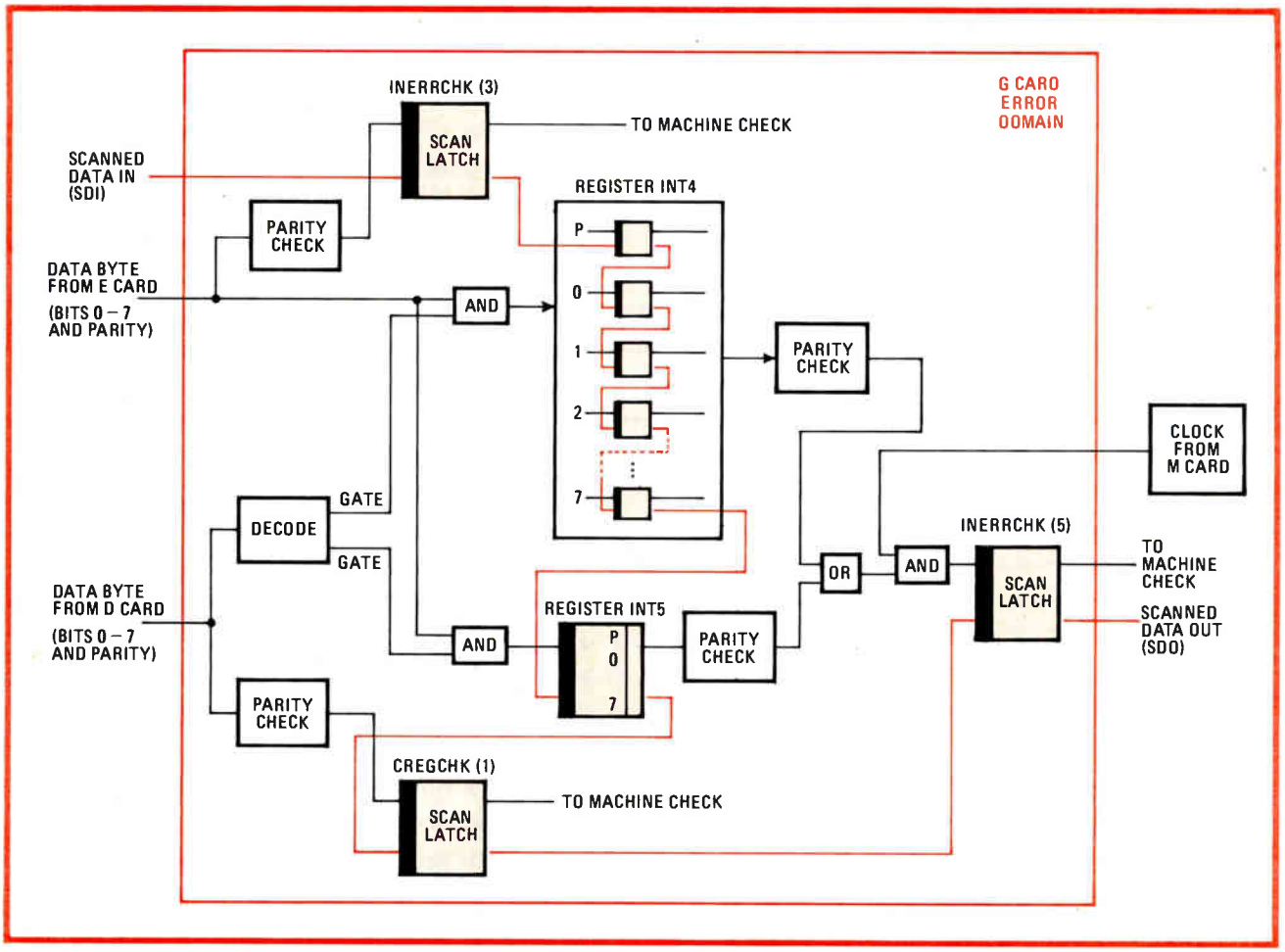
The Error Log Analysis microcode, divided into several modules, contains approximately 17,000 bytes of code. Its purpose is to analyze the machine-check error logs and produce a reference code that identifies the failing field-replaceable circuit card or cards. The analytic program can be started manually by the service engineer or automatically when a retry of a machine check is unsuccessful.

The analysis is started by the microcode's root module, which controls the entire analytic procedure. This module is resident in the support system throughout the analysis of the error log. It reads the error log, calls other error log analysis modules as necessary and passes the reference code (which identifies any faulty cards) to the system console for display.

The other modules in the analytic microcode first isolate the specific areas of the processor that contain failures and then pinpoint the sources of failure within those areas. Some modules isolate failures in specific areas of the processor such as control storage, instruction processing unit, channels, and storage controller (which includes the main memory).

Two of the modules isolate failures across subsystem boundaries to trace failures occurring in more than one subsystem. They analyze false machine checks (errors in the maintenance hardware), clocks, duplicate hardware mismatches, and board-to-board cables. Then, by sectioning and establishing priorities for the tests of the more than 300 error checkers, the Error Logic Analysis microcode modules can isolate the fault to a particular error domain.

Once the failing domain has been determined, the



3. Diagnosing domains. Dedicated error-checking latches divide the computer into error domains. If, for example, a parity error is detected in register INT4, itself made up of nine latches, latch INERRCHK5 signals. If other latches are off, error did not come from another domain.

fault is isolated within the domain. By interrogating either one latch or a group of latches within and/or common to a particular error domain, it can usually associate the fault with between one and three field-replaceable cards.

After the error log analysis microcode determines the precise card or group of cards at fault, an eight-digit code is then retrieved from memory and displayed on the system console to tell the operator where the fault is located. The customer can now pass this reference code on to the IBM field-service engineer. Once supplied with the code, the service engineer can determine the card group required to repair the system and can bring it along on the service call.

To illustrate this procedure, consider the error domain shown in Fig. 3. The registers labeled INT4 and INT5 on circuit card G are being parity-checked by the error-checker scan latch INERRCHK(5). (The error checkers labeled CREGCHK(1) and INERRCHK(3) are checkers for other error domains on cards D and E.)

Domain example

For example, assume that a single-bit error in the INT4 register is producing a problem. The parity-check logic detects the single-bit error and causes INERRCHK(5) latch to come on, signaling a machine-check. If the instruction retry is unsuccessful, the support processor starts to analyze the error log.

To isolate this error domain, the analytic microcode first determines that latches INERRCHK(3) and CREGCHK(1) are off and that INERRCHK(5) is on. This test ensures that the error did not propagate into this domain from the D or E card error domains.

Once the domain of the failure is determined, the fault is isolated to the smallest possible number of field-replaceable cards. In this case, a test is made of the INT4 and INT5 registers. Since the two 9-bit registers are each constructed from nine scan-ring latches, the internal conditions of the registers can be checked to determine if either has a bad parity condition.

Should bad parity exist, the reference code for the G card is the field-replaceable unit that is listed. If the parity is good in both registers, the G card and the system clock M card would be listed. But the G card is listed first, because it is still the most probable cause of this failure.

When necessary, additional diagnostic microcode can be used to isolate processor faults not covered by error log analysis or to enhance the fault isolation. These diagnostics also exercise the system, in order to verify that the system is working properly after the card has been replaced.

Streamlined architecture achieves software compatibility

by Hartmut R. Schwermer
IBM Corp., Böblingen Development Laboratory, Böblingen, West Germany

"Save our software!" is the cry heard from all computer users contemplating a new generation of hardware. In response, the 4300 computers have been designed with two operating modes. System software has been changed to take advantage of these modes in a way that allows application programs to perform better in the new mode without making them unable to run on the System/370.

One mode is in fact called the System/370 mode; in this mode the 4300 appears to be, for programming purposes, identical to the System/370. The System/370 mode also allows the 4300 to use the 370's operating system (Disk Operating System/Virtual Storage, or DOS/VS).

The second mode reconfigures the 4300 architecture, enhancing software performance most notably through more efficient virtual-memory management. There are some changes in instruction set, and the new operating system (Disk Operating System/Virtual Storage Extended, or DOS/VSE) must be used. This second operating mode is called Extended Control Program Support: Virtual Storage Extended, or ECPS:VSE for short.

Control program changes

The ECPS:VSE architecture is designed to make the control program of the operating system perform better. The architecture is problem-state compatible, but not supervisor-state compatible, with the System/370 architecture. Therefore application programs written for the System/370 need not be changed to run on a 4300 operating in the ECPS:VSE mode. Changes in the architecture require the use of the newer operating system, DOS/VSE, when the 4300 is in the ECPS:VSE mode.

The architecture—the machine as the programmer sees it, not its physical or logical design—can be modified by switching from one mode to the other thanks to the internal use of microcode. The architectural mode must be selected at the time of initial program loading; it cannot be changed during normal operation.

Eight of the 183 instructions of the System/370 architecture are dropped in the ECPS:VSE mode and a dozen new ones are added, among them a new status-saving instruction and others pertaining to the new single-level management scheme for virtual memory, or virtual storage, as IBM calls it. ECPS:VSE memory addressing is considerably faster; it allows the same virtual-memory addresses to reference main memory from both the central processing unit and input/output channels. The System/370 architecture uses separate addressing schemes for the two.

The ECPS:VSE addressing facility supports only one virtual memory of 16 megabytes maximum size, instead of the multiple virtual memories supported by the System/370, but the ECPS:VSE facility is easier to use. As in all schemes of this kind, virtual storage (on disk drives, usually) is larger than the machine's actual main memory. Unused portions of data and programs are stored on disk until they are needed. When these portions of data are called for, memory management swaps 2,048-byte pages on disk with pages stored in main memory that are not currently in use.

Since the disk drives and main memory work together in the virtual-memory system, it is advantageous to have both of them able to address it directly, as they do under ECPS:VSE. As mentioned, both the central processing unit and the I/O channels use the same set of virtual addresses. Main storage is not directly addressable by CPU programs or channel programs—all references are through virtual memory. In the 370 architecture, the CPU and I/O channels each use separate address lists. One-level addressing improves both instruction processing and control-program performance because the control program does not have to spend time translating the virtual addresses of the channel programs.

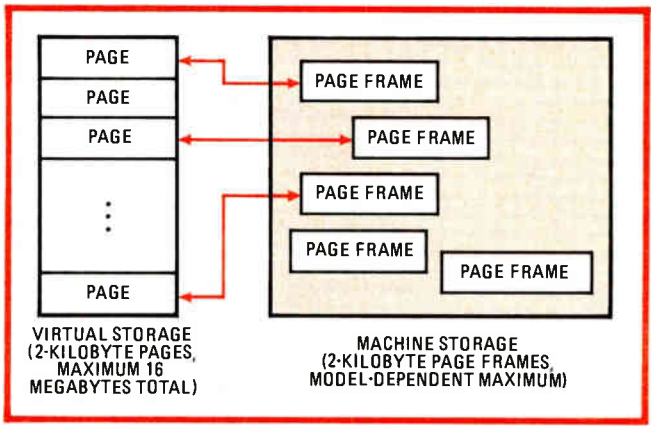
Faster translation

This single virtual storage environment also avoids the process of translating the virtual-storage addresses into real addresses used to reference the usually smaller actual main memory of the machine. Instead of the more complex Dynamic Address Translation software used in the System/370, the ECPS:VSE lets machine hardware do the translation automatically and efficiently.

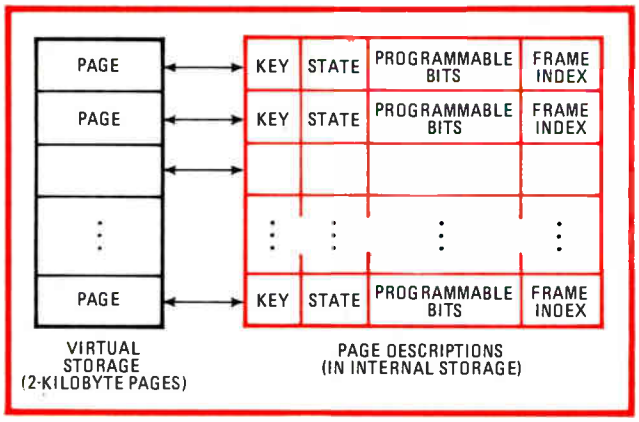
The virtual-storage size is established and can only be changed when initial program loading is performed. Once set, it cannot be changed by the control program. It is always a multiple of 2,048 bytes up to a maximum of 16,777,216 bytes (16 megabytes).

Addresses equal to or greater than the specified virtual-storage size are invalid addresses. Any attempt by the CPU to refer to storage with an invalid address is indicated by an addressing exception. An I/O operation using an invalid address is terminated by a channel-program check. When storage size is set to the 16-megabyte maximum, all addresses are valid.

Virtual storage is divided into pages, each consisting of 2,048 consecutive bytes. The address of the first byte



1. Frame up. Virtual storage (generally on disk) is divided into 2,048-byte pages that must be linked to a page frame in main memory before they can be directly accessed by the central processing unit or input/output channel programs.



2. Bookkeeping. To help the 4300 CPU keep track of the pages in virtual storage, 28-bit page descriptions are held in main storage. The storage key is used for security and housekeeping; other bits in the description keep track of a page's location and state.

of each page is an even multiple of 2,048. Machine storage is divided into page frames, each capable of containing the data of one 2,048-byte page of virtual storage (Fig. 1). Each page can be in one of three states—disconnected, connected, or addressable.

Swapping pages

In order for a virtual-storage page to be accessible by CPU or channel programs, it must be associated with a machine-storage page frame. Therefore an instruction is provided in the ECPS:VSE instruction set that automatically connects a page frame to a page. When the control program issues that command, a page frame in machine memory is referred to by the virtual address of the corresponding virtual-storage page. Once the page has an associated page frame, it is in the connected state but is accessible only by the I/O channels. As long as a page I/O operation is being performed to or from external storage, the page is kept in the connected state by the control program. CPU and channel programs can address any part of virtual storage as if it were directly accessible even during the transfer operation.

When the contents of a page have been retrieved from external storage and placed in a page frame in machine memory to become ready for accessing by a CPU program, the control program uses another instruction to make the page addressable. Now it is accessible by both the CPU and the I/O channels. As the supply of free page frames diminishes, the control program makes room by disconnecting a page from its page frame. A replacement algorithm chooses to remove a page that has not been recently referenced.

If any byte in the page has been changed, the page contents will be written out to update the copy in external storage. If no changes were made, that copy is accurate and the time-consuming I/O operation is avoided. An instruction may then be issued to disconnect the page, thus freeing its page frame. That page is no longer accessible by the CPU or I/O channels—only the control program software can retrieve it.

Each virtual-storage page has an associated 28-bit page description that is maintained in internal storage (Fig. 2). It consists of a 7-bit storage key used for data security and other housekeeping chores, 3 programmable bits used by the control program, 2 page-state bits, and the 16-bit frame index of the page frame currently assigned to the page, if any. The 3 programmable bits assist in managing pages in external storage: one of them, for example, indicates whether or not a version of the page in fact exists on external storage.

Identification

Each page frame in machine storage has a unique 16-bit integer, the frame index, assigned to it. The frame index should not be confused with the address of the frame in machine memory. The algorithm for assigning a frame index varies from model to model. This index helps the control program maintain compact tables of connected or addressable pages.

Special privileged instructions that are not in the System/370 instruction set have been defined to support the ECPS:VSE virtual storage. The connect-page command changes the state of a page from disconnected to connected. The make-addressable instruction changes the state of a page from connected to addressable, and the make-unaddressable instruction changes a page's state from addressable back to connected. A page's state is changed from connected to disconnected by the disconnect-page command. The deconfigure-page command also disconnects a connected page, but in addition it makes the corresponding page frame unavailable for further use. To test the state of a page and display its frame index, the load-frame-index instruction is used.

The clear-page instruction sets the contents of a page to zero; the set-page-bits instruction tests the reference and change bits of a page and sets them along with that page's 3 programmable bits. The programmable page bits, the reference bit, and the change bit are retrieved by the insert-page-bits command.

Diagnostics

As was discussed in the preceding article, the 4300 computers have better internal diagnostics than previous IBM computers. Each time a machine malfunction occurs, the cause of the failure is recorded on an internal diskette. After the recording has been completed, normal system operation is resumed if possible.

Because of these improved internal diagnostic facilities, machine-check, channel-check, and other model-dependent features contained in the System/370 architecture are superfluous. These parts of the architecture became model-independent for both operation modes of the 4300. As a consequence, the error-handling procedures of the DOS/VSE control program became simpler. Machine serviceability has been improved because internal diagnostic functions allow more precise identification of the cause of a machine malfunction.

The other big change to the System/370 and instruction set is the replacement of the store-status command with the new machine-save instruction. The ECPS:VSE mode's machine-save instruction preserves the entire CPU state and the first 2,048 bytes of storage; it is used by the operator to prepare a complete storage dump. It is easier to use than the store-status instruction, which altered some of the storage contents to be dumped. □

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Trio of dense bubble memories has large supporting cast

Two sets of interface chips adapt three sizes of bubble memory to many applications, with or without error correction

by Gerald Cox, *Texas Instruments Inc., Dallas, Texas*

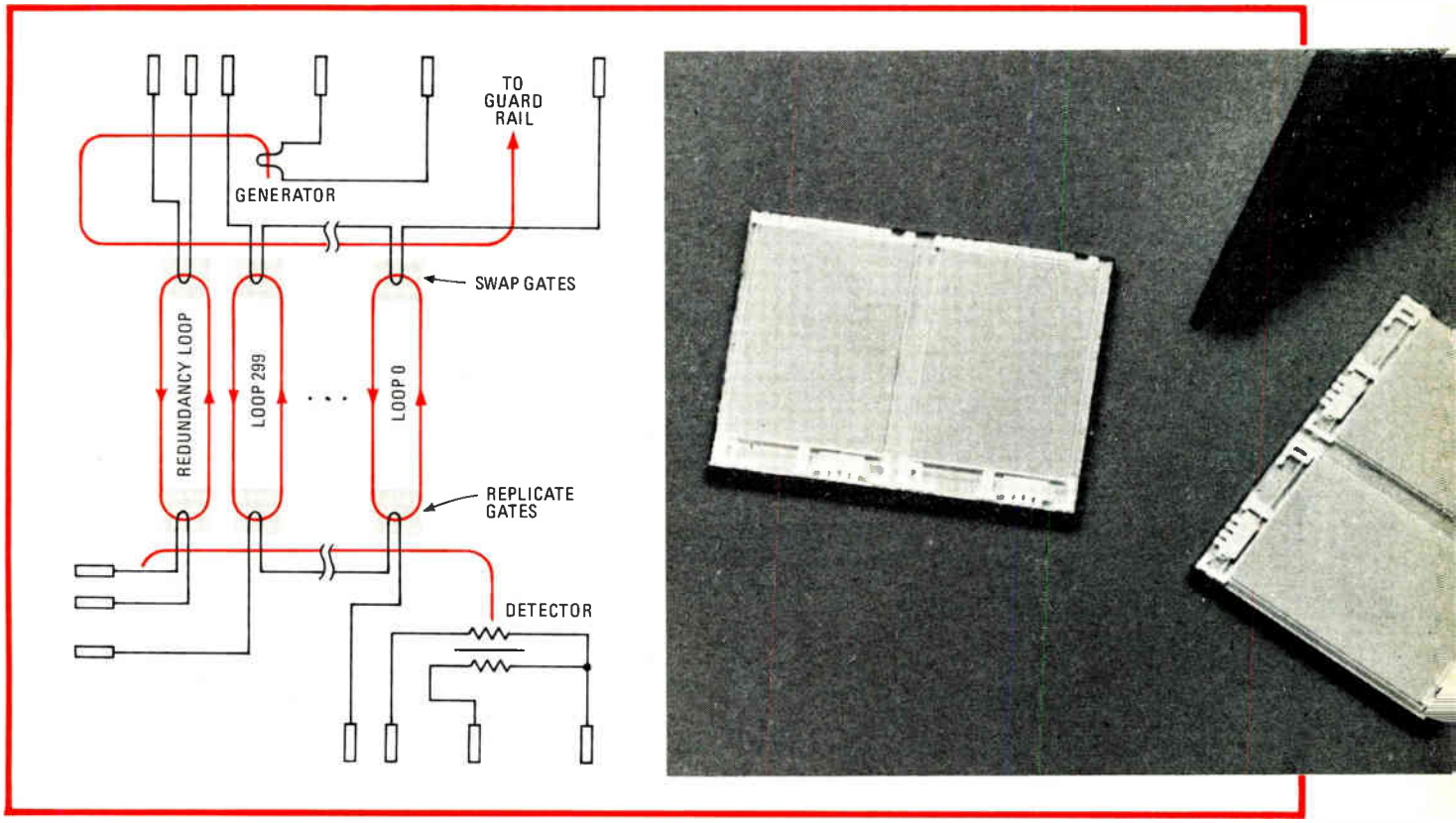
☐ For a magnetic-bubble memory family to be successful, it must be complete: it must include bubble devices of varying capacity, and it must contain support circuits so that the designer can put a system together—yet forego a course in magnetics.

The TIB1000 family meets those requirements and more. The 1-megabit TIB1000 is electrically and physically interchangeable with two other new bubble memories: the 512-K TIB0500 and the 256-K TIB0250 (Table 1). And the family is fully supported by a comprehensive line of custom interface circuits.

Actually, the bubbles will be supported by not one set of interface chips but two: one for general applications and another that provides error correction and detection—a must for the disk-replacement market.

The TIB1000 is a 1,122,852-bit single-chip magnetic-bubble memory (Fig. 1, right). It features a new page-swap and -replicate architecture for speedy access and cycle times, and it has dedicated map loops for transparent handling of redundant minor loops. The memory is split into two 512-K sections, one of which is diagrammed in the left half of Fig. 1.

There are 300 minor loops per section, and each minor loop stores 2,049 bits. Of the 300 loops, 274 are available for storage and the remaining 26 are allowed to be defective to increase chip yields and lower cost. When using error correction, 18 of the 274 loops are used to store error-correction codes. If error correction is not elected, 272 loops are used to store data and two loops contain odd parity bits for two sets of 136 loops.



1. Page swap. On the right is a die photograph of the TIB1000 million-bit magnetic-bubble memory. On the left is a schematic of one of the two 512-kilobit sections in the chip. The swap gates transfer a page of data into the minor loops. The replicate gates feed a detector.

TABLE 1: THE TIB1000 DEVICE FAMILY

Device	TIB1000	TIB0500	TIB0250
Capacity (bits)	1,122,852	561,426	280,850
Organization (bits)	512-K-by-2	512-K-by-1	256-K-by-1
Total loops	300 (X2)	300	
Good loops	274 (X2)	274	
Loops with correction	256 (X2)	256	
Loops without correction	272 (X2)	272	
Bits per loop	2,049		1,025
Access time (ms)	11.2		5.6
Field rate (kHz)	100		
Burst data rate (kb/s)	200	100	
Average data rate (kb/s)	170	85	
Power dissipation (W)	1.2		

The minor loops are tangential at one end to swap gates and at the other to replicate gates. A bit of data enters or leaves each minor loop during a swap or replicate operation. Thus, the number of loops storing data determines the size of a data page. If 272 loops store data, for instance, a page is equal to 34 bytes.

The TIB1000 chip measures only 149,000 square mils (less than 1 square centimeter), resulting in the highest bit density for a commercial bubble memory product by a factor of more than two. The 8-by-8-micrometer cell supports 2-μm bubbles. The small cell is made practical by the development of a truly planar process [*Electronics*, Sept. 27, 1979, p. 37] and by refinements in projection photolithography. The dice of the TIB0500 and TIB0250 are scaled in size by two and four, respectively.

A significant improvement in architecture is made possible by a double-period gate that moves bubbles two periods (cells) for every cycle of the rotating magnetic field. With this design, only one bubble generator and one pair of detectors are needed in each 512-K (or 256-K) section. Data need no longer be separated into odd and even banks nor merged into a common detector pair, as happened in previous designs.

In operation

The devices employ page swap and page replication of data. During a write operation, data is generated in every field cycle and shifted by the double-period gates until it is aligned with the respective minor loops. Then a swap current pulse simply exchanges old data in the top bit position of the minor loops with new data located in the input swap track. The old data in the swap track is shifted to a guard rail where it is destroyed.

A read operation is conducted at the opposite end of the minor loops where data is replicated a page at a time. Again, data travels two periods for every field cycle to the detector, which consists of two arrays of interconnected Permalloy patterns. The arrays are connected to constant-current sinks located in an external sense amplifier. The current sinks form a balanced bridge that becomes unbalanced in the presence of a bubble. A guard rail destroys the bubble before it can enter the second detector, in order to insure that common-code signals are not encountered by the sense amplifier.

The time required to write or read data into or out of a magnetic-bubble memory consists of the time it takes for a desired page of data to circulate through the minor loops to the swap gate or replicate gate, plus any delay associated with the write and read tracks. The average access time, T_{av}, is usually considered to be the time it takes a page of data to propagate half the length of a minor loop plus the write- or read-track delay. For the TIB1000 this is calculated by adding one half of the number of bits per loop to 100 field cycles to find the delay from the replicate operation to the detector. This result is then divided by the field frequency. Hence:

$$T_{av} = \frac{2{,}049 \text{ bits/loop} \times 0.5 + 100 \text{ cycles}}{100 \text{ kilohertz}}$$

$$= 11.2 \text{ milliseconds}$$

The initial specification of 100 kHz for the field frequency will later be increased to 200 kHz. This will lower the average access time to 5.6 ms.

The rate at which data can be transferred to or from the bubble memory, once the desired page of data has been accessed, is determined by the bubble's field frequency and the number of field cycles required to transfer a page of data (including redundancy, error correction, and the interpage gap) out of the chip. The average data rate, DR_{av}, for the TIB1000's multipage read or write mode is derived as follows:

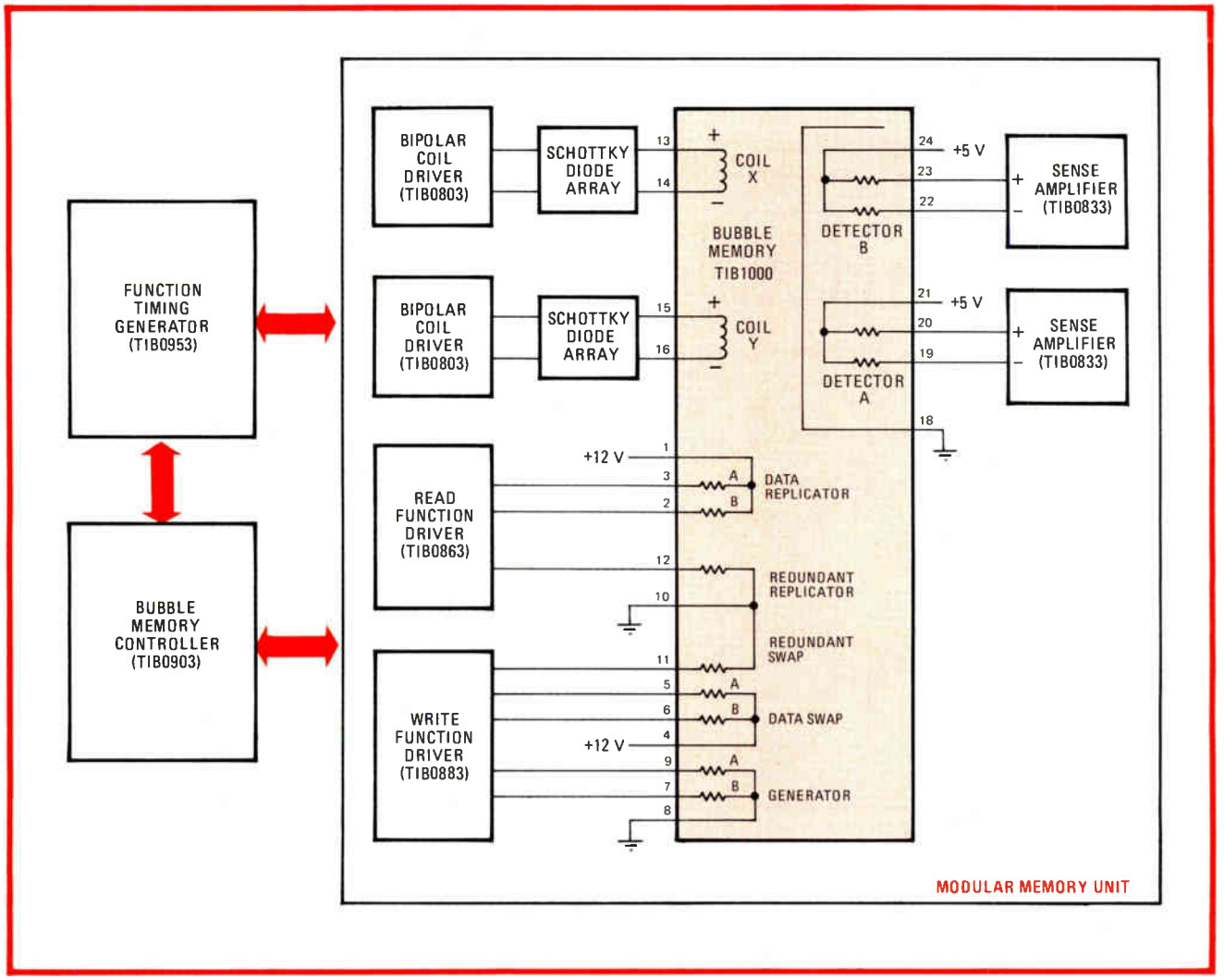
$$DR_{av} = \frac{\text{data bits/page} \times \text{field frequency}}{\text{loops/page} + \text{interpage gap}}$$

$$= \frac{256 \times 100 \text{ kHz}}{(300 + 20) \text{ field cycles}}$$

$$= 80 \text{ kilobits/s per channel}$$
$$= 160 \text{ Kb/s (both channels)}$$

If the user does not need error correction, the 16 additional bits of data per page increase the average data rate to 85 Kb/channel.

The data rate of the TIB1000 bubble memory system is normally slower than for that of the host system. An



2. Modular. The bubble memory is surrounded by custom interface circuits to ease system design. The controller provides a general interface between the bubble device and the host microprocessor. The timing generator is capable of driving up to 10 modular units.

integrated circuit for correcting and formatting data (to be described later) double-buffers the data between the bubble device and the host system. This allows a totally asynchronous data interface that may operate up to a 4-megahertz burst rate.

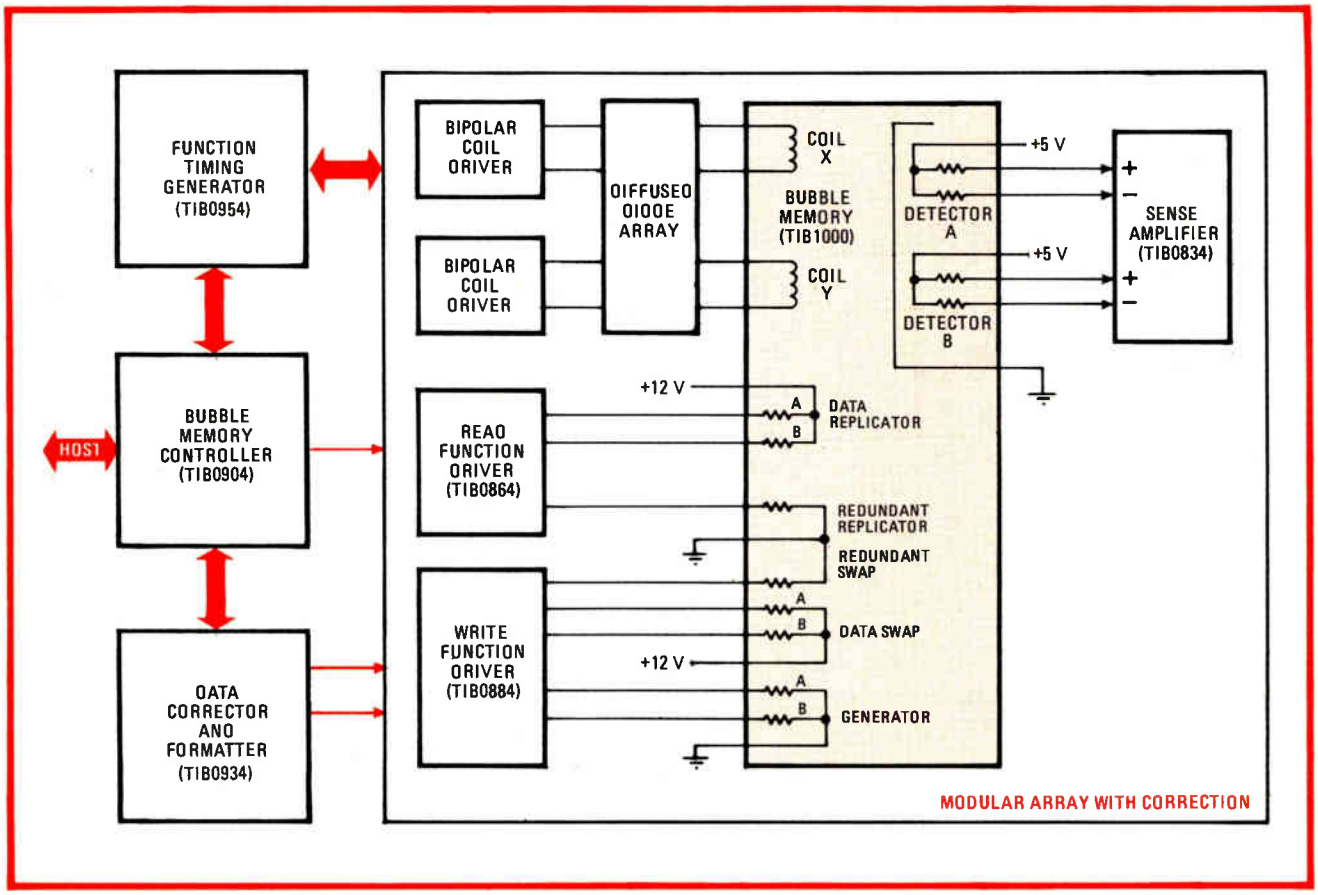
The support circuits

As mentioned, the TIB1000 will be supported by two families of custom integrated interface circuits. The first family, to be available at the same time as the TIB1000, includes the TIB0903 bubble memory controller, TIB0953 function timing generator, TIB0804 bipolar coil driver, TIB0863 read function driver, TIB0883 write function driver, and the TIB0833 single-channel sense amplifier. Except for the controller and the timing generator, all of the interface circuits are required for each bubble memory in the system whether it is a TIB1000, TIB0500, or a TIB0250. Hence, the collection of these circuits and the bubble memory has been given a name: the modular memory unit (Fig. 2)

The TIB0903 controller provides a general interface between the memories and the host microprocessor system. Its basic functions are to start and stop bubble movement, to maintain page position information, and to control generation and swapping of data, block replication, and initialization of redundancy (map loop) information. It also controls all bubble operations, including multipage reading and writing.

The TIB0953 timing generator will directly drive up to 10 modular memory units on a common bus, but can communicate with only one modular memory unit at a given time. More than 10 modular memory units can be driven with the addition of simple noninverting buffer gates. The read- and write-function drivers control the generation, swapping, and replication of bubbles for either or both sections of the TIB1000. Each output function is monitored by an internal time-out circuit to prevent damage to the bubble device even if a timing fault occurs elsewhere in the system.

The second family of support circuits, to be introduced in mid-1980, is especially designed for parallel bubble operation as well as error detection. The need becomes acute when challenging the disk-replacement market. A more advanced modular memory unit, the bubble modular array with correction, gives the most flexible and powerful answer. The system addresses the lower-



3. With correction. A second family of support circuits provides error detection and correction designed expressly for bubble memory systems. An advanced bubble memory controller, the TIB0904, and a data-corrector and -formatter chip make this possible.

performance—but cost-sensitive—application as well as the high-performance fixed-head-disk market with a single set of custom interface circuits.

The modular array consists of the TIB0864 advanced read-function driver, the TIB0884 write-function driver, and the TIB0834 dual-channel sense amplifier (Fig. 3). In addition, to interface the modular array with correction to the host processor, a more advanced controller, the TIB0904, and the data-corrector and -formatter circuit will also be introduced. This controller performs the same basic functions as the 0903, except it also contains several status registers for error monitoring and it has internal data accumulators to control up to four corrector and formatter circuits in parallel.

Correcting and formatting

The data-corrector and -formatter circuit (Fig. 4) combines two data buffers, each able to store up to 272 data bits, a RAM to store the map-loop information for one bank of 300 loops, error-correction circuitry for each data buffer, and a control and status section. Its four modes of operation let the user read or write 256 bits with transparent error correction, 272 bits with transparent parity detection, 274 bits for diagnostic purposes, or all 300 bits for off-line bubble-device testing.

The map-loop data is corrected for all four modes, and two identical copies of the map data are stored in the map loop along with an identification bit to tell them apart. This is necessary because the address-reference pointer is also contained within the map data. If one of the two copies is ever found to be in error, the map loop may be rewritten automatically with a simple two-instruction sequence with no losses of the addresses in the map loop or data in the good minor loops.

The corrector and formatter circuit uses an error-correction code developed especially for magnetic bubbles. Table 2 ranks error probability in order of occurrence versus correction ability. A soft error is of a transient nature and is recoverable with another operation. A hard error, however, occurs within the minor loops and recurs on successive read operations; it may be removed only by rewriting the page containing the error.

The significance of the formatter's code for detecting and correcting burst errors is its ability to detect all randomly spaced double errors in a page of data and correct 50% of them. Moreover, the corrector and formatter automatically appends and strips off the error-correction bits, interrupting the host system only when an error goes uncorrected.

The corrector and formatter can transfer data to and from the host system at rates of up to 4 MHz per channel because the bubble device is handled through the other data buffer. However, operation of the corrector and formatter is fully static; data transfers can take place at any speed the processor prefers to run at.

Up to 16 modular arrays may share a common formatter, but only one array may be active at a time because the corrector and formatter contains only

TABLE 2: ERROR RATE ANALYSIS VERSUS ERROR CORRECTION ABILITY

Definition of error within a 256-bit page (in order of occurrence)	Probability of page in error	TI bubble code	
		Correction	Detection
Single soft error	3×10^{-4}	100%	–
Single hard error	3×10^{-6}	100%	–
Randomly spaced double soft error	3×10^{-8}	50%	100%
Soft error burst length 2	3×10^{-9}	100%	–
Hard error burst length 2	3×10^{-11}	100%	–
Soft error burst length 3 or 4	2×10^{-11}	–	100%
Randomly spaced double hard error	3×10^{-12}	50%	100%
Soft error burst length 5	3×10^{-12}	–	100%
Randomly spaced triple soft error	3×10^{-12}	–	87%
Single soft and soft burst length 2	8×10^{-13}	–	100%
Undetected and uncorrected system error escape rate per 256 bit/page	4×10^{-13}	–	–

enough storage for one map of 300 loops. This can be updated each time a new modular memory unit is selected, but a faster method is to store all map loops in the host system. After the map loops have been read sequentially and their contents transferred to the host system via the data channel, the map data may then be loaded from the processor to the corrector and formatter at rates of up to 4 MHz.

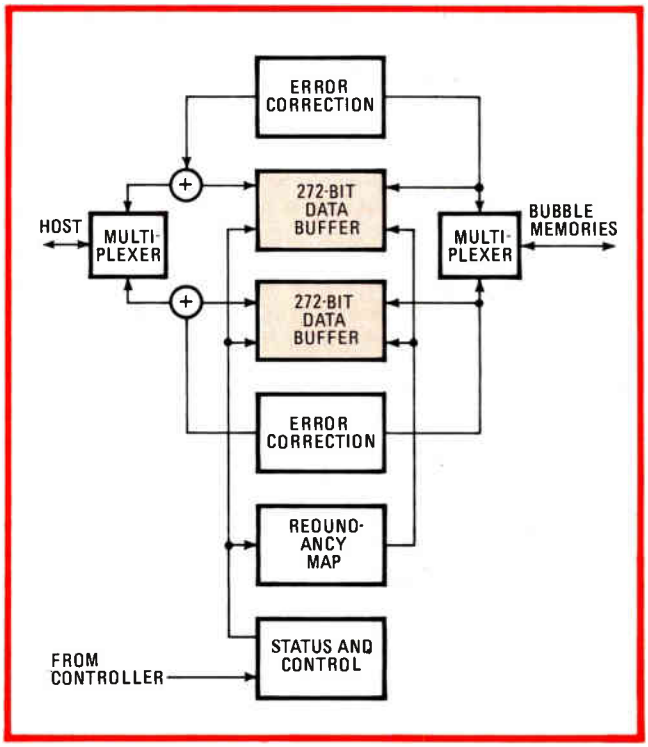
The TIB0954 timing generator, like the 0953, receives control signals from the controller and in turn provides timing signals to the function drivers, coil drivers, and sense amplifier. However, the 0954 has improved resolution to operate at bubble field rates exceeding 200 kHz. As the input clock frequency may be as high as 25 MHz for these extended field rates, the 0954 is built not with MOS but with low-power Schottky technology.

The coil drivers, in conjunction with a monolithic diode array, generate triangular current waveforms to drive the field coils. The TIB0804 coil driver uses all three power supplies in the system: +12, −12, and +5 volts. The bipolar drivers are the most cost-effective solution for driving a single bubble device. However, for systems with four or more memories in parallel, discrete V-groove MOS power transistors controlled by a predriver will cost less and use less power.

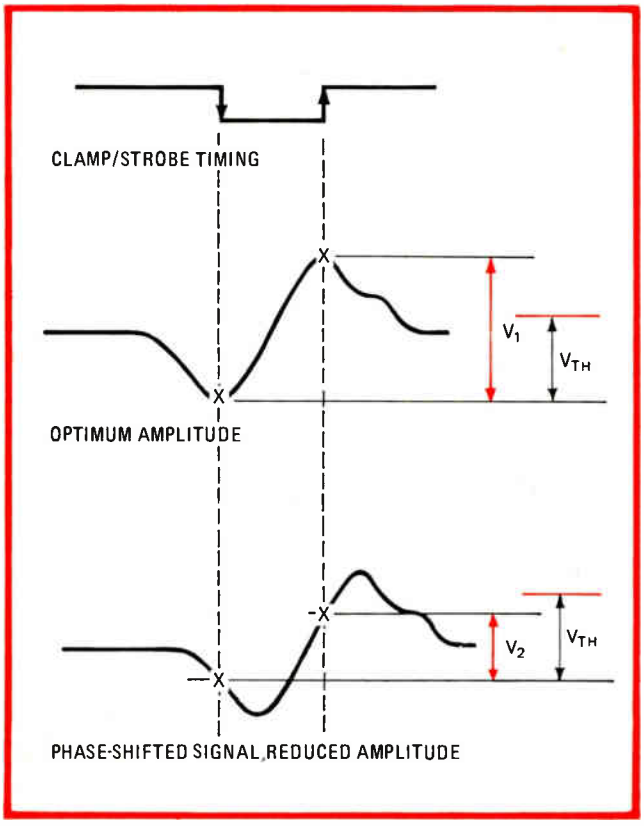
The TIB0834 dual sense amplifier detects signals from both sections of the 1-Mb bubble memory. The circuit uses negative and positive peak detection, which renders it phase-tolerant to variations in signal timing. As Fig. 5 indicates, a delayed output signal would otherwise result in a drastic reduction in the signal amplitude when using a conventional sensing technique. The dual sense amplifier will use window-searching methods to always maximize the signal amplitude (V_{th}). The circuit may also be temperature-compensated to provide a constant voltage amplitude to the threshold circuit for a wider temperature range.

During system operation, six registers within the TIB0904 controller provide communication with the host system. They are the command, status, parameter, results, read-data, and write-data registers, and they are accessed by means of chip-select, address, read, and write signals.

The processor uses commands to initiate data transfers and to determine the status of the bubble memory subsystem. A wide variety of commands is available: read, write, restore (initialize), read redundancy RAM, write redundancy RAM, reset interrupt, read page-



4. Correction. This data corrector operates by buffering data transfers between the host and the bubble devices twice. Its error code can detect all randomly spaced double errors in a page of data and correct 50% of them without interrupting the host.



5. Phase-tolerant. The sense amplifiers in the bubble memory support family can make up for phase errors in the data. A phase-shifted signal will have a low amplitude, so the sense amplifier will look for the optimum value using window-searching techniques.

position counter, write page-position counter, read error status, read data errors (single, double or multiple), set DMA mode, write redundancy loop A or B, and read and write seek. The TIB0904 controller is compatible with the TMS9900, 8080, Z80, 6800, and 6502 series of microprocessors.

Reading and writing data may be performed via polled I/O ports, with interrupts, or by direct memory access. In the first mode, the processor polls the status registers in the controller, and when data is ready to be transferred, a read or write command is issued. The controller automatically halts to prevent any overflow of data in the corrector and formatter circuit. This operation further decouples the bubble system from the host.

Interrupt mode

In the interrupt mode, the controller activates the interrupt line when the data buffer is empty (during a write operation) so that more data can be transferred to the host system. After all operations are completed, the interrupt line is again activated. The processor may then issue the next command.

Direct memory access is generally required if eight or more bubble memory devices are operated in parallel because the date rate will be greater than 800 kilobytes per second. An external DMA controller can provide the timing and sequential addressing for the DMA transfers. The DMA burst length and the interval between the bursts are programmable to provide maximum system flexibility. Communication with the DMA controller is performed via the usual DMA-request and DMA-grant signals, while actual byte transfers are clocked by the read or write signals.

The modular array has been partitioned to give the user total freedom in configuring one TIB1000 or a large array of the devices. The system may be expanded along any combination of the X, Y, or Z axes. Expansion along the X axis allows corrector and formatter circuits to be time-shared between up to 16 modular arrays, and more can be accommodated with TTL buffer gates. Chip-select lines common to all interface circuits within the modular array are controlled by I/O lines from the microprocessor.

System expansion

When expanding only in the X dimension, the data is normally routed from the corrector and formatter to the controller where it is then sent to an 8-bit accumulator and on to an 8-bit data bus. Since pages of data have already been buffered in the corrector and formatter, the data can be transferred at a 1-MHz burst rate to the controller to fill its accumulator rapidly.

For more data throughput, expansion in the Y dimension can be accomplished by repeating the number of corrector and formatter circuits. The number of available channels cannot be exceeded, however; the number of available channels is equal to twice the number of TIB1000 devices. The TIB0904 controller can control any number of channels up to a maximum of 32. For odd numbers of channels a TIB0500 can be mixed with a TIB1000 system. For a 32-bit-wide system, the maximum burst data rate is 16 megabytes per second. Since data pages may be doubly buffered in the corrector and formatter circuit, 512 bits of error-corrected data can be transferred to or from the host system at a time.

The TIB0904 controller can receive data from one, two, or four corrector and formatter circuits in parallel and reformat it into 8-bit parallel data to interface with the microprocessor. In larger configurations, the I/O lines of the coil driver circuit may bypass the controller altogether and connect directly to the host data bus.

If expansion in the Y dimension still does not satisfy system requirements, expansion in the Z dimension is possible by multiplying the entire basic system to the point where the number of buffers in the corrector and formatter will allow continuous operation to and from the host. A chip-select input to the corrector and formatter decouples each memory subsystem from the host system bus but allows reading and writing of the bubble memory to continue. This data can be processed while the host system goes on to the next memory plane to read or write data into its corrector and formatter buffers.

Sixteen or more memory planes may be multiplexed via chip-enable lines to share a common address and data bus with the host system. The total system capacity equals 256 Mb per memory plane times 16 banks for 512 megabytes. Each corrector and formatter has a 512-bit buffer capacity (with error correction) that, with a 3-bit-wide data bus, provides the capability to read or write continuously at a rate of up to 16 megabytes per second. As discussed previously, the average access time is still 5.6 ms at a field frequency of 200 kHz. □

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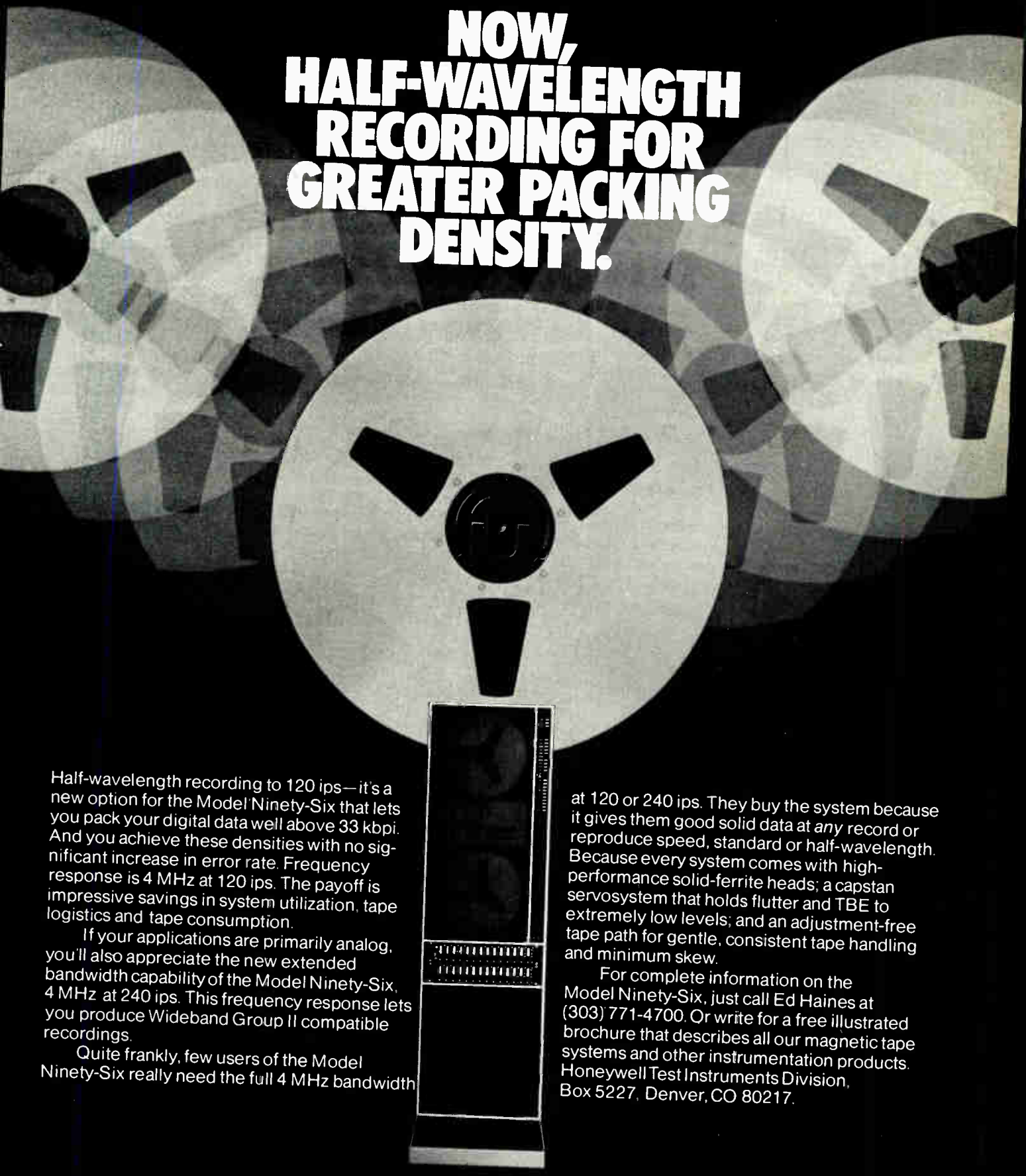

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Low-cost fiber-optic link handles 20-megabit/s data rates

by A. Podell and J. Sanfilippo
Loral Electronic Systems, Yonkers, N. Y.

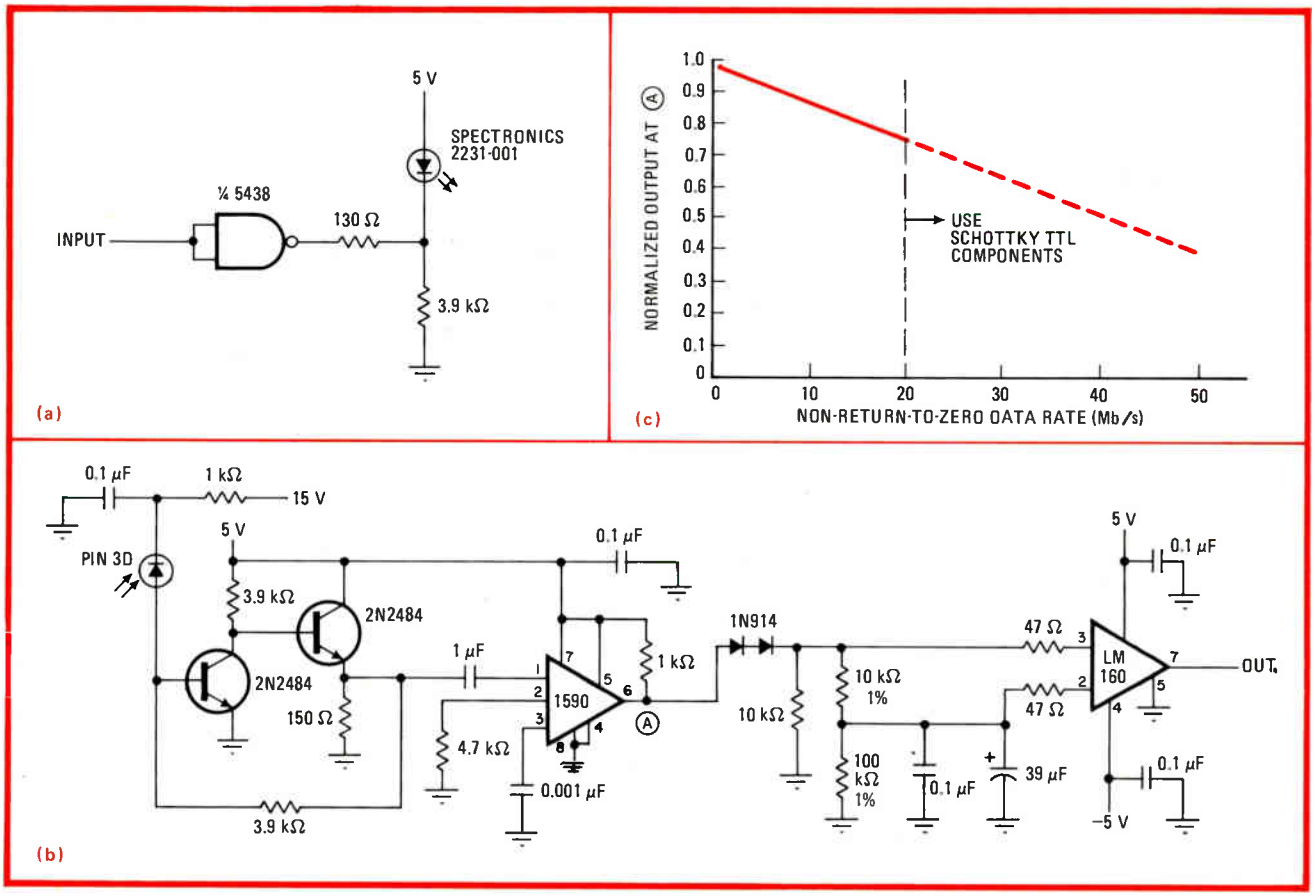
Providing an inexpensive link for the transmission and detection of digital signals over short distances, this fiber-optic system handles data rates in excess of 20 megabits per second. The system, which can be built for about $90, including cable, processes all types of data—a continuous-wave clock waveform, a burst of N clock cycles, handshaking signals, or a non-return-to-zero (NRZ) stream.

A TTL driver and a light-emitting diode serve well as the transmitter, shown in (a). The 5438 TTL driver is a two-input, open-collector NAND gate selected for its low power dissipation and 48-milliampere current-sinking capability. The LED is a gallium-arsenide device operating at 910 nanometers and provides 2 milliwatts of optical power at a forward current of 100 milliamperes. The 130-ohm resistor sets the current through the LED at about 30 mA, and so the output power is about 0.6 mW in this circuit.

The receiver (b) is also simple and sensitive. The output from the p-i-n photodiode (labeled the PIN 3D device) is several microamperes. This current is converted into a voltage by a two-transistor transimpedance amplifier. The 2N2484 transistors selected give low input capacitance, an adequate gain-bandwidth product, and the ability to detect small currents. Amplifier output is about 25 millivolts.

The MC1590 video amplifier that follows greatly boosts signal levels over a wide band (c). Two 1N914 diodes drop the output offset voltage of the single-ended amplifier, nominally at 4 volts, to within the input range of the LM160 comparater. The comparator's threshold is set by a simple voltage divider. The capacitors, across pin 2 and ground, combined with the 100-kilohm resistor, form a low-pass filter providing a threshold that varies with the comparator's supply voltage.

As for the electro-optical interface, the LED, which is contained in a TO-46 package, is easily mounted in an inexpensive window bushing made by AMP, model 530563-1. The PIN 3D photodiode can be mounted in



Light bits. Simple data transmitter (a) and a receiver (b) form the nucleus of a fiber-optic transmission system that is capable of handling all types of digital waveforms. Link operates over a wide band of frequencies (c). Cost of the 10-meter-long unit, including cable, is under $90.

the same type of connector if desired. The need for delicate mounting adjustments is avoided here by using a fiber bundle of sufficient diameter, in this case 45 mils. Galite 2000 cable is satisfactory, and Valtec, Rank Industries, and others produce similar bundles.

The Galite cable has 210 fiber elements having an attenuation of 450 decibels per kilometer at 910 nm and a bandwidth-distance product of 15 megahertz/km. For a 10-meter-long link, therefore, the cable loss will be 4.5 dB and the bandwidth will be 1 gigahertz. With the measured loss of 1.5 dB in the LED-to-cable interface and a cable/detector interface loss of 3.9 dB, the total loss amounts to 10 dB. Thus, the 0.6-mW output of the LED is reduced to 0.06 mW at the receiver.

Transmitter layout is not critical in a one-way link. Duplex operation will require electrical isolation between transmitter and receiver components. There are several precautions to take in constructing the receiver. Notably, the lead from the anode of the detector diode to the transimpedance amp must be kept as short as possible. The output of the receiver should be isolated from all previous stages to prevent unwanted pickup. A ground plane is not a necessity, but is recommended for processing data rates greater than 10 megabits/s.

The link's signal-to-noise ratio is slightly less than 40 dB, implying a bit-error rate above 10^{-8}. The system is operational over a temperature range of −40°C to 100°C, and a supply variation of 4.5 V to 5.5 V. □

Line-frequency converter transforms 50 Hz into 60 Hz

by Juan E. Piquinela
Montevideo, Uruguay

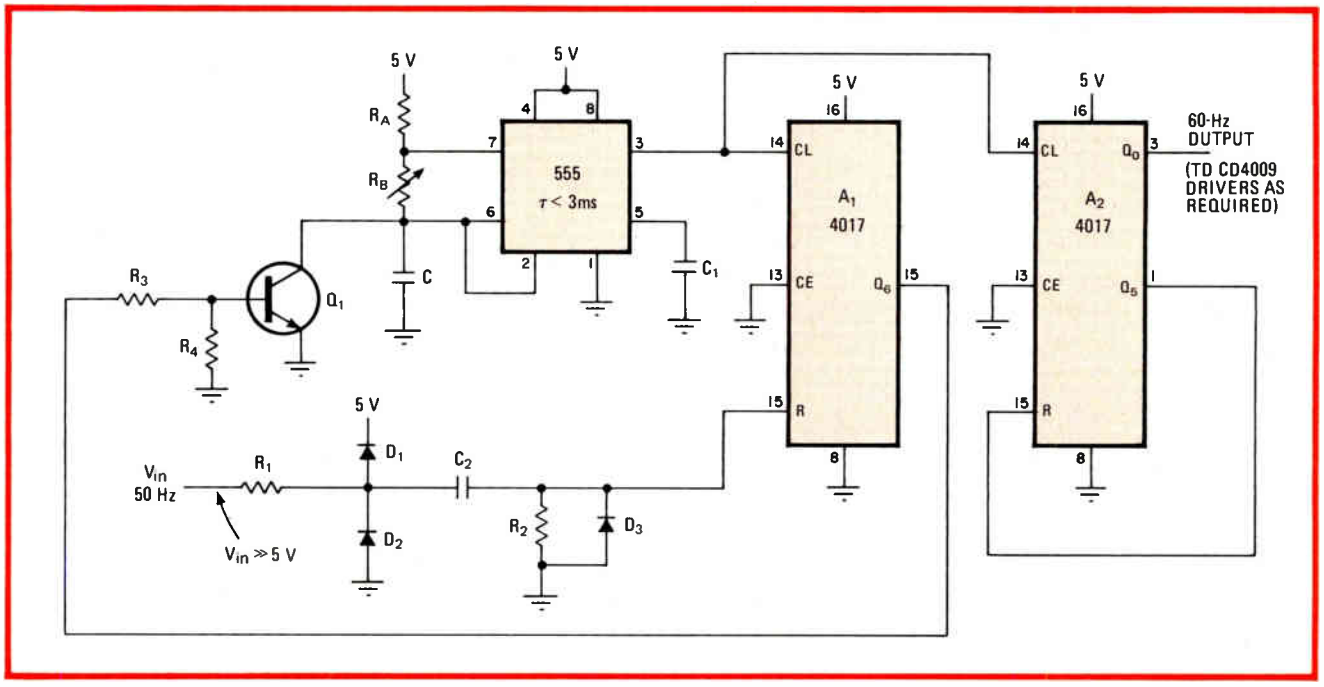
Low-power equipment driven from the 60-hertz power line can usually be expected also to work properly at 50 Hz—that is, except for electric clocks and other time-keeping devices, to which many a traveler outside North America will attest. For such devices, a circuit that provides a multiplication ratio of 6:5 for generating a 60-Hz output from a 50-Hz input is required. Such a low-cost, low-power circuit is shown here.

The 555 timer, operating as an astable multivibrator at 300 Hz, provides the 4017 counter, A_1, with six count-pulses for every reset pulse from the 50-Hz line. The timer's period of oscillation—about 3 milliseconds—is not critical as long as six of its cycles are completed in less than 20 ms, the period of the 50-Hz line frequency.

On the sixth pulse, Q_6 of A_1 moves high and disables the timer through transistor Q_1 by shorting capacitor C. Thus, independent of the period set for the 555, its average frequency is 50×6 = 300 Hz. At the positive zero-crossing of the line voltage that occurs shortly after the sixth pulse, A_1 is reset through R_1-R_2, C_2, and D_1-D_2, and the process repeats.

Counter A_2 provides a divide-by-five function at 300 Hz, thereby generating an output frequency of 60 Hz. C-MOS drivers or transistors can provide increased current capability as required. □

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.



On time. Three-chip multiplier converts 50-Hz power-line frequency into 60 Hz for devices used in the U. S. A_1 generates six pulses for every 50-Hz cycle, forcing 555 timer to generate average frequency of 300 Hz. A_2 provides divide-by-five function on 555 waveform.

Electronic security lock has nonvolatile latch memory

by Ray Oakley
Plessey Semiconductors, Irvine, Calif.

Nonvolatile quad latches serve as the memory bank in this electronic security lock, which can be programmed with any one of more than 65,000 possible four-digit combinations. The number of combinations that can be selected for opening the lock can be greatly increased, simply by cascading the latches and their corresponding control circuitry.

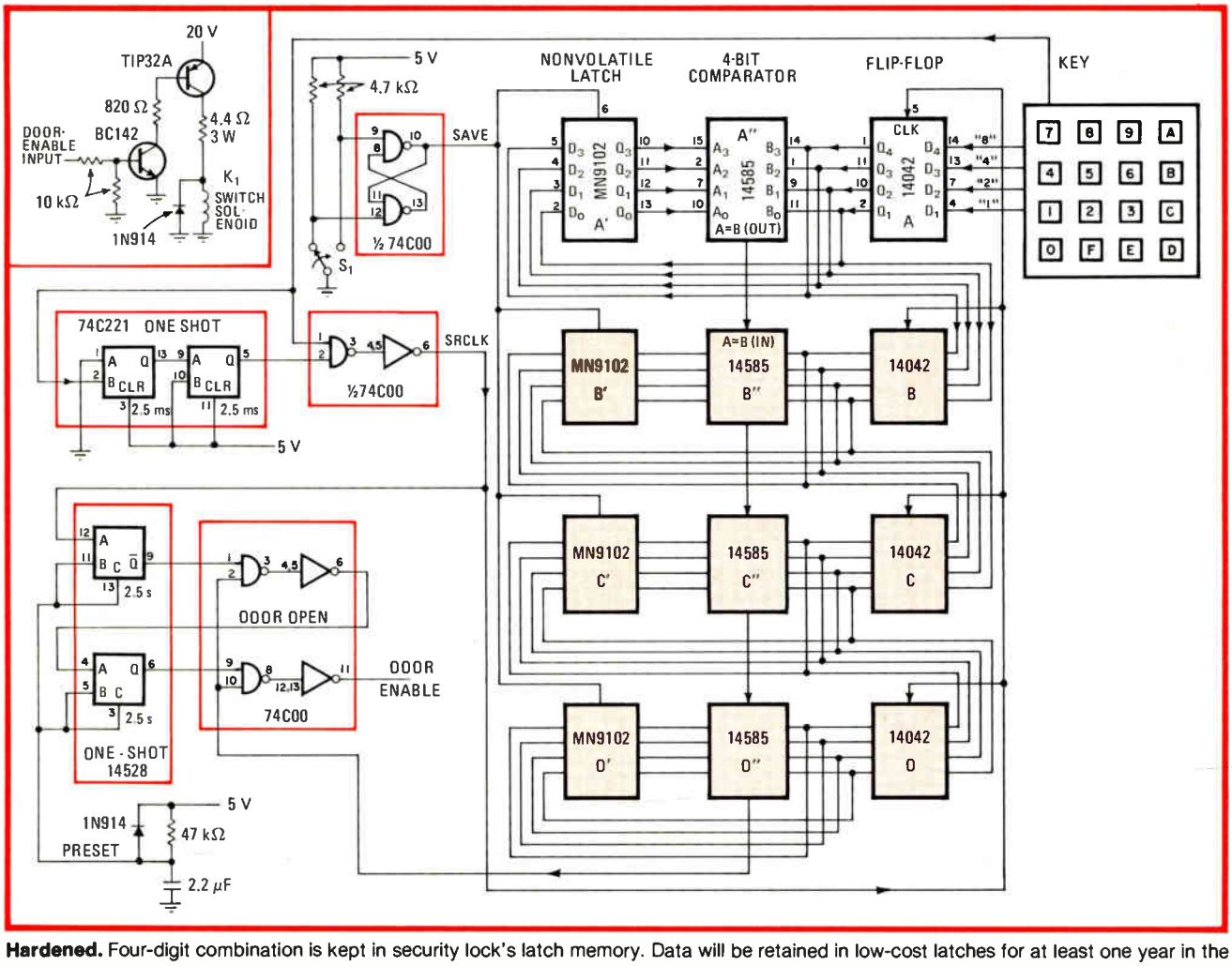
The desired four-digit combination is stored in the Plessey MN9102 latches by first entering the number via the keyboard, which provides a hexadecimal output. If the code were 3579, digit 3 would first be introduced to the D input of flip-flop A. At the same time, the signal KEY, which indicates contact closure, is generated. KEY produces clock signal SRCLK, generated by a monostable multivibrator, which prevents keyboard bounce and which clocks 3 into A.

Because the outputs of each flip-flop, n, are connected to the D inputs of the next flip-flop in the line, n + 1, the successive introduction of the remaining digits translates the digit 3 from A to flip-flop D, with the end result that 5 will be in flip-flop C, 7 in B, and 9 in A at the conclusion of the sequence. The outputs of A to D are also connected to latches A′ to D′, respectively, and so by activating switch S_1 momentarily in order to generate the $\overline{\text{SAVE}}$ signal, the digits can be stored in their corresponding latches.

Data can be retained in the latches for at least one year in the absence of applied power (+5, −12 volts). Typically, 10 million save operations can be made before device performance is affected.

In actual operation, the first digit keyed in is compared with the 9 stored in A′, at comparator A″. Assuming the first digit keyed is a 3, there will be no output from the A = B port of the comparator. Neither will there be any output from B″ or C″ as the digits 5 and 7 are entered.

As the final digit, 9, is entered, however, digit 3 is placed in D, 5 moves to C, and 7 is stored in B. All comparators therefore indicate A = B, and a door enable signal is generated, thereby activating K_1 after a user-selected delay provided by the 14528 one-shot. □



Hardened. Four-digit combination is kept in security lock's latch memory. Data will be retained in low-cost latches for at least one year in the absence of applied power. Matching input code entered via keyboard energizes relay K_1 after user-specified delay.

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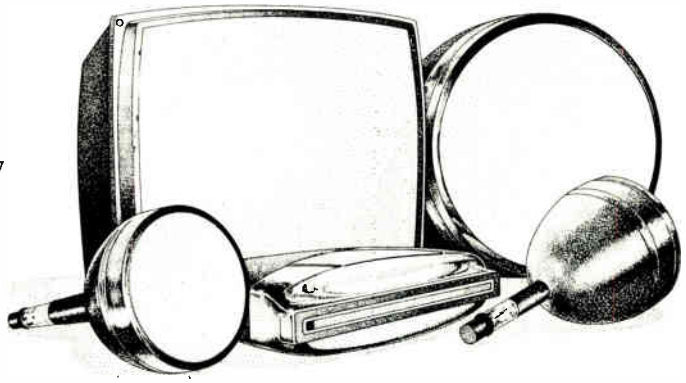

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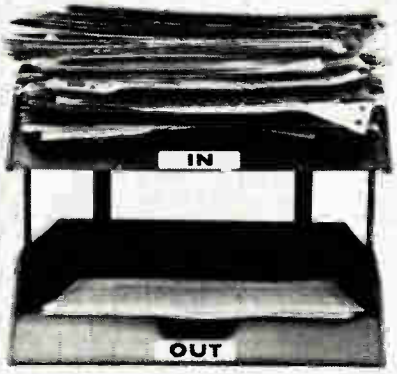

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Interface processor has two minds to transfer data faster

Custom two-in-one processor shares bipolar logic to interface computer and asynchronous mass storage

by Alton B. Otis Jr., *Xebec Systems Inc., Santa Clara, Calif.*

☐ As fast and as capable as microprocessors have become, applications continue to crop up that ask them to do too much too fast. Often the special demands of these applications can only be met by custom designs—such as the Xebec X2, a board-level control processor built from bipolar medium- and large-scale integrated circuits.

The X2 has most of the logical elements of two entire processors that execute two independent routines at the same time but share a single arithmetic and logic unit (ALU), a microinstruction sequencer, and common working storage. It has two accumulators and two program-address registers; while one processor uses the 8-bit ALU, the other is selecting its next instruction. The overlapped operation is fast. The X2 has a 125-nanosecond microinstruction cycle time—allowing it to execute 8 million instructions per second, 75% to 125% more than a comparable bipolar processor without the overlap.

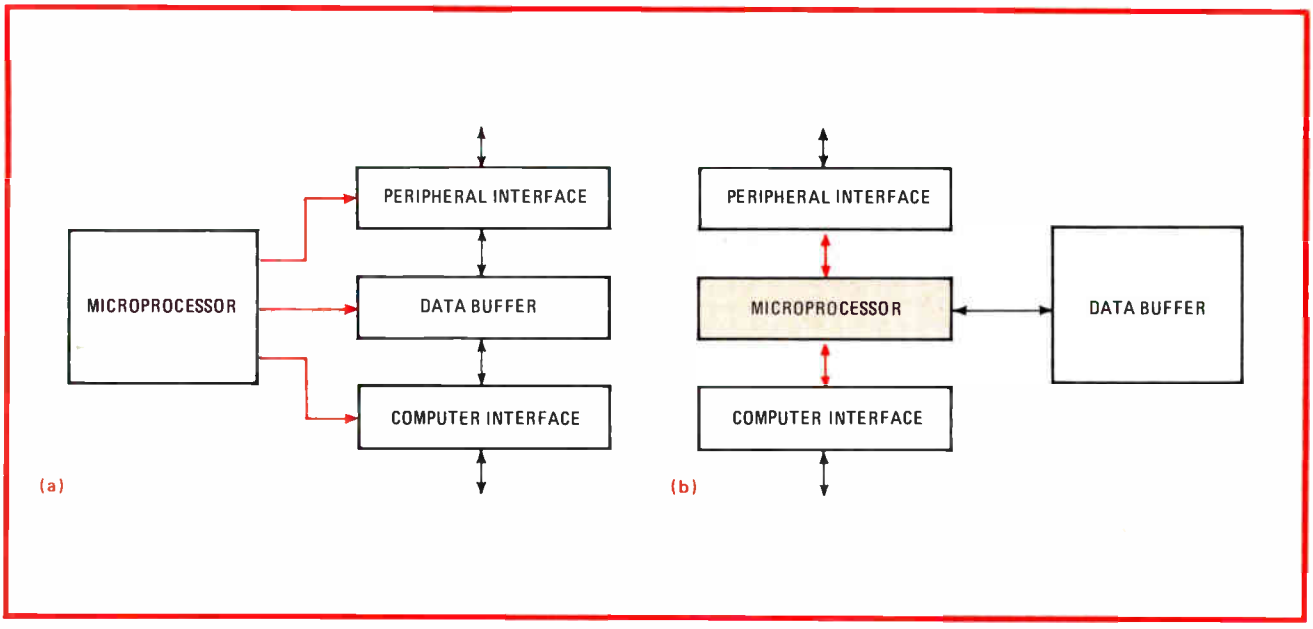
This custom circuit arose from a decision by Xebec Systems Inc. in late 1977 to develop a new series of program-transparent mass-storage controllers for the computer peripherals market. The engineering department reviewed the approaches taken in this area and went about developing a unified design philosophy that would be adaptable across a broad range of computers and peripherals.

Stated generally, the objective was to produce the optimum interface between two high-speed asynchronous devices. The specific product goal was to develop a set of single-card controllers that would marry disk and tape drives to computers.

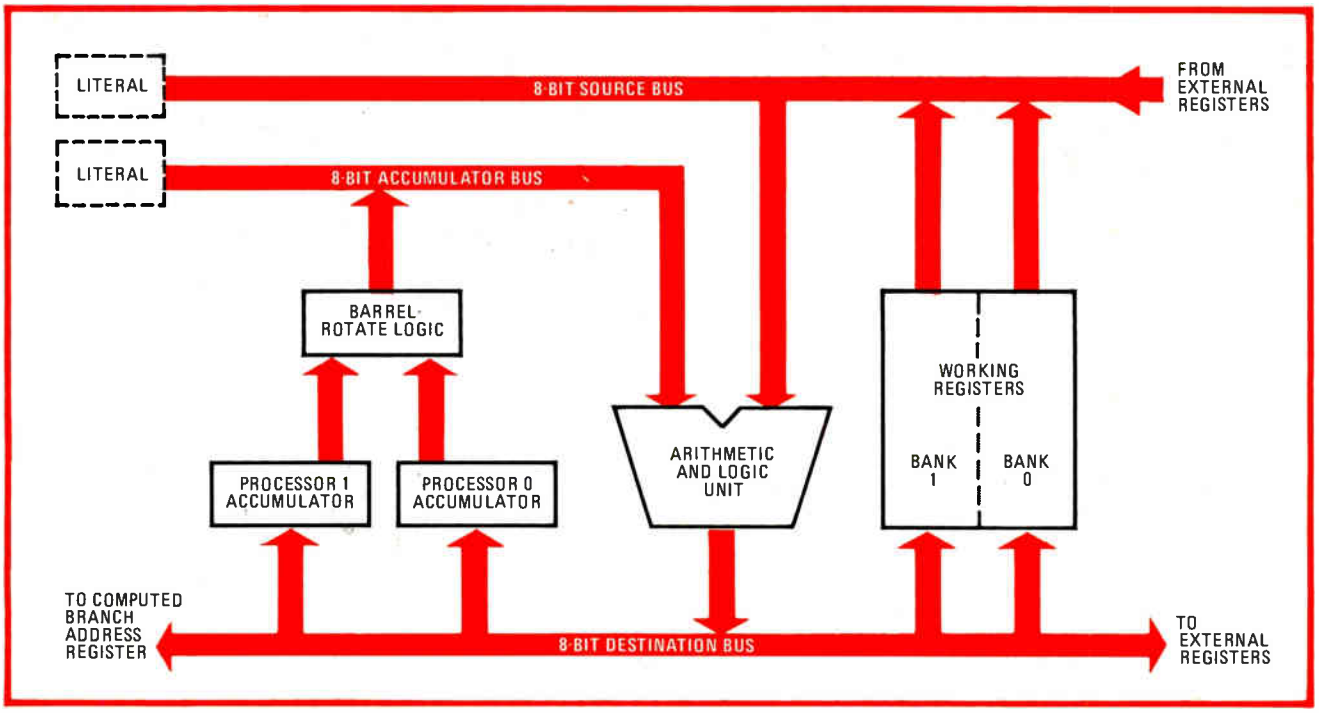
The interface design for each peripheral and computer pair selected was to be sufficiently adaptable to allow the emulation of two or more existing controllers available from other sources. It was also hoped that the basic design would allow new controllers to be built with little or no hardware modification.

Modular design

If the portions of each design common to a given peripheral or computer type could be made to exhibit a high degree of similarity, the way would be open to a set of programmable building blocks that could be readily combined to create new controller products. Such blocks



1. Position-dependent. The microprocessor in a peripheral controller could serve for overall control (a), in which case data-path switching is performed by discrete logic. Alternatively, it could be made central to all interface functions (b). The latter approach was chosen.



2. Shared ALU. The X2's two processors share one physical set of logic: while one uses the arithmetic and logic unit, the other uses the logic that selects next instruction. Shared working storage locations eliminate the need for an interprocessor communication channel.

or modules reduce engineering efforts for new product development and decrease training requirements for manufacturing and field-service personnel.

From the outset it was apparent that a microprocessor-based design would be required, but the microprocessor's precise role in the system was not immediately clear. It could, for instance, serve only for overall control, with data-path switching and other high-speed functions performed by discrete random logic (Fig. 1a). On the other hand, it could be made central to all interface functions (Fig. 1b).

Although the first approach promises an optimal design for each product, its building blocks are less general. In the second approach, however, each controller consists of three design modules: the peripheral interface, the computer interface, and the microprocessor. The interfaces communicate only with the microprocessor, so they can be independent of each other.

Having chosen the second route, the Xebec engineers looked around for a microprocessor fast enough to service the peripheral and computer interfaces simultaneously with data transfer rates as high as 300 kilobytes per second. Depending upon the instruction set, it was felt that an execution rate of 5 to 10 million instructions per second would be adequate. This rate was deemed necessary to allow each of the interface firmware service routines to execute 10 to 20 instructions per byte transferred and to allow control firmware to be switched between the service routines.

When it was discovered that the speed requirement could not be met by any single commercially available high-speed microprocessor, the idea surfaced to use two processors—one to service the peripheral and the other to service the computer. This appeared very promising with regard to speed but posed the problems of increased cost and interprocessor communication. The two independent, asynchronous processors called for some form of communication channel between them having an associated firmware protocol to avoid access-contention problems. To take advantage of the increased speed from dual processors, the design needed an interprocessor communication protocol that was as simple as possible. The following seemed to be a simple solution to the communication problem:

- Divide the instruction cycle into two phases of equal length, with an ALU (arithmetic and logic unit) phase for data processing and another for the selection of the next instruction (the NIS phase).
- Synchronize and interleave the phases between the two processors so that while one is in its ALU phase the other is in the NIS phase.
- Allow both processors to share a common data bus; provide on this bus a working storage unit that can be read, modified, and rewritten in a single ALU phase.

The working storage of this scheme became the interprocessor communication channel, with either processor able to set and/or clear bits within an instruction cycle without contention with the other processor. Thus the hardware communication channel was eliminated.

Shared logic

This design made it possible to share the bulk of the ALU and NIS logic between the two processors due to the interleaved process by which the processors utilized the logic. That is, while one processor used the ALU logic, the other used the NIS logic, and vice versa. This technique, in fact, permitted the two processors to share one physical set of logic.

The interleaved dual processor approach appeared so promising that the search for a commercial microproces-

PROGRAM BRANCH CONDITIONS	
Code	Condition
0	Unconditional branch
1	Destination bus negative (high order bit = 1)
2	(unused)
3	ALU carry ≠ 0
4	ALU carry = 0
5	Destination bus value ≠ 0
6	Destination but value = 0
7	No branch

sor was abandoned and the X2 custom dual microprocessor was designed from existing MSI and LSI circuits.

The X2 architecture (for which there is a patent pending) makes possible a system that executes 4 million instructions per processor per second. Its shared ALU, shown in Fig. 2, utilizes separate source and destination buses for data input and output, instead of a single three-state bus. The separate buses eliminate the time that a single bus needs to reverse its direction.

The processor-dependent accumulators in the figure are connected to the ALU via barrel-rotate logic. This logic provides a 0- to 7-bit rotation and improves throughput by allowing multiple-bit shifts within a single instruction cycle. The placement of the rotate logic between the accumulator and the ALU (rather than at the output of the ALU) increases the system speed. Also, each instruction word contains an 8-bit literal value that may be selected in lieu of either input to the ALU. This permits the contents of the accumulators or the source-bus registers to be combined with a literal value prior to processing.

At the end of the ALU phase, the output of the ALU may be stored in the processor's accumulator, a selected working-storage location, a selected destination-bus register, or any combination of the three. This feature allows the firmware to maintain in working storage a current copy of the destination-bus registers, which cannot be read by the processor.

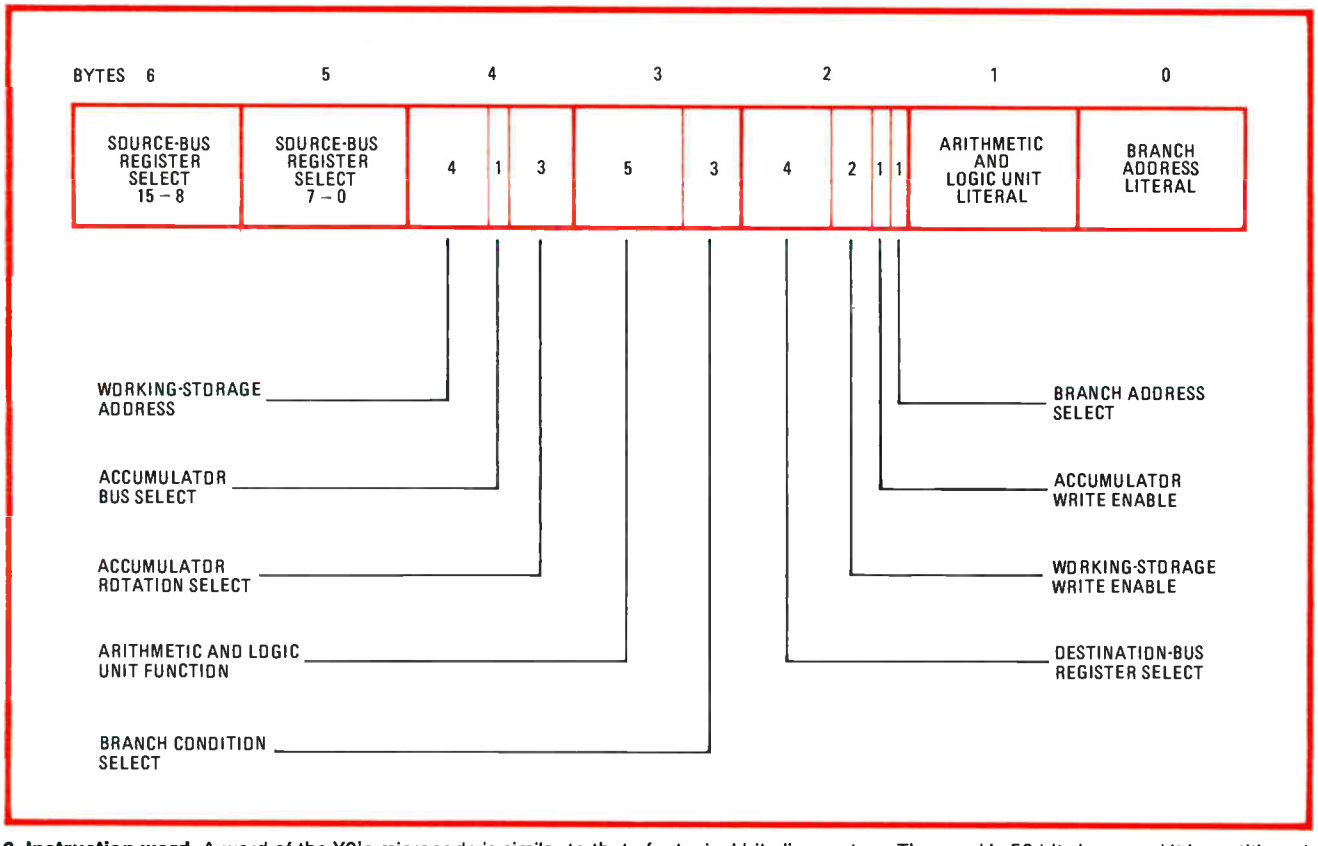
Decision making

In addition to the ALU function, each instruction word may specify a conditional or unconditional program branch. For conditional branches, the condition is tested at the end of the ALU phase (branch conditions are listed in the table). The branch address may be obtained either from the instruction word (a literal branch) or from the output of the ALU (a computed branch).

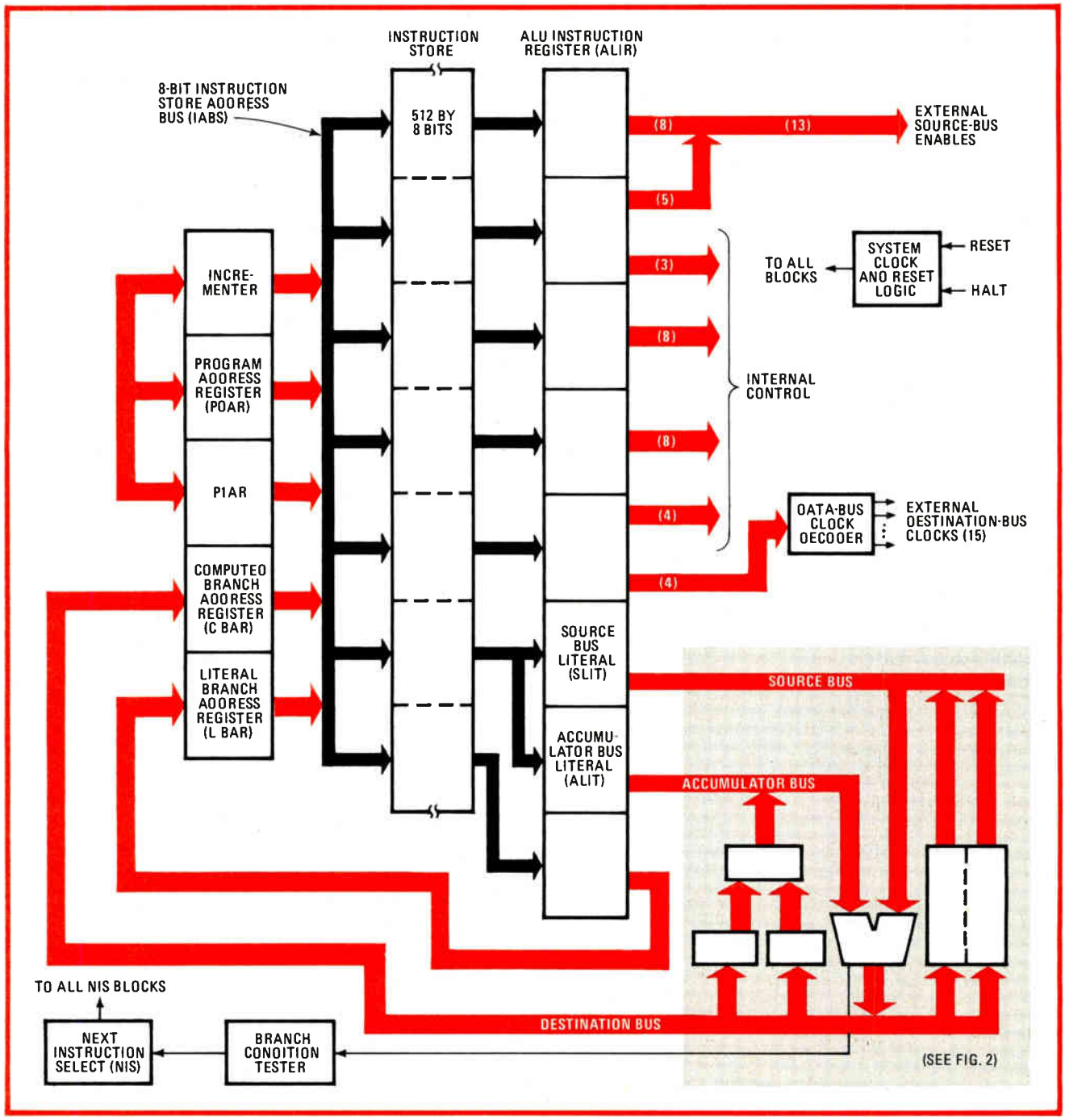
A total of 32 bytes of working storage is provided in two banks of 16 bytes apiece. The output of the storage is latched internally and the input is edge-triggered to allow for a complete read-modify-write cycle within a single ALU phase.

The instruction store consists of 512 56-bit words, divided equally between the two processors. This store can be extended via a bank-switching scheme.

Figure 3 shows the format of the X2's instruction word. The two high-order bytes select the source-bus input for the ALU. Direct 16-bit mapping is used (1 bit per device or register) rather than 4 bits and a decoder to



3. Instruction word. A word of the X2's microcode is similar to that of a typical bit-slice system. The word is 56 bits long, and it is partitioned into 7 bytes for register selection, ALU functions, branch conditions, addresses, and literal values for use in ALU operations or branching.



4. Custom. The entire X2 microprocessor requires 46 small- and medium-scale integrated circuits. When used as a peripheral controller, it resides between the peripheral and the computer. But it has many other possible applications in the control of fast asynchronous devices.

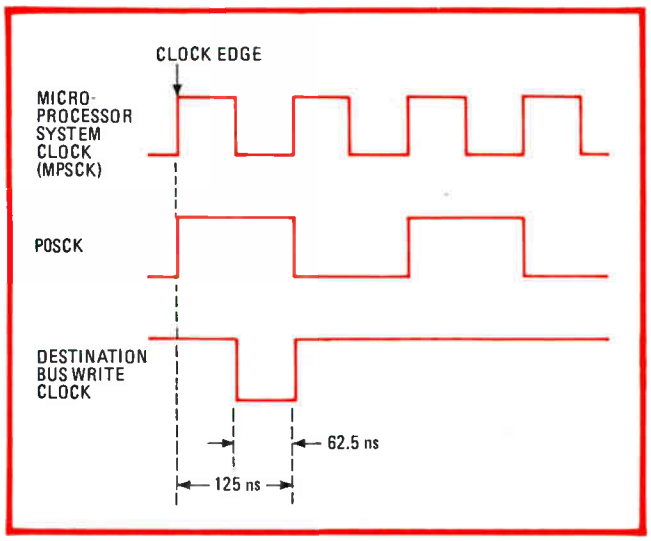
improve the system speed. Three of the bits are assigned to the working-storage banks and source-bus-literal devices within the X2, leaving 13 bits to be assigned to external devices.

The working-storage address is held in byte 4, along with 3 bits to specify the degree of accumulator rotation and 1 bit to signify whether the accumulator or the literal value will be the ALU's input.

Byte 3 specifies the ALU function and selects the branch condition; byte 2 specifies the destination of the ALU result (destination-bus register, working storage bank, accumulator, or combination thereof) and the branch-address source (literal or ALU). Bytes 1 and 0 contain the ALU and branch-address literals, respectively. The destination-bus register is selected by a 4-bit address that is decoded into 15 clock lines, each assigned to an external destination-bus device.

Bus service

The X2 has four primary buses for data movement (Fig. 4). The source bus feeds the ALU with operands. It is a three-state bus and serves as the primary input for all registers and devices external to the X2. The destination bus is actively driven with ALU output data. It is the



5. In step. The X2 system is controlled by an 8-megahertz single-phase system clock and a secondary half-frequency clock (POSCK). The latter determines which of the two processors is using the circuitry for next-instruction selection and which is using he ALU.

primary output path for all registers and devices external to the X2.

The accumulator bus is a three-state path that carries operands into the ALU. The accumulator and source buses are combined by the ALU to create a single destination-bus output.

Finally, the three-state instruction-store address bus (IABS) is used to interface four registers with the instruction store. The high-order address bit fed into the instruction store (not shown) is derived from a clock signal that splits the store in half. Processor 0 accesses the first half, locations 0 to 255, while the other, processor 1, addresses 256 to 511.

The ALU instruction register, ALIR, holds the instruction word of the processor currently using the ALU. The ALIR includes source-bus and accumulator-bus literal registers (SLIT and ALIT).

The five registers at the left in Fig. 4 include an incrementer, a program-address register for each processor (P1AR and P0AR), and two branch-address registers, LBAR and CBAR (literal and computed addresses).

During a processor's ALU phase, its program-address register contains the address of the instruction that follows the one currently executing in the program. The literal and computed branch-address registers hold branch addresses (whether they are used or not) during the NIS phase.

The system is controlled by a single-phase microprocessor system clock (MPSCK) and a secondary, half-frequency clock called POSCK (see Fig. 5). POSCK determines which processor is utilizing which portion of the logic (ALU or NIS). From this signal is derived the high-order address bit used to partition the instruction store. The write clocks for the destination bus are generated in the last half of the MPSCK cycle and have a positive-going edge that is synchronized with the edge of the MPSCK. All system clocking occurs on the positive edge of the MPSCK. The rest of the clock period is assigned to output settling and input setup time.

The events that occur at the clock edge are as follows. For the processor in its ALU phase, the ALU output is first stored at the selected destinations and in the CBAR of the NIS logic. Next, the branch-address-literal and branch-address-select bits are transferred from the ALIR to the LBAR and NIS control logic, respectively. Finally, the selected branch condition is tested and a bit is set in the NIS control logic if a branch is to occur.

This processor now enters the NIS phase with the clock edge. It uses the two branch-select bits to gate the contents of one of three registers onto the IABS. The selected register is the processor's program-address register (for no branch) or the CBAR or LBAR (for a computed or literal branch).

The instruction address, incremented by 1, settles at the inputs to the P0AR (or P1AR) prior to the next clock edge. The instruction selected by the address also settles at the inputs to the ALIR prior to the next clock edge.

The output of the instruction store is transferred into the ALIR at the rising edge of the MPSCK. The address of the instruction that follows the currently selected instruction in the program is stored in the processor's program-address register, and the processor enters the ALU phase.

The selected source- and accumulator-bus inputs are combined by the ALU and the result is settled on the destination bus prior to the next clock edge. The selected branch condition settles at the input to the NIS control logic. This occurs after the destination bus and ALU carry bit have settled but prior to the next clock edge.

Two external control lines are provided to reset and halt the processor. The reset line, when active, stops all clock signal generation and activates an internal reset signal used for register initialization. After the reset is deactivated, the internal reset signal remains active for the next two NIS phases and forces both processors to branch back to their respective starting locations.

The halt line is used in conjunction with a firmware debugging device and a manufacturing test fixture. It provides halt, step, and start functions for firmware and hardware debugging.

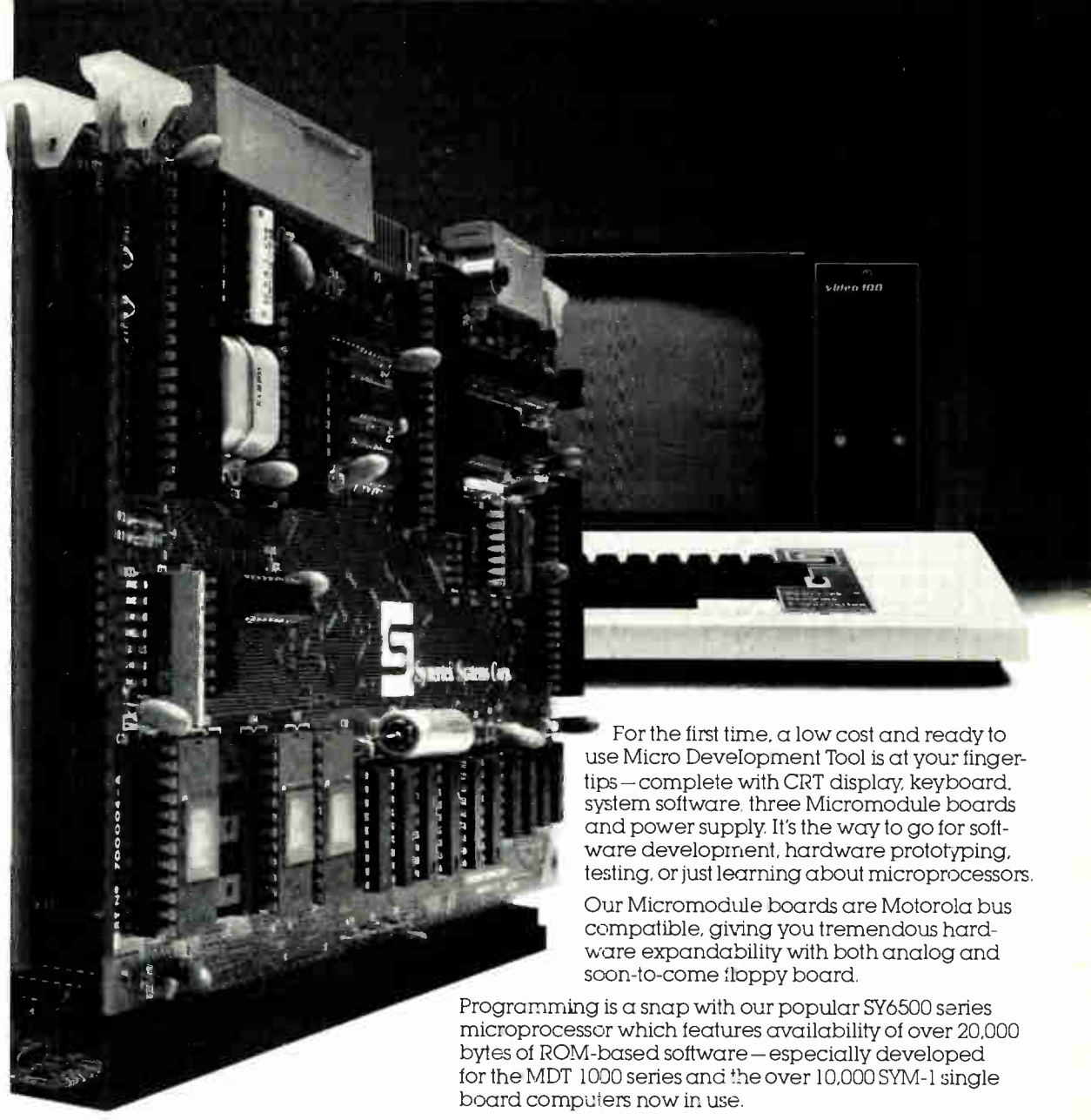
The real thing

A minimum implementation of the X2 requires 46 currently available parts (excluding a 16-megahertz oscillator module). Of these, two are 24-pin dual in-line packages while the rest have 20 pins or less.

When used as a peripheral controller, the X2 resides between the peripheral and the computer. The interfaces consist of registers that are read and written via the source and destination buses, respectively. If required, the interfaces could also incorporate logic to perform high-speed functions or provide additional storage beyond the requirements of a minimum implementation.

The X-2 can interface DEC's LSI-11 and PDP-11 minicomputers with cartridge and floppy disks. It is also available in a floppy-disk system compatible with the IEEE-488 bus. The use of the X2 architecture to optimize peripheral control is only one of many possible applications of this concept. The cost-effective control of two high-speed asynchronous devices is an oft-encountered engineering objective. □

SYNERTEK SYSTEMS



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Circle 149 on reader service card

Up-down counter measures cumulative frequency error

by A. M. Downing
Palomar Electronics Ltd., Victoria, Australia

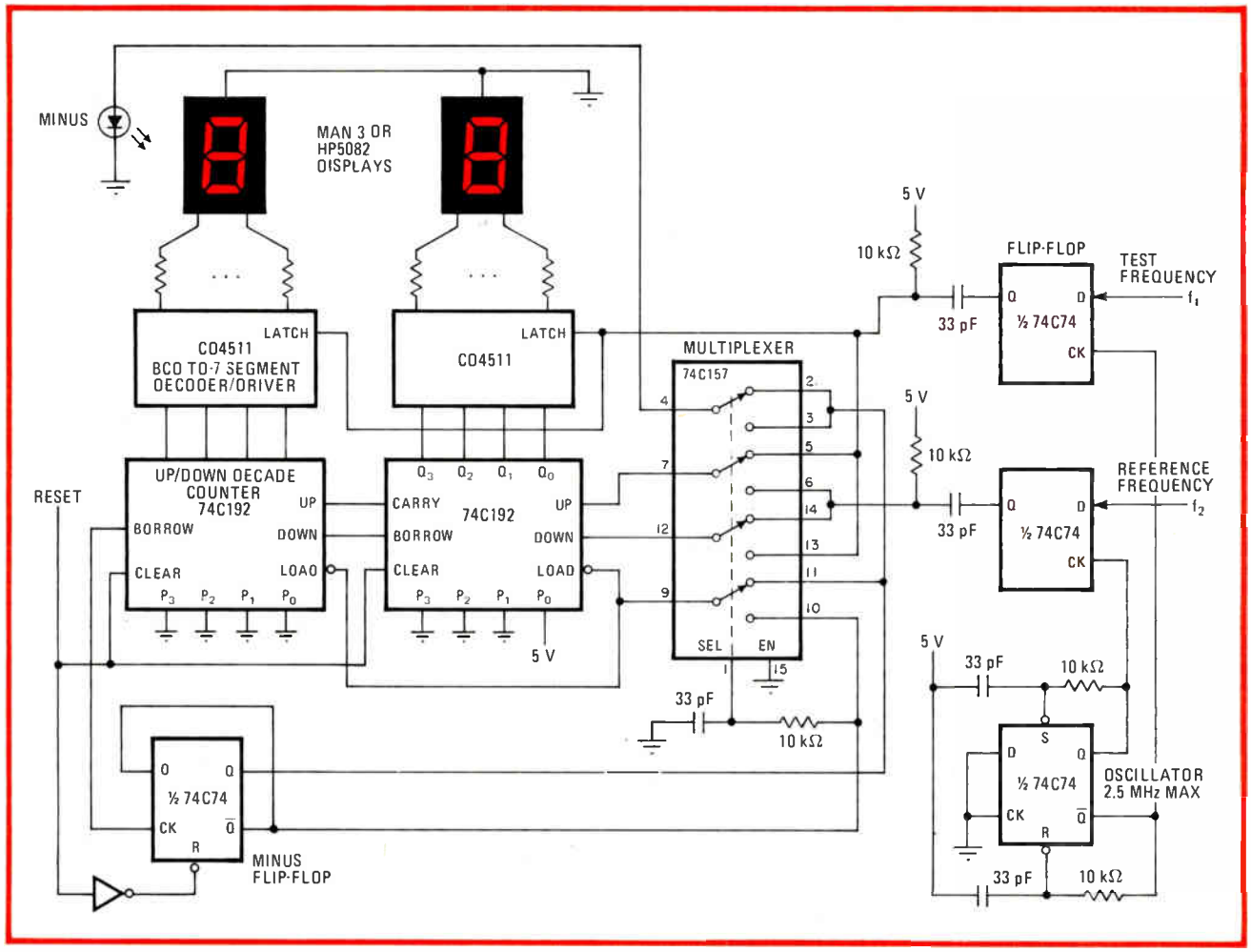
Determining the cumulative error, in cycles, between the frequency of a test signal and that of a secondary standard, this simple circuit is particularly useful in monitoring the short-term stability of a power-line generator versus a quartz-crystal reference. The sign of the error (plus if greater than the reference frequency, minus if less) is also displayed.

Two counter chains are usually required to compare the corresponding frequencies, and often a third chain is needed to accumulate the error count. Here a single up-down counter provides both functions, simplifying the circuit and cutting cost.

Signals f_1 and f_2 are initially synchronized by the 74C74 flip-flops at the input, which are clocked out of phase by a high-speed oscillator. The output of each signal-path flip-flop is therefore always separated by at least one half cycle of the oscillator frequency, depending on the actual frequencies of f_1 and f_2.

The Q output of the flip-flop associated with f_1 drives the up port of the two-stage 74C192 up-down counter via a two-channel multiplexer. Similarly, the f_2 flip-flop drives the down input of the 74C192. Thus, if $f_1 = f_2$, the 74C192 alternately counts up from zero to some value in a given sampling period, then decrements back to zero. Therefore the display—which is latched at the beginning of the next sampling period so that a correct value is rendered without flicker—indicates a zero count.

If f_1 is greater than f_2, the counter does not return to zero and the display will indicate a positive value. In the



Accumulation. Single-chain counter finds the cumulative error, in cycles, between the test and reference frequencies. Signals f_1 and f_2 increment or decrement the counter, respectively, over a given sampling period; the result in the counter at that time represents the magnitude of the error. The light-emitting diode indicates the polarity of the differential count with respect to the reference.

opposite case, that is, for f_1 less than f_2, the counter generates a borrow signal as it attempts to go below zero and thence to 99. In that event, the minus flip-flop is toggled so that the multiplexer is switched to its remaining channel. Thereafter, the f_1 flip-flop drives the counter's down port and the f_2 flip-flop drives the up input. Simultaneously, a counter-load pulse is generated, and the counter proceeds to count up from one, but with the minus light-emitting diode activated.

Should the count go below zero in a subsequent cycle, a borrow pulse is again generated and the multiplexer switched back to its initial channel. The LED is thus turned off, indicating a positive count. □

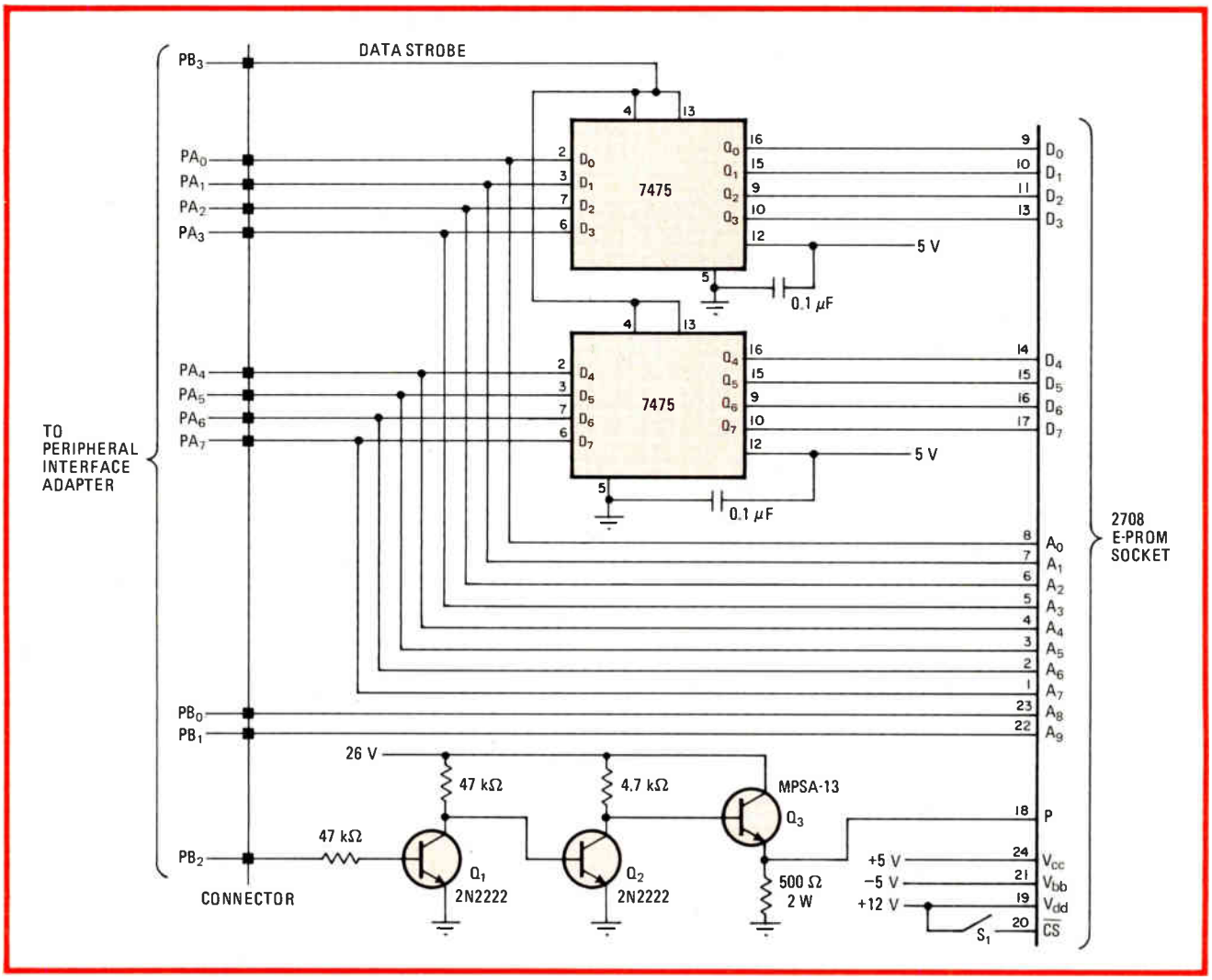
Engineer's notebook is a regular feature in *Electronics*. We invite readers to submit original design shortcuts, calculation aids, measurement and test techniques, and other ideas for saving engineering time or cost. We'll pay $50 for each item published.

Low-cost interface automates E-PROM loading

by Henry Jan Stec
Panama Canal Co., Panama

This on-board interface and the accompanying routine equip a microprocessor-based system with the ability to program erasable programmable read-only memories. A specific circuit realization and program for the Motorola MEK6800D2 evaluation kit are presented here to illustrate the simplicity of this low-cost scheme, but in general any microprocessor system can be adapted for such a task.

The MEK6800D2 kit accepts two 2708 8-K E-PROMs that may be programmed with data stored in the microprocessor system's random-access memories. These 1-K-by-8-bit E-PROMs are most easily programmed in two operations that load half the memory at a time with upper and lower blocks of 512 bytes each. The loading is done with two quad latches, three transistors, and the



Loading blocks. Two-chip three-transistor interface and short software routine for MEK6800D2 evaluation kit simplify writing into an E-PROM. Under software control, the E-PROM is quickly programmed in 512-byte blocks with data transferred from random-access memory.

STRATHCLYDE

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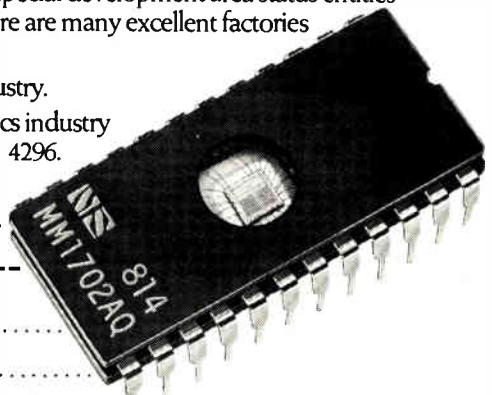

Name.....

Position.....

Company.....

Address.....

.....Tel.....

Strathclyde Regional Council

Industrial Development Department, 21 Bothwell St., Glasgow G2 6NJ. Tel.041 221 4296

The silicon chip illustrated (type MM 1702 AQ) is manufactured in the Strathclyde Region by National Semiconductor (UK) Ltd.

MEK6800D2 E-PROM PROGRAMMING ROUTINE

Location	Op code	Operand	Mnemonic	Comments
00	8E	A04F	LDS	
03	86	FF	LDAA	set up PIA's input/output lines
05	B7	8004	STAA DDRA	
08	B7	8006	STAA DDRB	
0B	86	04	LDAA	
0D	B7	8005	STAA CRA	
10	B7	8007	STAA CRB	
13	86	64	LDAA	number of loops = 100
15	B7	A041	STAA C1	
18	CE	03FF	LDX	
1B	8C	FFFF	CPX	end of current loop?
1E	27	4E	BEQ	to 6E
20	FF	A042	STX C2, C3	
23	FF	A044	STX C4, C5	
26	7A	A042	DEC C2	
29	7A	A042	DEC C2	
2C	2C	07	BGE	to 35 – does highest E-PROM address point to lower E-PROM?
2E	FE	A044	LDX C2, C3	
31	A6	00	LDAA	
33	20	02	BRA	to 37
35	86	FF	LDAA	
37	B7	8004	STAA ORA	output accumulator to PIA
3A	86	08	LDAA	
3C	B7	8006	STAA ORB	strobe latches
3F	7F	8006	CLR ORB	
42	FE	A044	LDX C4, C5	
45	B6	A045	LDAA C5	
48	B7	8004	STAA	output address bits 0 through 7
4B	B6	A044	LDAA C4	
4E	B7	8006	STAA ORB	output address bits 8 and 9
51	01		NOP	delay for address setup
52	01		NOP	
53	01		NOP	
54	01		NOP	
55	01		NOP	
56	86	04	LDAA	raise program pulse 1 ms
58	BB	8006	ADDA ORB	
5B	B7	8006	STAA ORB	
5E	C6	65	LDAB	pulse length adjust
60	5A		DECB	
61	26	FD	BNE	to 60
63	86	FC	LDAA	lower program pulse
65	BB	8006	ADDA ORB	
68	B7	8006	STAA ORB	
6B	09		DEX	
6C	20	AD	BRA	to 1B
6E	7A	A041	DEC C1	
71	26	A5	BNE	to 18
73	3F		SWI	stop

program shown, which initially resides in system RAM.

The program is loaded into the microprocessor system by its own bootstraps when the power is turned on. Because the program is short, there is plenty of room for many other utility programs in even a small (8-K) utility E-PROM.

Under software control, data to be written into the desired half of the 2708 E-PROM is passed from each RAM location to the peripheral-interface adapter's PA_i lines. For each location, the PIA strobes the data into the 7475 quad latches and the D_i bus. The program then sends the desired byte address through the PIA to the E-PROM's A_i bus and applies a programming pulse (P) via transistors Q_1 through Q_3.

In this way, the lower half of the E-PROM is programmed. Logic 1s are then applied to the quad latches so as not to disturb any data previously stored in the upper half.

The actual mechanics of programming is simple. After the E-PROM is placed in its socket, the system is turned on and a system-reset pulse applied. The 26-volt supply required for E-PROM pulsing is then activated. Switch S_1 is closed and the program is executed, whereupon S_1 is opened and the 26-V supply turned off.

To program the upper half of the E-PROM, location 2C of the program must be modified so that it contains 2B and location 30, containing 42, is added to the listing. The time required to program an E-PROM is 2 minutes. □

Engineer's newsletter

Conductive adhesive meets copper foil

Copper foil with pressure-sensitive conductive adhesive coated on one side is a natural for use on flexible and rigid printed-circuit boards and cables. This material is now available, consisting of 2-mil copper foil with an adhesive called RPM 3142, an acrylic-based product with a 30-oz-in. peel strength.

The conductive component of the adhesive forms an electrical path from the copper to any conductive material it is stuck to. Its service temperature range is −40° to +150°F. For information write Richards, Parents & Murray Inc., 206 South 14th Ave., Mount Vernon, N. Y. 10550, or phone (914) 664-3464.

Handbook translates Basic into Basic

The Basic computer language is basic to the operation of most computers—especially of the home and office type. But **Basic has never been standardized; there are more than 100 "dialects."** A guide called "The Basic Handbook: an Encyclopedia of the Basic Computer Language," written by David A. Lien, provides a good deal of help in coping with these assorted dialects.

This book covers 78 of the most popular versions of Basic in such a way that its readers can convert nearly any program to run on a computer that uses a different version of the language. The versions of Basic used with more than 50 computers from IBM, Cromemco, Apple, Exidy, Imsai, Heath, Ohio Scientific Instruments, Radio Shack, Commodore, Southwest Technical Products, Hewlett-Packard, and Wang, among others, are represented in the 360-page book. It is available for $14.95 plus $1.35 postage and handling from CompuSoft Publishing, a division of CompuSoft Inc., 8643 Navajo Rd., San Diego, Calif. 92119.

Music signals program completion for small computer

When running a long program on a home computer, it's handy to have an audible cue that signals the end of execution. The Radio Shack TRS-80 personal computer, for instance, is not normally equipped with an audio output, but can easily be set up with the equivalent.

This is accomplished by inserting a CSAVE command, which instructs the computer to save the program on tape; 100 CSAVE "X" will do the job. The tape recorder normally attached to the computer is left in the play mode with a music cassette loaded in it. The earphone jack must be unplugged, of course. When the computer encounters the CSAVE instruction, it will turn the tape recorder on. The sound of music serves notice that the program has finished running.

Cass R. Lewart of System Development Corp. in Eatontown, N. J., came up not only with this idea but also with a second one concerning tape loading. **Tape loading is one of the most critical operations for the TRS-80 user.** It often involves a lot of fiddling with the volume control on the tape machine.

Wiring a VU meter (such as a Calectro DI-930 without external shunt) across the earphone jack of the tape recorder and setting the output level with the volume control to −3 VU solves the problem for all but the poorest tapes. For bad tapes, Lewart says, you will need a scope to adjust the pulse height to approximately 0.7 V. **-Harvey J. Hindin**

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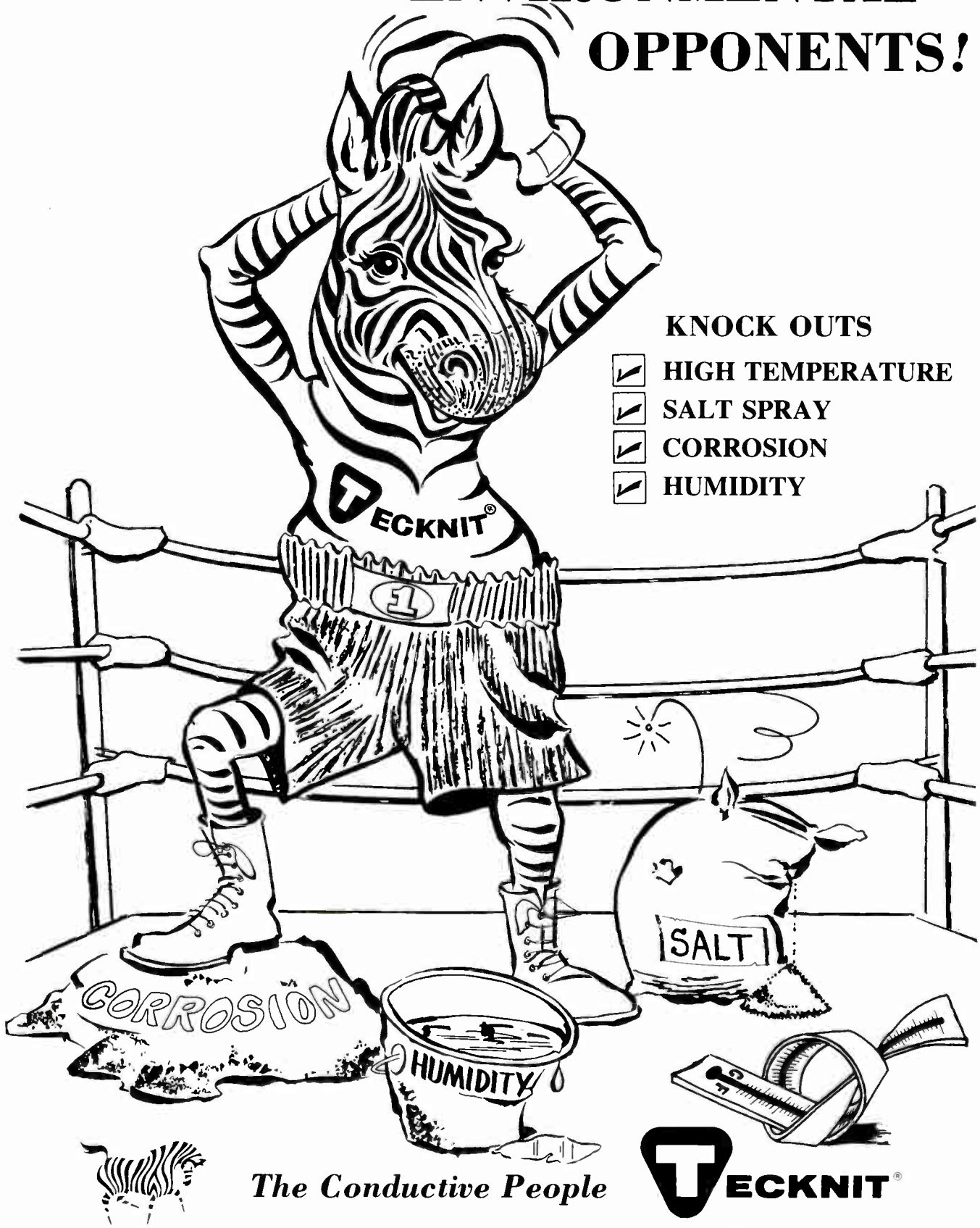

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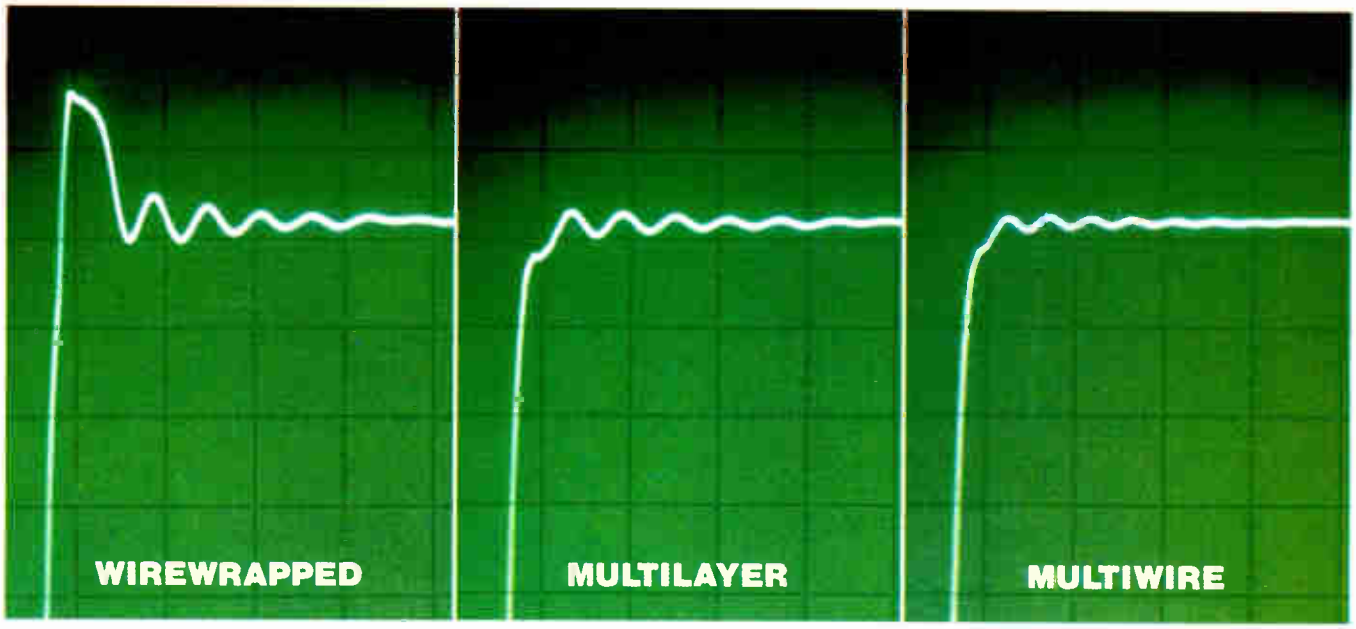

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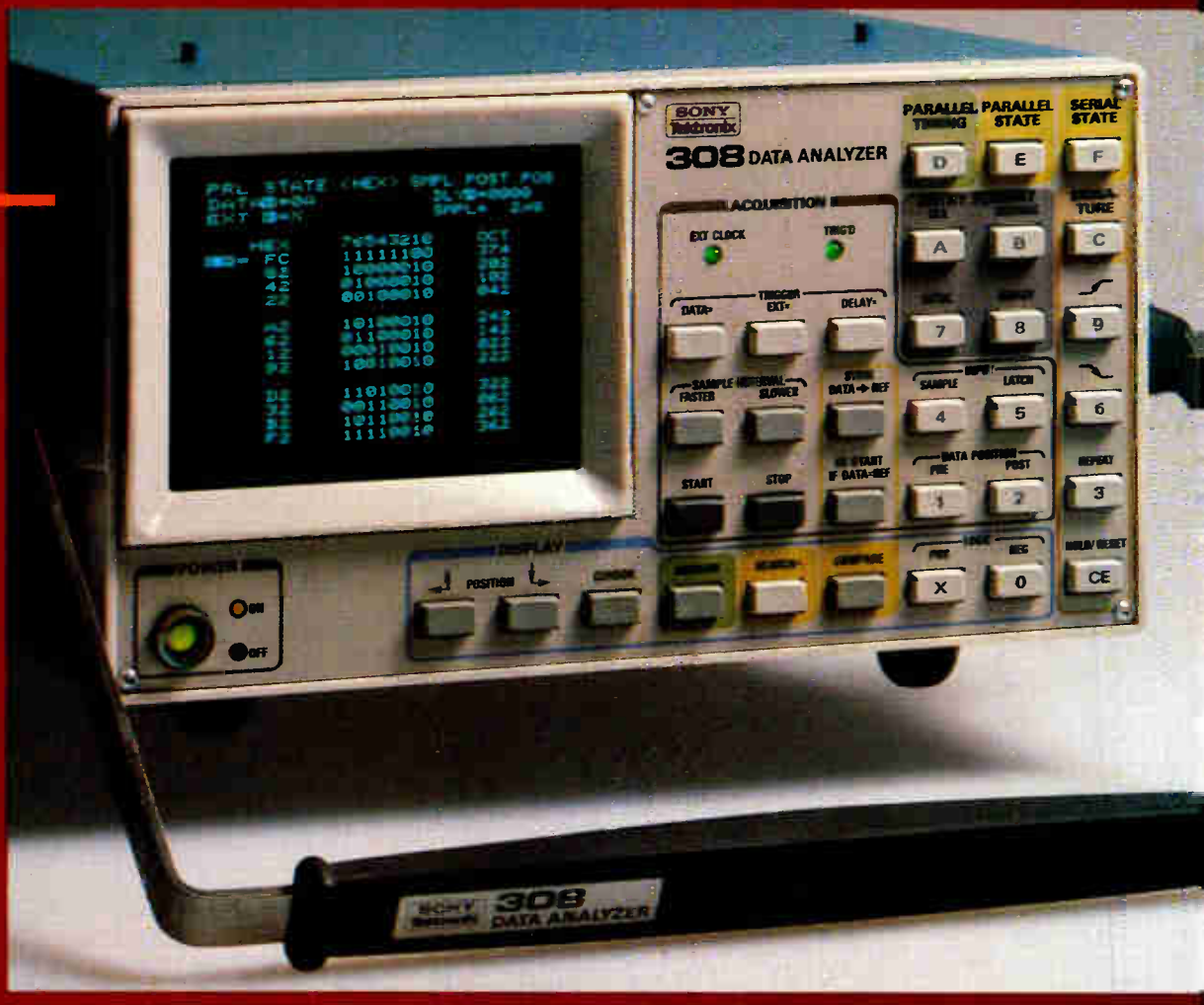
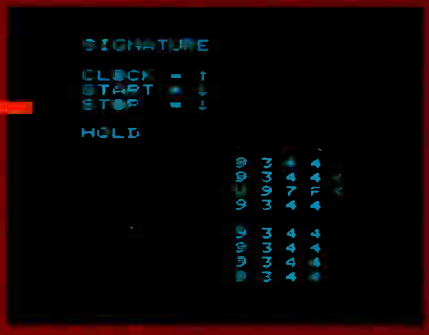
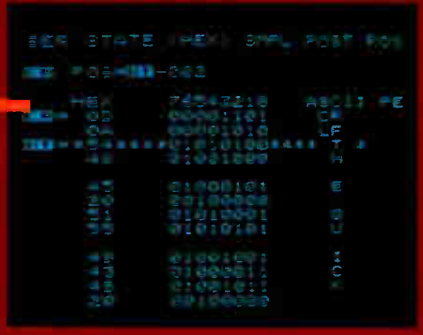


308 display of parallel state data.

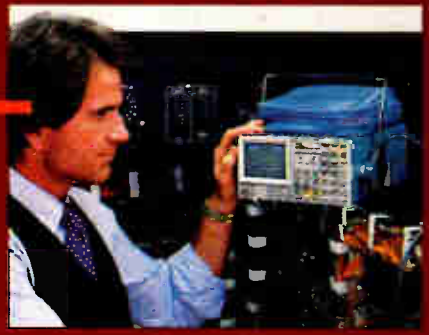
Parallel timing diagram can also be displayed as a state table in hex, binary and octal.



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



Serial display includes ASCII readout in addition to hex and binary.



The 308 is lightweight (3.6 kg/8 lb) and portable.

All logic analyzers handle parallel data. Only one also does serial and signature.

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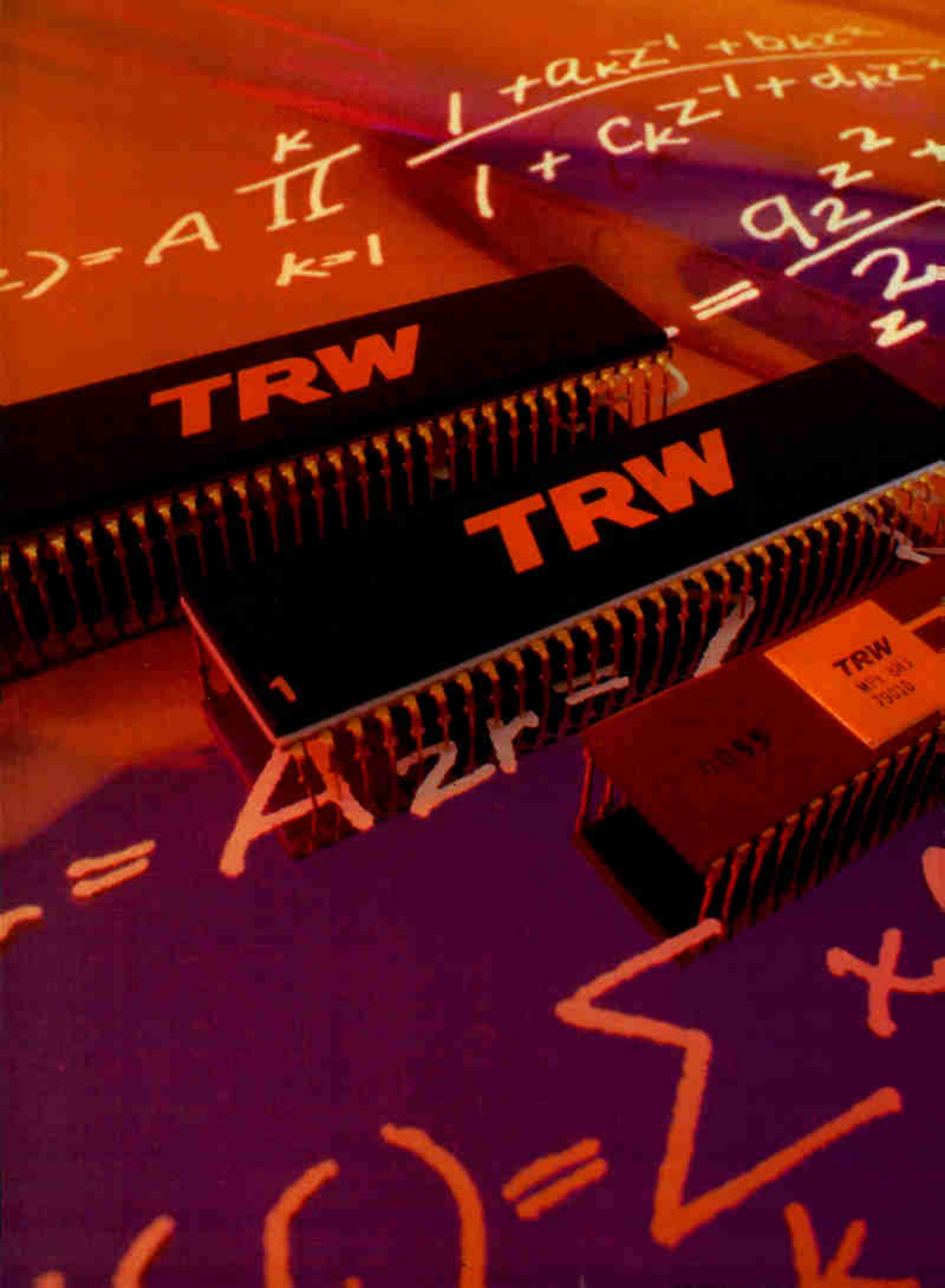
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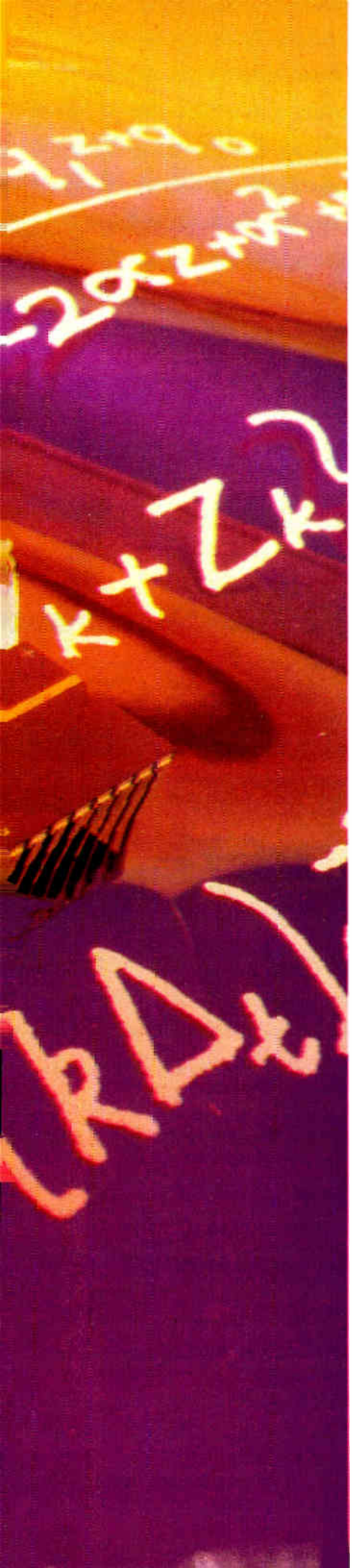

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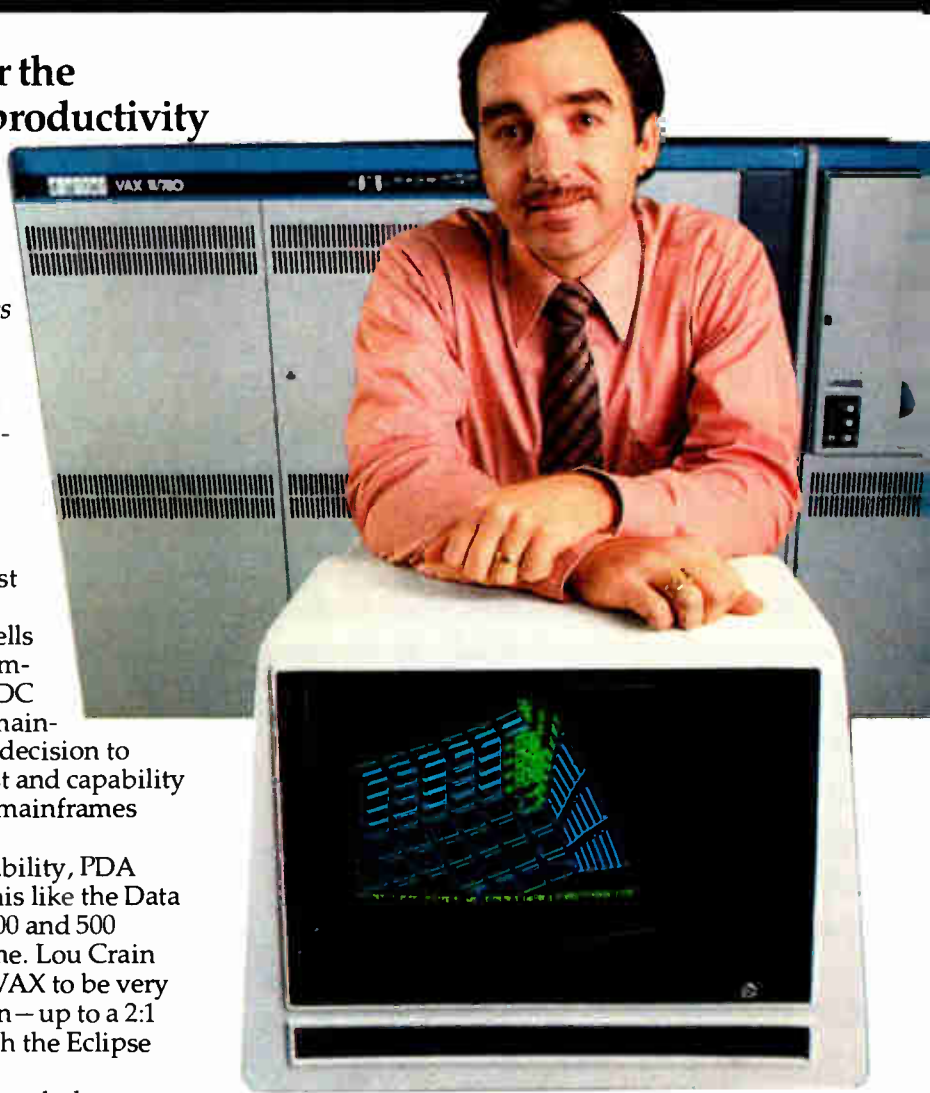

PDA is an employee-owned engineering concern whose business ranges from fundamental research in structural analysis to the manufacture of critical aerospace components.

The VAX-11/780 is PDA's first in-house computer. Lou Crain, Manager of Software Products, tells us, "We've been doing all our computing through utilities using CDC 6600, Cyber 74 and Univac 1108 mainframes. The key elements in our decision to acquire the VAX-11/780 were cost and capability—compared to service bureaus, mainframes and competitive minis."

From the standpoint of capability, PDA considered traditional superminis like the Data General Eclipse and the Prime 400 and 500 series, plus a used 1108 mainframe. Lou Crain says, "Our benchmark showed VAX to be very powerful against the competition—up to a 2:1 performance advantage over both the Eclipse and the 1108."

"After installation," Crain concludes, "VAX has lived up to our expectations and has performed impressively. It's resulted in better products for our customers, as well as improved cost-effectiveness. Having our own interactive capability in-house has meant an increase in engineering productivity of up to 300%."

"VAX turns out to be twice the machine for the same amount of money."

Roger Vossler,
Section Manager and Systems Engineer
TRW Defense and Space Systems Group
Redondo Beach, California

Sensor data processing and distributed processing systems in support of real-time embedded applications are among the specialties of TRW's Defense and Space Systems Group.

To find the right computer, TRW continues to evaluate numerous machines—including Digital's VAX-11/780. They've also conducted numerous FORTRAN and PASCAL benchmarks.

In every test, VAX stands out as a clear winner.

Roger Vossler, Section Manager and Systems Engineer, says, "VAX is one of the best implementations we've seen of a successful integrated hardware and software system."

Since TRW's sensor data processing applications require enormous memories—over a million bytes to store a single image, for example—VAX's true 32-bit address space is vitally important. In addition, says Vossler, "VAX's I/O bandwidth capabilities are extremely important for effectively moving large quantities of real-time data at very high data rates."

Because TRW already had an investment in Digital technology, Vossler is particularly impressed with the relative ease of moving PDP-11 series programs onto VAX.

"But," says Vossler, "Even if I were starting all over again—without our Digital experience—I would still pick VAX, on the basis of its architecture, both hardware and software, and its impressive performance."

"Implementation was faster on VAX than on 25 other machines."

Brian Ford, Director
Numerical Algorithms Group
Oxford, England/
Downers Grove, Illinois

The Numerical Algorithms Group develops and maintains mathematical and statistical software libraries for customers in industry, science and academia.

Before VAX, NAG had implemented their complex Mark 6 Library on 25 major machines, including the Burroughs 6700, CDC 7600, Univac 1100, and the IBM 370. The average implementation time was 13 man-weeks.

VAX took five.

In Dr. Ford's words, "A successful implementation requires the correct functioning of the 345 library routines to a prescribed accuracy and efficiency in execution of NAG's suite of 620 test programs. Whilst the activity is a significant examination of a machine's conformity to the ANSI standard of the FORTRAN compiler, its main technical features are file creation, file comparison, file manipulation and file maintenance."

And implementation performance was just the start. Dr. Ford comments on VAX's impressive record of reliability after the program was up and running: "No problems were encountered in the VAX/VMS software even though approximately 3000 files were being handled. The operational availability time for the machine was close to 100%, an outstanding statistic for new hardware and a new operating system.

"VAX," Dr. Ford concludes, "is an implementor's dream."

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Circle 164 on reader service card

$99 meter puts measurements in hand

3½-digit DMM, aimed at service market, uses dual-dial scheme that offers single-finger switching and easy range reading

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

Beating the price down on instrumentation while keeping the performance high is not an easy feat with today's inflation. Yet Keithley Instruments Inc. has managed to do just that, producing a high-quality portable 3½-digit multimeter that sells for just $99. Aimed squarely at the heart of what Keithley sees as the real market for such instruments—service—the model 130's price tag is truly the result of a thorough and practical design and development effort.

"We're not simply trying to buy the market with an artificially lower price; we couldn't make an honest profit if we did," asserts president Thomas G. Brick. He points to the effort that Keithley expended to bring the 130 to market, an effort that went from canvassing purchasers of generically similar meters to the construction of a dedicated high-volume production line, automated to assemble the portable's 35 components in the most efficient manner. The effort also underscores the direction that Keithley is taking into the 1980s. Traditionally known for serving research workers with high-technology instruments, Keithley plans to gain similar respect in the service field by continuing to apply its technical expertise there, too.

To do that, Keithley designed the model 130 not as a "solution" but as a hard-working tool. "When a guy wants to drive a nail into a board, he doesn't look for the 'nail-board solution,' he looks for a hammer," says Joe Reedholm, vice president for instruments. With that view point, Keithley studied just what servicemen wanted in a digital tool and embodied the desires they found in the model 130. Paramount was ease of use. To fulfill this requirement, Keithley designed a novel switching scheme, the meter's most striking feature next to its price. Two rotary switches, one for range and one for function, are set at the meter's left edge. This configuration gives the user two ways to select range and function: with one finger (the thumb of the left hand or the index finger of the right) of the hand holding the instrument or in the conventional two-handed manner—holding the meter in one hand and turning the switches by means of their center handles with the other.

Use of this scheme provides several benefits, Reedholm points out. First, it reduces selection of the color-coded range and function to a simple dial-setting process. Second, it clearly indicates them without need for annunciators in the 0.6-in. liquid-crystal display (which is about 60% larger than most), which helps keep cost down. And third, it also helps make the meter more rugged by reducing the number of components needed.

The goal of ruggedness was addressed in every other aspect of

the design as well. The switches and all other components, except the 3½-digit liquid-crystal display, are mounted on one side of a single printed-circuit board. The board is rigidly attached to the front half of the case, thus capturing the LCD firmly in a shock mounting that reduces the motion between board and case in the event the meter is dropped. That event is unlikely to occur because the user's arm gets tired—the 130 weighs a mere 10 oz.

Like its physical parameters, the meter's electrical specifications also represent very practical design. Keithley's investigation showed that a plurality of users only needed a dc voltage accuracy within ±0.5%, so, rather than trade cost for higher accuracy, they built the meter to that accuracy level. The best dc voltage resolution needed in most cases was only 1 mV, but Keithley found it could offer 100 μV resolution for about the same cost and satisfy 90% of potential customers, and so did. Using similar tradeoffs, they determined the meter's other specifications: for example, 750 V maximum ac range, a maximum current range of 10 A, a maximum resistance range of 20 MΩ, and a nonswitched ac or dc input protection of 1,000 V maximum peak.

The results of the study were disappointing in one respect. "We found that in the majority of cases there was no need for audible response," says Reedholm wistfully. "It was too bad, because we really wanted to put that in—we had even provided the space for it in designing the case." That space is still there, and who knows but that sufficient demand may lead to a low-cost audible meter.

But putting the future aside, the model 130 is available from stock now and comes with a battery and standard probes. High-voltage, radio-frequency, and clamp-on current probes are among the optional accessories offered, as are a kit of spare parts able to support a number of meters and a stand for bench use.

Keithley Instruments Inc., 28775 Aurora Rd., Cleveland, Ohio 44139. Phone (216) 248-0400 [338]

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Intel's new Talker/Listener and Controller give you the green light for simplified IEEE-488 systems.

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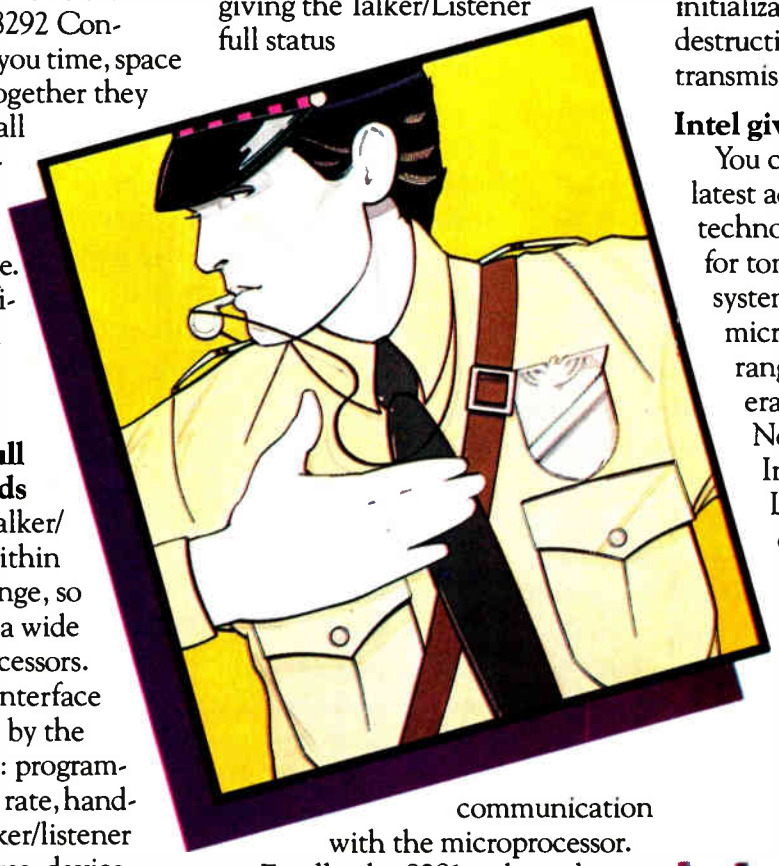

communication with the microprocessor.

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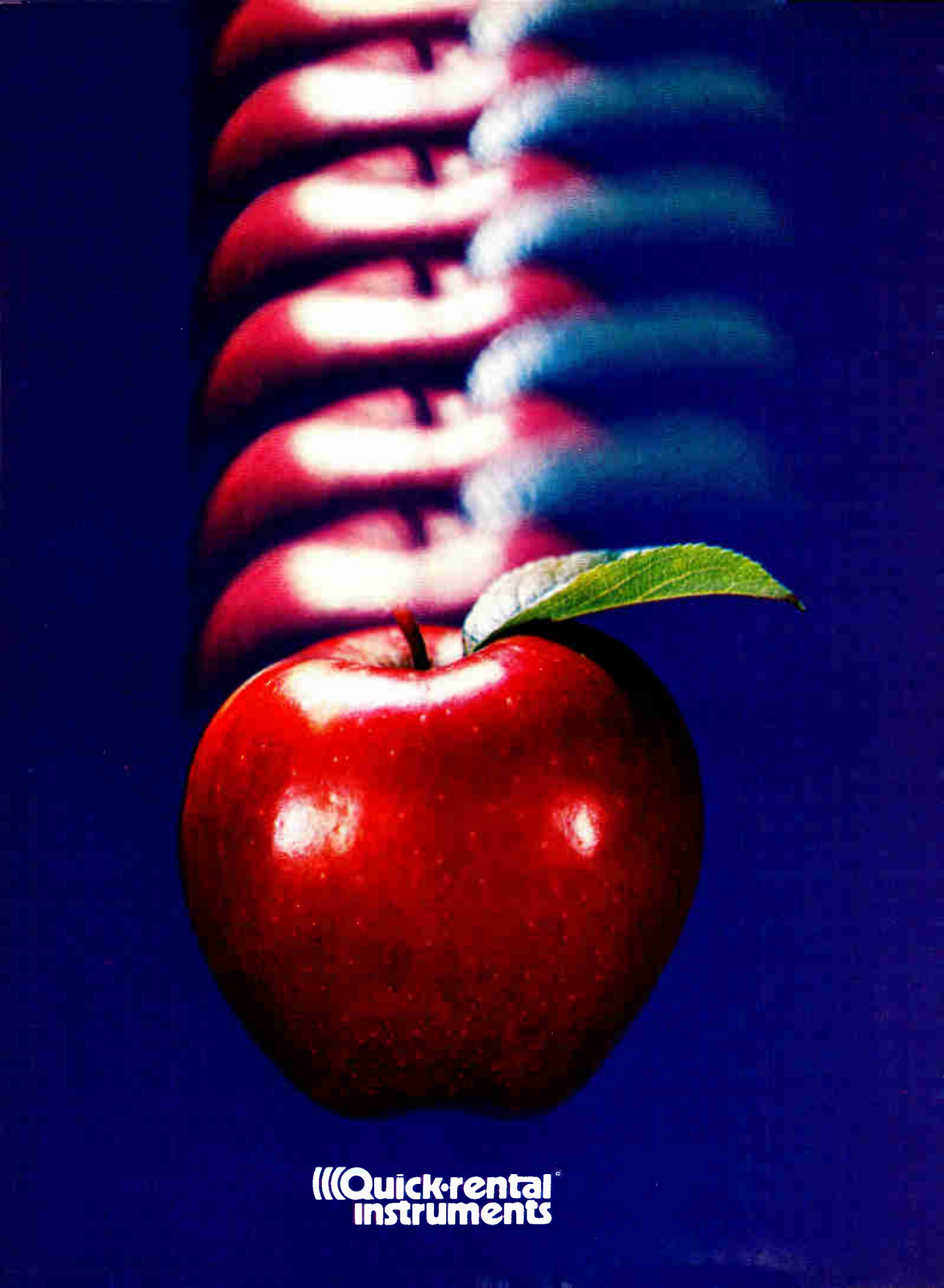
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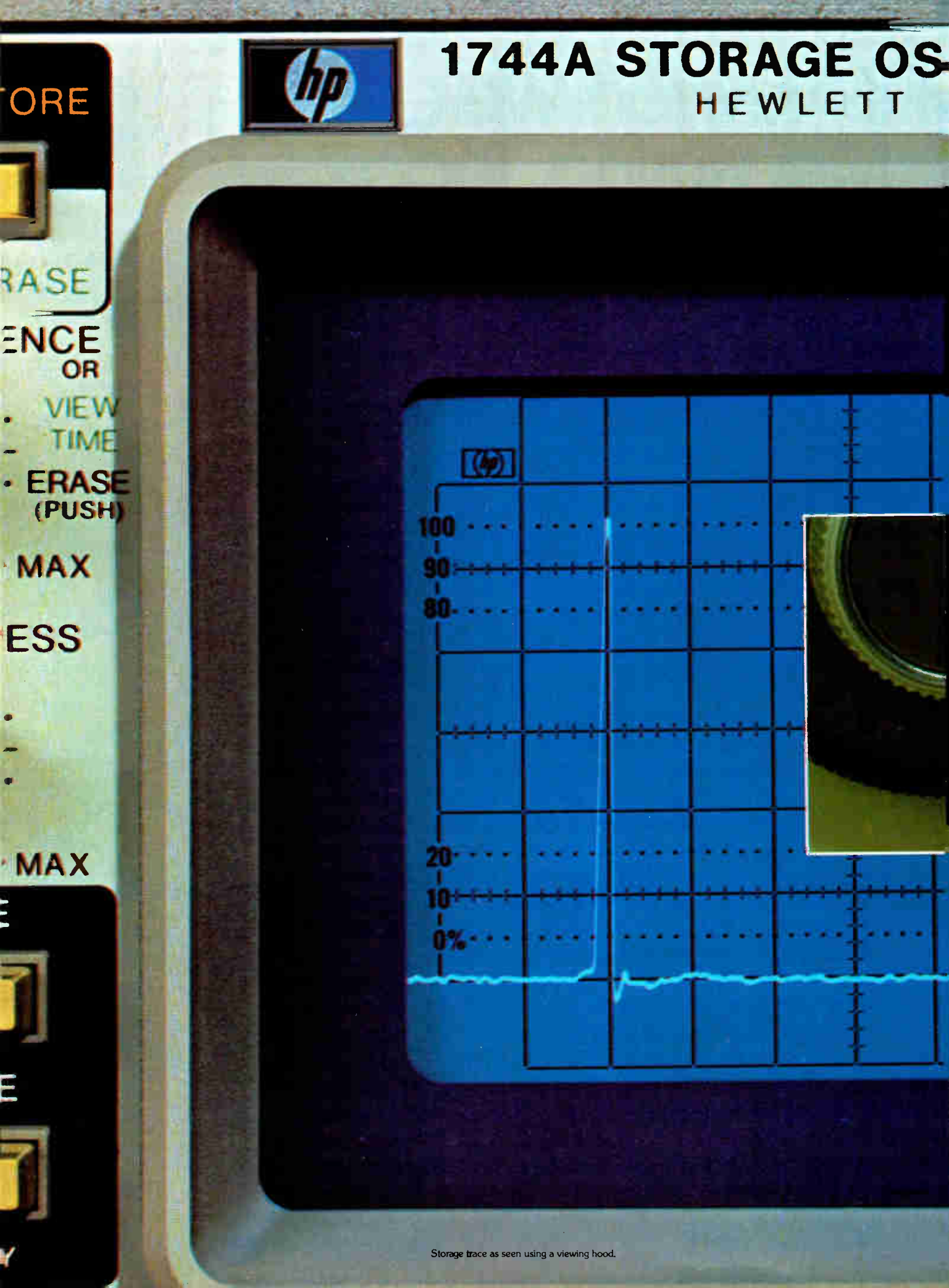
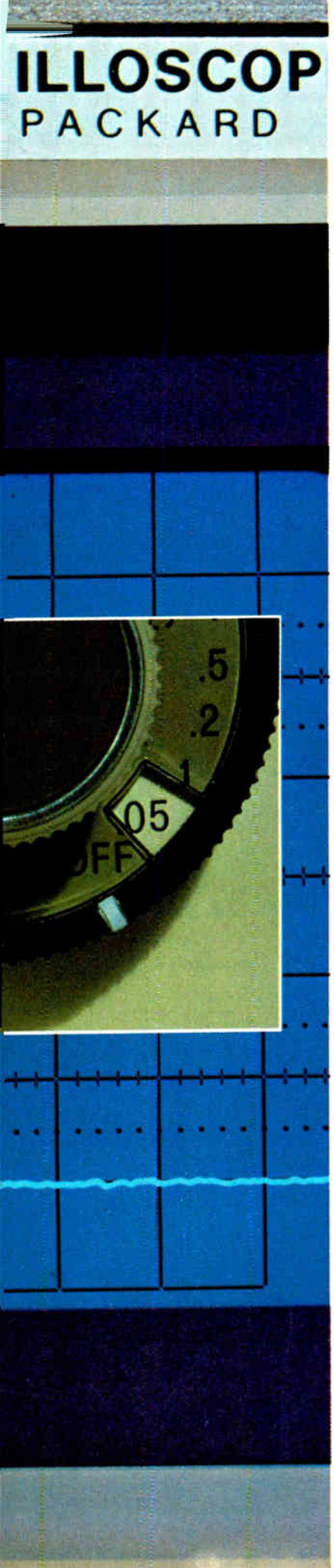


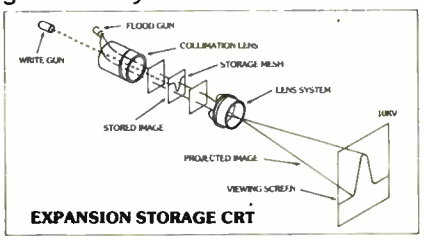
Storage trace as seen using a viewing hood.



For a 100 MHz storage scope that can capture its bandwidth and display glitches this sharply...

HP's new 1744A is the Answer.

The key to this storage scope's superior performance is HP's advanced CRT design. It's called Expansion Storage. And this faster-writing technique lets you capture single-shot and low-rep-rate events over a larger display area with greater clarity.



EXPANSION STORAGE CRT

Take a good, hard look. Any input signal within bandwidth specification will be displayed cleanly by the 1744A, even at the maximum writing speed of 1800 cm/μsec when using a viewing hood. That provides the sharpness you need for detailed evaluation of hard-to-catch waveforms. Our Auto Erase/Auto Store modes simplify your pursuit of these elusive signals. Auto Erase provides hands-off operation while Auto Store prepares the scope to snare the troublemaker the instant it occurs. Both are powerful tools for capturing the spurious spikes that disrupt your logic circuitry.

Catch that glitch. Expansion Storage technology combines a small storage mesh (about the size of a postage stamp) and an expansion lens system. This exclusive arrangement permits a writing speed of 1800 cm/μs and a fine spot size, which lets the 1744A write faster and further than any other 100 MHz storage scope. That gives you full-scan glitch capture capability over a broad range of sweep speeds and repetition rates.

A new view. Three channels are better than two. And with the 1744A you have pushbutton selection of a third-channel trigger view. Now you can view timing relationships between the trigger signal and the two vertical channels simultaneously.

Rounding out the 1744A's capabilities are these convenient measurement features: **Easy-IC Probes** to improve closely spaced probe connections and eliminate shorting hazards; a selectable input impedance (1 megohm/50 ohm) for general purpose probing or 50 ohm matching; and measurement sensitivity as low as 1 mv/div to 30 MHz on both channels without cascading. Priced at $5250*, the 1744A furnishes the state-of-the-art technology and performance needed today in digital design and troubleshooting applications.

Call your local HP field engineer for further details. And for a lower cost, high quality storage scope where an extremely fast writing speed isn't required, ask him about HP's 1741A 100 MHz storage scope.

* Domestic U.S.A. price only.

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088/7A

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Circle 171 on reader service card

Store Recorders have made

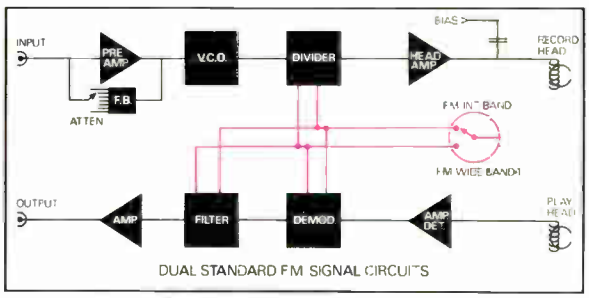
Flick a single switch on a dual standard recorder in the new Racal Store DS range, and you've changed instantly from Intermediate Band to Wideband operation on FM. A single switch that selects either recording standard – without the need to interchange plug-in modules. A single switch changes all the signal channels (four to fourteen) on all seven speeds.

FM Capability

The Store range of instrumentation recorders, well-renowned for research in the scientific, automobile, aerospace and medical fields, now offers an FM capability over the entire band DC to 40 kHz, and up to 300 kHz on Direct Recording.

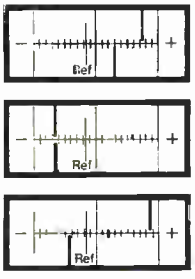
Greater Flexibility

And even greater flexibility. Switch any channel to unipolar, and the full dynamic range becomes available to either positive or negative going signals. Switch any channel to offset, and you can record a 100 mV peak-to-peak signal on a 20 V step–without losing any dynamic range.



DUAL STANDARD FM SIGNAL CIRCUITS

a quick switch to wideband.



Proven Success

All these outstanding new advantages have been added to the host of features which have made the existing range such a success–like single switch seven-speed selection, full servo operation, dual peak-indicating meters, full remote control of all functions, portability, and operation from AC or battery power sources.

That's why, by switching to the Racal Recorders' new Store DS range, you can make a quick switch to a whole new wideband world.

Racal Recorders Limited Hardley Industrial Estate,
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Telephone: 0703-843265 Telex: 47600.

Racal Recorders Inc 5 Research Place,
Rockville Maryland 20850.
Telephone (301) 948 3085.

Racal Recorders Inc, 1109 West San Bernardino Road,
Suite 110 Covina California 91722
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Racal Recorders Always on the right track

RACAL

Circle 173 on reader service card 173

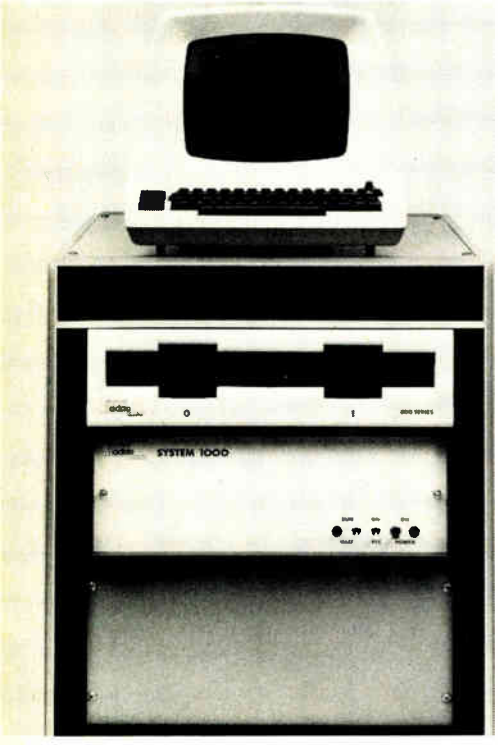
Brainy controller sells for $14,000

High-level programming language and a plethora of options are keys to flexibility of LSI-11/2—based industrial control system

by James B. Brinton, Boston bureau manager

The largest system yet introduced by Adac Corp., PROSYS I is an industrial data-acquisition and control system, which its makers claim is the lowest-cost system of its type. Its lengthy list of accessories, plus an English-language software package, may make it also one of the most comprehensive.

Aimed at test and measurement applications as well as industrial control, PROSYS I is based on a DEC LSI-11/2 with 64 kilobytes of memory, a dual-port serial interface, a double-density floppy-disk drive, a cathode-ray-tube display terminal, and high-level software. These are the basics. There is also a laundry list of analog and digital input/output modules available to fit 18 card slots in the system. Mounted in a roll-about cabinet that is 33 in. high, with the CRT terminal sitting on top, the whole basic package, including software, sells for $14,000.



Software. Despite a list of 38 options—almost all I/O devices—Adac's vice president A. L. Grant seems proudest of the system's specially developed software package, called PRO. It is specifically targeted at industrial applications and allows users to program in abbreviated English regardless of how obscure their applications are. "We have field-tested this system with users having no prior software experience, and they have been online in one to two weeks," he says, adding that even users without programming training can modify PRO for their applications.

PRO is completely self-contained, says Grant. No auxiliary storage assemblers, loaders, or other utility software packages are needed to load and use it. PRO operates as a multitask system, handling many jobs simultaneously; meanwhile, program statements may be added, changed, or deleted, while other programs are running and while process I/O points are being scanned.

Despite its flexibility, PRO takes up somewat less than half the system's main memory and thus leaves about 32-Kbytes with which the user may customize the system. This may, of course, be augmented by the standard floppy drive. For memory-intensive applications, a second drive is available.

The options run the gamut from high- and low-level digitizers, to digital-to-voltage and digital-to-current converters. There are also contact-closure detectors, standard TTL inputs, optically isolated ones, high-current latched outputs, optically isolated outputs, and standard TTL-compatible ones.

For example, among the 13 available analog I/O boards is the 1012 with eight differential inputs, 12-bit resolution, and the ability to handle signals of a volt or more, and the 1112RL-8CJT, an eight-channel, 12-bit thermocouple digitizer, with cold-junction compensation, a thermocouple panel, and the ability to operate with a wide variety of thermocouple types. There is a 16-channel version, too.

Though specific configurations are bound to vary from user to user, a typical "fully loaded" system, according to Grant, might contain as many as 32 thermocouple inputs, 16 high-level analog inputs, 16 current-loop drivers, 16 contact-closure detectors, 16 optically isolated inputs, 128 TTL inputs, 128 TTL outputs, 32 high-current outputs, and 16 optically isolated outputs.

Connection with the system is via sets of screw terminals on the rear of its cabinet. There is a special panel for thermocouple applications that allows thermocouple extension wires to be connected directly to the system's terminal blocks. Other accessories allow control and monitoring of ac power.

The PROSYS I costs $14,000 in quantities up to four, with discounting beyond that point; deliveries are being specified at 45 to 60 days, though units are already on the shelf.

The Adac Corp., 70 Tower Office Park, Woburn, Mass. 01801. Phone A. L. Grant at (617) 935-6668 [339]

Your low cost way out of the impedance jungle.

Before they get on board,
fend off wild RCL components for $745 (usa).

Those untamed components. They swarm over your circuit boards, eat into your resources, trap you in the impedance jungle.

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At $745, the 252 rivals instruments costing twice as much.

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- Lightweight, tiltstand handle

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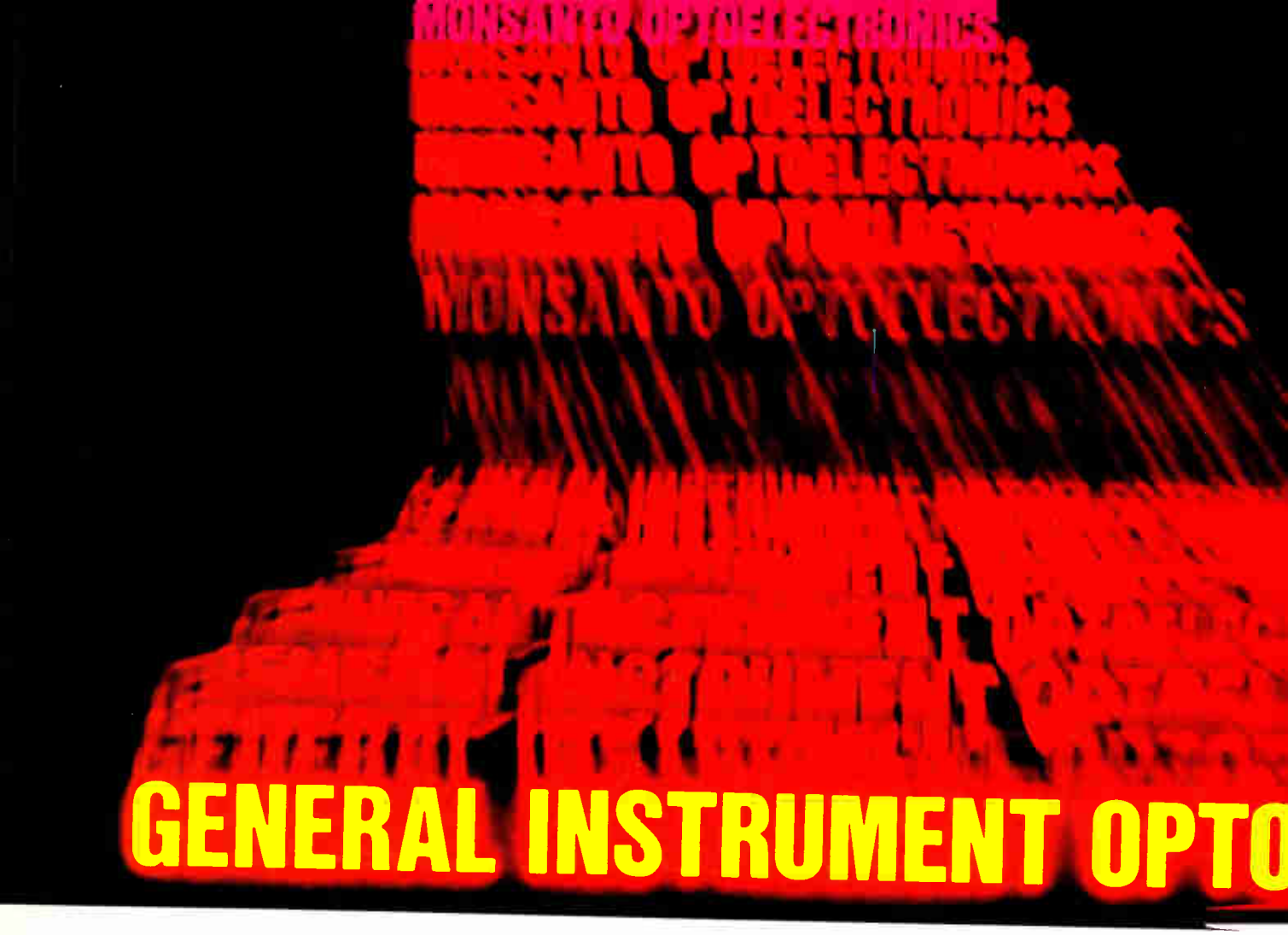
Want autoranging? Gear up with the Model 253. And if you test at low frequency, check out the 120 Hz Model 254.

For over 25 years we've tamed the ways of the impedance jungle. A detailed 252 brochure shows you how.

The sure way to innovation. esi ELECTRO SCIENTIFIC

Electro Scientific Industries, Inc., 13900 N.W. Science Park Drive, Portland, Oregon USA 97229, 503/641-4141; telex 15-1246

Circle 175 on reader service card



It's a name that is already well known in semiconductor products as well as in data systems, cable TV products, and industrial components. Now, we're taking it into another area of high technology.

In June, General Instrument acquired the total optoelectronics operations of Monsanto. Their broad product line. Their experienced people. Their modern production facilities. And most important . . . an outstanding expertise in optoelectronics.

We are the new name in optoelectronics . . .

TEN YEARS OF EXPERIENCE IS A GOOD PLACE TO START

Since 1969, the major thrust has been to apply high technological capability to product development. Result—a continuing series of "firsts" in LED lamps, displays and optoisolators. Today, you can select from over 150 high performance devices in our product line. And you are assured of high quality and top performance because of vertically integrated production . . . from LED crystal to finished LED product.

NO BREAK IN CONTINUITY OF CUSTOMER SERVICE

The same conscientious and dedicated people will continue to back up our product line. With the same prompt product and technical assistance, order processing and after-sale service. Even the product

designations remain the same. The only change you will notice is a more aggressive attitude. General Instrument is committed to providing total resources to become the leader in optoelectronics.

OUR FIELD ORGANIZATION IS THE SAME TOP TEAM

Over 50 of the most competent distributors throughout the world will continue to provide our customers with immediate availability of our wide variety of optoelectronic products. And our sales representatives are strategically located to give on-the-spot assistance in design and product selection.

THE FUTURE IS EVEN BRIGHTER

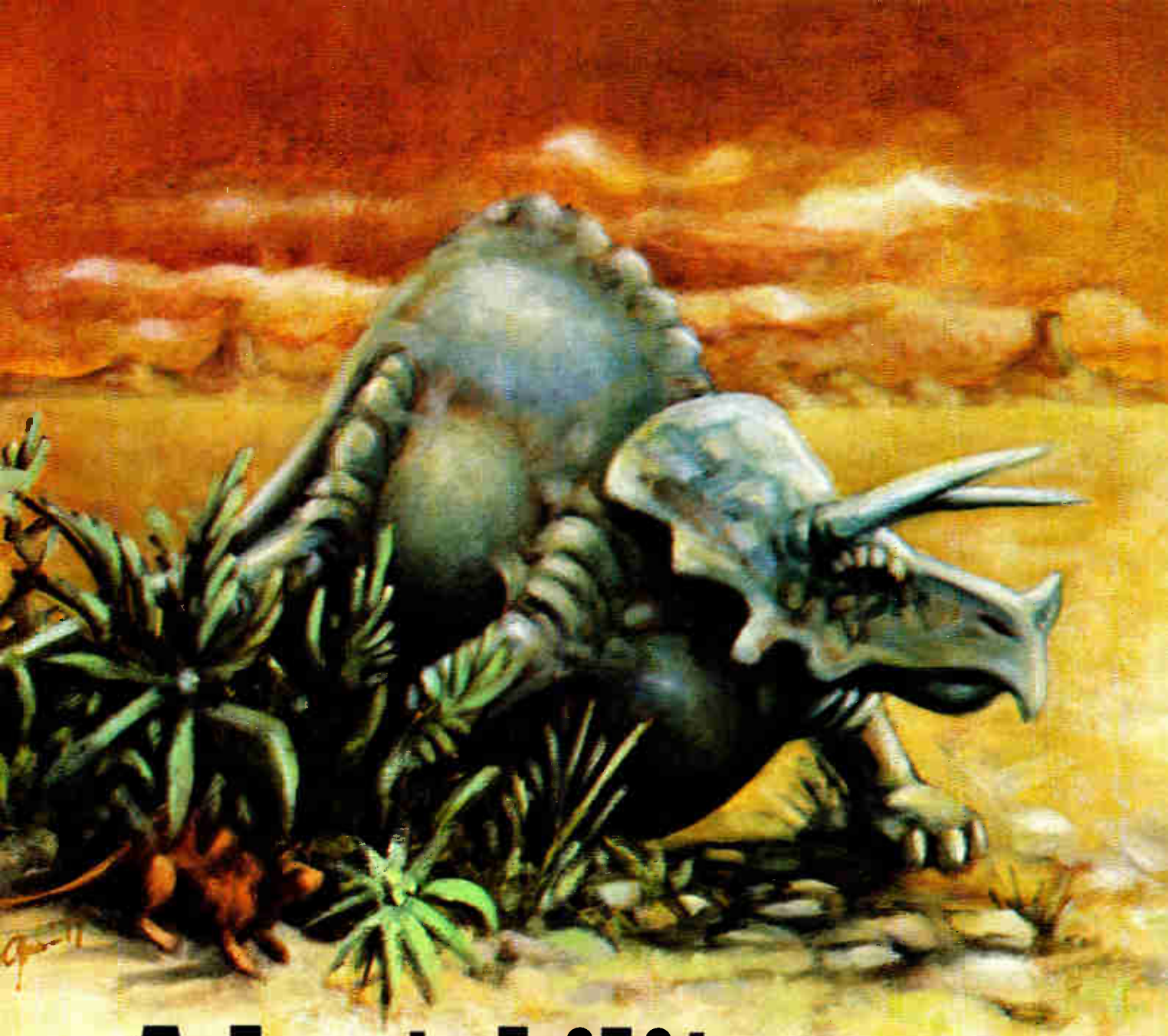
During the past year we "enlightened" the industry with better ways to use alphanumerics, new approaches to panel design and how to get bigger, brighter digits in less space. And that's just the beginning. You'll soon see the result of constant research and development as we announce a number of creative new products in the months to come. As the "oldtimer-newcomer" in optoelectronics, we'll continue to design, produce and improve the products that best fill your design needs. That's a promise.

General Instrument Optoelectronics Division, 3400 Hillview Avenue, Palo Alto, California 94304, Telephone (415) 493-0400

GENERAL INSTRUMENT

and we will continue to make a name for ourselves.

Circle 177 on reader service card



Adaptability. Key to survival in the production test environment.

Coping with production test costs as products and technology change can really be a matter of survival. Fairchild's Faultfinder® test systems will help you survive with built-in adaptability to help you manage costs as you manage quality.

In the Faultfinder 200 series, you'll find low-cost, microprocessor-controlled shorts and continuity testers for reliable incoming inspection of bare boards and for checking boards after component stuffing. And every model is designed for modular expansion to adapt to changes in your production test volume.

Our workhorse Faultfinder FF101C is the most adaptable in-circuit test system you can buy, with its unique capability for testing analog and hybrid boards. Its broad range of hardware options includes a minicomputer with I/O flexibility and expandable test capacity to 2400 points—more than any other in-circuit test system. You can add IEEE-488 compatible instruments, too.

High volume testing of complex hybrid PCBs presents special problems and the Faultfinder FF303 gives you the power and flexibility to solve them. Complete analog component testing. Testing of virtually all SSI and MSI devices. And LSI testing, including RAMs, ROMs, PROMs, UARTs and ALUs. Plus modular functional test capabilities through the IEEE-488 bus.

Faultfinder single-user BASIC makes test programming for the FF101C and FF303 simple. It's easy to learn and it permits fast, line-by-line editing. Datalogging and automatic program generation put high-powered software to work at the test station with real-time fault analysis and faster programming turnaround.

And wherever in the world your Fairchild in-circuit test system is installed, you can count on Fairchild service and engineering support to help you keep your test systems productive.

Fairchild in-circuit test systems can help you adapt to the changing production test environment. Let us show you how. Call or write:
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The First Family of ATE

Circle 179 on reader service card

Semiconductors

Display driver eases interfacing

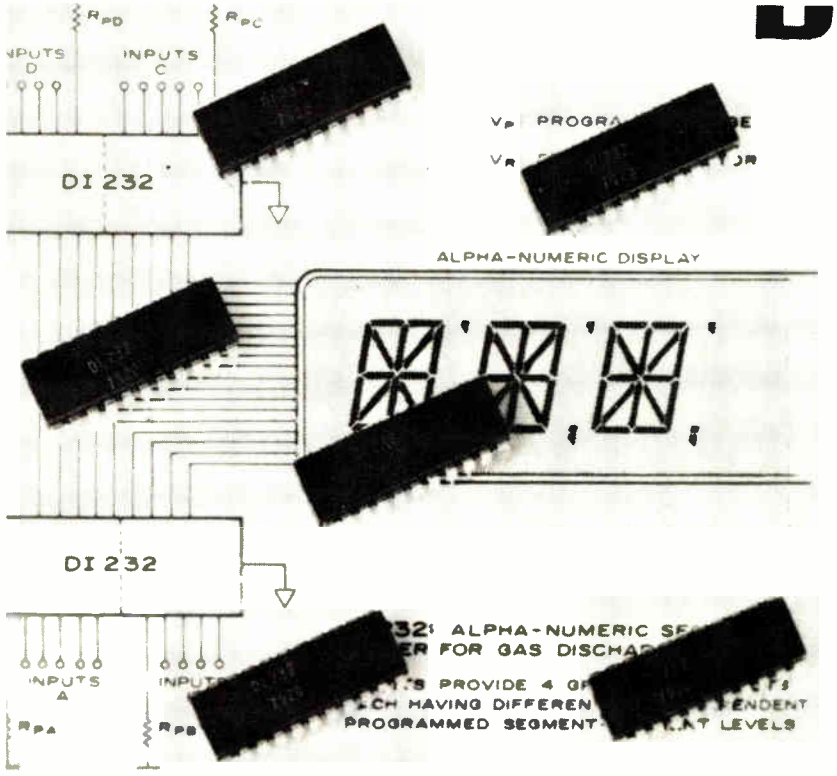
IC for high-voltage gas-discharge displays offers programmable currents

A designer of alphanumeric displays must typically contend with several different drive currents, because segments of different length will produce different levels of brightness if driven with the same current. A 16-segment display, for example, can have three segments—horizontal, vertical, and diagonal lines—of differing length. In addition, punctuation marks like commas and periods must also be driven at different current levels to maintain uniform brightness. Typically, limiting resistors are placed in each current-drive line to adjust the individual segment currents. The model EI-232/242 driver—a monolithic integrated circuit for gas-discharge displays—now greatly simplifies matters.

The high-voltage driver, made with Dionics' proven dielectric-isolation technology, delivers nine output-current lines, in two groups of four and five, with each output group having an independent, programmable current level. Programming is achieved by a single external resistor. Two such low-cost ICs can be ganged together for up to 18 outputs, in two groups of four and two groups of five lines, to satisfy any gas-discharge alphanumeric display requirement.

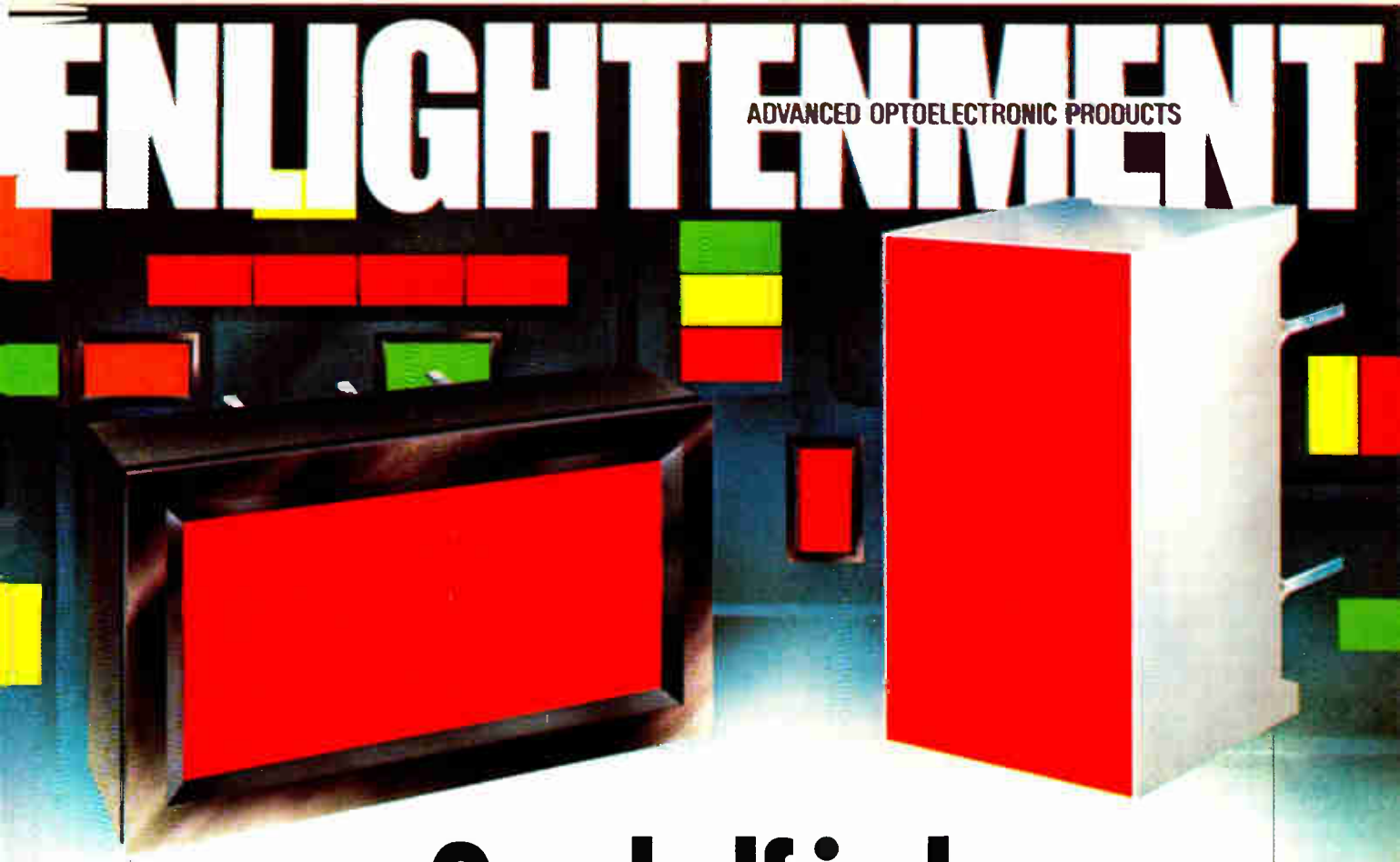
Two versions of this high-voltage driver IC are available: the model DI-232, which has an output-voltage compliance of 80 V, and the model DI-242, with an output-voltage of 125 V. Both provide programmable constant-current output sinks at a maximum of 5 mA and both are compatible with TTL and MOS inputs, with input ratings up to 40 V. Maximum power dissipation is 800 mW. The operating temperature range is 0° to 70°C, while the storage temperature range extends from −55° to +125° C.

The new segment driver is designed for use with gas-discharge



ENLIGHTENMENT

ADVANCED OPTOELECTRONIC PRODUCTS

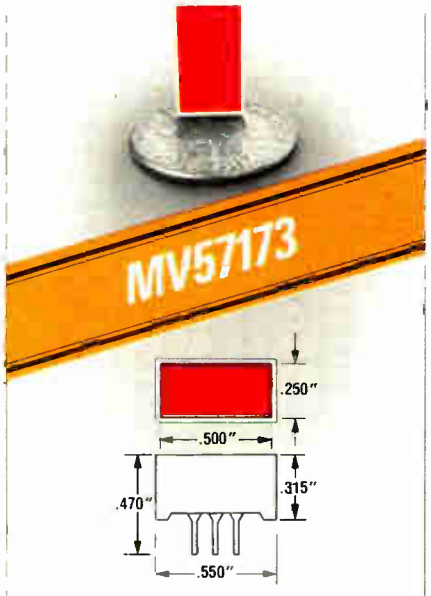


One-half inch of uniform brightness

General Instrument's new rectangular lamp gives panel indicators a larger, brighter look.
You get more than brightness. Our new MV57173 has a large rectangular emitting area, a wider viewing angle and more design flexibility than conventional lamps. It's a perfect lamp for panel indicator applications in appliances, vending machines, telecommunication equipment, instrumentation, or control panels.

The right size for backlighting legends. With a light emitting area of .50" x .25", this high efficiency LED lamp is large enough and bright enough to backlight legends. And they are categorized for brightness uniformity.

A convenient and compatible package. Mounted in a .2" dual in-line package, our new rectangular lamps are easy to install and are directly compatible with off-the-shelf IC's. And they are end stackable.



Mounting hardware available. A special mounting grommet (MP73) further simplifies assembly and provides a professional look to your panel.

High efficiency red with more colors coming. The new General Instrument rectangular lamp is now available in high efficiency red (MV57173). With orange, yellow and green available in early 1980.

Another first from the new name in optoelectronics. For more technical data and pricing information on the MV57173 and MP73, see your local General Instrument distributor or contact General Instrument, Optoelectronics Division (**Formerly Monsanto Optoelectronics**), 3400 Hillview Avenue, Palo Alto, California 94304. Telephone: (415) 493-0400.

GENERAL INSTRUMENT

Circle 181 on reader service card

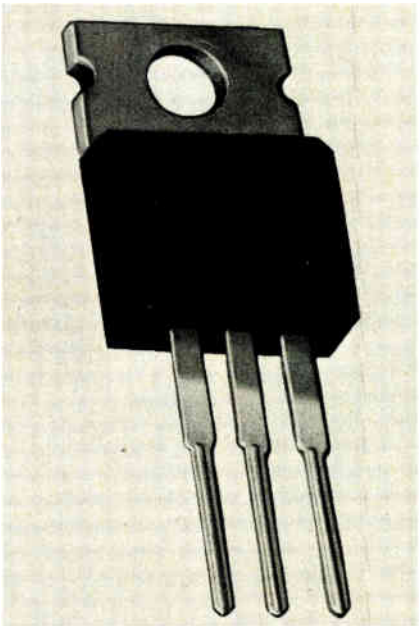
displays such as those manufactured by Beckman Instruments (model SP452), Cherry Electrical Products (model W416-1051), and Dale Electronics (model PD1-16A040).

At the 1,000-lot level, unit pricing is $2.26 for the 80-V DI-232 driver and $2.64 for the 125-V DI-242 driver. Delivery is within 8 to 10 weeks.

Dionics Inc., 65 Rushmore St., Westbury, N. Y. 11590. Phone (516) 997-7474 [411]

Rectifiers recover in 35 ns, sell for $1.55 each

The first of a line of high-efficiency rectifiers from Unitrode Corp. [*Electronics*, Sept. 13, 1979, p. 34] are designed for operation in switching power supplies at frequencies of over 100 kHz. Both the two-pin, single-diode UES1401 and the three-pin, twin-diode UES2401 series of rectifiers feature 35-ns reverse recovery



times and low forward voltage drops—0.8 to 0.9 V at 4 A or 0.895 to 0.975 V at 8 mA.

Unitrode is housing the diodes in TO-220 packages, which, according to Peter L. Jenner, product marketing manager, reduce the cost by one third and simplify circuit-board and heat-sink mounting. He expects the package to be the "low-cost rectifier

Fluke Portable Test Instruments

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Either way you win.

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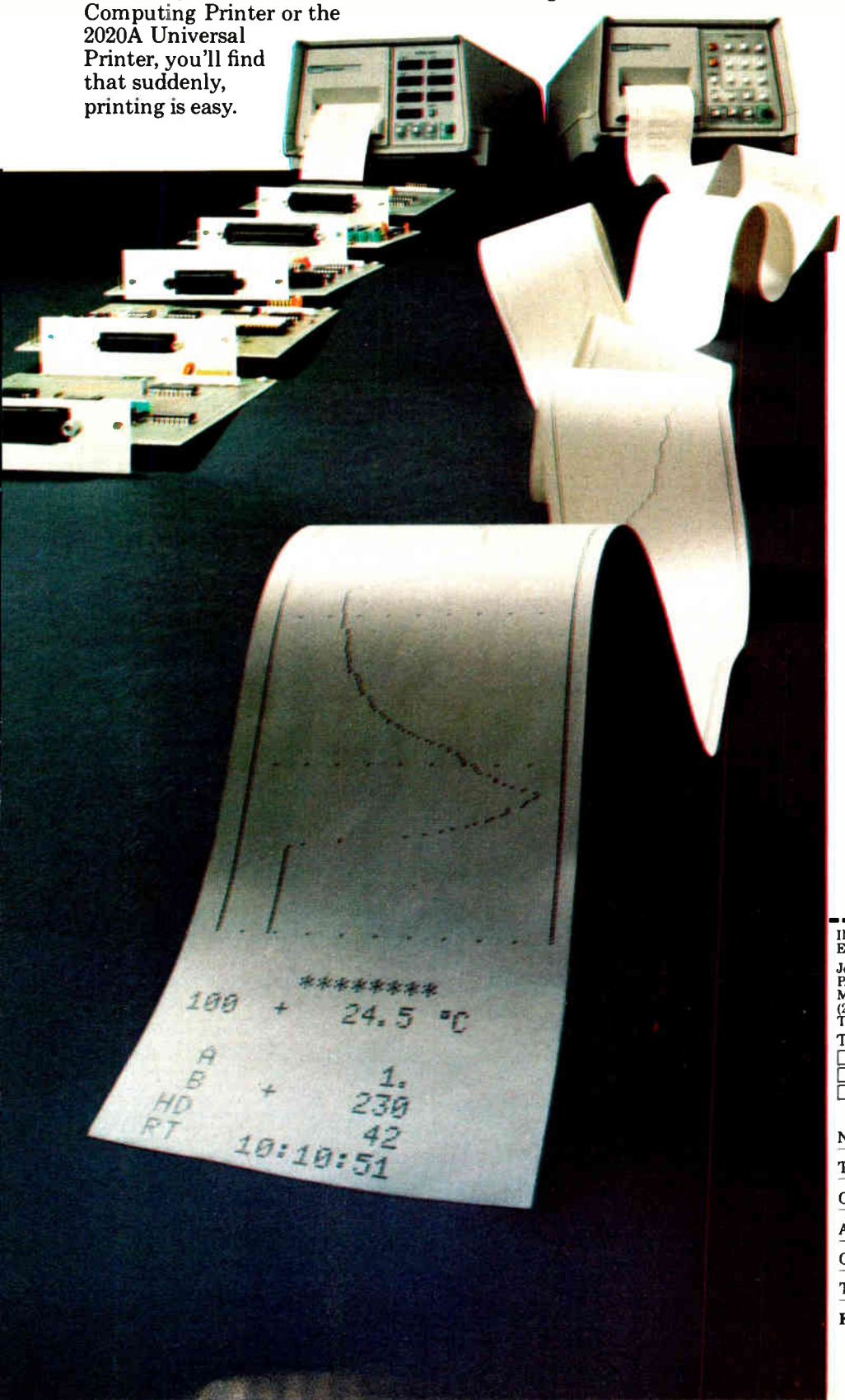
For printing flexibility or that one special job, the 2020A Universal Printer, starting at just *$745, is for you. Five interchangeable interfaces make it compatible with IEEE-488, RS232C, parallel ASCII, BCD or PTI polling for Fluke's line of Portable Test Instruments (PTI). Choose one, or all five interfaces. With just a screwdriver you can reconfigure the quick-change artist in minutes.



The thinker in control.

For an intelligent printer to match up with Fluke's PTI voltmeters, counters, and thermometers, choose the 2030A Computing Printer. At just *$995, it's long on performance features, including multiple-instrument scanning, seven print modes, math computations and alarms. It even plots trends with a graphic trace.

Simple systems without software.

Both printers are part of Fluke's growing PTI family. Modular packages and simple interfacing let you quickly stack and latch single instruments into economical printing systems without writing software or buying an expensive IEEE-Controller.

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For literature circle no. 183

E1 11/79

New products

package of the future."

Both diode series contain three models—units with 50-V, 100-V, and 150-V peak-inverse-voltage ratings. Operating and storage temperature range for all models is −55° to +150°C. At 25°C ambient temperature, the UES1401 and UES2401 rectifiers have maximum outputs of 3 A. The use of a Wakefield-type 295 heat sink with convection cooling increases their respective outputs to 8 A and 10 A. At a case temperature of 125°C, the 1401's output is 8 A and 2401's is 16 A.

Prices range from $1.55 to $2.05 each (in 100-piece quantities) for the UES1401 and from $2.32 to $3.05 apiece (also in 100s) for the UES2401. Delivery is from stock.

Unitrode Corp., 580 Pleasant St., Watertown, Mass. 02172 Phone (617) 926-0404 [413]

Power transistors meet JAN specifications

The JAN 2N174A and JAN 2N1358 are germanium power transistors satisfying JAN specifications MIL-S-19500/13 and MIL-S-19500/122. The devices, which have high-current and high-power capabilities, are housed in hermetically sealed TO-36 packages.

The 2N174A and the 2N1358 are characterized by collector-to-emitter voltages of 55 V and 44 V, respectively, and saturation voltages of 0.9 V and 0.7 V at 12 A, respectively. Both display a minimum gain of 25 at 5 A.

In 100-unit quantities, the JAN 2N174A and the JAN 2N1358 sell for $6.75 each. They are manufactured in house, and delivery is from stock.

Silicon Transistor Corp., Katrina Road, Chelmsford, Mass. 01824. Phone William Schromm at (617) 256-3321 [416]

Low-voltage silicon rectifiers recover in 150 ns

Featuring recovery times as brief as 150 ns, four new series of low-

How to put μP with the mad, mad world of product development.

Futuredata launches support for 10 more processors.

We can help you stay ahead in the race for new microprocessor-based product designs. Our universal 2300 series Advanced Development Systems already support five chips . . . now we're adding support for ten more.

Assemblers are available now for all 15 processors. High level language compilers, relocating macroassemblers, disassembling debuggers, in-circuit emulators and logic analyzers are ready now for the 8085, 8080, 6800, 6802 and Z-80. This full level of software/hardware support will be added in the coming year for ten more processors, giving you the widest choice of processors ever: 8086, Z-8000, 6809, 3870, 3872, 3874, 8048, 6502, 1802, 6801, 8080, 8085, 6800, 6802 and Z-80.

There is no finish line in this race. To stay ahead you need a flexible, expandable development system and a supplier with staying power: 2300 series advanced hardware/software development systems, stations and networks from GenRad/Futuredata. Sales office: 6151 West Century Boulevard, Suite 1124, Los Angeles, CA 90045. (213) 641-7200. TWX: 910-328-7202.

GenRad
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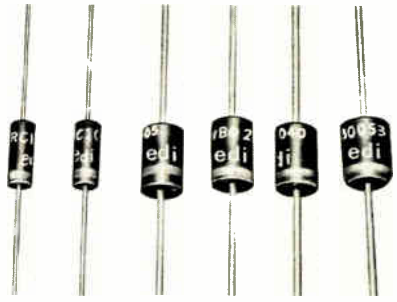
Circle 185 on reader service card

New products



voltage silicon rectifiers are now available. The RC series is rated at 1 A, the RAB and RJB at 3 A, and the RWB at 5 A. With high surge capabilities up to 350 A, the diodes have peak reverse voltages as high as 1,000 V.

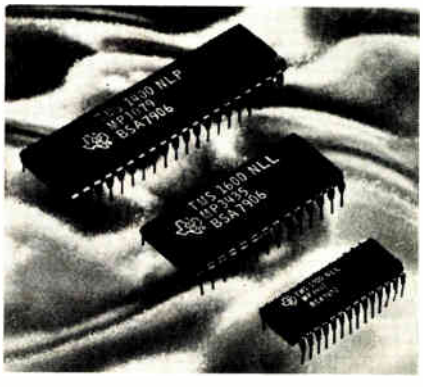
Diodes in the RAB, RJB, and RWB series are 0.38 in. long by 0.26 in. in diameter, with 1-in. leads that are 0.05 in. in diameter. The RC diodes are the same length, with a 0.16-in. diameter and 1-in. leads that are 0.03 in. in diameter.

In 100-piece quantities, with a 400-V rating, the diodes have the following unit prices: the RC series, 43¢; the RAB series, $1.60; the RJB series, $1.80; and the RWB series, $1.85. Delivery is from stock.

Electronics Devices Inc., 21 Gray Oaks Ave., Yonkers, N. Y. 10710. Phone Dennis Dean at (914) 965-4400 [415]

TI's 4-bit microcomputers have 4-, 0.5-K-byte ROM

Expanding the family of TMS 1000 devices, Texas Instruments has recently announced the addition of two new microcomputers. The TMS 1400 series is a 4-bit single-chip microcomputer with read-only mem-



See for yourself why design engineers specify more CTS cermet resistor networks than any other make.

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Each CTS SIP and DIP network is 100% value and tolerance tested before shipment. And, with more than 1 billion element hours of extended load life testing, CTS resistors have exhibited a failure rate of only 0.00047%/1,000 hours @ a 95% confidence level.

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A world leader in cermet and variable resistor technology.

ory organized as 4 K by 8 bits and random-access memory organized as 128 by 4 bits. This is twice the ROM and the same amount of RAM as is on the TMS 1100.

The TMS 1700, also a 4-bit single-chip microcomputer, features half the ROM (512 by 8 bits) and half the RAM (32 by 4 bits) of the TMS 1000.

The new microcomputers are manufactured using p-channel MOS technology and are architecturally compatible with other members of the TMS 1000 family. The entire family is made up of single-chip microcomputers that are mask-programmed for customers' functional applications. Operating voltage options include those for −15-V power supplies and a −9-V battery.

Design support for the entire TMS 1000 family includes: system evaluators with an external erasable programmable ROM, a development system for application-program development, and assemblers and simulators that are accessible through time-sharing.

The price for the TMS 1400 is less than $3.50 in production-quantity volumes and for the TMS 1700 it is less than $1.50 in similar quantities.

Texas Instruments Inc., P. O. Box 1443, Mail Station 6404, Houston, Texas 77001 [414]

V-MOS power transistors in TO-3 package sell for $16.05

With voltage ratings from 300 to 450 V and a current rating of 4 A, the VN03 family of n-channel V-groove MOS power transistors is the first in a series of high-voltage V-MOS transistors to be announced by Supertex Inc. Transistors with both higher and lower current ratings will be available before the year's end; they, too, will be made with a high-voltage process.

Packaged in a TO-3 case, these transistors have a threshold range of 1-to-3-V and a high gate-input impedance that allows them to interface low-voltage analog or digital circuits directly with higher-voltage devices. With a typical on-resistance

New products

of 1.5 Ω, this family of transistors should find use in many applications.

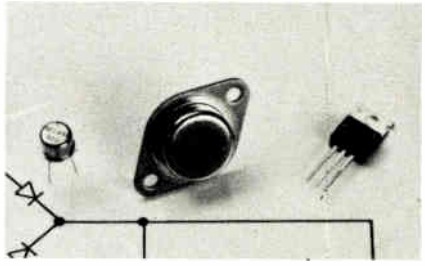
The TO-3 packaging allows the devices to be used in high-power-dissipation applications; the units are also available in the TO-39 package for lower-power applications, as well as in chip form for use in hybrid circuits.

The 400-v VN03 in the TO-3 package is priced at $16.05 in 1,000-piece quantities. If housed in the TO-39 package, the VN03 sells for $13.13 in 1,000-unit lots. The company expects to introduce VN03 devices in TO-220 packages during the first quarter of 1980.

Supertex Inc., 1225 Bordeaux Dr., Sunnyvale, Calif. 94086. Phone (408) 744-0100 [417]

Mask-programmable IC synthesizes 28 basic tunes

The AY-3-1350, a mask-programmable integrated-circuit tune synthesizer, can generate up to 28 different tunes or any combination of tunes consisting of up to 252 notes. This n-MOS device, operating from a 5-v power supply, will provide up to two minutes of music; it is well suited for battery applications because it can be wired into the



circuit so that it consumes practically no power when in the standby mode. The standard AY-3-1350 is available from stock in both sample and production quantities. The 1-to-24-piece price is $11.25 each, with the price dropping to $6.30 each in 1,000-unit volumes.

General Instrument Corp., Microelectronics Division, 600 West John St., Hicksville, N. Y. 11802. Phone Marty Burden at (516) 733-3120 [418]

Three new TM 500 Digital Multimeters give you more performance choice...

from Tektronix.

Introducing:

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  4½ digits, true rms, dB, .05% accuracy, seven functions.
- **DM 502A**
  3½ digits, true rms, autoranging including dB, seven functions.
- **DM 505**
  3½ digits, five functions.

We've put the best combination of accuracy and convenience into compact, affordable DMM's. Simply put them to the test. These versatile DMM's are at home everywhere, making your electronics tests faster and easier.

Choose seven function capability, including dB and temperature, from the new DM 501A and DM 502A. Increase your accuracy with the 4½ digit DM 501A, featuring true rms capability and 10 μV resolution. The 3½ digit DM 502A features autoranging in voltage, resistance, and dB, plus true rms capability. Add the all-around testing capabilities of our low-cost DM 505, and you've got a digital multimeter for practically every purpose.

They're all part of the TM 500 family. Just plug them into any TM 500 Mainframe to make on-site, rack, or bench measurements. Combine them with any other TM 500 instruments to build a compact test set just right for your application.

And, there's even more to these new DMM's. They give you Tektronix reliability, too. Add TM 500 configurability and modularity, and you get more testing clout for your dollar.

To learn more about these new TM 500 Digital Multimeters, contact the Tektronix Field Office nearest you. For a copy of our TM 500 Digital Multimeter Data Sheet, call our toll-free, automatic answering service: 1-800-547-1512. In Oregon, call collect: 644-9051. Or, send your request on your letterhead to Tektronix, P.O. Box 500, 76/260, TM 500 A6, Beaverton, OR 97005. In Europe: Tektronix International Inc., European Marketing Centre, Postbox 827, 1180 AV Amstelveen, The Netherlands.

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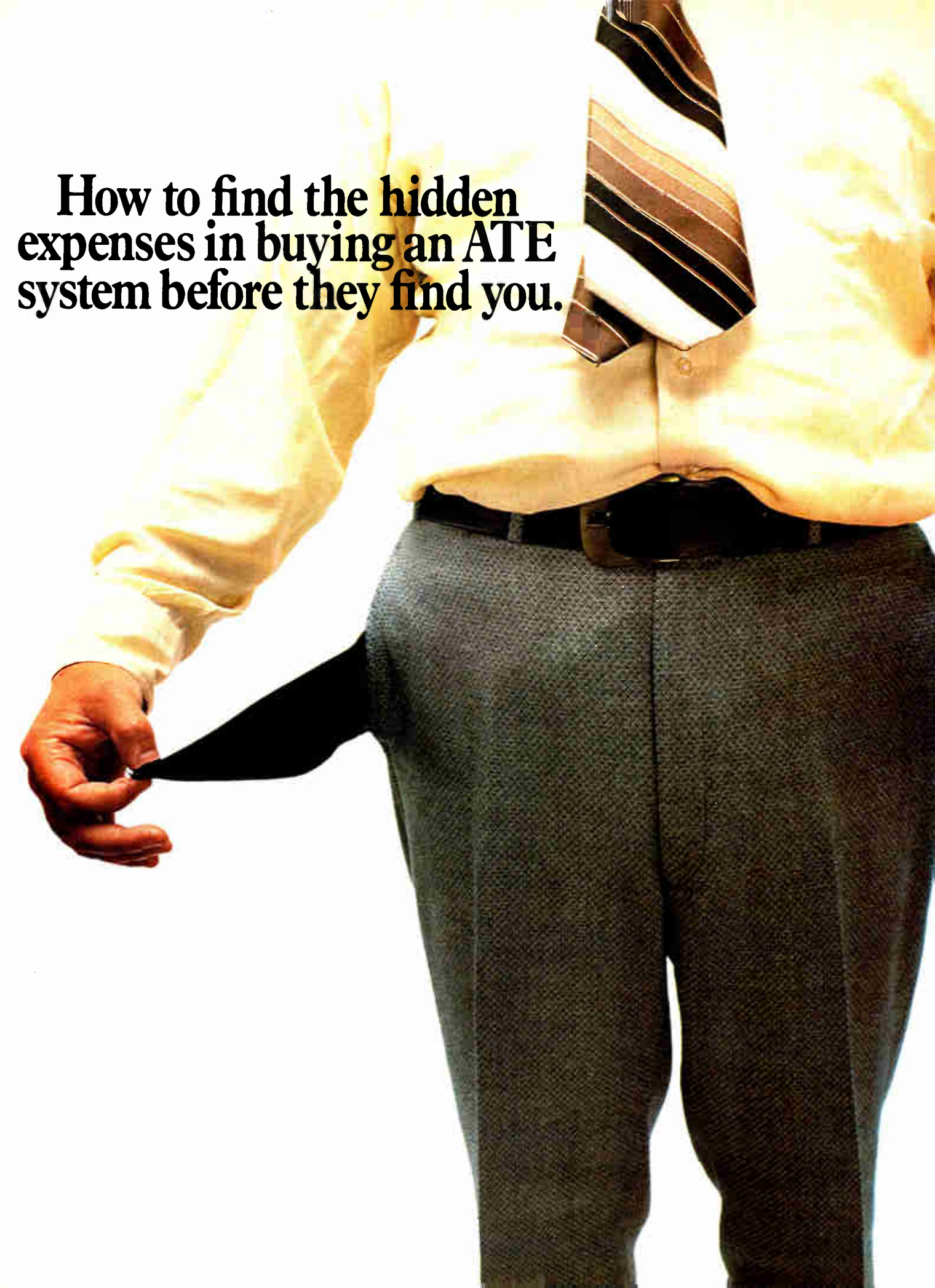
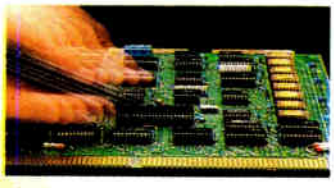
How to find the hidden expenses in buying an ATE system before they find you.





GenRad's in-circuit test systems employ a simple SCRATCHPROBING™ technique to quickly pinpoint faults—cutting labor costs up to $50 a board.

The secret is to know what to look for.

Take digital in-circuit test systems, for example. Most of them cost roughly the same to buy as GenRad's.

But they don't cost the same in the long run. Far from it.

That's because only GenRad's test systems can easily differentiate between an interconnect failure and a faulty device. So you can pinpoint the problem to its exact location in seconds—not minutes. That cuts repair time and labor costs dramatically. And saves you as much as $50 a board.

Looking for a functional tester? Watch out for the set-up costs. They can really set you back. The answer? GenRad's functional testers. They run on our unique CAPS Interactive Test Generation system, with a library of over 1,000 complex devices. As a result, your programming time and set-up costs are reduced substantially. Often by $100,000 or more.

Finding the hidden expenses in IC testing is easier. Basically, the problem is paying for a big test system with lots of diagnostic and programming capability that you'll never need. GenRad's solution is to give you the capabilities you really want—for one-fourth the price.

GenRad digital IC test systems offer you big system capabilities—including MSI and LSI testing—at one-quarter the big system price.

Shopping for a microprocessor development system? Then make sure you pay special attention to the emulation package. If it only operates at one-half speed, it may not catch a problem till you've reached the production stage. And that's expensive.

To detect every bug as early (and cheaply) as possible, you need a full-speed emulator. And we don't have to tell you who makes the only one in the industry.

Finally, there's field testing, where the biggest expense is spare board inventory. Turnaround time on a bad board can run 3 to 15 months. And tie up 5 to 10% of your gross sales.

GenRad's answer is a functional field tester that's small and inexpensive enough for any field office or depot. It cuts turnaround time to 5 minutes or less. And that can save you millions in financing alone.

So before the hidden expenses in ATE equipment find you, you ought to find out more about us.

For complete details, write GenRad, Concord, MA 01742.

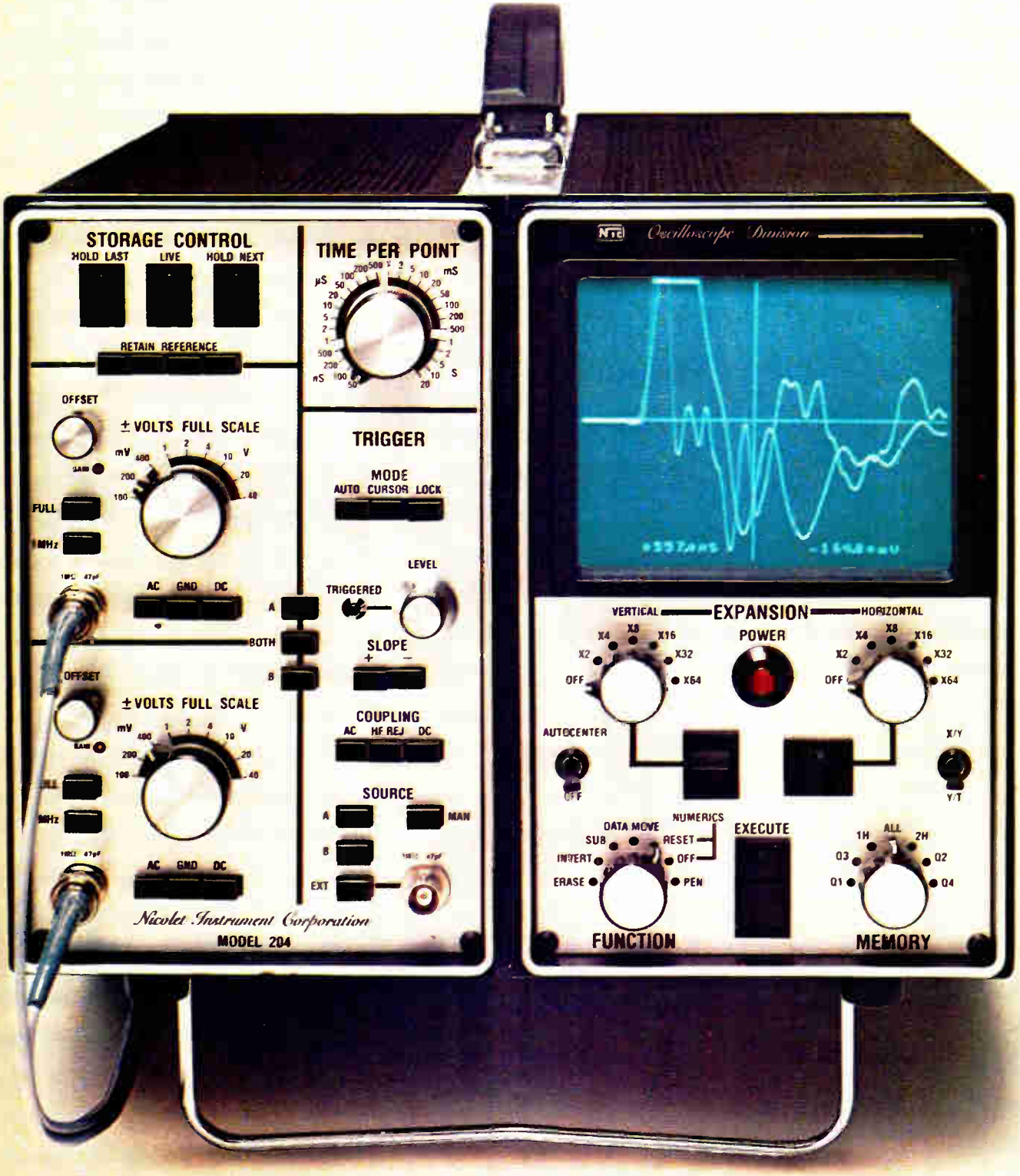
GenRad's functional field tester lets you diagnose and repair bad boards in the field, reducing spare board inventory that can tie-up 5 to 10% of your gross sales.

Circle 193 on reader service card

GenRad

Put our leadership to the test.

Nicolet EXPLORERS



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Nicolet is a leading manufacturer of digital electronic measurement instruments (signal averagers and FFT spectrum analyzers), analytical instruments (FT-IR and FT-NMR spectrometers), biomedical computers and digital graphic plotters. Nicolet's expertise in high technology digital instrumentation led to the first digital oscilloscope in 1973.

To learn how the EXPLORERS can help you, call toll free, **1-800/835-2246** (in Kansas, **1-800/362-2421**) and request our new brochure. To discuss your application or to arrange a demonstration, call **608/271-3333.**

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HP presents a computer
Start today.

At Hewlett-Packard, we've participated in the growth of networking for distributed systems right from the start. So we've had time to iron out a lot of the problems that go with it.

One problem was how to implement a distributed network today without limiting the growth needs of your company tomorrow. The answer: HP's Distributed Systems/1000—an advanced, real-time interactive communications package that you can install today without worrying about what changes the future may bring. DS/1000 gives you full system-to-system communications with the design flexibility to preserve your software investment, as well as accommodate the rapid advancements in computer technologies.

Rings, strings, stars: you name it.

No matter what configuration you need, HP's "layered" software approach lets you structure your network in a way that makes sense for your applications. You can arrange HP 1000 systems in star, ring, or string configurations—or any combination of them. Information passes from one system to another through intervening network nodes on an automatic "store-and-forward" basis without special instructions in your application software. And because you can access any system by simply specifying its node number, you can use the network just as easily from a remote terminal as from a local station.

With DS/1000, you can link workstations within a department as well as connect several departments on the factory floor (incoming inspection, final test, and quality control, for example). Or, you can link local manufacturing divisions to a host IBM mainframe or HP 3000 business system in your corporate EDP center. You can even create a nationwide network to coordinate geographically dispersed information.

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HP has a full range of real-time compatible hardware for implementing distributed computer networks—from terminals and interconnection hardware to sophisticated technical computers. A powerful data base management package with remote

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Expand tomorrow.

access capabilities will put the information you need right at your fingertips. And the modular software design will assure your orderly growth by allowing you to add to, or reconfigure, your DS/1000 network without affecting your existing programs.

Our long experience as a supplier of distributed systems means that HP's advanced technology is available now. Since 1973, HP computers have been installed in distributed networks around the world, all backed by extensive support systems.

If you'd like to know more about the HP 1000 computer system in distributed networking applications, call your nearest HP office listed in the White Pages and ask for a hands-on demonstration. Or for more information, write Hewlett-Packard, Attn: Roger Ueltzen, Dept. 654, 11000 Wolfe Road, Cupertino, CA 95014.

HEWLETT hp PACKARD

Circle 197 on reader service card

Packaging & production

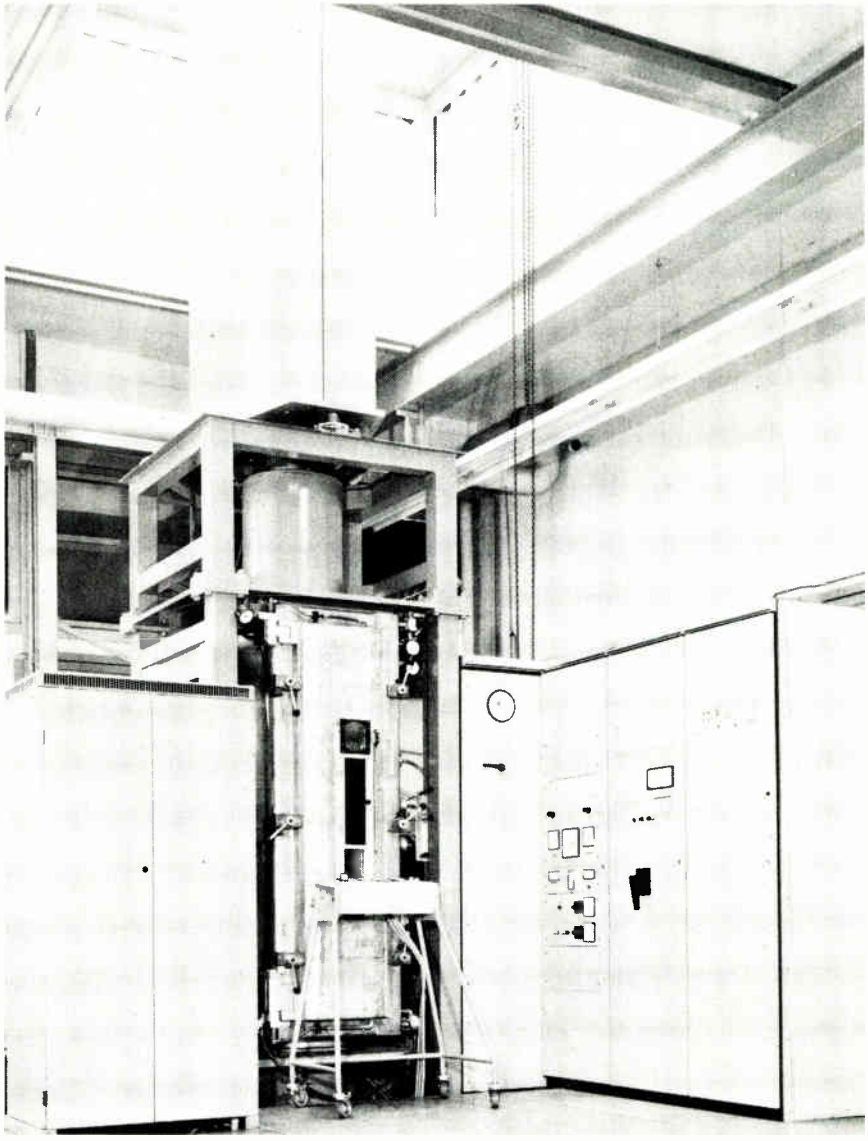
Zoner handles 4-in. rods

Rf furnace for preparing single-crystal silicon pays for itself in a year

Most single-crystal silicon used today is made by the well known Czochralski method, which yields crystals of sufficient purity for the manufacture of integrated circuits. When greater purity is needed—for the manufacture of fast-switching power devices, for example—zone refining is usually employed. This process, in which a heated zone is made to travel the length of a polysilicon rod, has been limited until now to rod diameters of 3 in. or less.

After 2½ years of development, Siemens Corp. is changing this picture with its model VZA9, a float-zoner capable of turning out high-quality, high-yield single-crystal rods with diameters up to 4 in. The VZA9 has the potential for zone-refining 5-in. polycrystalline material, but this operation has yet to be perfected.

The machine takes a 1,500-mm feed rod (competitive units use



When it comes to developing a fiber optics system, we are the source to come to. Within ITT Cannon and the other ITT companies worldwide are the knowledge and the resources to get the job done. From connectors to fibers to connectors—we do it all.

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For further information, contact Fiber Optics Marketing Manager, ITT Cannon Electric, 666 East Dyer Road., Santa Ana, CA 92702. Toll-free 24 hours (800) 854-3573; in California (800) 432-7063.

CANNON ITT

Six decades on the leading edge of interconnect technology.

Circle 199 on reader service card

1,000-mm rods). Extremely smooth electronically controlled dc motors drive both the feed rod and the seed crystal support mechanisms. The same type of vibration-free motors are also used for the rotation drives of the pulling shafts.

Optimum heating of large-diameter rods required the design of a special thyristor-controlled radio-frequency generator as well as a (patented) rf coil.

The zoner itself, as the photo shows, is a major installation, which costs about $500,000 to $600,000. Studies conducted at Siemens indicate that going from 3 to 4-in. silicon rods can save about $600,000 a year because of increased production of refined silicon. This savings almost writes off the cost of the machine in its first year of operation.

Siemens will soon install five of these systems in its IC facilities in Germany. Within a year, the company expects to have made several sales of the unit to U. S. firms.

With the advent of extremely dense circuit details on silicon wafers, IC manufacturers are now starting to look at the use of float-zoned material for VLSI and bubble memories. Float-zoned material has the advantage of a high level of homogenity, which could result in higher yields for VLSI products.

Siemens Corp. 186 Wood Avenue South, Iselin, N. J. 08830. Phone (201) 494-1000 [391]

Connectors simplify, speed mounting of TO-220 devices

Designed to correct the overheating problems encountered when soldering TO-220 devices to printed-circuit boards, Amphenol series 146 mounting connectors offer simplified solderless attachment at speeds up to five times faster than with ordinary solder methods. The connector body, contacts, and other parts of the device are constructed of materials specified under UL 310 and other related standards.

The connector features crimp contact connections to allow faster,

Challenge any wave with electrifying confidence.

Now you can say good-by to waveform jitter and triggering instabilities, with the new B&K-PRECISION Model 1535 dual-trace oscilloscope. The 1535 offers a full complement of features and high performance specs to more than meet your challenges.

The B&K-PRECISION 1535 is one of the few dual-trace scopes available with an alternate triggering mode. In this mode, the trigger source is sampled from channel A or channel B on alternate sweeps. With alternate triggering, you'll be able to display two stable signals that are unrelated in frequency. As in much more costly dual-beam scopes, the use of one channel is not dependent on the triggering signal at the opposite channel. Many other trigger source positions can be selected.

Other significant features include variable hold-off, for accurate display of pulse trains; single sweep, for non-repetitive waveforms; and even UNCAL "reminder" LEDs for sweep and input level verniers. A video sync separator is standard, for use with video circuits or computer terminals.

With 2mV sensitivity and flat 35MHz bandwidth, the 1535 will display most any signal you're likely to encounter. For observation of the leading edge of fast digital pulse signals, a signal delay is built-in. The 1535 is especially well suited for microprocessor work.

Also new from B&K-PRECISION is the 1520 dual-trace scope. This 20MHz scope offers many of the features found on the 1535. It's a cost-effective substitute for more costly scopes, when a 20MHz bandwidth is all that's required. The 1520 offers a 10 times sweep magnifier, 5mV/cm vertical sensitivity and independent chop/alternate display selection.

The 1535 and 1520 scopes are available now. For immediate delivery, a ten-day free trial or in-plant demonstration, contact your local B&K-PRECISION distributor.

For Additional Information Circle #138
For Free Demonstration Circle #139

B&K PRECISION DYNASCAN CORPORATION

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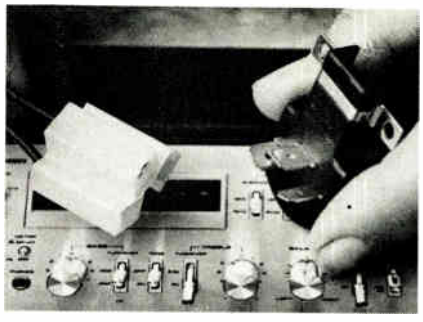
B&K-PRECISION Model 1535 $1240; Model 1520 $940. Other oscilloscopes from $255.

New products



simpler, and more economical attachment of TO-220 leads than with soldering: all three leads are crimped simultaneously to allow high-volume assembly, and a metal mounting strap ensures simple, positive connection to a heat sink. The connector also features individual wires that attach to separate mating terminals; alternatively, the user may choose an optional polarized plug that accepts three mating terminals.

Traditionally, TO-220 devices have been difficult to mount and are prone to overheating because the devices' internal heat-sink plates are attached to one of three leads and are therefore electrically hot. But with the series 146 connectors, the unit's heat-sink back, when mounted, is pressed into contact with the external heat-sink surface. Positive contact between the heat-sink plate and the heat-sink surface is maintained by the metal mounting strap.

Each connector is priced at 40¢ in production quantities. The units are available as off-the-shelf items.

Amphenol North America, Bunker Ramo Corp., General Offices, 2122 York Rd., Oak Brook, Ill. 60521 [393]

Lossy wire attenuates microwave noise

Lossyline is a flexible wire designed to act as a filter for the suppression of noise and electromagnetic interference generated by such electronic equipment as computers and microwave tubes. By forcing unwanted electromagnetic energy into the Lossyline material, where it is absorbed and dissipated, the wire virtually eliminates mismatch and electro-

Sharpen your competitive edge with A-B resistive components.

When you specify Allen-Bradley components, you put greater assurance of reliability into your products. You also share in A-B's nationwide reputation for high quality. In addition, our in-depth factory and distributor stocks (at competitive prices) make it easier for you to meet your delivery commitments. In short, our competitive edge can add to your competitive edge.

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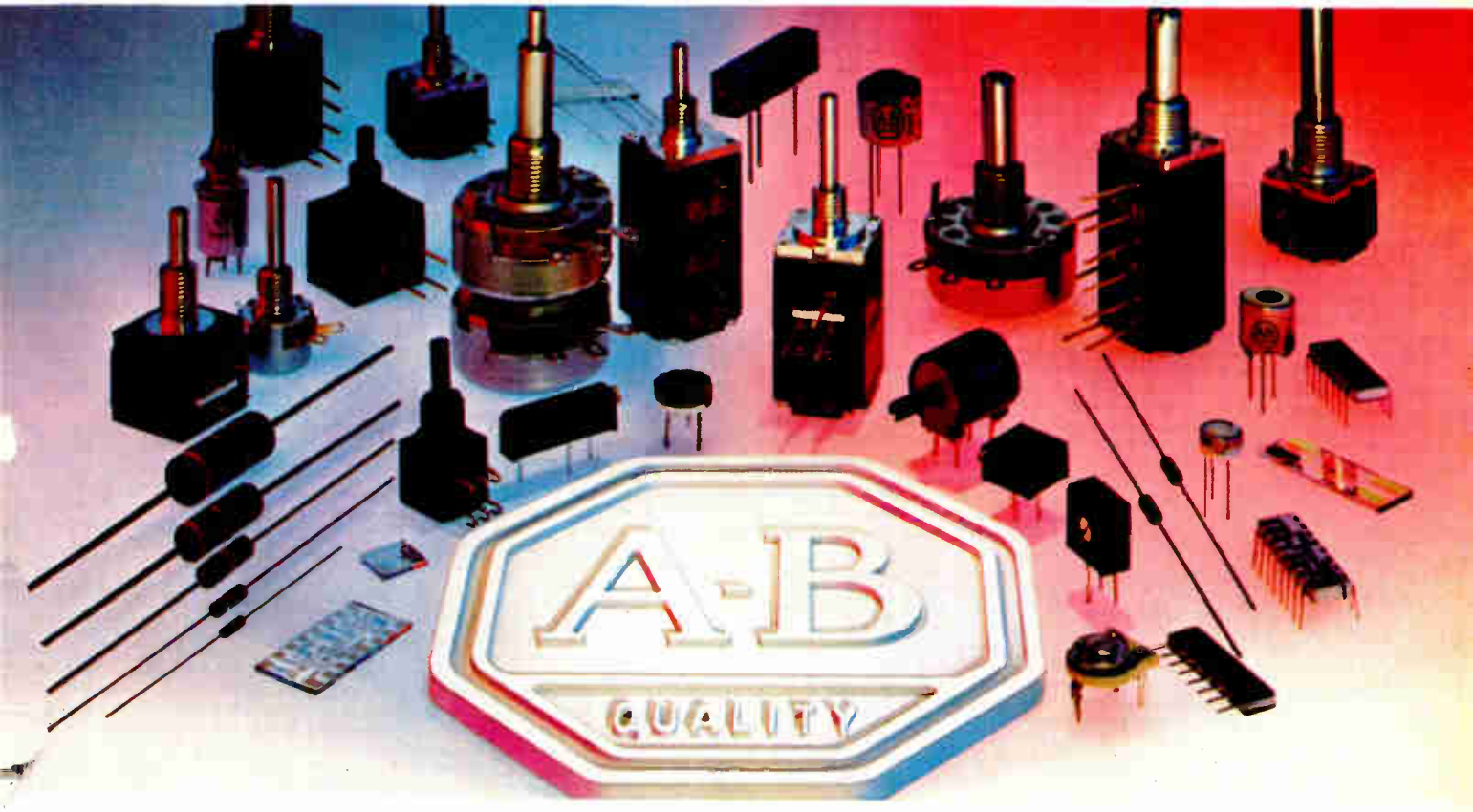

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Circle 40 on reader service card EC193

Circle 42 on reader service card

New products

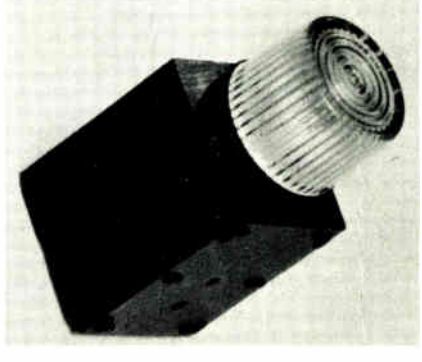
magnetic interference problems.

Lossyline acts as a low-pass filter providing over 100 dB of attenuation at microwave frequencies; it is available with cut-off frequencies from 10 MHz to over 45 GHz. Offered with many current, voltage, and power ratings, Lossyline will withstand operating voltages to 100 kv at temperatures from -67° to $+250^{\circ}$C. The filter wire is priced at $1 per foot and up; the length of the wire can be trimmed to exact attenuation requirements and can be supplied in semiflexible tubes of copper, brass, or other metals. Delivery is within two to three weeks.

Capcon Inc., 145 West 25th St., New York, N. Y. 10001. Phone Dennis Henderson at (212) 243-6275 [395]

Assembly allows mounting of LEDs to pc boards

The P-C-Lite allows direct mounting of an LED onto a printed-circuit board, eliminating the need for hard wiring required in front-panel displays. Using a lens with striated lines and fresnel rings (which provides viewing from an 180° angle) combined with a nondiffused LED, the P-C-Lite forms an assembly that



Whatever you need in an IC socket...

RN has 'em all!

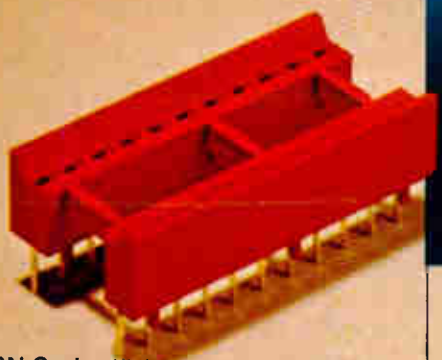
—and with "side wipe" reliability

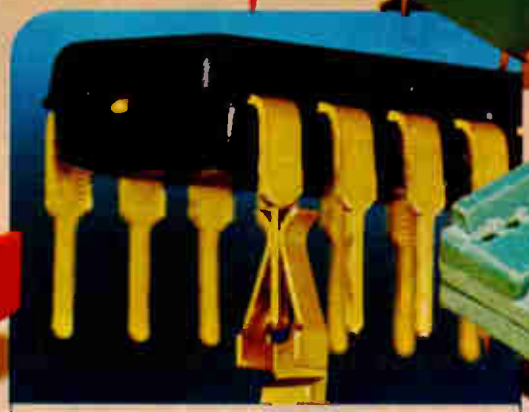
PRODUCTION SOCKETS

BURN-IN, TEST SOCKETS

NEW! ICL Series
26% lower profile—.150" Ideal for high density, high volume configurations, provides maximum vibration resistance. Solder type, single leaf "side-wipe" contacts. 8 to 40 contacts

TS Series
very long contact life. Very low insertion force. Ideal for incoming inspection. With 14 to 40 contacts. Also strip sockets up to 21 positions.



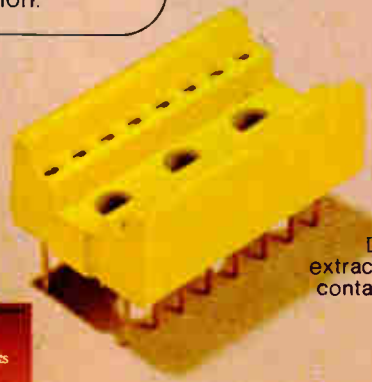


RN HIGH RELIABILITY eliminates trouble. "Side-wipe" contacts make 100% greater surface contact with the wide, flat sides of your IC leads for positive electrical connection.

ICN Series high reliability general-purpose sockets. Low insertion force allows automatic IC insertion. In solder or wire-wrap. 6 to 64 contacts. Dual leaf "side-wipe" contacts.

IC Series
moderate cost, long life. Designed for general test and burn-in up to 350°C. With 14 to 40 contacts.

ICA Series
high reliability pin socket contacts. Low profile in solder or wire-wrap. 8 to 40 contacts.



ICN/S2 Series
lowest cost burn-in socket available. Designed to accept IC extraction tool. With 8 to 40 contacts, with strip sockets up to 25 positions.

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ROBINSON-NUGENT, INC. • 800 East Eighth Street • New Albany, Indiana 47150 • Phone: (812) 945-0211

Circle 44 on reader service card

New products

allows either vertical or horizontal mounting of any standard T1 ¾ LED to a pc board. The lens may be flush mounted, recessed, or extended through the panel for full visability; the lens is at a standard height that is compatible with other switches and components mounted on pc boards.

The entire P-C-Lite and lens assembly encloses the LED and offers stability during packaging, and protection after assembly. The lens portion of the assembly is manufactured with butyrate plastics and is available in five colors: red, green, amber, yellow, and clear. The pc board mounting portion is constructed from nylon plastic. This complete assembly (but not including an LED) sells for 24¢ in 1,000-piece quantities. Delivery time is stock to two weeks.

Visual Communications Co., P. O. Box 986, El Segundo, Calif. 90245. Phone (213) 822-4727 [398]

Enclosure houses three fans, plus 19-in. card cage

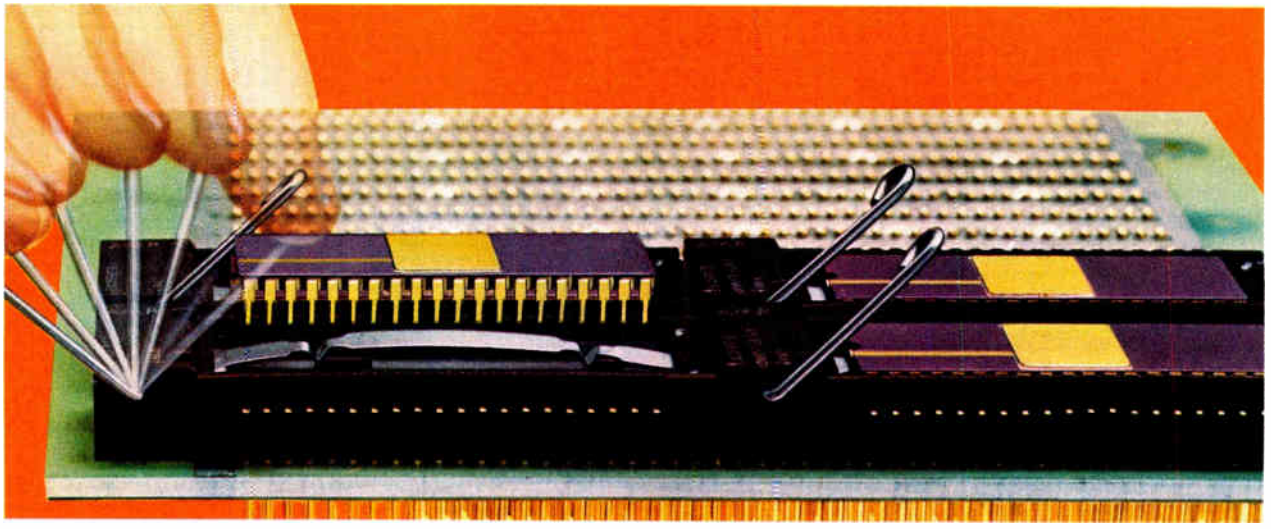
Sturdily constructed to hold up to three fans of different types, the Fan-Cage incorporates a standard 19-in. card cage and a fan container. The compact design increases the cage size by less than one RETMA (Radio Electronics Television Manufacturing Association) unit, and therefore allows standard cabinet packaging to be retained. By placing the fans directly beneath the printed-circuit boards or power pack, an efficient, evenly distributed air flow is created throughout the entire cage. With three fans producing as much as 100 ft³/min. each, even the most difficult boards and power supplies can be cooled with ease. Unless otherwise specified by the user, the fan-mounting holes are placed on 4.125-in. centers.

Each Fan-Cage is priced at $44, which does not include the fans. Availability is stock to two weeks.

Unitrack division, Calabro Plastics Inc., 8738 West Chester Pike, Upper Darby, Pa. 19082. Phone (215) 789-3820 [399]

"We must find a way to stop LSI package lead damage during burn-in and testing."

Good news. AMP LIF Eject.



Give the kid glove treatment to the leads of your microprocessors, ROMs, PROMs and EAROMs during plugging and unplugging. The new AMP LIF-Eject Connector combines the advantages of a Low Insertion Force design with a unique eject mechanism that lifts the LSI for utmost handling ease. No screwdrivers. No prying up. Nothing else is needed to assure damage-free insertion and extraction.

A three-position arm handles everything. One cams the contacts open. Another position cams them closed with a contact force of 150 grams. And the third position activates a leaf spring that pushes the package out of the contact area.

Two types of LIF-Eject Connectors are available from 24 to 40 positions, one rated at 105°C maximum and 25,000 cycles for electrical testing and programming, and another rated at 150°C maximum and 1,000 cycles for burn-in applications.

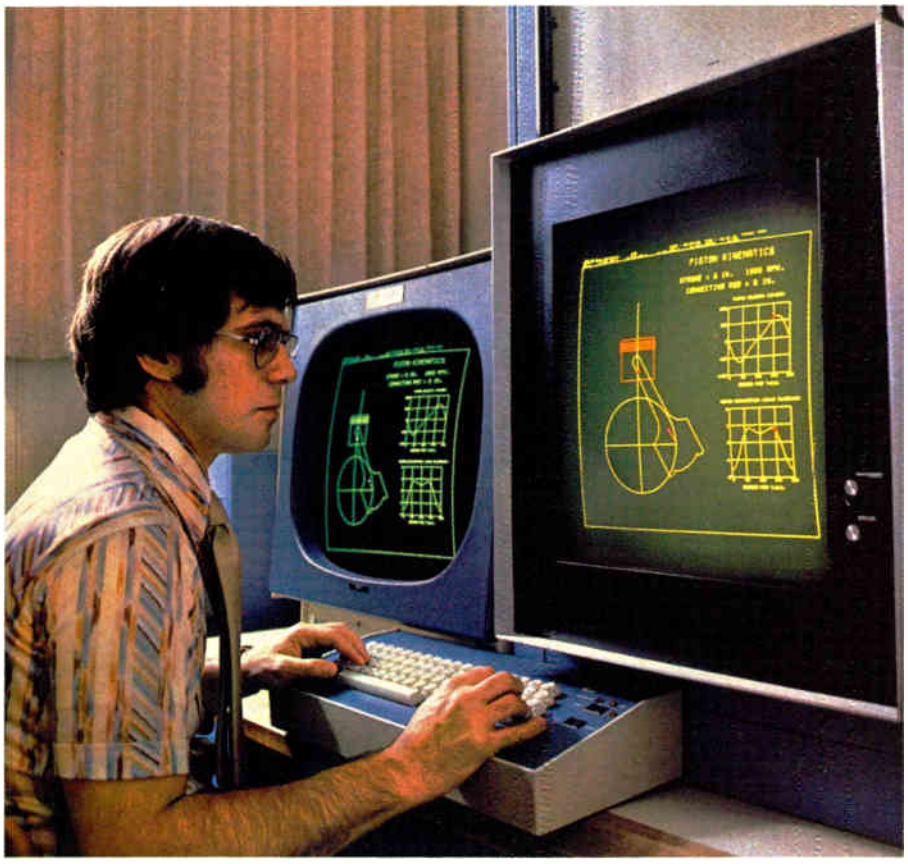
Sound interesting? Call the AMP LIF-Eject Information Desk at (717) 564-0100, Ext. 8400. Or write AMP Incorporated, Harrisburg, PA 17105.

AMP has a better way.

AMP

Control Data: Committed to

Control Data people, systems and services are helping manufacturers prepare for the '80's.



Exemplifying what state-of-the-art CAD technology can do for manufacturers, Chrysler Corporation Chief Engineer Robert Brauburger reports dramatic gains in the speed and efficiency of their design process. Above: a Chrysler engineer uses a color graphics terminal to analyze piston performance. Below: the control room at Chrysler's Technical Computing Center, where an operator monitors four interconnected Control Data® CYBER 170 systems.

American manufacturers are challenged by spiraling inflation and increasing competition. They must keep pace with productivity gains abroad to maintain market share and protect the jobs of their employees.

In the U.S., the annual growth in productivity over the last ten years has been half of what it was over the previous two decades. Many manufacturers are turning to computer-based technology to reverse this trend.

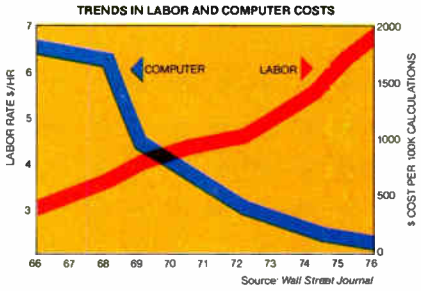
Over half the FORTUNE 500 are using our products and services.

Large scale Control Data computers are recognized for their outstanding ability to perform complex scientific and engineering computations rapidly and with great accuracy. Our systems are installed in major manufacturing companies around the world. And Control Data's recently announced CYBER 170 Series 700 continues in this tradition by offering increased performance at reduced cost.

Control Data also offers manufacturers a wide range of data services through some of the world's foremost data processing networks.

Through our CYBERNET® Services we provide the benefits derived from processing on Control Data computer systems, along with sophisticated application programs

the Manufacturing Industry



for structural, mechanical and electronic design and analysis.

Through our Service Bureau Company, we provide a whole range of services for business planning, analysis and control, plus a complete interactive system for material requirements planning, production control and management information.

In addition, many companies are training their personnel with our PLATO® computer-based educational service.

A new automated design and drafting system

One of the most important ways Control Data is helping manufacturers make better use of human resources is through computer-aided design (CAD).

Recently, we announced AD-2000*, an automated design and drafting system which speeds the design process by eliminating many of the tedious, time-consuming tasks previously performed by hand. AD-2000 offers practical and up-to-date design and drafting capabilities while providing a link to numerical control and other computer-aided manufacturing (CAM) functions.

*Developed by Manufacturing and Consulting Services, Inc., Costa Mesa, CA.

Coming from Control Data—a fully integrated CAD/CAM system

The critical link between CAD and CAM is the effective control and flow of data among respective systems. Control Data has the products and expertise to allow the interface of design, analysis and manufacturing applications.

And when our new CAD/CAM technology is available, manufacturers will be able to go from a design on a CRT screen to a finished part—all with greater productivity and better use of resources than offered by the present technology.

Control Data is committed to helping industry bridge the gap between the old and new technologies. Through our Manufacturing Consulting Services organization we are helping manufacturers plan and implement their CAD/CAM strategies through training, consultation and technical assistance. And through Commercial Credit Company, an important part of Control Data, we provide manufacturers with a whole range of financial services, including capital equipment financing.

Boeing, a long time user of Control Data computers, recently installed two CYBER 175's in a CAD/CAM center to assist in the design of its new generation of passenger aircraft.

Systems. Services. Solutions. Measures of Control Data's commitment to the manufacturing industry.

For further information, write: Control Data Corporation, Manufacturing Industry Marketing, HQW09F, Box 0 Minneapolis, MN 55440.

CONTROL DATA CORPORATION

More than a computer company

ADVANTAGE: FLEXIBILITY

Another way the Model 730 aces the competition!

Centronics' Model 730 miniprinter shatters the rules of the game. Greater flexibility than any printer is one of the reasons why.

APPLICATIONS FLEXIBILITY Now you can meet a wide range of applications requirements with just a single printer: the Model 730. Payroll checks on preprinted continuous forms. Inventory listings on fanfold. Direct mail on company letterhead. General information on roll paper . . . and change from one to another quickly.

INVENTORY FLEXIBILITY Model 730's versatility means no more costly inventories of limited-use printers. Stock only one set of spares. One set of service tools. Train to service only one highly reliable machine.

INTERNATIONAL FLEXIBILITY To make your overseas marketing easier, international models of the 730 can print 96 character U.S., British, French, German, Italian, and Swedish/Finnish. Available in all standard international power requirements.

Here are more reasons why the Model 730 is the newest sensation on the circuit.

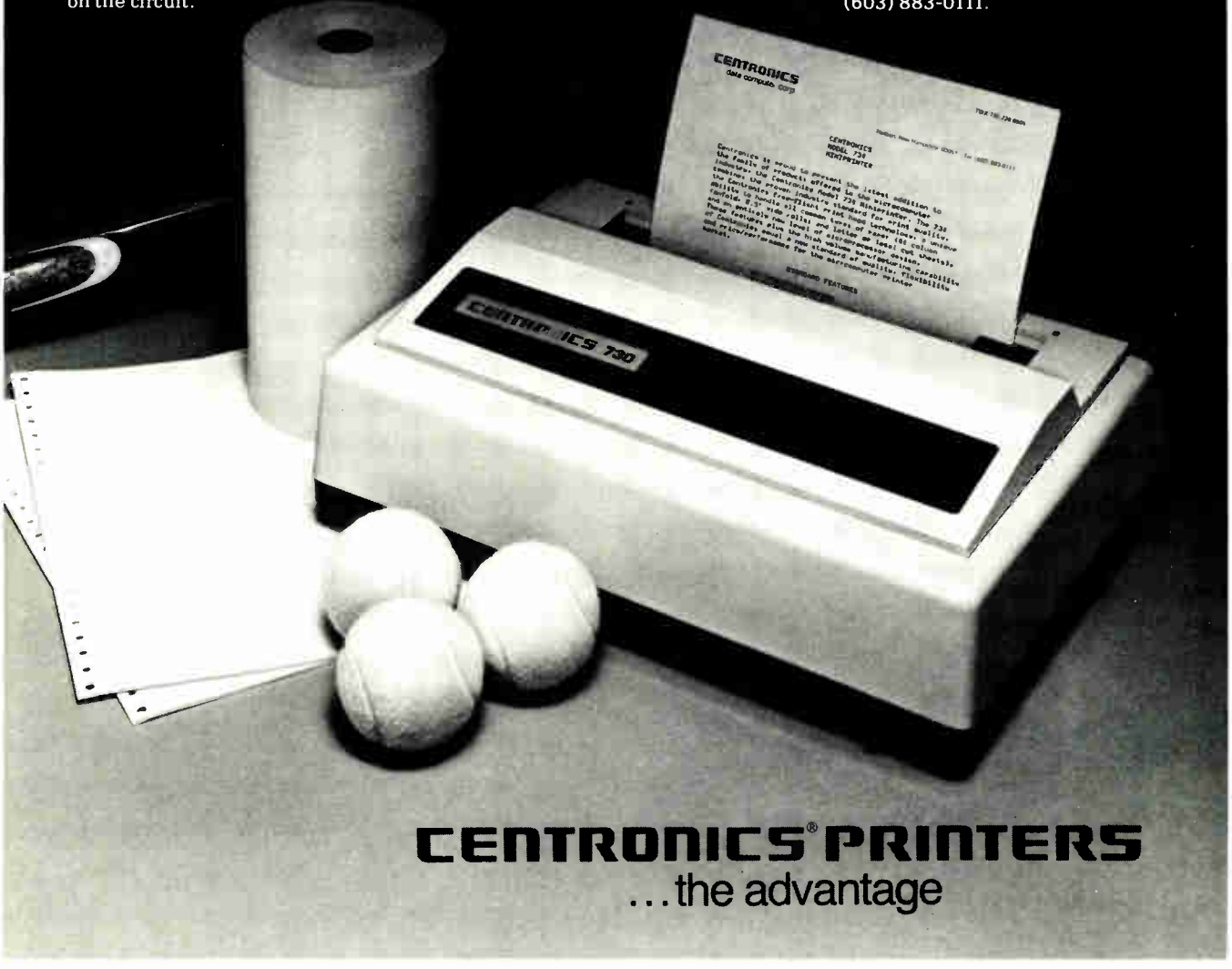
Its simple design ensures reliability. Combine that with an attractive purchase price and you have a very low cost of ownership.

Although it's surprisingly affordable, Model 730 sets new quality standards. Its 7x7 dot matrix produces crisp, clean characters, and its quiet, compact, and stylish design makes it welcome in any environment.

Best of all, because of Centronics' manufacturing capabilities, volume delivery is assured.

ADVANTAGE:MODEL 730 Model 730 leads the way to a whole new era. Naturally, it's from the leader: Centronics. No other company can match our strong serve in performance, selection, and value. And every Centronics printer is backed by one of the largest worldwide service organizations of any independent printer company.

On flexibility, features, price, and support, the Model 730 is a clear winner. For more information on products or employment opportunities, please write or call today: Centronics Data Computer Corporation, Hudson, New Hampshire 03051 (603) 883-0111.



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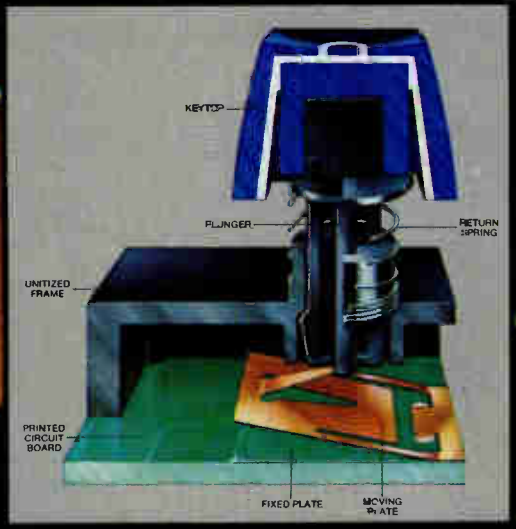

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E 11

Instruments

Tester sells for under $45,000

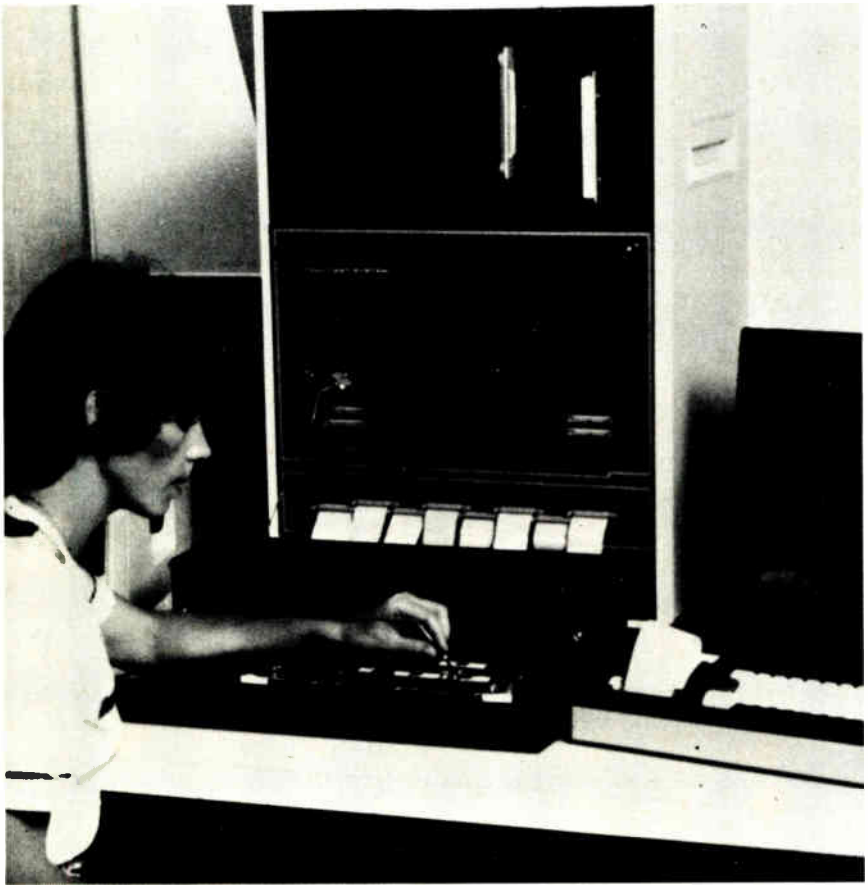
Programmable benchtop logic tester for digital pc boards offloads larger test systems

With a programmable, functional benchtop logic tester that it calls the Logic Test System (LTS), Omnicomp Inc. is introducing the concept of distributed testing. Capable of automatic high-speed testing and component-level fault isolation of digital printed-circuit boards, the LTS is designed for high-volume service and production, both as a stand-alone tester and as a means of offloading large production test systems to increase board throughput.

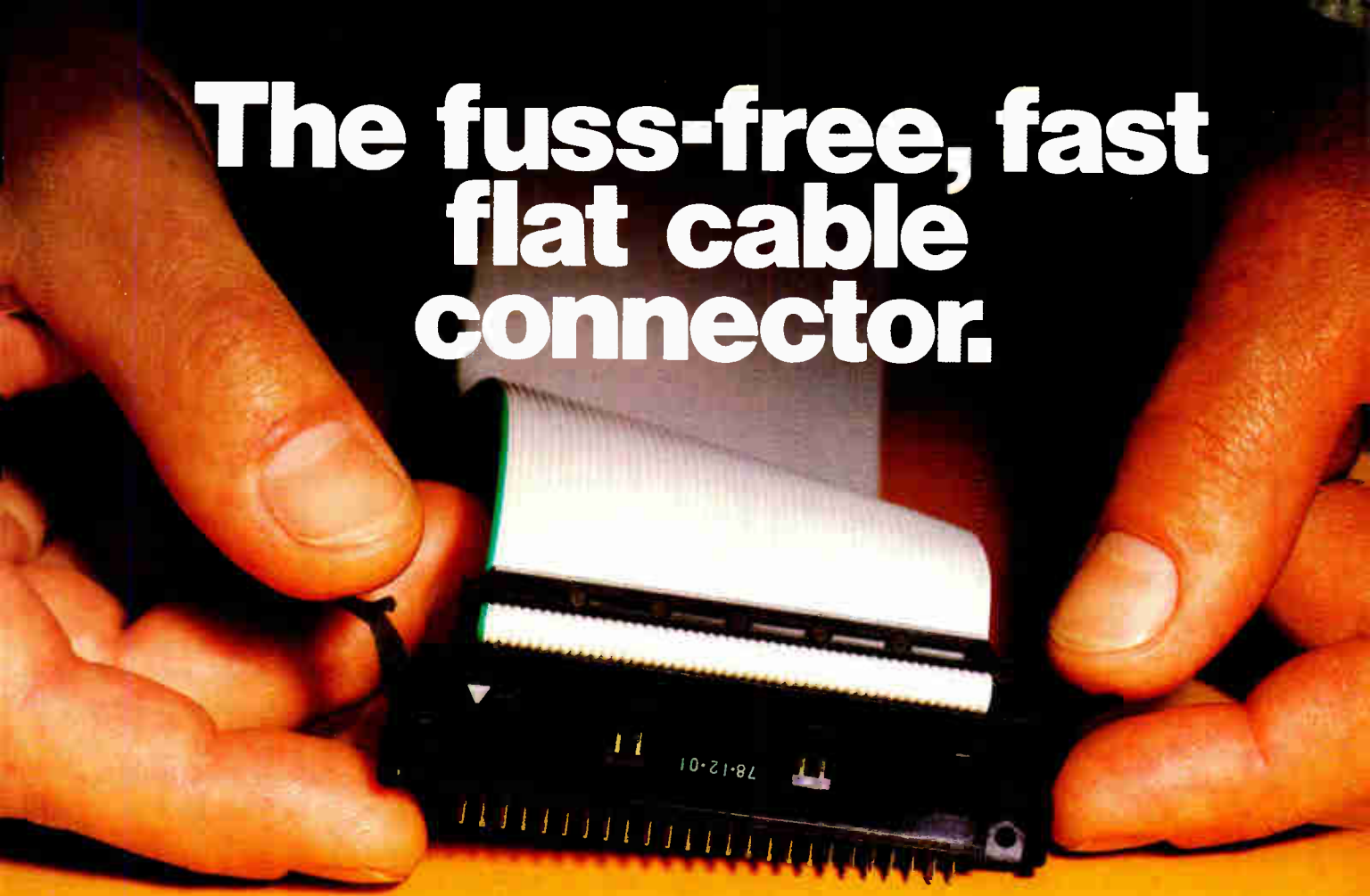
Incorporating many of the testing concepts that Omnicomp used in developing its popular Portable Service Processor (PSP) for NCR Corp. [*Electronics*, Feb. 16, 1978, p. 41], the LTS is programmable in a high-level test language based on Basic. It provides pin-change rates to 2 MHz on a maximum of 384 programmable driver/sensor pins for boards containing up to 12 different logic families; it also performs guided-probe diagnostics. The LTS is program-compatible with the PSP. (GenRad Inc. of Concord, Mass., markets the PSP as its model 2225 portable, functional logic tester.)

The LTS, also to be marketed by GenRad under a recent agreement, will be priced between $35,000 and $45,000, depending upon quantity. That is approximately one quarter to one half the price of equivalent production test systems, depending upon the combination of features included in a comparison, says Omnicomp's vice president Robert E. Anderson.

Distributed testing. The relatively low cost, high performance, and



The fuss-free, fast flat cable connector.



The new Amphenol® IDC Connector. Fuss-free because it locks when it mates. Fast because there's no wire stripping.

Simply insert the socket into the header and push gently. Click! The connector locks. No doubt about it. You heard it lock. You can see it's locked.

These connectors also have integral polarizing keys. There is no chance of mismating.

To unlock, just flip the ears and pull the connector apart.

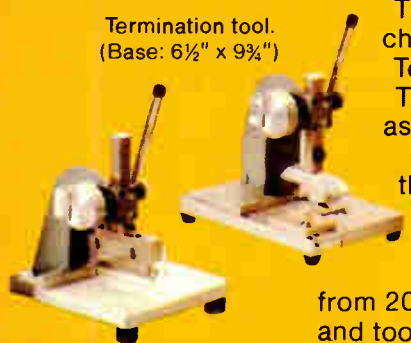
The insulation-displacing contacts mean there's no wire stripping. So assembly is faster. And that cuts costs.

The socket and header bodies are made of UL-recognized 94V-O thermoplastic. Which should make it easier for you to get UL approval.

Additional coding and keying guides are available if several connectors of similar configuration are on an assembly.

New Amphenol IDC Connectors are offered in six sizes, with from 20 to 60 contacts. Also offered are matching cutting tools for flat cable and tools for connector termination.

For complete information, technical data, dimensions, and prices, contact your nearest Amphenol North America sales office or distributor.



Termination tool.
(Base: 6½" x 9¾")

Cutting tool.
(Base: 7⅞" x 10⅛")

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Circle 213 on reader service card

small size (29 by 20 by 17 in.) of the LTS, Anderson says, introduce the concept of distributed testing "because production testing can be performed at multiple locations throughout a board-assembly area for the same or lower cost than a single, larger, and more expensive tester." The LTS can easily be deployed at board areas in the factory, at off-site board-production locations for vendors, as well as at large field engineering-rework depots, engineering labs and test-programming areas, he adds.

Furthermore, the software compatibility between the LTS and PSP (or GenRad's 2225) allows the consistency of a single test program to be used from engineering, through production and the larger rework centers with the LTS, to local board repair on the earlier, portable PSP logic tester, Anderson explains. The LTS, he continues, also makes an ideal programming station for the smaller tester.

The LTS can provide a complete functional test of the board, displaying a pass/fail result in seconds, regardless of board complexity, according to Anderson. The unit's test rate is faster than those of most commercial static test systems. Therefore, he adds, the functional test time is shorter, brief one-shots can be tested, and marginal dynamic failures can be detected.

The LTS contains a custom bipolar processor that provides the 2-MHz pin-change rate so that boards containing dynamic microprocessors and memories can be tested without removing them from the boards. Built around this custom microprocessor with the power of Digital Equipment Corp.'s LSI-11, the LTS's hardware features include a cathode-ray-tube display, dual floppy-disk drives with a total of 2 megabytes of storage capacity, 96 kilobytes of random-access memory, a 16-character light-emitting diode display, a low-profile keyboard, a thermal printer, and high-speed-printer, RS-232-C, and IEEE-488 bus interfaces. Collectively, these new features let the operator interact faster and more conveniently with the LTS during

New products

programming, testing and fault isolation, says Anderson.

Among other conveniences the LTS offers the operator are a lateral test position for the board under test, a 90° rotatable board fixture, and a command key that can enter most system commands and programming statements by itself. A line- and character-editing capability with the CRT cursor simplify any program changes, and an "immediate" execution mode minimizes debugging time.

Initial production units of the LTS will be shipped later this month. NCR and Great Britain's ICL Ltd., two of the major users of Omnicomp's PSP, are believed to be among the first customers. This programmable logic tester will be available within six to eight weeks after receipt of order.

Omnicomp Inc., 5150 N. 16th St., Phoenix, Ariz. 85016. Phone (602) 264-2475 [351]

3½-digit DMM responds with beep to five testing ranges

With its audio response capabilities, the model 6100 Roadrunner 3½-digit multimeter will permit go/no-go testing of fuses, capacitors, diodes, resistors, transistors. All of these components can be tested using the five ranges of audio response—less than 1 V, less than 2 V, less than 1 Ω, less than 10 Ω, and less than 100 Ω. This audio-response function allows incoming dc pulses to be

ELEC-TROL BLUE BOY REED RELAYS

NOW TWO GRADES OF LOW-PRICED SEALED RELAYS

Elec-Trol now offers its Blue Boy Reed Relays in both an instrument and a commercial grade. The instrument grade provides low and stable contact resistance over a large number of operations, for use in such applications as ATE systems, data acquisition and telecommunications.

The new commercial-grade units have a higher contact resistance and a lower life expectancy but are well suited for applications where contact resistance is not critical, such as switching into high impedance loads, for use in such end-products as microwave ovens, water heaters, and TV's.

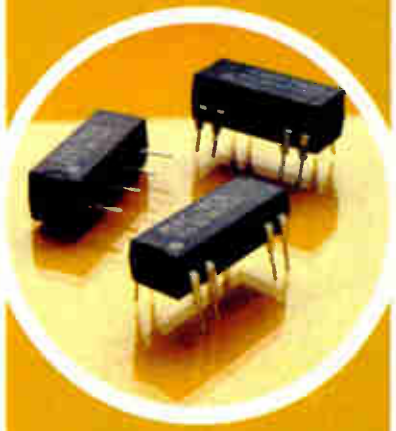
Both grades are totally encapsulated in rock-hard epoxy, and the reed switch contacts and coil are secured to a rigid internal lead frame which incorporates the PCB terminals. These little inch-long units incorporate a 1 Form A hermetically-sealed reed switch, and can switch low-levels up to 10W with 5-48 VDC coils. For prices or samples, contact your local Elec-Trol distributor.

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

ELEC-TROL

Circle 63 on reader service card

ELEC-TROL RELAYS



140 STANDARD MODELS

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

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Solid State Electronics Co of Texas, Inc.
(713) 772 8510
UTAH SALT LAKE CITY
Diplomat Electronics, Inc (801) 486 4134

Circle 217 on reader service card

New products

monitored by acknowledging the presence of the pulse with an audio signal. Continuity tests on printed-circuit boards, wire-wrapped cables, transformer windings, and light bulbs can also be performed.

The model 6100 features five testing functions: ac and dc voltage, ac and dc current, and resistance. The basic accuracy of the meter is within 0.5% of reading ± 1 count for the dc voltage mode. Hand-held, the $139 unit is packaged in a ruggedized case for field use.

Weston Instruments, a division of Sangamo Weston Inc., 614 Frelinghuysen Ave., Newark, N. J. 07114. Phone (201) 242-2600 [354]

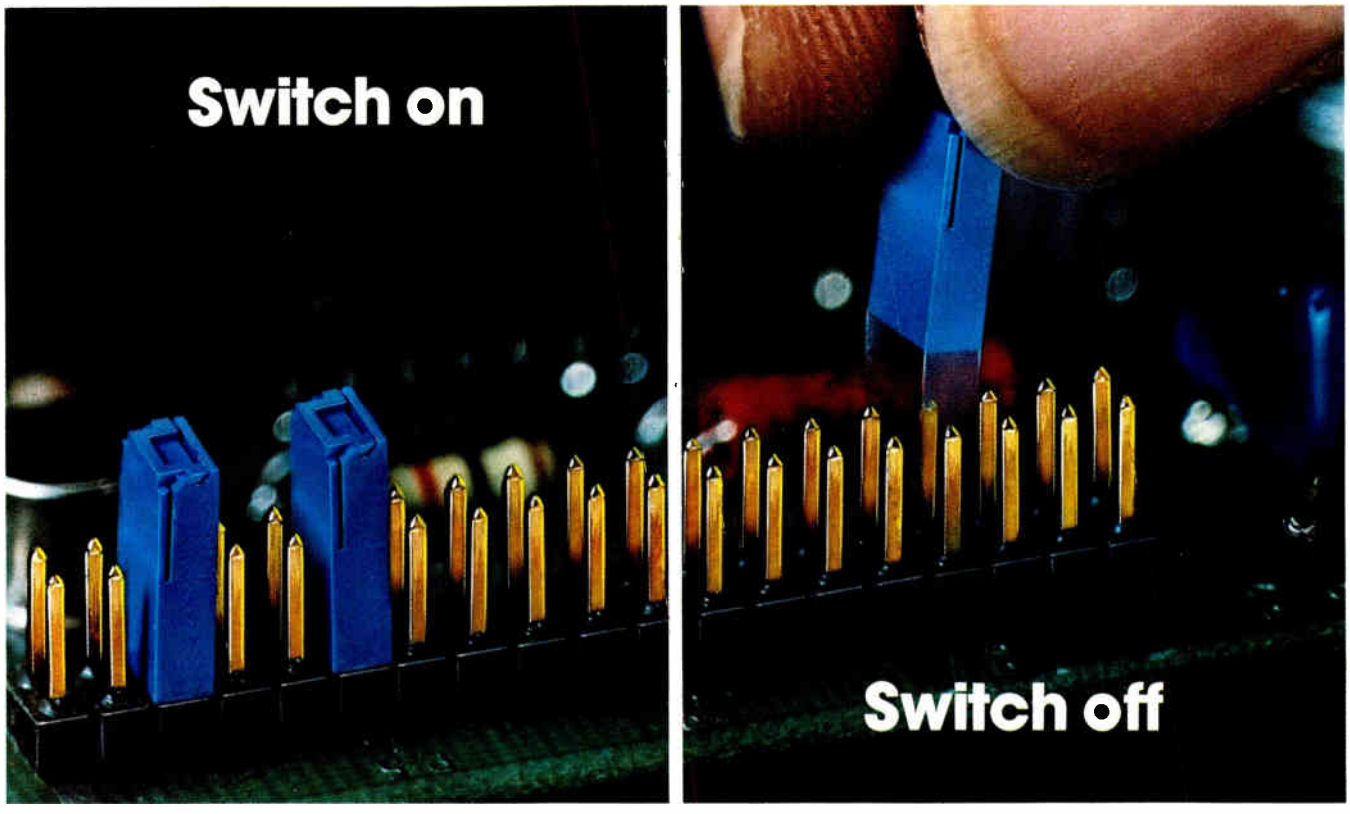
$39.95 temperature probe works with any voltmeter

The TP-20, a temperature probe that can be used with almost any voltmeter, measures temperatures ranging from −55° to +150°C (in the Celsius model) or −67° to +302°F (for the Fahrenheit version). This probe operates up to 500 hours on a single 9-v battery.

The accuracy of the probe is within ±2.7°F or ±1.5°C; when it is used with a digital multimeter with a 200-mV full-scale sensitivity, the TP-20 has a resolution of 0.1°. The probe's tip is electrically isolated so that temperatures of electrically "live" components can be measured even if they are operating 500 v above the meter circuit.

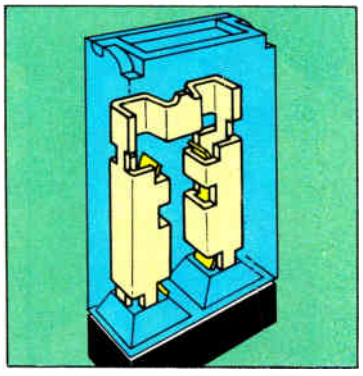
Useful for measuring integrated-circuit, resistor, and transistor temperatures; for checking enclosure

DIP switches can deprogram. Berg's Mini-Jump™ can't. Our design guarantees it.



Far more reliability. Far less field service. Accidents, vibration — anytime you'd expect a DIP switch to fail, you can count on Mini-Jump* to stay programmed. Careless fingers can't deprogram it because there's no switch to hit. Only a deliberate action can change the circuit.

The interior spring of the "Mini-Jump" maintains a high normal contact force for reliability during vibration — even severe vibration. And, because you install the "Mini-Jump" after soldering, you avoid contamination which can lead to corrosion.



Inside the "Mini-Jump", dual metal PV† contacts provide excellent electrical and mechanical performance.

Permits higher density packaging. The "Mini-Jump" is available in single position, stackable on 0.100", 0.125", 0.150" and 0.200" centers. Also in two positions on 0.100" centers and three and five positions on 0.150" centers.

Write for literature. The Du Pont Company, Berg Electronics Division, New Cumberland, PA 17070. Telephone (717) 938-6711.

*Du Pont trademark for its .025" disconnect jumper.
†Du Pont trademark for its .025" dual metal female disconnect.

Berg Electronics

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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.

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A member of the EMI group. International leaders in music, electronics and leisure.

Circle 67 on reader service card

New products

temperatures and heat-sink efficiencies; and for monitoring environmental-test temperatures, the unit also has industrial applications. These include: measuring the temperature of liquids, checking stored-grain temperatures, and checking insulation efficiencies.

The TP-20 sells for $39.95 and is available from stock.

The Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio 44108. Phone Tom Hayden at (216) 541-8060 [356]

Station stands alone for AFIT software development

A stand-alone programming station providing off-line software development for Fairchild Camera and Instrument Corp.'s Testline AFIT family of in-circuit printed-circuit-board testers is now available. Programmers can develop, edit, and duplicate test routines on the station, independently of a system test operation. By freeing production system testers from such programming chores, the unit can increase testing throughput by 23%.

Capable of generating programs for all Testline AFIT products on minicassettes, minifloppy disks, and standard disk media, the programming station can develop programs for up to 20 integrated circuits per hour.

Controlling the system is a 6800 microprocessor. The front panel contains three disk drives that will accept standard, hard-sectored disks. A keyboard incorporates six accessory outlets for a cathode-ray-tube display, a line printer, a cassette duplicator, a synchronization line, two standard ac lines, and a reset button.

The basic system includes a CRT-display interface for RS-232 or current-loop operation, a line printer interface, and a disk interface for the three standard disk drives. The base price of the system is $22,000.

Fairchild Camera and Instrument Corp., Subassembly Test Systems Division, 1400 White Dr., Titusville, Fla. 32780. Phone (305) 267-7212 [357]

American Optical gives you a big stage...for a really big show.

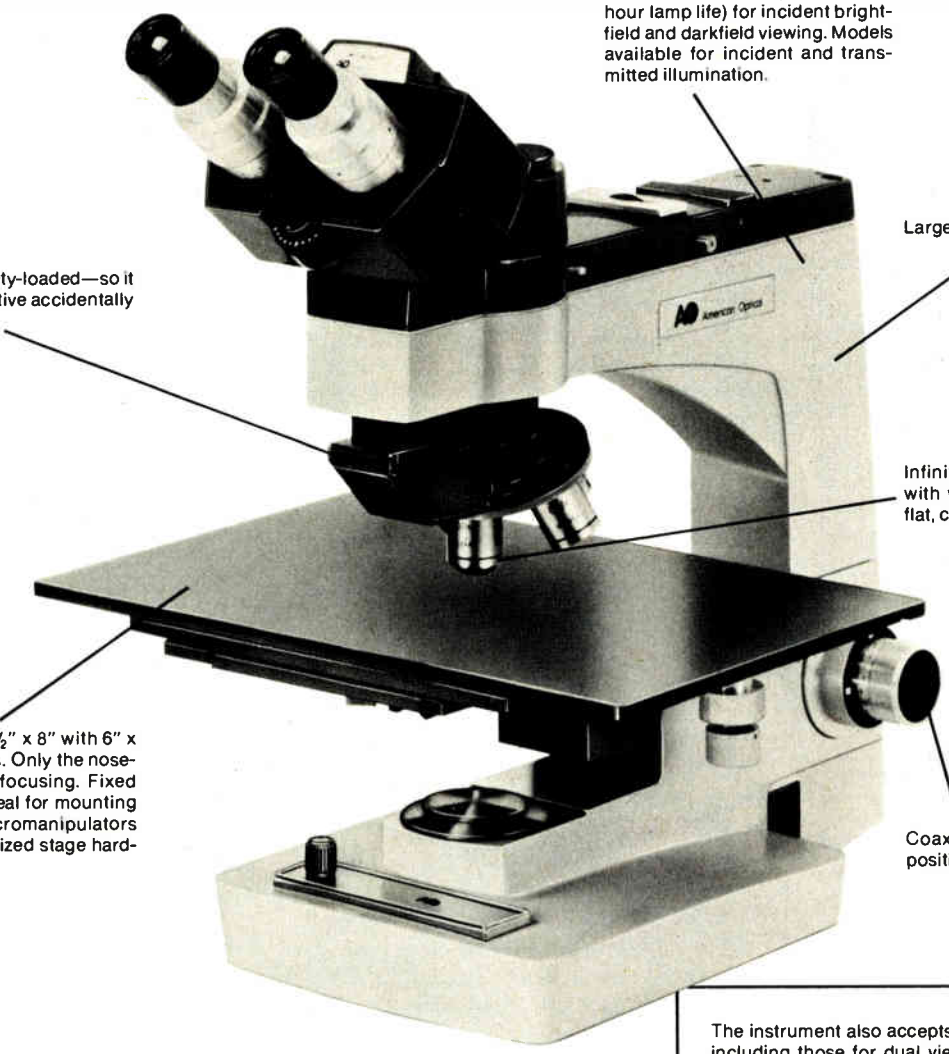
The AO® Series 1860 Industrial Microscope offers a 12½" x 8" stage with a full 6" x 6" X-Y stage travel, for quality control, failure analysis, fabrication or general inspection of masks, wafers and other microelectronic components.

With exclusive AO nosepiece focusing, the stage height remains fixed for excellent stability and easier use of ancillary equipment.

And the stage will accept carousels or any other commercially available stage hardware.

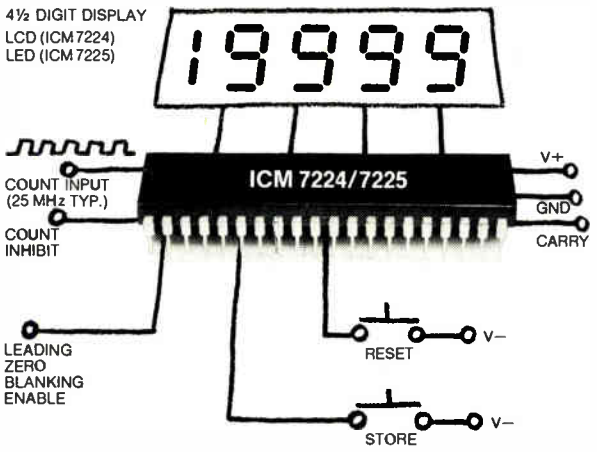
If you'd like to see how an AO Series 1860 Industrial Microscope can fit into your production number, contact your American Optical dealer for a demonstration. Or call or write: American Optical, Scientific Instrument Division, Buffalo, NY 14215; (716) 895-4000.

AO® American Optical



The instrument also accepts a variety of accessories, including those for dual viewing and multi-viewing, photomicrography and differential interference contrast. Ask your dealer for details.

ALL THE PARTS YOU NEED FOR A 4½ DIGIT CASCADABLE COUNTER/DECODER/DRIVER:

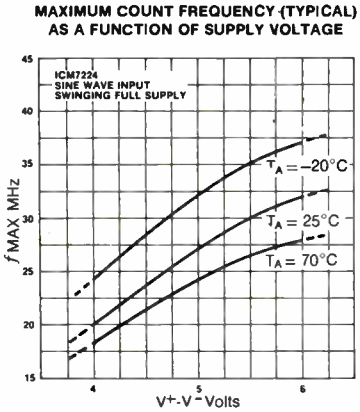


ONE.

LCD or LED. One chip.

The ICM7224 (LCD) and ICM7225 (LED) counters offer 19999 maximum count, or 15959 maximum count in version "A" (timer). In both versions, the display is not multiplexed and, RF interference is eliminated. Bright digits are assured (with a guaranteed minimum of 5mA per segment on the ICM7225 LED version).

High frequency. Low frequency.



The ICM7224 offers high frequency counting, (15MHz guaranteed; 25MHz typical at 5V). For those applications that require low frequency counting, down to DC, a Schmitt trigger on the count input allows accurate operation in noisy environments or with slowly changing inputs.

Low power.

Current requirements of the ICM7224 are 10μA up to 1KHz and 1mA at 10MHz with a 5V supply. That means less than 10mW power consumption when counting from DC to 15MHz...terrific for long battery life operation.

Cascadable.

Cascade in four-digit blocks. The ICM7224/7225 family of counter/decoder/drivers provides a carry output which allows cascading to 8, 12 or 16 digits. Leading zero blanking control pins provide correct blanking on cascaded devices.

MAXCMOS.® More for less.

Greater reliability. Lower component count. Super performance. Less design and manufacturing cost. At prices like these:

	ORDER PART NUMBER	COUNT OPTION	1-24	25-99	100-999
LCD DISPLAY	ICM7224IPL ICM7224AIPL	19999 15959	$9.80	$8.40	$7.00
LED DISPLAY	ICM7225IPL ICM7225AIPL	19999 15959	$8.90	$6.35	$5.30

Available now.

Call your Intersil Sales Office or Franchised Distributor for full information. Or, return the coupon below for complete product information on all the parts you'll need for a 4½-digit cascadable LCD/LED counter/decoder/driver: One.

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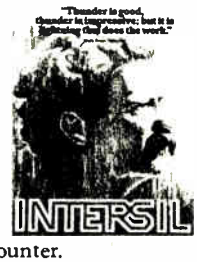

One?
Send me the details on: ___ ICM7224 (LCD) counter.
___ ICM7224A (LCD) timer. ___ ICM7225 (LED) counter.
___ ICM7225A (LED) timer. ___ Send me your Mark Twain Poster.

Name_____

Company_____

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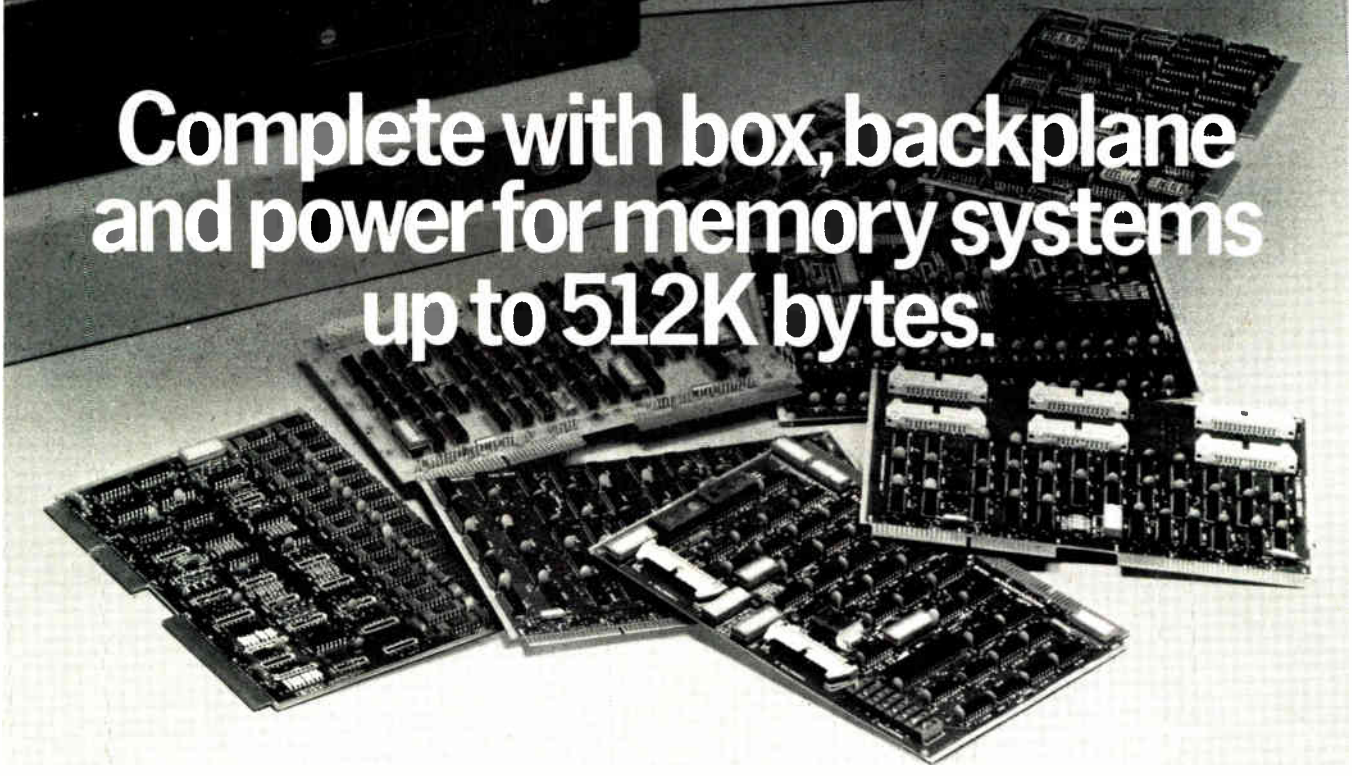
Plessey 'FASTOR' Ultrafast 100ns modules.

Complete with box, backplane and power for memory systems up to 512K bytes.



Plessey 'FASTOR' provides fast access memory for high-speed computing, in a highly convenient package. Designed around double Eurocards with 16K bytes each of the fastest memory available anywhere.

The 19-inch rack mounting chassis is complete with power supplies and a parallel backplane with all signals available in all positions to make your interfacing easy. It is the ideal main storage for applications where data are collected or delivered at 20 megabytes/second.

If you don't need the full system, the cards are available individually as the PSM 3234.

The simple-to-use interface provides:

- block-select control bits.
- read/write control flag.
- additional data/source sink control, if more than one 1/0 port is provided.
- additional clock source control, if memory is required to cycle at different rates at different times.
- the block-select signal permits read/write and output-select signals to be applied to the appropriate 64K memory block.

If you're seeking a ready-built memory system, and need it pretty quickly, then move fast! Contact us for full details of Plessey 'FASTOR.'

OUTLINE SPECIFICATION
of 128 Kbit module

Capacity:
8K words, 16 bit
Access time:
100 ns max
Device type:
4K static RAM (2147 type)
Power supply:
5V ± 3%
Power consumption max:
19W selected
8W deselected
Options:
Depopulation to 4K words
Temperature range:
0 to 70°C ambient

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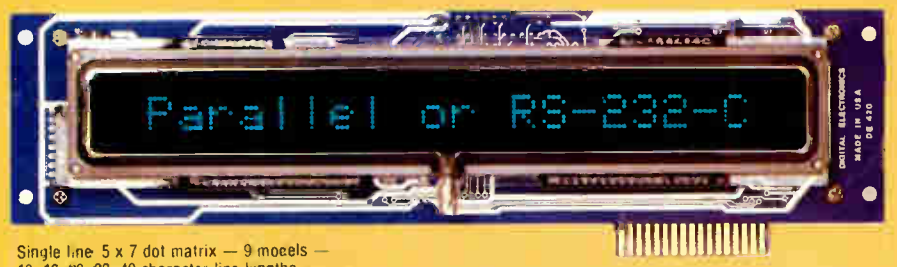
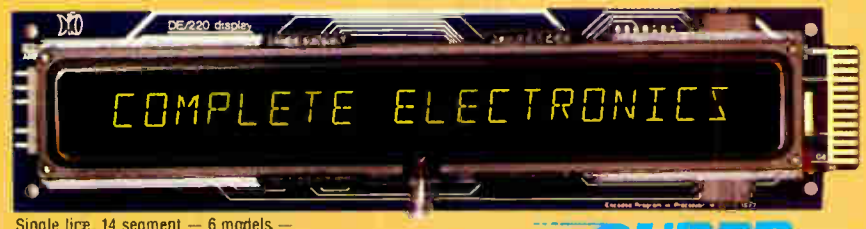


Single line 5 x 7 dot matrix — 9 models —
10, 16, 20, 32, 40 character line lengths



Single line 14 segment — 6 models —
10, 20, 32 character line lengths.

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WHY DO ENGINEERS SPECIFY DECO DISPLAY SUB-SYSTEMS?

Readability - Bright, sharp, highly readable characters even in daylight with proper filtering. Natural, eye-pleasing blue-green color filters to blue, green, aqua, amber, orange, red

Variety - Full range of sizes available from 10 to 240 character positions, 5mm to 15mm character heights.

Reliability - Vacuum fluorescent tube technology offers tube MTBF up to 100,000 hours, shock resistance to 100 G's

Low Power - As low as 65 milliwatts per character. Much lower power dissapation than LED or gas discharge displays. No need for 250 volt high voltage typically used in gas discharge displays

Self-contained - All drive, refresh and interface circuitry included at no extra charge. Many models also feature on-board power conversion circuitry — only +5VDC input required!

Complete Software - manual, mounting diagrams and interface electronics furnished in evaluation kits. Kits also include full assortment of filters, bezels and mounting hardware.

5x12 DOT MATRIX DISPLAY NOW AVAILABLE

New format allows decenders, accents, umlauts, etc.
40 character line length.

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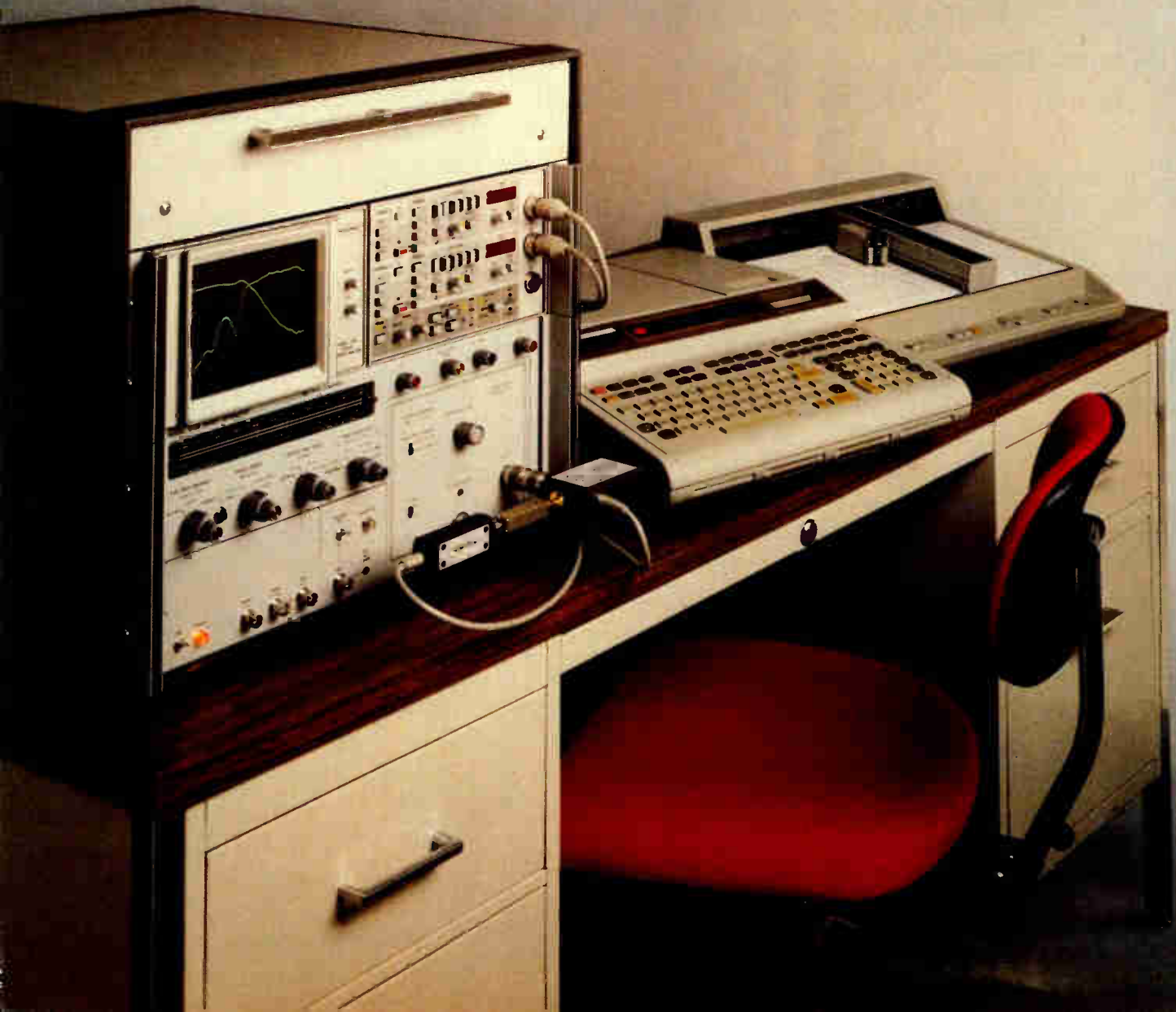
Circle 225 on reader service card

Introducing the 5610 Automated Network Analyzer System....

Fast, Automatic and Accurate from 10 MHz to 18 GHz.



It's a Wiltron.

Now you can automatically make the most important microwave measurements ...return loss (SWR), transmission loss or gain and absolute power...quickly and accurately over the 10 MHz to 18 GHz range with hard copy output. Straightforward program-guided inputs are easy to follow.

Wiltron's new 5610 desktop computerized system gives you a new level of accuracy, convenience and cost savings. You simply plug in the preprogrammed cartridge that comes with each system, enter a few simple inputs through the controller, then get hard copy test data over a 66 dB (+16 dBm to −50 dBm) dynamic range from 10 MHz to 18 GHz. No other scalar system is remotely comparable.

Turnkey system includes programming.

Wiltron's 5610 system is delivered complete and ready to work. The system includes a 560 Scalar Network Analyzer, 610D Sweep Generator, 560-97A50 (GPC-7) SWR Autotester, 560-7A50 Detector, HP 9825A Desktop Computer and HP 7225A Plotter. We also include the preprogrammed measurement software cartridge, as well as all cables and accessories. Option 3 provides a WSMA test port connector. Option 4 is Type N. Special versions are available for operation up to 40 GHz.

A new era in microwave measurement.

0.01 dB resolution. • SWR measurements with better than 40 dB directivity. • 66 dB dynamic range. • One sweep generator covers the 10 MHz to 18.5 GHz range. • A new WSMA (SMA compatible) connector with improved return loss measurement accuracy and life expectancy. • Digital memory techniques which substantially improve measurement accuracy. • Calibration techniques which correct for variations caused by frequency response variations and test port mismatch errors. • Refreshed display of memory-corrected measurement results.

Wide Application.

The 5610 is well suited to both laboratory and production line applications. Almost every kind of RF component or system can be tested. For instance:

Test amplifiers to measure gain, power, isolation and return loss over 66 dB dynamic range.

Test filters to plot insertion loss and return loss individually or together on a single page with 0.01 dB resolution.

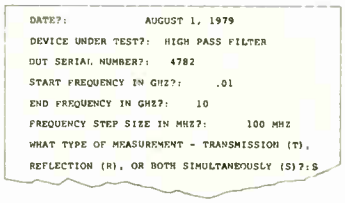
Test antennas to make precise return loss measurements with 40 dB directivity accuracy and memory-corrected test data.

In the lab, on the line, payback is fast.

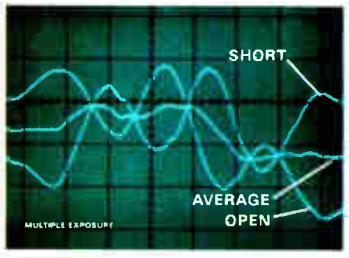
Even if you're only testing a single device, substantial savings are yours with the new Wiltron 5610 system. And, on the production line, you'll get your initial investment back even faster.

For an early demo or full data, phone Walt Baxter, (415) 969-6500, or address Wiltron, 825 East Middlefield Road, Mountain View, CA 94043.

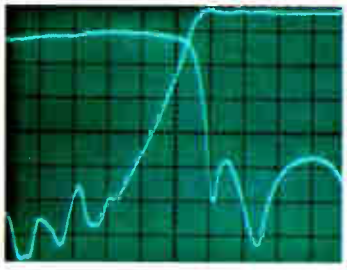
Easy 4-step operation



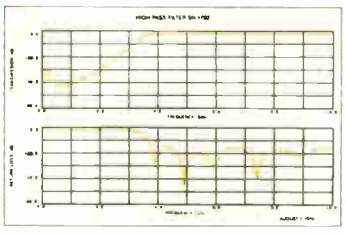
Enter test parameters on controller



Store system residuals in memory for later correction of test data



Use CRT display to confirm proper operation of system and to adjust device under test



Initiate automatic measurements and hard copy printout

WILTRON

Circle 226 on reader service card

New products

Industrial

Versatile chip controls motors

Programmable device has repertoire of 21 instructions, sells for $95

The control of stepper motors, especially in complex systems, promises to become far simpler in the near future with the introduction of a user-programmable control chip by Cybernetic Micro Systems Co. Currently available stepper-motor controllers have essentially one operating mode: for each pulse supplied through the controller, the motor is moved one step. "But with our chip that [single-stepping] is the very minimal function provided," notes Edwin E. Klingman, president of the Los Altos, Calif., company. The chip's on-board read-only memory contains a repertoire of 21 instructions, while its random-access memory allows the user (or a computer) to program specific instruction sequences and to enter values for such parameters as acceleration, speed, and position.

To ease the task of developing programs for the CY-500 chip by users who do not have a computer handy, the device has been made compatible with an ASCII keyboard that may be used in conjunction with a high-level language. Users who do their program development on a computer will probably find it better to communicate with the CY-500 in binary. They may do so with any machine operating at up to 1,200 bauds in an 8-bit parallel or serial format. Either binary or ASCII-decimal coding may be selected by the user in the field.

The 21 high-level function-oriented instructions are easily called up by single-letter labels such as P for position, S for slope, and R for rate. In addition to the standard instruction set, the user may choose to have his own set of instructions loaded into the controller at the factory as an option.

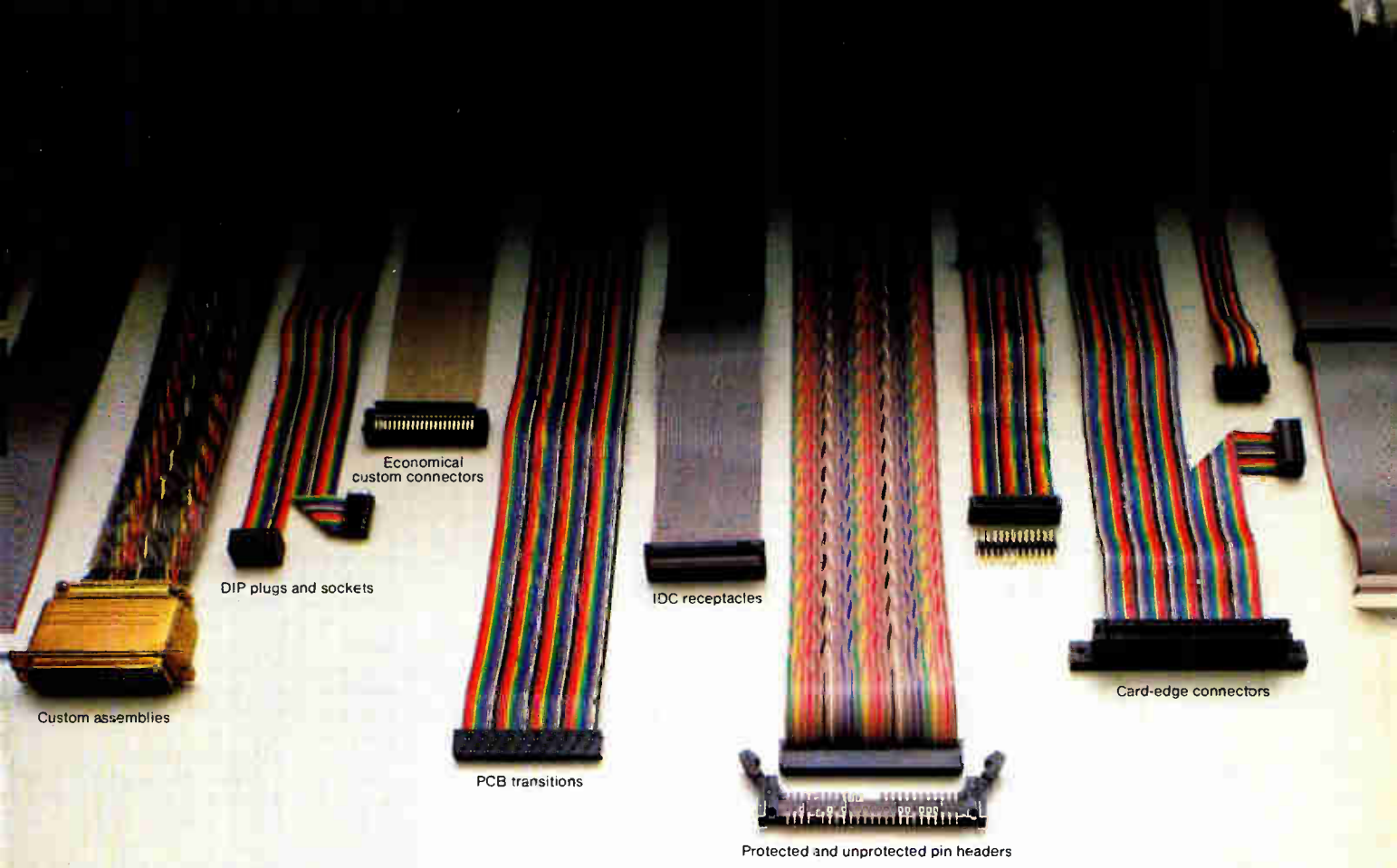
Among the key features that give the CY-500 its great flexibility are: half- or full-step operation; absolute- or relative-position mode; the ability to control rates as fast as 3,500 steps/s; both hardware and software control of the direction of movement, as well as starting and stopping; a home-direction capability; single- and multiple-step modes; ramp-up, slew, and ramp-down modes; triggered operation; and the ability to execute DO-WHILE commands. Moreover, programmable input pins allow the user to synchronize external events with the operation of the CY-500, and programmable output lines permit the CY-500 to provide synchronization and control signals to external devices.

Although the CY-500 is currently being manufactured in n-MOS, Klingman asserts that complementary-MOS, as well as military-grade, versions of the device will be available in the future. The present CY-500 is priced at $95 and will be available from stock in January.

Cybernetic Micro Systems Co., 445-203 So. San Antonio Rd., Los Altos, Calif. 94022. Phone Ed Klingman at (415) 949-0666 [371]

Pressure cells measure up to 10,000 lb/in.^{2} within 0.5%

Beta pressure cells, with rated capacities from 300 to 10,000 lb/in.^{2} and a compensated temperature range from −40° to +260° F, are readily applied to commercial and industrial uses. These pressure transducers have an overall measurement



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For the name and number of our nearest distributor or rep, write Spectra-Strip, an Eltra Company, 7100 Lampson Avenue, Garden Grove, CA 92642. Or call (714) 892-3361 today.

When you're down to the wire

Circle 229 on reader service card

New products

uncertainty of 0.5%—including nonlinearity, hysteresis, and repeatability—and provide a 3-mV/V full-scale output. Below 300 lb/in.², the output is 0.01 mV/V per lb/in.²

The devices are easily interchanged with no need for system recalibration. Measuring 2 in. in length and 1 in. in diameter, the cells have a ½-20 UNF-type pressure-port connector with an O-ring seat.

On quantity orders, the user may specify custom full-scale pressure values within the range of 300 lb/in.² to 10,000 lb/in.² at no additional cost. Unit-priced at $96, the pressure transducers sell for much less in production quantities.

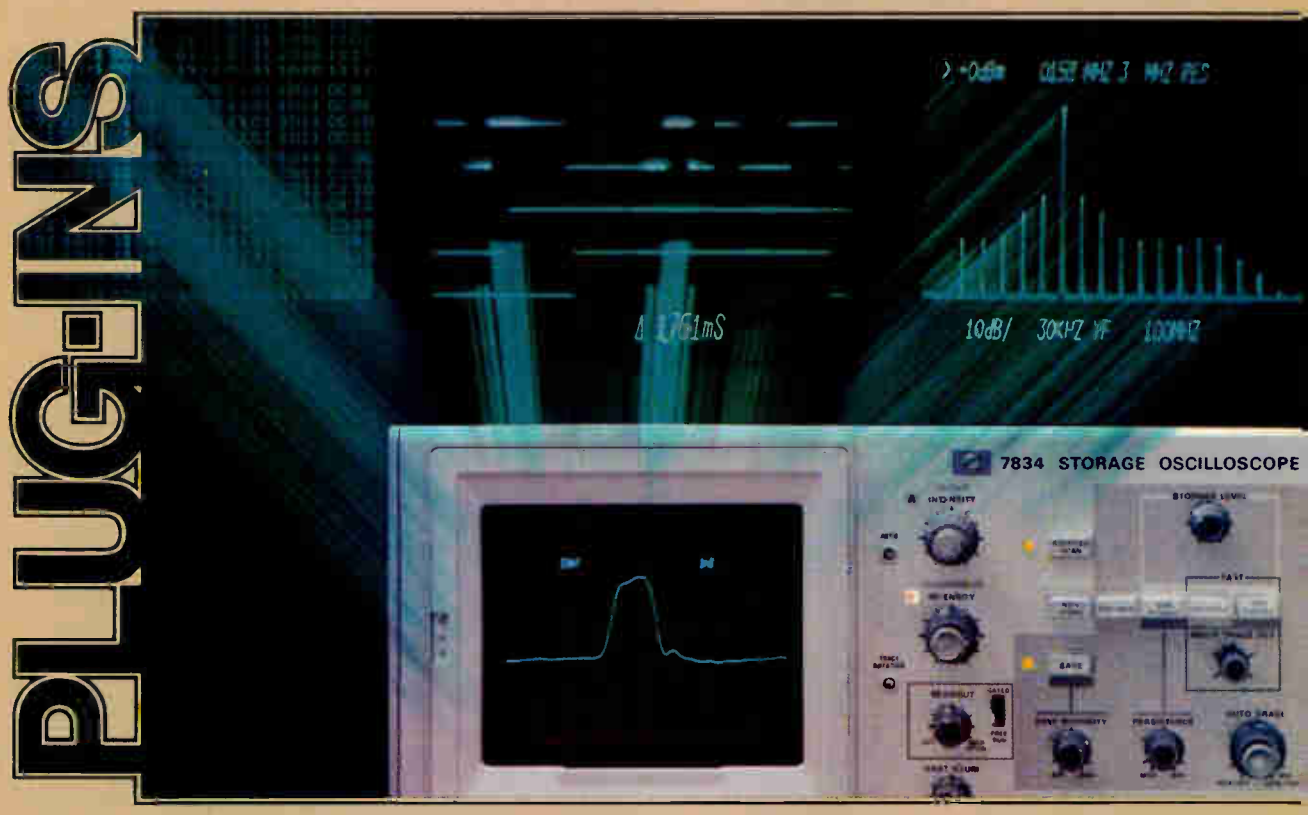
BLH Electronics, 42B Fourth Ave., Waltham, Mass. 02254. Phone Harry Owens at (617) 890-6700 [373]

Digital thermometer provides analog output for recorder

Series 44 digital thermistor thermometers linearize their probes over the thermistors' full temperature range and display the temperature reading to the nearest 0.1°F or C. The thermometers have an analog output signal suitable for recorders, alarms, and controllers. The signal level at 0° is 0 mV and increases (or decreases) by 1 mV for every 1° increase (or decrease) in temperature. Maximum error is ±(0.5% of reading + 1.4°F).

A wide variety of probes is available for the series 44 thermometers, making the instruments useful for applications in agriculture, research, quality control, heating, air conditioning, field engineering, food

FLEXIBILITY



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For literature, call (800) 547-1512 toll free.

processing, and energy studies.

The Celsius model, which provides for one thermistor probe, sells for $174 in unit quantities. It spans −50° to +150°C in increments of 0.1°C. The single-probe Fahrenheit version covers −60° to +300°F in 1° increments and sells for $199; it may be switched to 0.1° resolution at temperatures below 199.9°F.

Three-probe versions are also offered for applications in which it is necessary to measure temperatures at several points at a time. They are priced at $215 (Celsius) and $235 (Fahrenheit). All units are battery or ac-operable.

Atkins Technical Inc., 3401 S. W. 40th Blvd., Archer Interchange (I-75) Industrial Area, Gainesville, Fla. 32608. Phone (904) 378-5555 [374]

Incremental encoder offers 21-bit resolution

A bidirectional, incremental encoder, the Digisec RI 106(S)-QPZ offers resolutions of up to 21 bits (2^{21} parts per turn). The total root-mean-square error, including quantizing, is 0.7 arc-second. The unit has an operating temperature range of −40° to +70°C.

This encoder is most suitable for use as a rate- or position-feedback generator directly placed on the azimuth and elevation axes of telescopes, theodolites, radars, and rotary tables, as well as in precision machine-tool controls and in other military and commercial applications.

Housed in a package 10 in. in

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New products

diameter, with a through hole 6 in. in diameter, the system keeps its electronic components separate, permitting field maintenance of the system. A 10-in. interconnecting cable between the optical unit and the electronics package is supplied. Depending on the resolution and options selected, the encoder is priced at $9,000 to $15,000 with delivery in 90 to 120 days.

Itek Measurement Systems Division, 27 Christina St., Newton, Mass. 02161. Phone Harry Lowell at (617) 969-7300 [376]

I/O terminal digitizes, transmits industrial data

The SE100 terminal, for process-data input/output, measures, digitizes, isolates, and transmits industrial process data to computers, microcomputers, and data terminals. Accepting a wide range of transducer scanners, converters, and interfaces, the unit directly scans thermocouples and platinum resistor sensors for voltage and current. This terminal interfaces directly with Intel, Motorola, and Mostek microcomputers, as well as with larger computers and data terminals. The user may choose from among direct byte serial, isolated RS-232-C serial, or 20-mA current-loop interfaces. Featuring remote self-calibration, automatic cable-break protection, and complete optical isolation, the SE100 is microprocessor-based. Mainframe prices start at $1,490, with delivery within 8 to 10 weeks.

San Diego Instrument Laboratory, 7969 Engineer Rd., San Diego, Calif. 92111. Phone (714) 292-0646 [377]

Tiny digital actuator offers 4.5 lb of linear force

Providing up to 4.5 lb of linear force, a miniature digital linear actuator can be used in such applications as valve actuation and variable-displacement pump regulation in process control and medical equipment, in magnetic-pickup-head positioning

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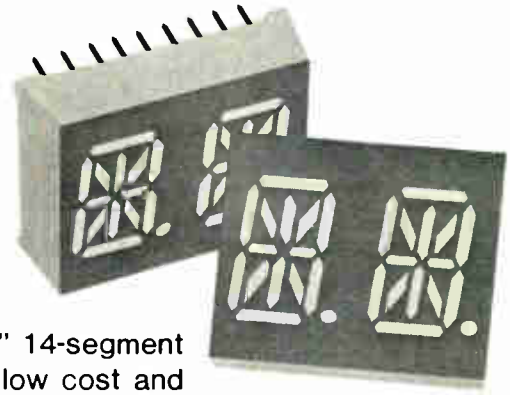
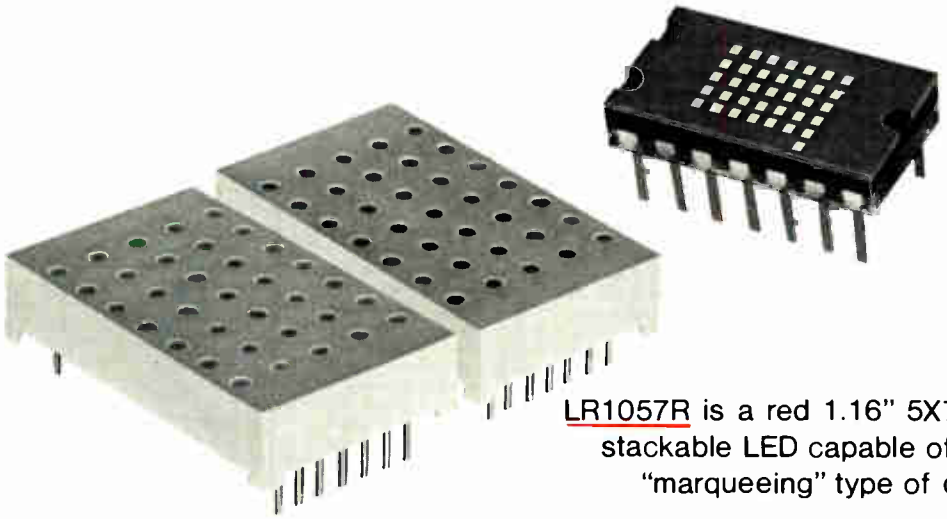


LR3784R/85R is a red, dual .54" 14-segment LED display; it is low power, low cost and end-stackable



LR1704R is a red .3" 5x7 LED array

LR1057R is a red 1.16" 5X7 dot matrix, side-stackable LED capable of creating a "marqueeing" type of display effect

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in floppy-disk computer operations, and in many others.

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In quantities of 100, the 6-oz digital actuators sell for $33 each. Small quantities are available within four to six weeks and production lots within 12 to 14 weeks. Applications that require different step increments, force output, or travel needs are handled on a custom basis.

Airpax, North American Philips Controls Corp., P. O. Box 768, Cheshire, Conn., 06410. Phone Larry Torok at (203) 272-0301 [379]

Glass-coated bead thermistor is smaller

A smaller version of the standard THM 0.043-in.-diameter glass-coated bead thermistor, the series B35 consists of a small ellipsoid of metal oxides that is sintered about a pair of 0.0004-in.-diameter platinum alloy wires. Designed to meet MIL-T-23648 specifications, these Thermobeads are available with adjacent or opposite leads in resistance values ranging from 30 Ω to 300 megohms. In quantities of 100 to 249 units, the devices sell for $1.40 each. (This price is for a unit with a 1-to-2-kΩ resistance value and standard 20% tolerance; actual price varies with the resistance value and tolerance selected.) Scheduled deliveries of the thermistors are from stock to four weeks after receipt of order.

Thermometrics Inc., 808 U. S. Highway 1, Edison, N. J. 08817. Phone (201) 287-2879 [378]

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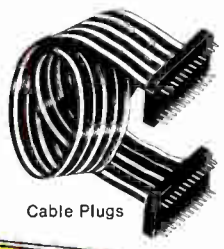
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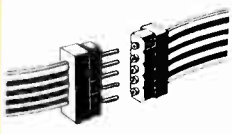
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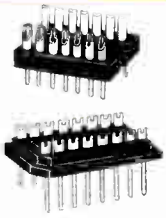
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Accuracy	±0.5%/FS	±0.1%/FS	±0.05%/FS
Power Supply	DC ±15V ±35mA		
Dimension	50W x 50D x 16H mm		

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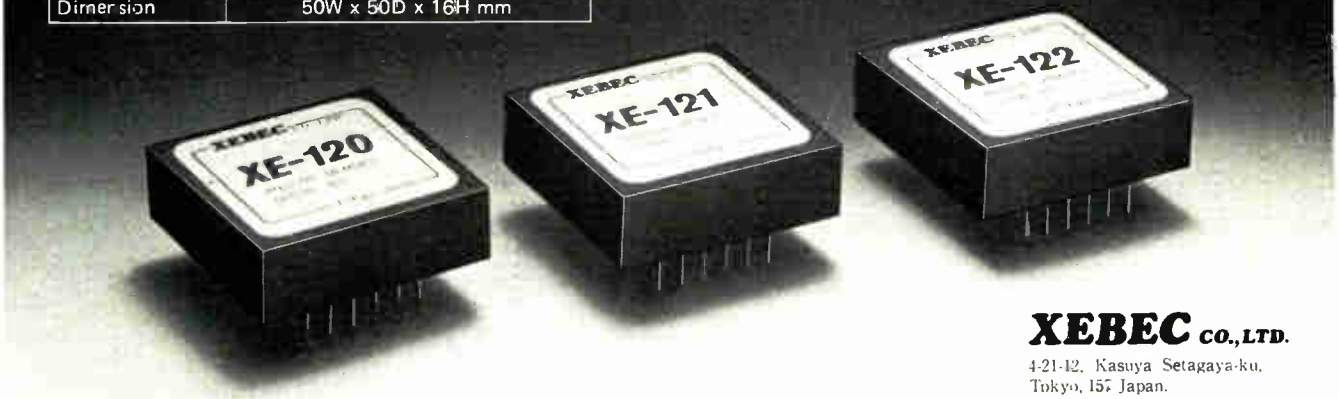

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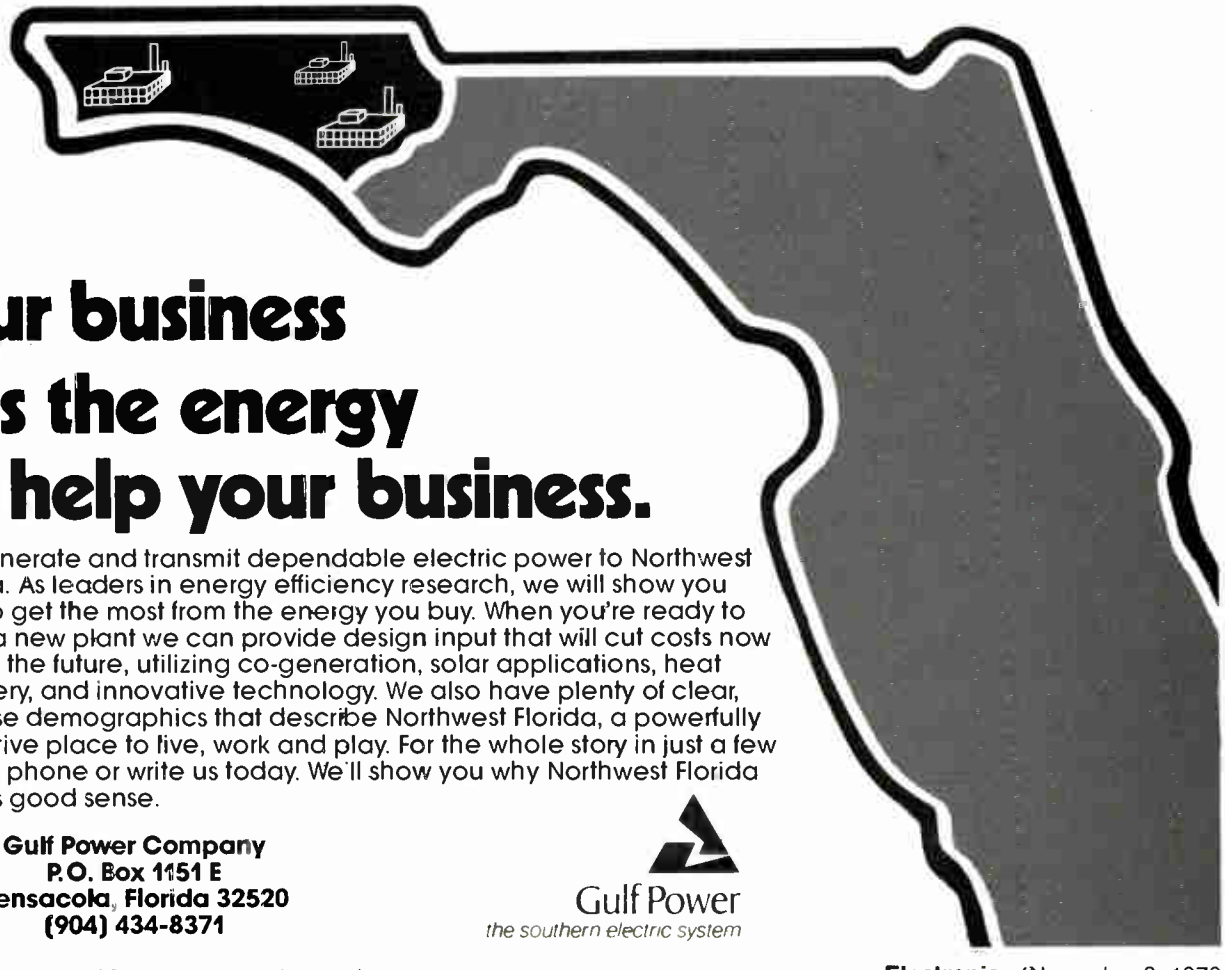

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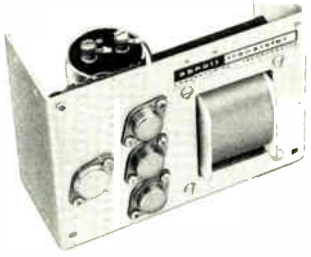

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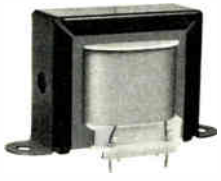

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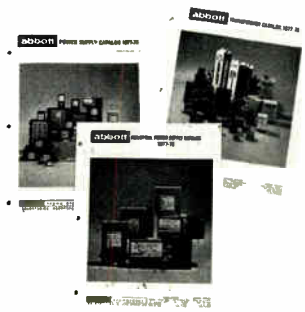
See Power Supply Section 4000, and Transformer Section 5600, Vol. 2, of your EEM catalog; or Power Supply Section 4500, and Transformer Section 0400, Vol. 2, of your GOLD BOOK for complete information on Abbott products.



abbott transistor

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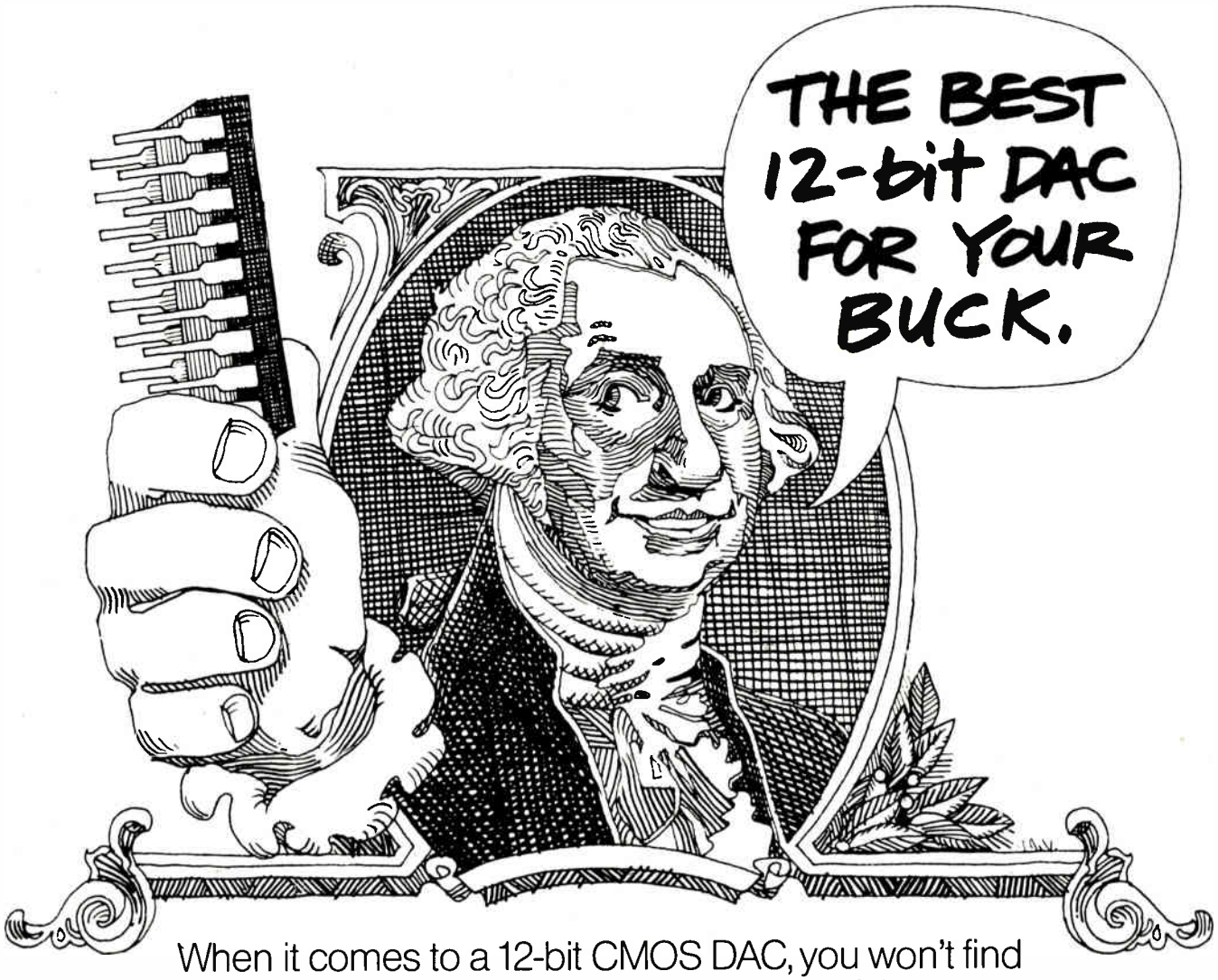

When it comes to a 12-bit CMOS DAC, you won't find a better buy than Teledyne Semiconductor's new 8641.

Performance-wise, there's none better. The 8641's guaranteed linearity of 0.01% (±½LSB) is accomplished without trimming of any kind. So it's less expensive to make.

We also added compensating CMOS switches to the feedback resistors and at the end of the resistive ladder. The result is a gain error tempco of 2 ppm/°C max.

What's more, the 18-pin DIP 8641 is a pin-for-pin replacement for AD7541. However, ours has improved supply rejection, lower variation of linearity and gain error with V_{DD}, and improved temperature stability. And even with its premium specs, the 8641 costs less: only $17.70 at 100 quantity for 0.01% guaranteed linearity.

Contact us for more information on why the 8641 is the best 12-bit CMOS DAC for your buck. Teledyne Semiconductor, 1300 Terra Bella Avenue, Mountain View, CA 94043; Phone: (415) 968-9241, ext. 241.

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Circle 240 on reader service card

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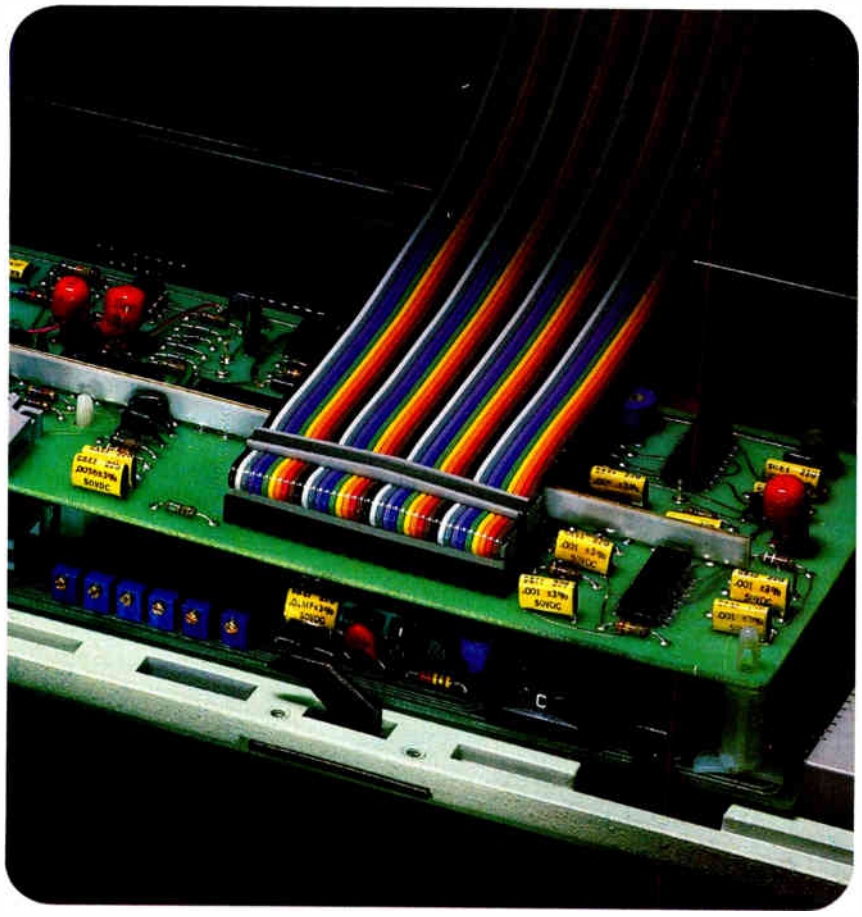
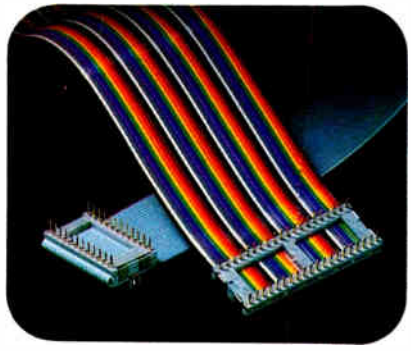


Want the speed, savings and reliability of mass termination with larger size D.I.P. connectors? Come to 3M. Our Scotchflex brand D.I.P. connectors in 24 and 40-contact sizes let you design quick, easy interboard jumpering with readily available parts. Their space-saving low-profile design makes them ideal for microprocessor applications. They also speed and simplify test jumpering or checkout of I.C. sockets.

Both connectors have .100" x .600" grid spacing and are available with either rectangular legs for use with standard I.C. sockets or round legs for use with high density packaging panels. They may be used with Scotchflex shielded, non-shielded or color-coded flat cable or with twisted pair or parallel lay woven cable.

Where frequent plugging and unplugging is necessary, strain relief bars and pull



tabs are available for all Scotchflex D.I.P. connectors including 14 and 16-pin sizes.

Need some more ways to simplify wiring and increase circuit density? 3M's Scotchflex line offers you the widest choice of mass terminating cable, connectors and system components to accommodate your design packages. Plus proven reliability. Off-the-shelf availability. And the unmatched experience of the people who pioneered the concept of electronic mass termination.

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More results, less effort. System 50 helps make original designs and any revisions fast and easy. Because it makes your design staff more efficient, more productive, you'll get prototypes faster and get your product to the marketplace sooner.

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System 50 is not only easily affordable by all drafting departments but it can actually pay for itself in a year through increased production efficiency. System 50 is being successfully used in departments with only a few designers as well as in departments with over a hundred.

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We're the easy mind people, TRW Capacitors. Our new X659F can solve your packaging problems. We call it "the new dimension capacitor". It's the smallest possible size—at the smallest possible price. The advanced design of the new TRW X659F utilizes very thin gauges of metallized polyester with design highlights such as capacitance values to 20.0 MFD, dissipation factors less than 1.0%. Electrically, the new X659F is interchangeable with our X663F. Same rugged durability and long stable life.

Oval shape allows either vertical or flat, horizontal board-hugging mounting. It's ideally suited to small portable equipment for commercial and instrument grade products.

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Actual size .022 MFD 400VDC

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Circle 243 on reader service card

Communications

Generator tests mobile receivers

Synthesized a-m/fm unit with Sinad capability covers 10 to 520 MHz

Designed to measure, test, and align radio communications equipment, especially mobile receivers and pocket-paging receivers, Krohn-Hite Corp.'s model SSG520 a-m/fm synthesized signal generator maintains high accuracy and stability over the frequency range from 10 to 520 MHz. Its standard 2-MHz crystal-controlled oscillator is accurate to within 2 parts per million and drifts less than 2 ppm per year.

Unusual for instruments in its class is the SSG520's SINAD (signal plus noise and distortion) measurement capability, which gives an indication of the expected intelligibility for a given signal strength. This type of measurement is taken by applying a signal of a known amplitude and modulation to the receiver input. The audio output—consisting of the recovered modulation, the distortion products produced by receiver nonlinearity, and the amplified thermal noise of the signal source and receiver—is then measured. A narrow band-rejection filter, tuned to the modulation frequency, is then placed between the receiver output and the power meter. A second reading—from the distortion plus noise output—is now taken. The ratio of the first power to the second is called the Sinad ratio.

Based on a built-in 1-kHz automatic distortion analyzer, the Sinad capability makes possible improved alignment of band-pass filters and other tuned circuits, helping to avoid false response peaks. The Sinad input level is adjustable from 50 mV to 3 V rms; measurement range is 6 to 30 dB.

Seven thumbwheel switches provide 100-Hz resolution over the generator's full frequency range. They comprise an unambiguous seven-digit display of the output frequency, making a frequency meter unnecessary.

The generator's output level is adjustable and controllable over the range from 0 to −119 dBm in 1-dB steps by means of two step attenuators. One, which has increments of 1 dB, has a maximum error of

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Teccor is a name you can specify with confidence. It's the company that pioneered electrically isolated SCR and triac packages. Teccor was well ahead of the times in development of thyristors for use in energy efficient applications — long before energy became a major design consideration.

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How about SSR's in your choice of "normally open" or "normally closed" configurations? You'll find those in your Teccor catalog too.

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TECCOR ELECTRONICS, INC.
P.O. Box 61447 Dallas, Texas 75261
214/252-7651

Circle 245 on reader service card

0.2 dB for any step; the other, a 10-dB-per-step device, is accurate to within 2 dB per step. Effective rf shielding allows sensitivity measurements to be made down to −119 dB (0.2 μV across 50Ω).

The instrument has internal and external a-m and fm capability, with a-m depth and fm deviation displayed on an analog meter. A-m depth ranges from 0% to 90%; four fm ranges have full-scale peak deviations of 3, 10, 30, and 100 kHz. For both a-m and fm, modulation rates range from 20 Hz to 50 kHz.

Options for the SSG520 include a high-stability crystal-controlled time base with an error of less than two parts in 10^7 and a temperature coefficient of less than 1 ppm/°C; a rack-mounting kit; and remote programming capability for frequency, attenuation, and modulation. The instrument has outputs for synthesizer lock, overrange and underrange lamps, a Sinad automatic-gain-control lamp, and supply of +5, +24, and ±15 V.

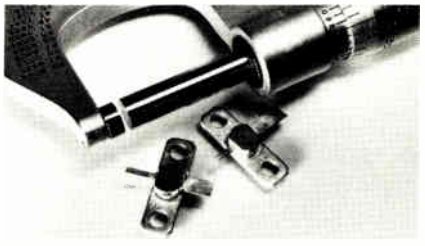
The SSG520 lists at $5,000 and has a delivery time of 60 days.

Krohn-Hite Corp., Avon Industrial Park, Bodewell St., Avon, Mass. 02322. Phone (617) 580-1660 [401]

Bipolar transistor delivers 27.5 dBm at 4 GHz

The model AT-7510/AT7511 bipolar silicon power transistor is a 4-GHz device capable of delivering an output power of 27.5 dBm at its 1-dB gain-compression point. The associated gain is 9.5 dB. Available in both chip and packaged form, the medium-power device combines diffused emitter ballast resistors, platinum-silicide contacts, and a thick gold metal system for high reliability even when operating at high temperature and high current density.

The packaged version of the npn epitaxial device—the AT-7510—is housed in a hermetically sealed metal-beryllia stripline case with a



heavy copper flange. The high thermal conductivity of the beryllia, combined with good thermal design, results in an overall junction-to-case thermal resistance of only 40°C/W.

The unpackaged AT-7511 is offered with both single and multiple base and emitter pads. The former are easier to install; the latter provide lower series inductance. In either case, the 12-by-16-mil chip features quartz scratch protection for reliable application in thick- and

thin-film circuits. Maximum junction temperature is 200°C, and storage temperature range is −65° to +200°C.

Avantek Inc., 3175 Bowers Ave., Santa Clara, Calif. 95051. Phone Mary Ann Hollen at (408) 249-0700, Ext. 181 [402]

Fiber-optics link works with interface bus

Hewlett-Packard Co., the originators of what has become the general-purpose interface bus described in IEEE Standard 488-1978, has developed a fiber-optic link that allows the bus to transfer data around power plants and factories, where ordinary electrical communication is a problem. Called the HP 12050A, the link offers complete immunity from electromagnetic interference and ensures safety even when the cable runs through explosive environments.

With the 12050A, users can gain access to clusters of bus-compatible instruments up to 100 m from the controlling computer. By using a dual-channel fiber-optic cable, the link can transfer data in both directions at speeds as high as 20,000 bytes/second.

In application, two link units must be used at each remote site. The units each contain a silicon-on-sapphire microprocessor that performs self-testing automatically whenever it begins operation or upon request from the user program. For transmission, the link automatically converts data from the standard bit-parallel format to a bit-serial format, which is better suited for optical communication. At the receiving end, the data is converted back to the parallel format for normal processing. A checksum algorithm is used to check all transmissions for errors. If one is found, the data is retransmitted automatically and repeatedly, if necessary, until it is received correctly.

Few special procedures are necessary to install the 12050A.

Hewlett-Packard Co., 1507 Page Mill Rd., Palo Alto, Calif. 94304 [406]

Fiber-optic cable has 0.4 numerical aperture

A high-numerical-aperture, large-core optical cable, well suited for data-link applications at distances of up to 500 m, has just been introduced by Siecor. The Super Fat Fiber cable comes in two versions: the single-fiber type 155 and the two-fiber type 255. Each has an all-glass 200-μm core. Attenuation for the cable is 35 dB/km, and length-bandwidth product is 5 MHz-km.

The 0.4 numerical aperture and large core allow low-cost light sources and photodetectors to be used. Low-cost connectors may be

WE JUST RE-INVENTED THE THUMBWHEEL.

AD7525. THE WORLD'S FIRST SINGLE CHIP DIGITAL POT.

Anyone who uses expensive and cumbersome 10-turn pots or thumbwheel-switch voltage dividers will welcome the accuracy, reliability and ease of use of the AD7525. It's a new solution to an old problem. That is the setting of AC or DC signal levels digitally and usually remotely. The AD7525 replaces the noise, inaccuracies and expense with a reliable, economical monolithic CMOS 3½ digit BCD digitally-controlled potentiometer. The world's first single chip digital pot and the only high resolution CMOS multiplying DAC available with BCD coding.

The AD7525 is perfect for controlling DC voltage levels or AC signal amplitude directly from the front panel. With step-resolution of 0.05%. A full-scale output range of 0.000 to 1.999V_{IN}. A maximum linearity error of ± ½ LSB (AD7525LN, CD and UD) over the temperature range guarantees monotonicity.

3½ DIGIT BCD RESOLUTION PLUS IC RELIABILITY.

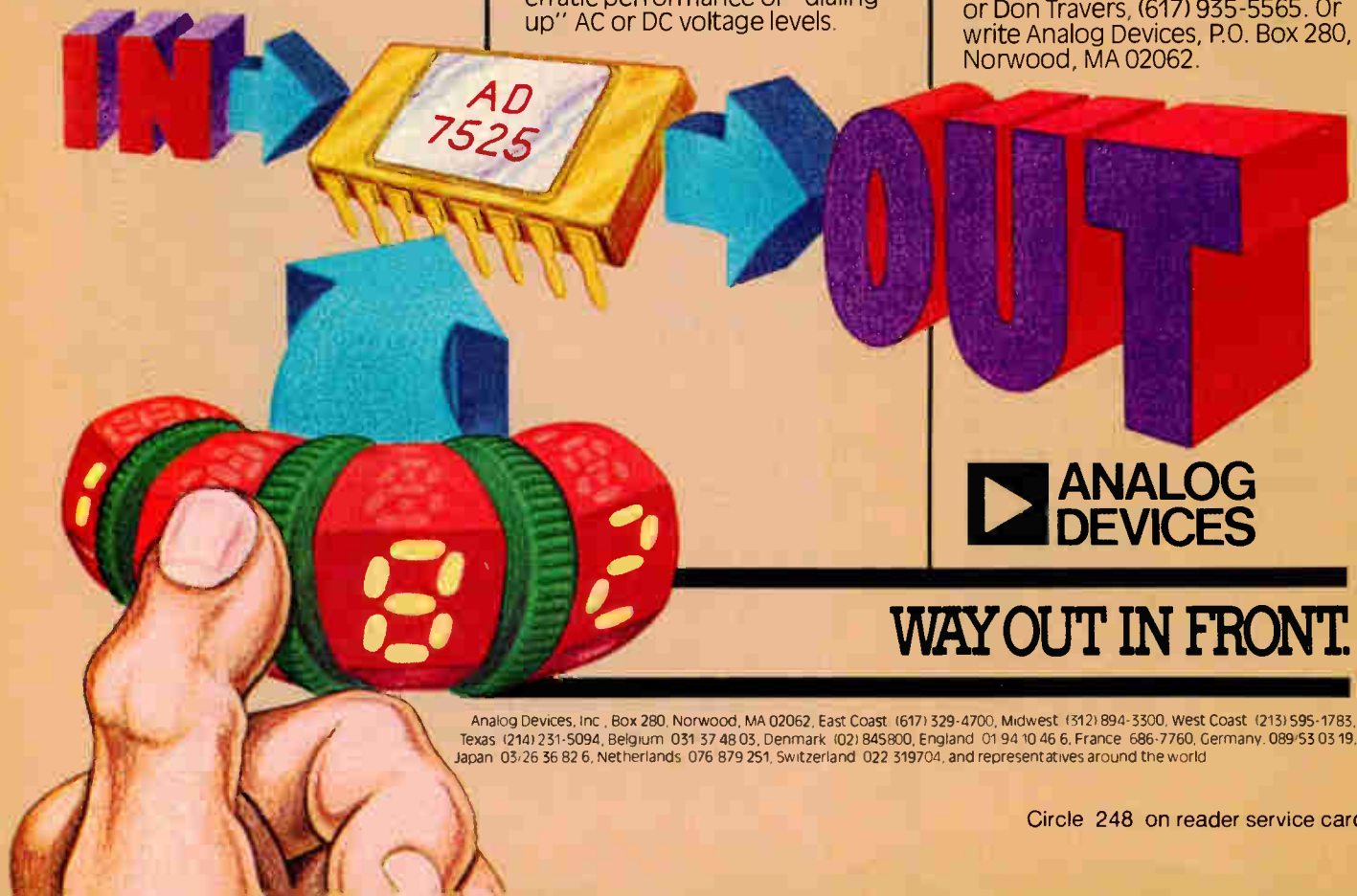
Combining the highest resolution of 13 input bits or 3½ digits BCD with monolithic reliability results in a digital pot that ends the mechanical unreliability and erratic performance of "dialing up" AC or DC voltage levels.

A NEW LOW PRICE.

$8.50

Only $8.50 in 1000's (AD7525KN). It means you can build an entire attenuator circuit for about $22. That includes the AD7525KN, an op amp, the trimming potentiometer (which allows gain accuracy to be precisely set), resistors and the thumbwheel-switch assembly. That's a lot less money for a lot more performance and reliability than the "old" way.

But prove it to yourself. Check out one of the six available performance grades of the AD7525, the world's first single chip digital pot. Call Doug Grant or Don Travers, (617) 935-5565. Or write Analog Devices, P.O. Box 280, Norwood, MA 02062.



ANALOG DEVICES

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Analog Devices, Inc., Box 280, Norwood, MA 02062. East Coast (617) 329-4700, Midwest (312) 894-3300, West Coast (213) 595-1783, Texas (214) 231-5094, Belgium 031 37 48 03, Denmark (02) 845800, England 01 94 10 46 6, France 686-7760, Germany 089/53 03 19, Japan 03/26 36 82 6, Netherlands 076 879 251, Switzerland 022 319704, and representatives around the world

Circle 248 on reader service card

used because of the large fiber diameter and the actual mechanical configuration of the cable. The small bend radius—15 mm—allows permanent bends. And with its temperature rating to 85° C, its high tensile strength, and its small size, the cable may be installed directly within many different types of military, industrial, and commercial equipment used in data-link applications.

The same cable may be installed in above-ground conduit outdoors, where it can withstand temperatures as low as −40°C. In fact, this is fiber cable that may replace miniature coaxial cable when long distances must be covered, or when there are problems of electromagnetic interference and ground loops.

Applications for the cable may be found in process control, industrial automation, power utility instrumentation, data transmission within a building, and military short-distance systems.

The price for the 155 cable is $1.30 per meter in 3-to-10-km lengths and delivery is within three to four weeks after receipt of order. The 255 cable is available on a special-order basis.

Siecor Optical Cables Inc., 631 Miracle Mile, Horseheads, N. Y. 14845. Phone (607) 739-3562 [403]

Programmable preamplifier interfaces with computers

The model 1201 preamplifier has been designed for interfacing with computers and calculators for remote control and for use in systems applications. The computer control and programmability of the 1201 are made possible because of two custom LSI chips. Offering full gain control and gain status indication, the 1201 has control outputs to indicate overload status, remote operation, and for high- or low-pass filter selection.

Preamplifier gating (also controlled through the computer) is through a TTL-compatible input or any other waveform input; this permits the user to control the input signal transmissions in a wide variety

of systems applications.

Gains are selectable from 10 to 25,000 with a gain accuracy of at least 1% and a gain stability of at least 0.03%/°C. Other features of the 1201 include: dc stability of better than 6 μV/°C, a common-mode rejection ratio of 140 dB, a common-mode input voltage rating of 10 V peak to peak, an input

current of less than 10 pA, a bandwidth of 400 kHz, and distortion of less than 0.01%. The 1201 also offers a unity-gain output, two 600-Ω outputs, and a choice of battery or line operation.

The 1201 sells for $1,525 with delivery in 45 days. The remote-programming option is an additional $450, with delivery in 90 days.

Ithaco Inc., 735 W. Clinton St., Ithaca, N. Y. 14850. Phone (800) 847-2080 or (607) 272-7640 [405]

$8.50 mixer handles inputs of 1 to 1,000 MHz

Priced at $8.50, the MLP-109 mixer handles local-oscillator and rf frequencies from 1 to 1,000 MHz, with a dc-to-1,000-MHz i-f range. Worst-case conversion loss for the mixer is 8 dB with mid-band performance typically 2 dB better, specified with a LO input of +7 dBm.

Minimum LO-rf isolation is 25 dB; LO to i-f is 15 dB worst case, with typical mid-band isolation 10 to 15 dB greater. Contained in a standard eight-pin relay header, the unit is available from stock. Models for +17- and +23-dBm LO inputs are also available.

Engelmann Microwave Co., Skyline Drive, Montville, N. J. 07045. Phone Carl Schraufnagl at (201) 334-5700 [404]

Miller-Stephenson does!

To serve these 6 functions and guarantee your system reliability.

We offer 25 different solvent combinations for electronic cleaning, contact cleaning, tape head cleaning, flux removal, freezing and release agents for epoxy potting and for injection molding.

We double filter our solvents and propellants and the filtered product goes directly into seamless cans, eliminating any possibility of flux contamination from seamed cans. Our spray cleaners have the lowest residual contamination in the industry, some approaching 5-7 parts per million. The general industry range is 50-130 ppm.

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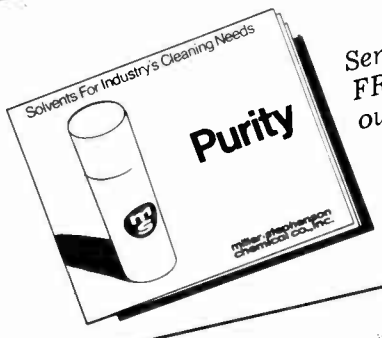
Let us help you find the right cleaning combination for *your* particular application.

Purity...it's something we never forget

1 Solvent Cleaning	MS-180 Freon® TF Solvent MS-190 Freon TMC Solvent MS-160 Freon T-P 35 Solvent MS-185 Freon TA Solvent	MS-175 Freon TE Solvent MS-165 Freon TMS Solvent MS-176 Freon TES Solvent MS-170 1,1,1 Trichloroethane Solvent
2 Flux Removal	MS-190 Freon TMC Solvent — Flux Remover & Cleaner	MS-190HD Flux Remover & Cleaner — Heavy Duty
3 Contact Cleaning	MS-230 Contact Re-Nu® MS-238 Contact Re-Nu & Lube*®	
4 Tape Head Cleaning	MS-200 Magnetic Tape Head Cleaner	
5 Freezing	MS-240 Quik-Freeze®	
6 Release Agents	MS-122 Release Agent — Dry Lubricant For Cold Molds	MS-136 Release Agent For Injection Molding & Hot Molds



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Circle 251 on reader service card 251

"Freon" is Du Pont's registered trademark for its fluorocarbon compounds.
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WE CALL IT BECKMAN'S INTELLIGENT DISPLAY SYSTEM

BECAUSE IT'S SO BRIGHT!

That's visibly bright and microcomputer smart!

In fact, it's more than two times brighter than comparable gas discharge display systems. Beckman's SM-810-001 alphanumeric display system is the apex of the five-year development of the Screened Image technology. That's what makes it so bright. And, makes it flexible enough that you can do your own customizing. The microcomputer gives it the control and versatility that only a microcomputer can.

The SM-810-001 will give you 40 — count 'em 40 — high brightness characters in a 5 by 7 matrix of large, uniformly illuminated dots. *Each* of the quarter-inch characters provides a minimum of 100 footlamberts of brightness. Think what 40 of them will do for the overall illumination. In addition, the unit offers a remarkable viewing angle (for a subsystem) of 130°, plus a flicker-free 94 Hertz refresh rate. And, it's all in one compact, microcomputer-controlled assembly . . . smaller than a carton of cigarettes.

The SM-810-001 is currently being evaluated by several major users. Obvious applications include: medical/scientific instrumentation, process control and point-of-sale. More importantly, the almost limitless flexibility of the Screened Image concept makes it possible to adapt this display system to your system . . . without the usual, high engineering design and development charges.

Significant Features of the SM-810-001

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- Compact, self-contained assembly.
  - — 10.75″ x 3.0″ x 2.0″
- Standard Interfaces.
  - — Single, 5 Volt Supply.
  - — 8 Bit Parallel Bidirectional Bus.

SM-810-001 JOINS THE SA-252.

If you prefer a larger character, 14-segment display, you may also wish to investigate Beckman's SA-252 Alphanumeric Display System. Its 16 characters are each 0.55″ high, and provide excellent viewability, even at long distances. The SA-252 is also microcomputer controlled, with direct user access. And, it's ideal for biomedical, process control and general electronics applications.

Beckman Displays. The Visible Edge.

For more information concerning your standard or custom requirements, write: Displays Systems Division, Beckman Instruments, Inc., 350 North Hayden Rd., Scottsdale, AZ. PHONE: (602) 947-8371. TWX: 910-950-1293. In Europe, write: Beckman Instruments (Belgium) S. A., 14, Avenue Hamoir. 1180 Bruxelles, Belgium. PHONE: (02) 275.44.30. TELEX: 23577

BECKMAN

252 Circle 252 on reader service card

Here are three electromagnetic X-Y display scopes that have a lot in common: each has a big 12-inch diagonal CRT, is economically priced, and is ideal for applications requiring continuous monitoring of response signals with bandwidths up to 15 kHz.

The one in front is specifically for use in OEM systems. With the Model 1951, you can have controls mounted on the rear panel, or they can be pre-set on an easily accessible PC board. And the unit's power supply can be removed and installed elsewhere in your system. The 1951 is particularly well suited to medical electronic systems.

The scope on the left is our Model 1901C which can be used with our (or anybody's) RF or microwave sweepers. The unit has a sensitivity of 1 mV per division which is ideal for low-level detection requirements. Features such as Z axis intensity modulation, Y marker adders and a blanking protection circuit contribute to the unit's versatility.

Finally, the scope at right is our Model 1910. It's basically the same as the 1901C except that it provides dual trace capability.

So just decide which of these low-priced scopes has the most in common with your operation. We'll be happy to ship as many as you want. WAVETEK INDIANA, P.O. Box 190, Beech Grove, Indiana 46107, Telephone (317) 783-3221, TWX 810-341-3226.

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Scope City!

Model 1951: $560 (in small quantities)

Circle #111 for literature
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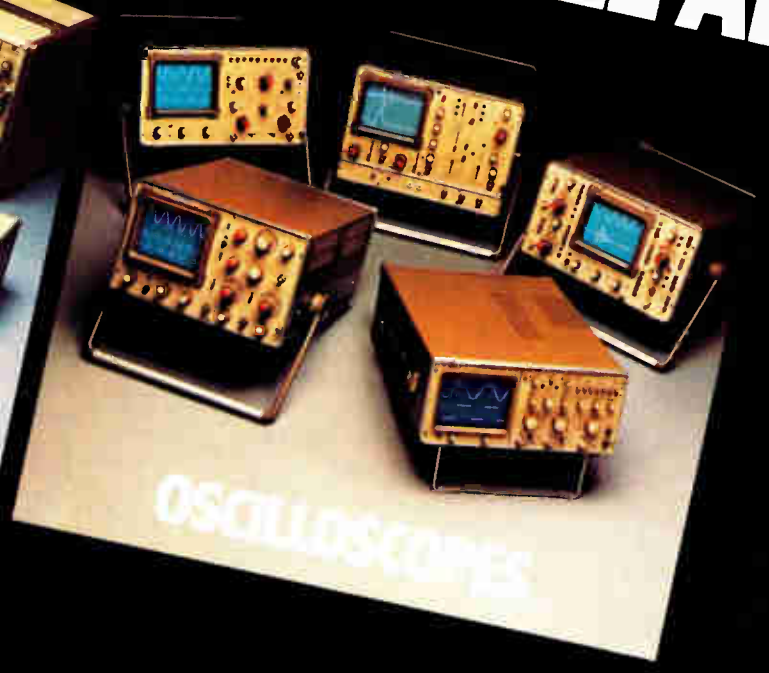

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Dialight is the first place to look. We make just about any kind of illuminated push button switch that anyone could want . . . Single lamp, dual lamp, neon, incandescent, LED lighted, you name it.

Perhaps you're looking for snap action switches with silver or gold contacts, or wiping action switches with gold contacts for low level application.

And if you're looking for rear panel or front bezel mounting switches, switches with momentary or alternate actions, or high quality switches for computer applications, we have them.

You'll find that Dialight switches are not only available at a reasonable price, they're also available with some very attractive features. Lamp removal is from the front so you don't have to remove an entire switch just to change a lamp. And you never have to use anything more complicated than your fingers for replacement or installation.

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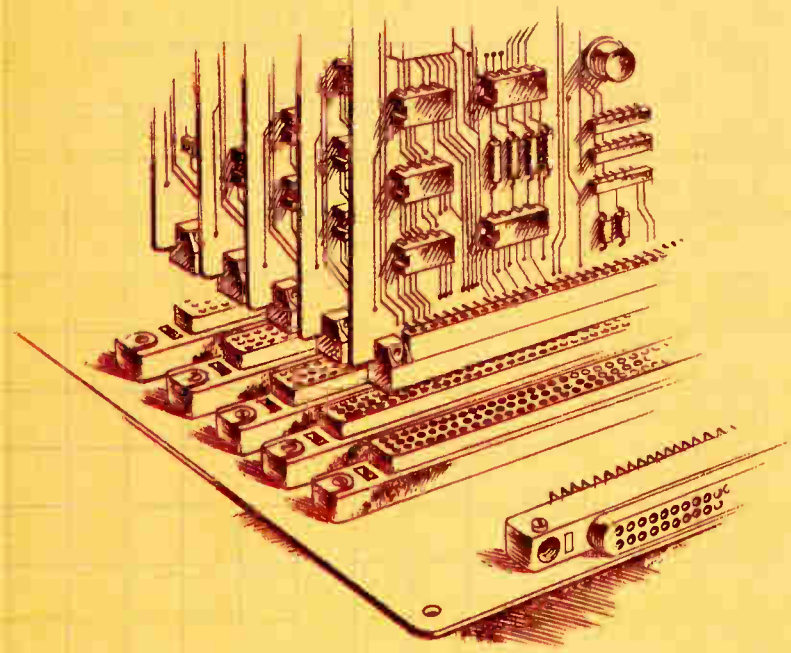
Circle 257 on reader service card

PCB Simplicity with Bendix Brush Connectors.



Bendix Brush Connectors can streamline your printed circuit board designs. They don't require the extra board support necessary with conventional, higher mating force connectors and they eliminate the need for secondary actuation systems or procedures used with zero-insertion force connectors. Here's how:

Bendix Brush Connectors increase circuit count per board.

- Reduce number of boards by allowing more circuits per board.
- Greater board effectiveness by providing exact circuit counts up to 400 contacts in only one connector!

Bendix Brush Connectors reduce mating force 70% to 90%.

- Less complex board supports.
- Secondary actuators eliminated.
- Extended mechanical life. Up to 20,000 mates/unmates.
- Fewer damaged boards.
- One connector instead of multiple, fixture-mounted connectors.

Bendix Brush Connectors—a broad product line.

- Mother Board, Daughter Board, Input/Output, PC receptacle body styles.
- 2, 3 and 4 row configurations.
- 90° and straight PC, solderless wrap, crimp removable terminations with multiple lengths and plating options.

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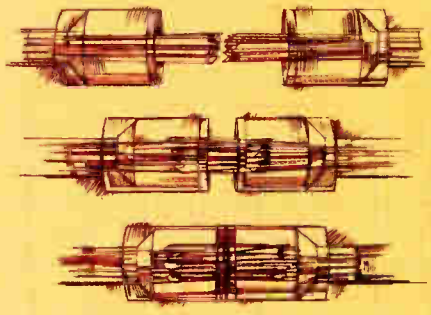
- Highly redundant contact sites with multiple electrical paths and wiping action.
- Gold plated wire bristles mesh together intimately with gas-tight junctions.
- Stable contact resistance even after extreme mechanical durability abuse to 20,000 matings.



For full information, call (607) 563-5302, or write The Bendix Corporation, Electrical Components Division, Sidney, New York 13838.

Bendix

We speak connectors.

Circle 258 on reader service card

Products newsletter

Analog Devices lets the chips fly

After dipping its toes for years, Analog Devices Inc. is diving headlong into the business of selling uncased chips. The Norwood, Mass., firm is about to unveil **a line of more than 50 generic types of monolithic integrated circuits, in multiple grades, with guaranteed specifications, and all conforming to MIL-STD-883.** The available chips include analog-to-digital, digital-to-analog, voltage-to-frequency, frequency-to-voltage, and root-mean-square-to-dc converters, as well as precision operational amplifiers, instrumentation amplifiers, precision references, analog switches, and multiplexers. Delivery is expected to be from stock to two weeks.

Analog expects competition mainly from Harris Semiconductor, Precision Monolithics, and National Semiconductor, but, claims Jeffrey R. Riskin, manager of microcircuits applications engineering, Analog is the only vendor of analog chips "with such a combination of product variety, temperature testing, premium versions, laser-trim accuracy, and technical support."

Shared-logic system offers data and word processing

Adding still further enhancements to its CPT 8000 family of stand-alone and shared-logic word-processing systems [*Electronics*, Sept. 27, p. 210], CPT Corp. of Hopkins, Minn., is now offering data-processing capabilities. The CompuPak software package serves as an interface between the user's own data-processing applications programs and the CPT processor, so that the same hardware can process both words and data.

The company has developed its own interface software, but is using the CP/M operating system software from Digital Research Inc., as the basis for the new data-processing capabilities. Initial deliveries of CompuPak are scheduled to begin next month, with pricing set at $800.

Logic analyzer comes to U. S.

The Sony/Tektronix model 308 data analyzer, which went on sale in Japan last month for $3,700 [*Electronics*, September 13, p. 71], will be offered in the U. S. in December. **Base price for the combination state and timing logic analyzer, serial data analyzer, and signature analyzer will be $3,000, according to Oregon-based Tektronix Inc.**

Price changes

Texas Instruments Inc., Houston, Texas, has cut the prices of three of its Silent 700 data terminals by approximately 15%. The model 743 keyboard send-receive (KSR) unit has been reduced from $1,395 to $1,195; the 743 receive-only (RO) printer has been lowered from $1,195 to $995; and the 745 portable data terminal has been cut from $1,995 to $1,695. All new prices are for the U. S. in quantities of one. . . . **Owens-Illinois Inc., Toledo, Ohio,** is raising the price of all of its glass containers by 6% as of Dec. 1. The company's last price increase on glass containers, announced on April 14, was also for about 6% . . . **Xebec Systems Inc., Santa Clara, Calif.,** has recently cut the price of its model 7600 controller for SMD-type drives for the PDP-8, PDP-11, and LSI-11 computers from $6,950 to $4,975. . . . **Continental Specialties Corp., New Haven, Conn.,** has raised prices on just about every item in its line of electronic test and prototyping equipment, effective immediately. One important exception is the model 3001 digital capacitance meter [*Electronics*, August 2, p. 141], which is not scheduled to go from its introductory price of $190 to its new price of $250 until Jan. 1, 1980.

POWER-ONE
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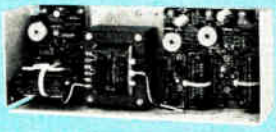
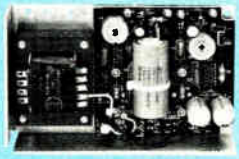
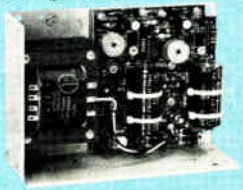
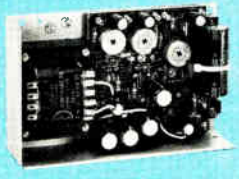
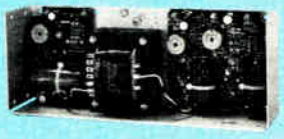
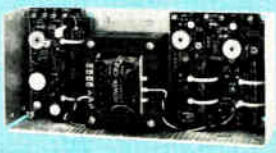
Now available for small systems applications

Power-One, the leader in quality open-frame power supplies, now offers a complete line of single, dual, and triple output models for small computer systems. Also available are special purpose models for Floppy Disk and Microcomputer applications.

Below are just a few popular examples of the over 90 "off the shelf" models now available from stock.

SINGLE OUTPUT & LOGIC POWER SUPPLIES • 56 "off the shelf" models • 2V to 250V, 0.1A to 40A • ±.05% regulation • 115/230 VAC input	5V @ 3A, w/OVP  HB5-3/OVP $24.95 single qty.	5V @ 12A, w/OVP  HD5-12/OVP $79.95 single qty.	5V @ 40A, w/OVP NEW  SK5-40/OVP Switching Model $250.00 single qty.
FLOPPY-DISK SERIES • 8 "off the shelf" models • Powers most popular drives • Single/dual drive applications • 2-year warranty	5V @ 0.7A, w/OVP NEW 12V @ 1.1A/1.7A PK  CP340 For one 5.25" Media Drive $44.95 single qty.	5V @ 1A, w/OVP −5V @ 0.5A, w/OVP 24V @ 1.5A/1.7A PK  CP205 For one 8.0" Media Drive $69.95 single qty.	5V @ 2.5A, w/OVP −5V @ 0.5A, w/OVP 24V @ 3A/3.4A PK  CP206 For two 8.0" Media Drives $91.95 single qty.
DUAL OUTPUT MODELS • 15 "off the shelf" models • ±5V to ±24V, 0.25A to 6A • I.C. regulated • Full rated to +50°C	12V/15V @ 0.25A NEW  HAD12-.25/HAD15-.25 $32.95 single qty.	5V @ 2A, w/OVP 9 − 15V @ 0.5A  HAA512 $44.95 single qty.	±12V @ 1.7A or ±15V @ 1.5A  HBB15-1.5 $49.95 single qty.
TRIPLE OUTPUT MODELS • 10 "off the shelf" models • 5V plus ± 9V to ± 15V outputs • Models from 16W to 150W • Industry standard size	5V @ 2A, w/OVP ± 9V to ± 15V @ 0.4A  HTAA-16W $49.95 single qty.	5V @ 3A, w/OVP ±12V @ 1A or ±15V @ 0.8A  HBAA-40W $69.95 single qty.	5V @ 6A, w/OVP ±12V @ 1.7A or ±15V @ 1.5A  HCBB-75W $91.95 single qty.

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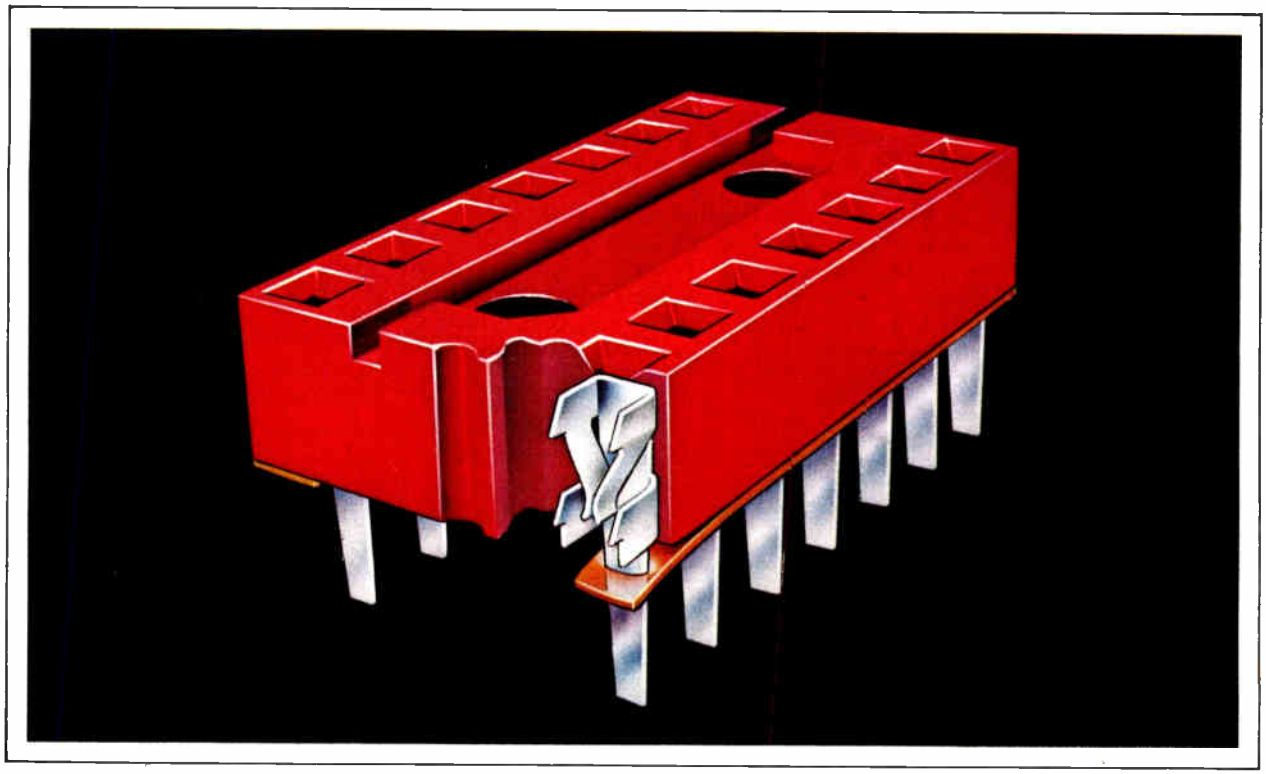

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Low profile solder tab sockets are now made by scores of manufacturers around the world. *But there's only one CAMBION – with Kapton film.*

- Unique inverted spring design overcomes insertion force resistance
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A special feature of X-Coat 225 is its chemical resistance: it may be overcoated with conventional solvent-based paints with no change in electrical resistance or shielding characteristics.

Electro-Kinetic Systems Inc., 1000 Herald Square, Aston, Pa. 19014. Phone (215) 358-3440 [476]

Polyvinyl-fluoride film, a releasing agent for epoxy and phenolic printed-circuit boards, can be safely exposed to 200°C for 24 hrs between clean chrome plates at 800 lb/in.^{2} According to Du Pont, this 100SM30MR material's higher temperature tolerance over the previous 100SM30PC film will reduce pc board costs, since production rates can be stepped up with shorter cycle times to reduce unit costs.

Two other advantages of the film are that epoxy residue on the plates and the transfer of phenolics through the film to the plates are reduced and that it gives pc boards a consistent matte finish. The Tedlar material does not contain any plasticizers or moisture and is also chemically inert.

The PVF film stands up to harsh weathering, ultraviolet radiation, most solvents, and corrosive chemicals.

Du Pont, Room 37480, PA, Wilmington, Del. 19898 [477]

A silver-filled epoxy compound for bonding and sealing applications, Tra-Duct 2902 can be used with such materials as metals, ceramics,

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Circle 263 on reader service card

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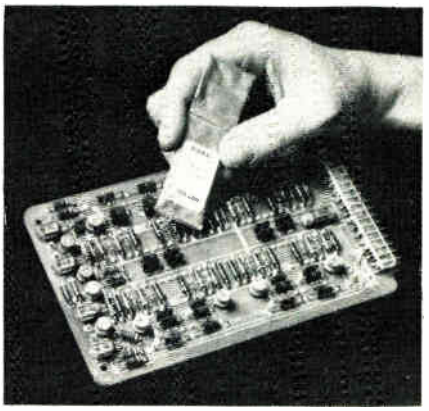

glass, and plastic laminates. Cured at room temperature, this electrically conductive material can be used for heat-sensitive components where hot-soldering is impractical. It can also be used for the assembly and repair of electrical modules, printed circuits, wave guides, flat cable, and high-frequency shields. It is free of solvents and copper or carbon additives.

Tra-Duct 2902 comes in different predispensed Bipax package sizes. Delivery is from stock.

Tra-Con Inc., 55 North St., Medford, Mass 02155 [478]

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Formulated Resins Inc., P. O. Box 508, Greenville, R. I. 02828 [480]

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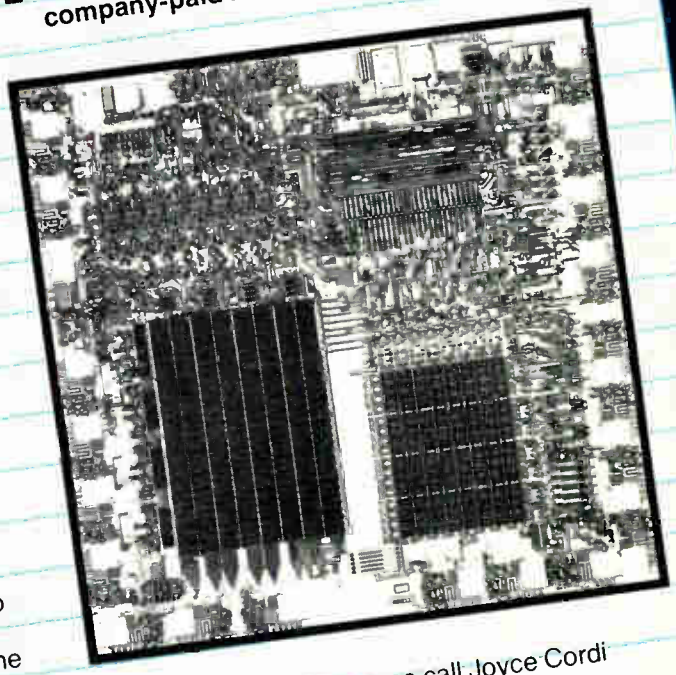

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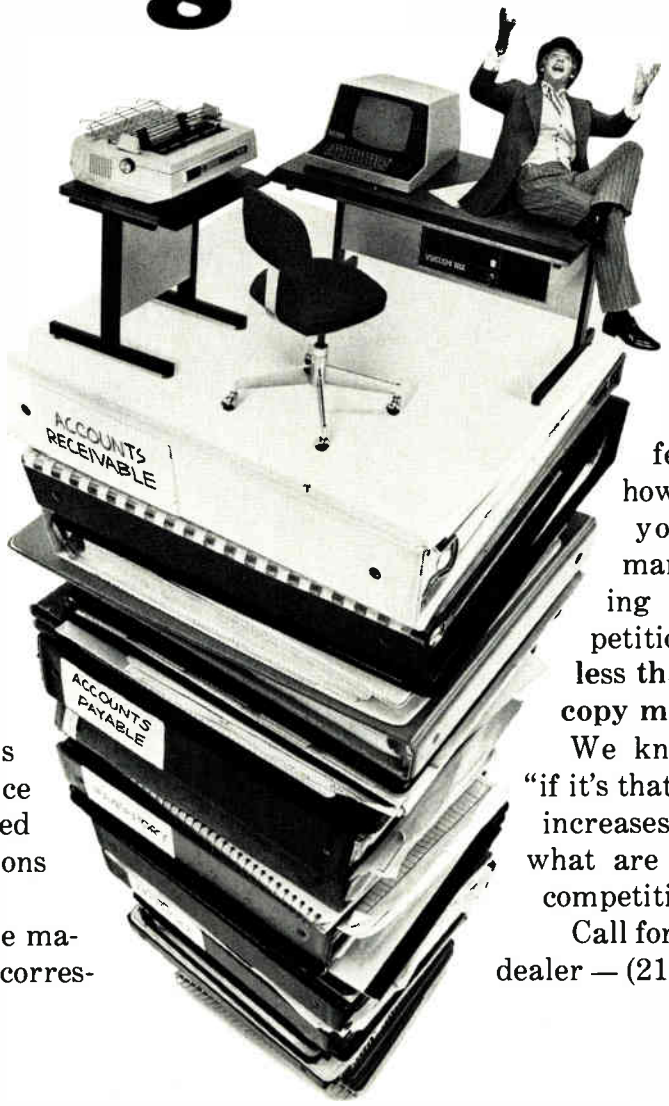

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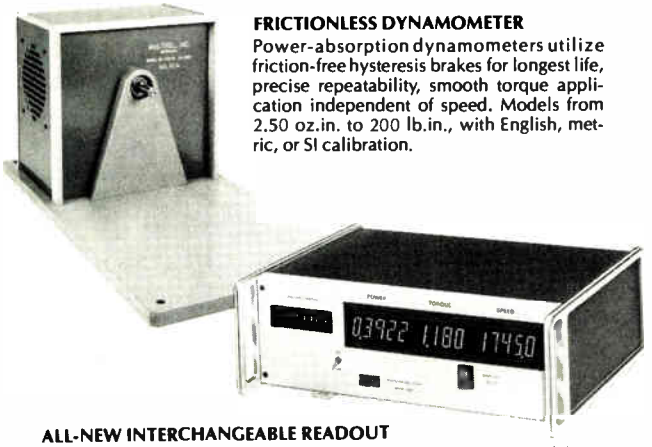

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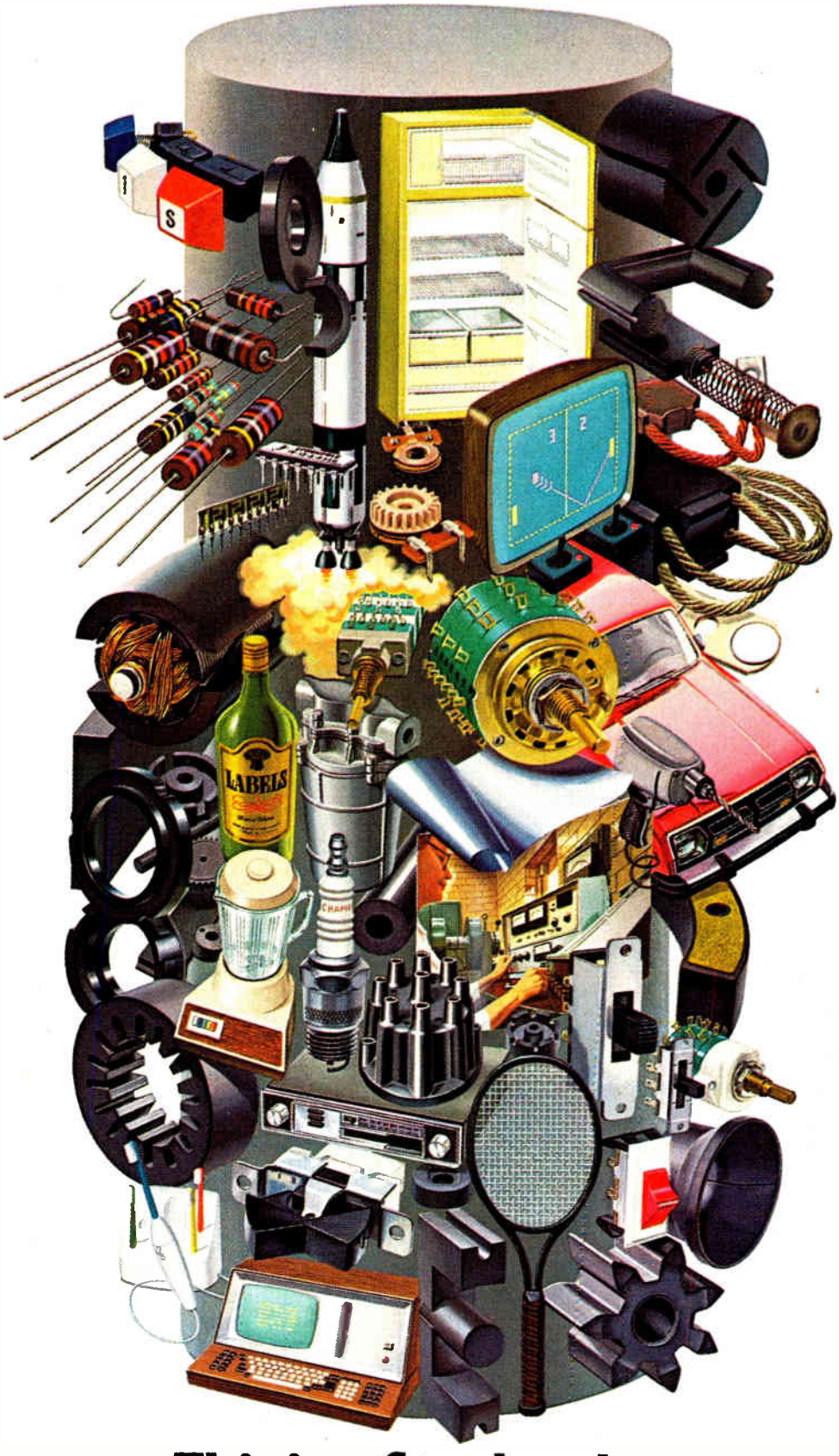

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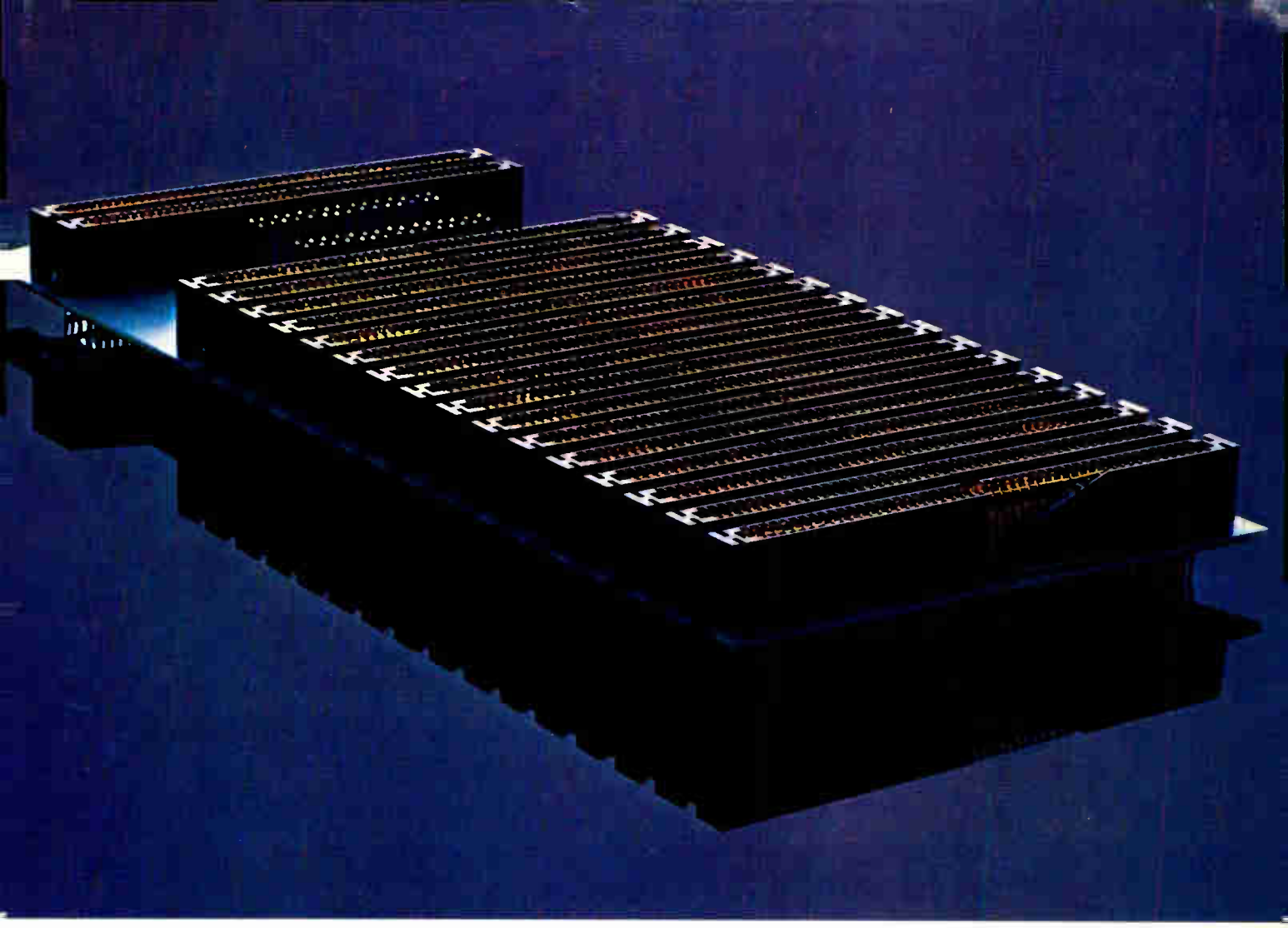
Power Basic language. "Product Reference Guide for Power Basic" describes the products available for Texas Instruments' Power Basic language. Designed for individuals who have had no previous experience with computer programming, Power Basic is fast and requires little memory overhead. The 15-page guide explains Evaluation Power Basic (TM 990/450), Development Power Basic (TM 990/451), Development Power Basic enhancement package (TM 990/452), and Configurable Power Basic (TMSW510F). The guide also includes Power Basic statements, commands, and functions. A copy of the reference guide may be obtained from Texas Instruments Inc., P. O. Box 1443, M/S 6404 (Attn: MP713), Houston, Texas 77001. Circle reader service number 421.

CTR degradation. "Consideration of CTR Variations in Optically Coupled Isolator Circuit Designs" discusses the causes of current-transfer-ratio degradation of optocouplers. The main cause of this degradation is the reduction in efficiency of the light-emitting diode within the optocoupler. The 16-page application note also develops a degradation model, describes second- and third-order effects of emitter degradation, and explains practical applications of an optocoupler. Application Note 1002, Publication no. 5953-0385, can be obtained from Hewlett-Packard Co., 1507 Page Mill Rd., Palo Alto, Calif. 94304 [422]

Reliability databook. "Digital Failure Rate Data, 1979," a new addition to the Reliability Analysis Center's Microcircuit Device Reliability series of handbooks, presents data that reflects the reliability experience of small-scale and medium-scale integrated devices currently used in active Government and industry programs. The data covers a wide range of functions and device technologies that include TTL, complementary-MOS, p- and n-channel-MOS, Schottky TTL, and emitter-coupled logic. The 430-page publication contains information on generic



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failure rates, observed failure rates vs MIL-HDBK-217B predictions, field replacement rates, and generic replacement rates, all of which are vital for reliability decisions. It also contains tabulations, charts, an index, and a user's guide that includes definitions of terms and statistical methods employed in analyzing data. A copy is available for $50 in the U. S. ($60 outside the U. S.) by ordering No. MDR-12 from Reliability Analysis Center, Griffiss Air Force Base, N. Y. 13441.

Printed-circuit techniques. "Eliminating Printed Circuit Design Problems" by James Wheeler is a reprint of a four-page story that appeared in Insulation/Circuits magazine. It deals with various design techniques that can be used to reduce printed-circuit–board production costs and difficulties. It also points out that circuit designers should work closely with pc board manufacturers in developing board designs that are easily and economically produced. A copy can be obtained from Reprint, The Sibley Co., Bridge Street, Haddam, Conn. 06438 [424]

Solders. A 17-page brochure, "Indalloy Specialty Solders," discusses Indium's technical and production capabilities and describes solders for microelectronics, solders incorporating flux, special solders for special applications, and the soldering of nonmetals. It contains a special section on solder creams formulated with spherized alloy particles that make it superior to conventional creams and provides a guide to Research Solder Kits listing 28 solders, their special characteristics, compositions, and physical properties. The Indium Corp. of America, P. O. Box 269, Utica, N. Y. 13503 [425]

Timer-flashers. "Solid State Timers and Flashers" describes a broad line of such products. The 130-page catalog presents application information and a glossary of terms of the timer-flasher language and contains charts that help the designer select the correct control. It also explains and

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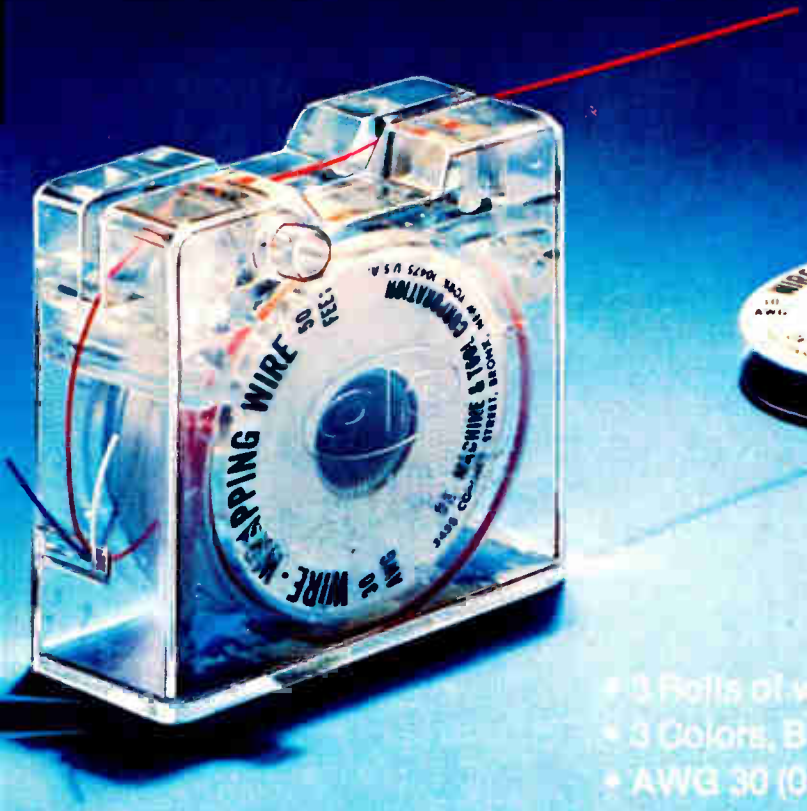

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compares mechanical, resistance-capacitance, and digital methods of time control. For a free copy, write to SSAC Inc., P. O. Box 395, Liverpool, N. Y. 13088 [426]

Digital meters. "Digital Instrument Guide," an eight-page catalog, describes Data Tech's range of digital panel meters, digital multimeters, and data-conversion subsystems. It discusses 3½ and 4½ digit panel meters; a family of portable or benchtop digital multimeters with a choice of gas-discharge, light-emmitting–diode, or liquid-crystal displays; data-conversion subsystems using a modular approach; and two logic-card series, blue-chip modules and M series digital and analog modules. Data Tech, Division of Penril Corp., 2700 South Fairview St., Santa Ana, Calif. 92704 [427]

Video tape library. The Genesys Video Tape Library contains more than 200 video courses in engineering and science. Recently, the company announced the addition of 50 new video courses that help teach and train engineers and technicians. The subjects covered include lasers, microprocessors, computers, computer science, amplifiers, networks, systems, microelectronics, integrated circuits, programming analysis, design, industrial engineering, mechanical engineering, mechanics, combustion, heat transfer, energy, materials, structures, quality control, reliability engineering, economy, communications, modulation, mathematics, physics, chemistry, chemical engineering, and much more. The courses, ranging in price from $400 to $11,000, were produced by such organizations as: the Massachusetts Institute of Technology; the universities of Rochester, Kentucky, Delaware, and Wisconsin; Oklahoma State Univ., Purdue, and the University of Southern California; and Texas Instruments Inc., the Society of Manufacturing Engineers, and Lawrence Livermore Laboratory. For a free listing of the courses, write to Genesys Systems Inc., 1180H East Meadow Dr., Palo Alto, Calif. 94303 [428]

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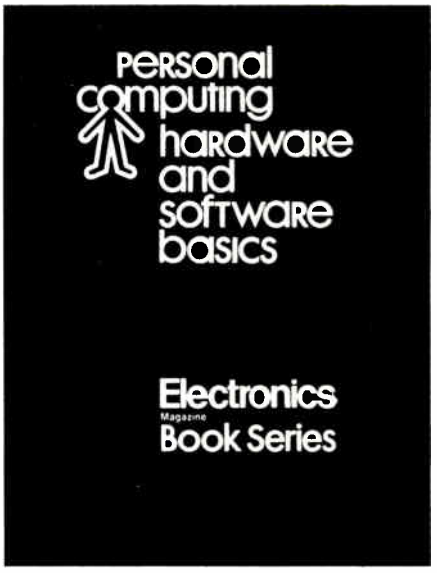

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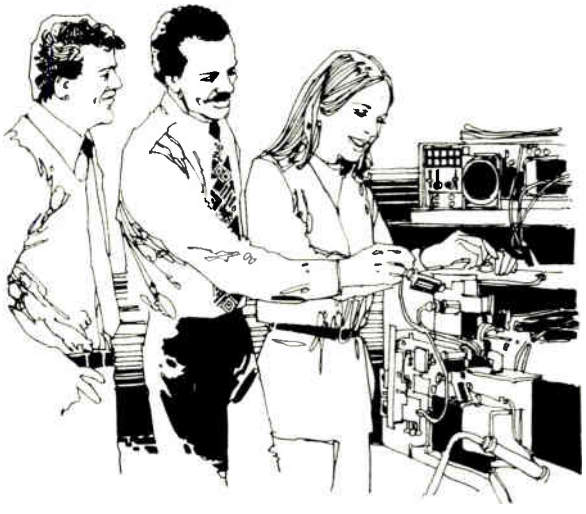

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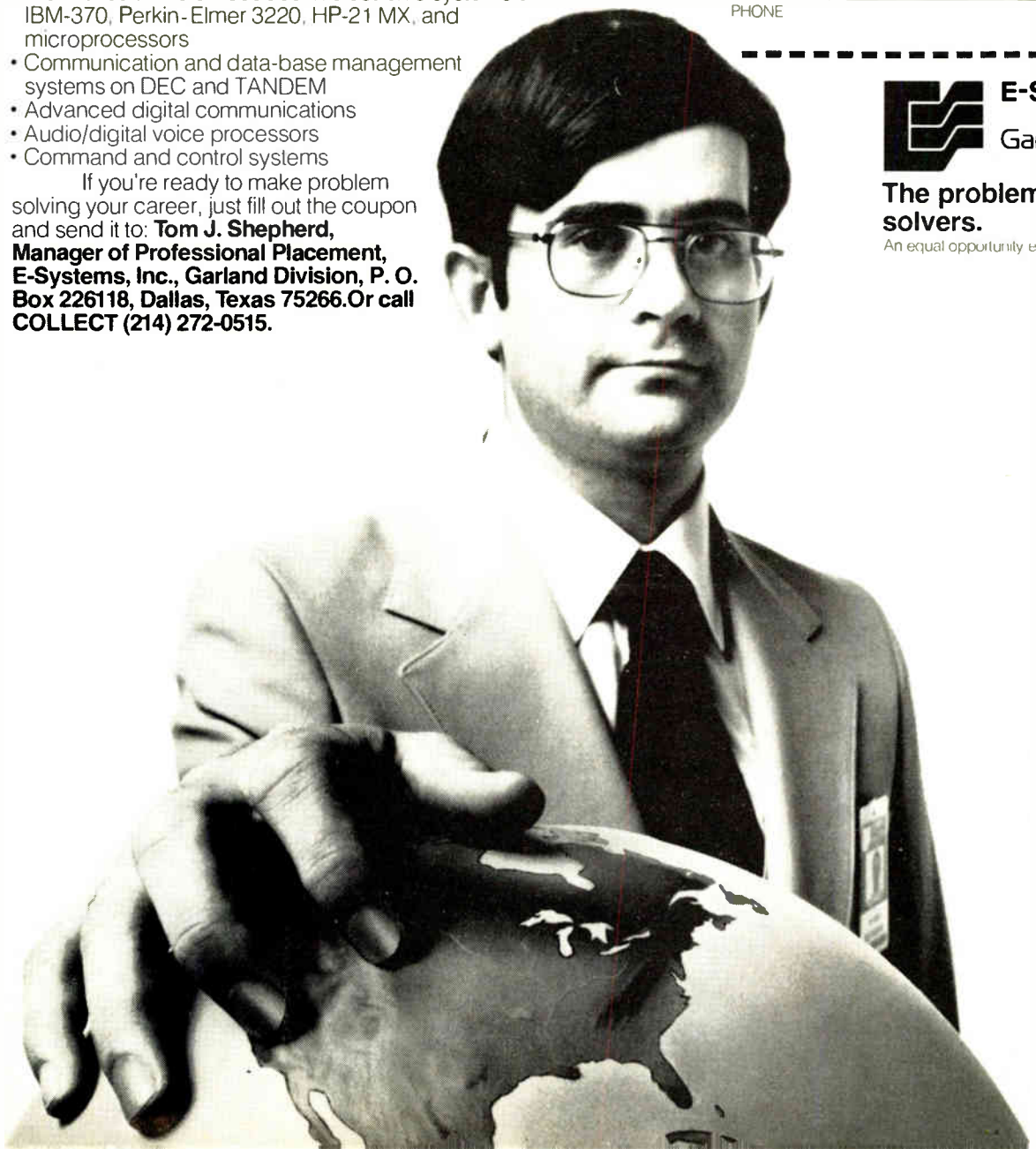

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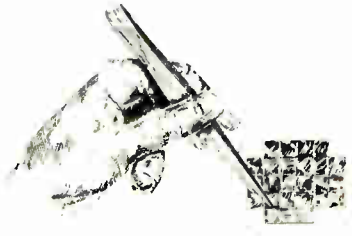

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1 16 31 46	61 76 91 106	121 136 151 166	181 196 211 226	241 256 271 348	363 378 393 408	423 438 453 468	483 498 703 718
2 17 32 47	62 77 92 107	122 137 152 167	182 197 212 227	242 257 272 349	364 379 394 409	424 439 454 469	484 499 704 719
3 18 33 48	63 78 93 108	123 138 153 168	183 198 213 228	243 258 273 350	365 380 395 410	425 440 455 470	485 500 705 720
4 19 34 49	64 79 94 109	124 139 154 169	184 199 214 229	244 259 274 351	366 381 396 411	426 441 456 471	486 501 706 900
5 20 35 50	65 80 95 110	125 140 155 170	185 200 215 230	245 260 275 352	367 382 397 412	427 442 457 472	487 502 707 901
6 21 36 51	66 81 96 111	126 141 156 171	186 201 216 231	246 261 338 353	368 383 398 413	428 443 458 473	488 503 708 902
7 22 37 52	67 82 97 112	127 142 157 172	187 202 217 232	247 262 339 354	369 384 399 414	429 444 459 474	489 504 709 951
8 23 38 53	68 83 98 113	128 143 158 173	188 203 218 233	248 263 340 355	370 385 400 415	430 445 460 475	490 505 710 952
9 24 39 54	69 84 99 114	129 144 159 174	189 204 219 234	249 264 341 356	371 386 401 416	431 446 461 476	491 506 711 953
10 25 40 55	70 85 100 115	130 145 160 175	190 205 220 235	250 265 342 357	372 387 402 417	432 447 462 477	492 507 712 954
11 26 41 56	71 86 101 116	131 146 161 176	191 206 221 236	251 266 343 358	373 388 403 418	433 448 463 478	493 508 713 956
12 27 42 57	72 87 102 117	132 147 162 177	192 207 222 237	252 267 344 359	374 389 404 419	434 449 464 479	494 509 714 957
13 28 43 58	73 88 103 118	133 148 163 178	193 208 223 238	253 268 345 360	375 390 405 420	435 450 465 480	495 510 715 958
14 29 44 59	74 89 104 119	134 149 164 179	194 209 224 239	254 269 346 361	376 391 406 421	436 451 466 481	496 701 716 959
15 30 45 60	75 90 105 120	135 150 165 180	195 210 225 240	255 270 347 362	377 392 407 422	437 452 467 482	497 702 717 960

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Tempco	100 ppm/°C	100 ppm/°C	100 ppm/°C
CRV	3%	3%	1%
Adjustment	15 turns	25 turns (top or side adj.)	Single-turn (top or side adj.)
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