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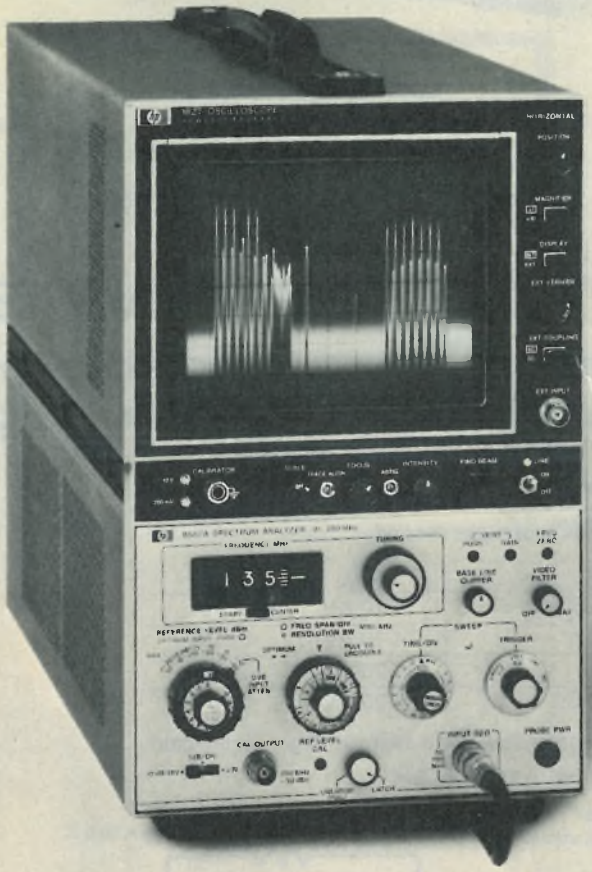

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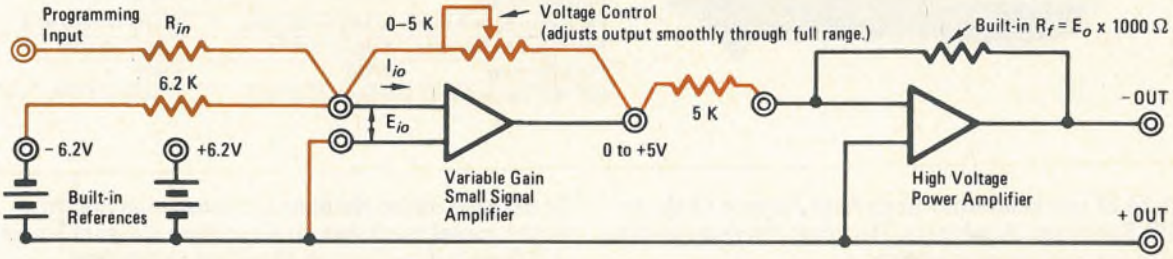

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Electronics
The International Magazine of Electronics Technology
Vol. 48, No. 12-June 12, 1975

Highlights

Cover: Word processing transforms the office, 89
To turn out more paperwork with fewer people, businesses are buying electronic equipment that speeds up dictation and typing. Typing/editing machines range in complexity from typewriters with a memory to time-shared computers. Innovations among dictating machines include magnetic recording disks and centralized systems.

Art Director Fred Sklenar created the cover, which was shot by photographer Syd Karson.

Must the 40-year-old EE be obsolete? 65
The Institute of Electrical and Electronics Engineers has uncovered "massive age discrimination" against its older members.

Steel firms look for electronics help, 104
Part 2 of this series on electronics and industry finds that steel companies would pay handsomely for customized electronic equipment capable of increasing the accuracy of controls in rolling mills, economizing on the use of zinc and electrical power, and reducing rejection rates.

C-MOS picks up speed from sapphire, 115
Parasitic capacitance is virtually abolished from silicon-gate complementary-MOS circuits when a thin silicon film on a sapphire substrate is used in place of bulk silicon. Speed and device density improve significantly at the large-scale-integration level of complexity, yet power requirements remain low.

And in the next issue . . .
Special report on power semiconductors . . . the 1-kilobit C-MOS random-access memory . . . a monolithic negative-resistance device that's the first of its kind.

Electronics

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Publisher's letter

The plight of older engineers is not a happy one. Indeed, a recent report by the IEEE's Manpower Committee presents persuasive evidence that age discrimination is a fact of life in the electronics industries. To be sure, preferential treatment shown to younger engineers at the expense of veteran engineers may be unthinking, careless acts on the part of management. But there is mounting evidence that, whether carefully planned or accidental, corporate practices hit engineers who are over 40 harder than those who are younger.

On page 65 you'll find a Probing the News story on age discrimination, its recent history, and the moves that are being made to ease its threat. And, because the editors of *Electronics* feel quite strongly about the impact age discrimination can have, they have devoted this issue's editorial to detailing some of the steps the individual engineer should take. We welcome constructive suggestions on how best to deal with the problem.

Did you ever stop to think how many times a book, a magazine article, a technical report, and even a letter are typed and retyped before they are considered final? Well, the times a manuscript is redone can be numerous, and—as business is finding out—the redoing can be quite costly. Indeed, says associate editor Jerry Walker, "today correspondence can cost a company anywhere from $5 to $10 a page."

That was one of the facts that he uncovered while doing research for the 10-page report on electronics and word processing that begins on page 89. As for the lastest trends, he reports that "in the last year, new, more powerful machines have begun to appear. Applications of microprocessors for control and memory, floppy disks for storage, and advanced cathode ray tubes have entered word processing equipment design.

"All of the signs thus point to steady growth of word processing; electronics technology moves in on yet another established electro-mechanical field. For the companies that have been trying to to get this market off the ground for the last decade, the necessary ingredients—lower cost, greater equipment capability, and user interest—are finally beginning to coalesce."

The second installment in our five-part series on electronics role in raising industrial productivity covers the steel industry. And the unusual problems in that vital basic industry are luring more electronics companies into the competition.

As our industrial editor, Peggy Maas, comments: "For electronics companies, there's gold in the iron and steel industry. Although there is only a handful of major steel companies and each requires no more than a half dozen of any one control system, the total value of those systems can add up. And the industry will be spending more than ever during the next two years."

For the details on the steel industry's needs, and how electronics technology is filling more and more of them, turn to page 104.

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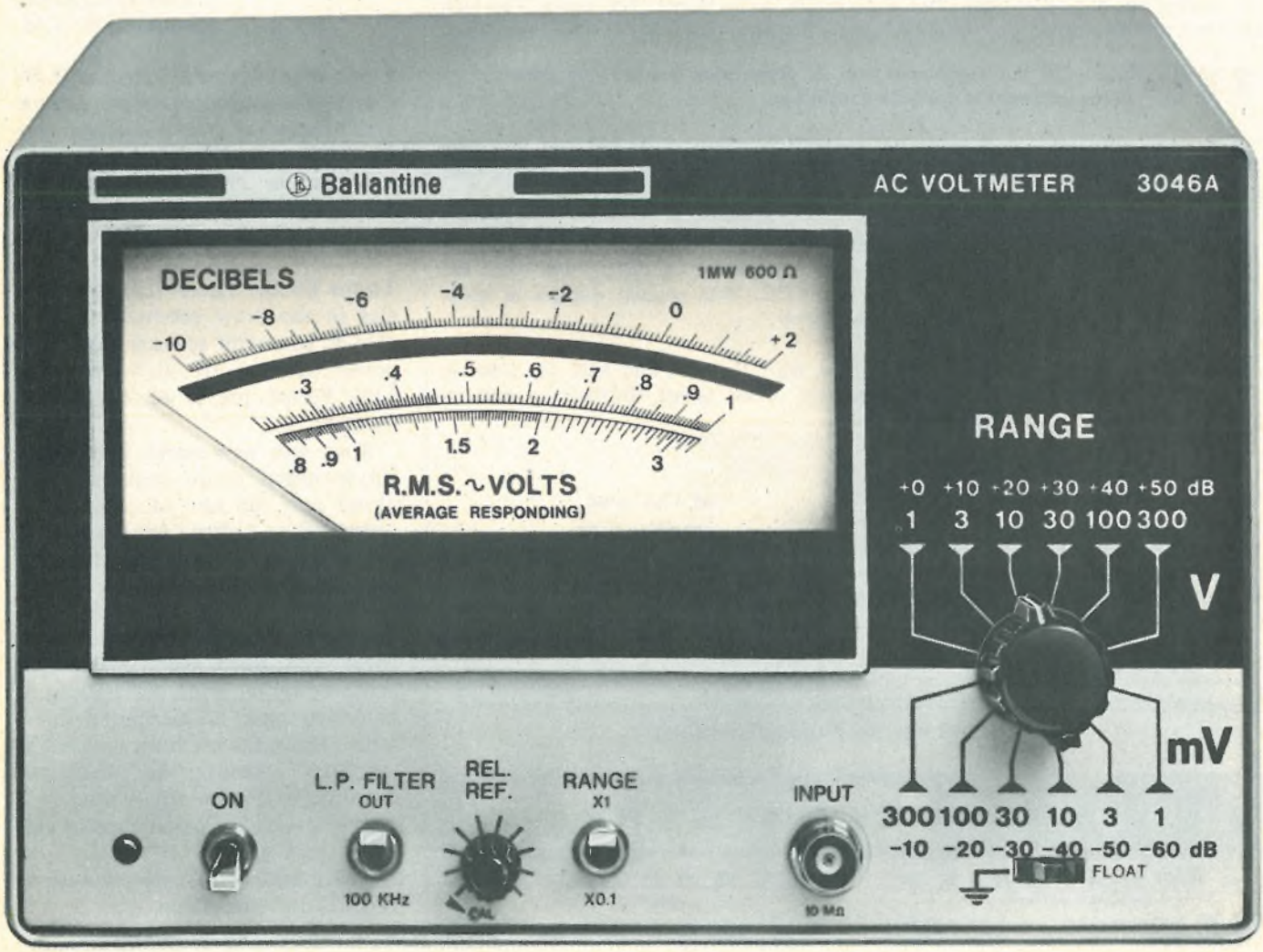

Readers comment

Chronology counts

To the Editor: Bell Labs certainly ranks among the most productive laboratories in the world, but Bell did not develop the semiconductor laser [*Electronics*, May 15, p. 70]. The first semiconductor lasers were demonstrated almost simultaneously in the fall of 1962 by R.N. Hall of General Electric, M.I. Nathan of IBM, and T.M. Quist of MIT.

Seven years later the Soviet scientist Z.I. Alferov devised the so-called double-heterostructure injection laser, which displayed a very low lasing threshold. This led to the the first semiconductor laser capable of continuous operation at room temperature, developed in 1970 by I. Hayashi and his co-workers at Bell Labs. This is no doubt the achievement to which your otherwise excellent article was referring.

Forrest M. Mims
Albuquerque, N.M.

■ *Mr. Mims is correct. He and R.W. Campbell co-authored a history of the development of the semiconductor laser, "Semiconductor Diode Lasers," published in 1972 by Howard W. Sams & Co.*

Converter redescribed

To the Editor: There were inaccuracies in the New products feature, "Dc-dc converter sources have high power density" [April 3, pp. 127-128]. Permit me to set the record straight.

Since our new series F modular single-output dc-dc converters are about half the size of competitive units, they offer approximately twice the power density. For example, our 5-watt model, which measures 2 by 2 by 0.375 inches, has a power density of 3.3 watts per cubic inch. Such performance was achieved by reducing the amount of heat that must be dissipated internally. The units are built with high-efficiency converter and regulator circuitry, and they are housed in a copper package. Power transfer efficiency is 70%.

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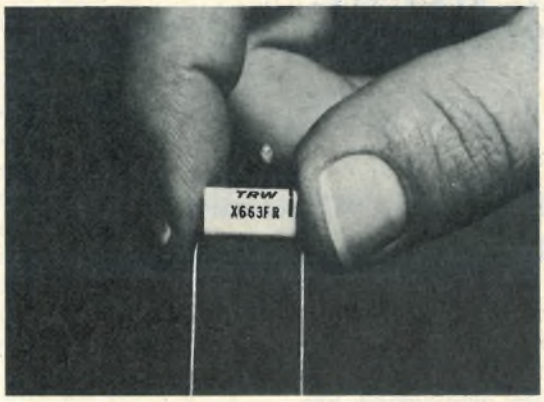

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*Du Pont T.M. for polyester film

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Readers comment

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Daniel T. Sheehan
Stevens-Arnold Inc.
South Boston, Mass.

Spying and lawsuits

To the Editor: Re the article "Theft of secrets: headache continues" [*Electronics,* May 15, p. 63], industrial spying is not to be condoned even in "hard economic times," but neither are lawsuits aimed at engineers who are rendered guilty until proven innocent. While a patent means "open to public perusal" it merely is a permit to prosecute. Engineers often can't afford the legal fees to prove that much "proprietary information" is common knowledge.

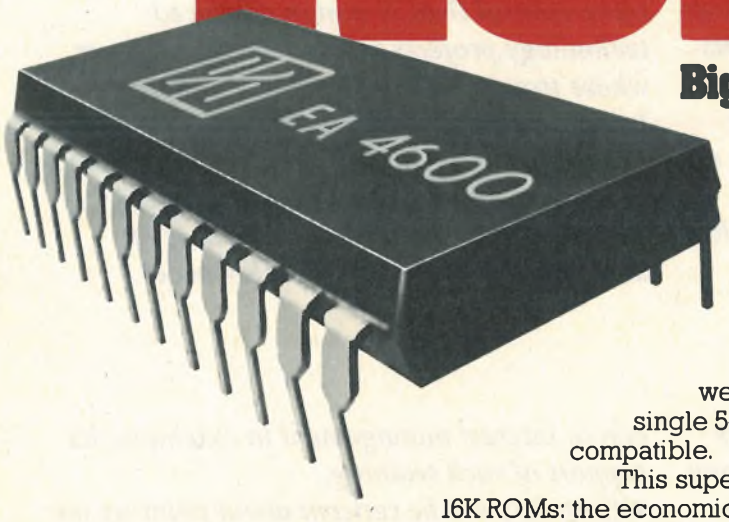
John J. Stapleton
East Brunswick, N.J.

Conditions unusual

A number of readers have commented that Roland J. Turner's integrator circuit [*Electronics,* March 6, p. 82] *has in fact the same transfer function as any other integrator, i.e.,–1/sCR; and that its input impedance is just R, because the feedback arrangement makes the op amp's noninverting terminal a virtual ground.*

The author agrees that, for operation with normal frequencies and voltages, these criticisms are indeed valid. But he says the approximations that yield them are not valid under the unusual conditions of his application (seismic pulses: 100 mV at 1 to 20 Hz). We regret that these conditions were not made clear in the original article.

Super ROM!



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Editorial

Age discrimination: the problem . . .

The conclusion of the IEEE's recent report—The EE At Mid-Career—that electronics engineers experience significant age discrimination is a sobering and serious one. Indeed, the finding that older EEs are victims of the very technology that gives them livelihood—because it moves so fast that training cannot keep pace—is one of the most serious professional problems facing the engineer today. For details on the report and reaction to it, see the story on page 65.

The data on discrimination appears to be clear-cut. "Older," by the way, is defined as over 40, a cut-off figure more in keeping with sports than with a profession as socially vital as engineering. The older engineer suffers more than his younger colleague when promotions or pink slips are handed out. What's more, his hurdles appear to be higher when he makes the rounds of the employment offices.

There are, of course, reasons given for the different ways of treating younger and older engineers. Technical training becomes outmoded very fast—15 years is the estimated "half-life" of electronics engineering education. Pay scales are certainly different, with the younger engineer at a lower salary considered more "cost-effective." And there can be no doubt that the older engineer costs a company more in fringe benefits and the like.

Yet that is not all the story. There are subtle management attitudes to be factored in. What is more natural than to assign advanced-technology projects to the younger engineer, whose training seems to suit the assignment better? But what happens, then, to the enhancement of the older engineer's knowledge by experience—the on-the-job continuing education that in other professions is an accepted tool in fighting obsolescence?

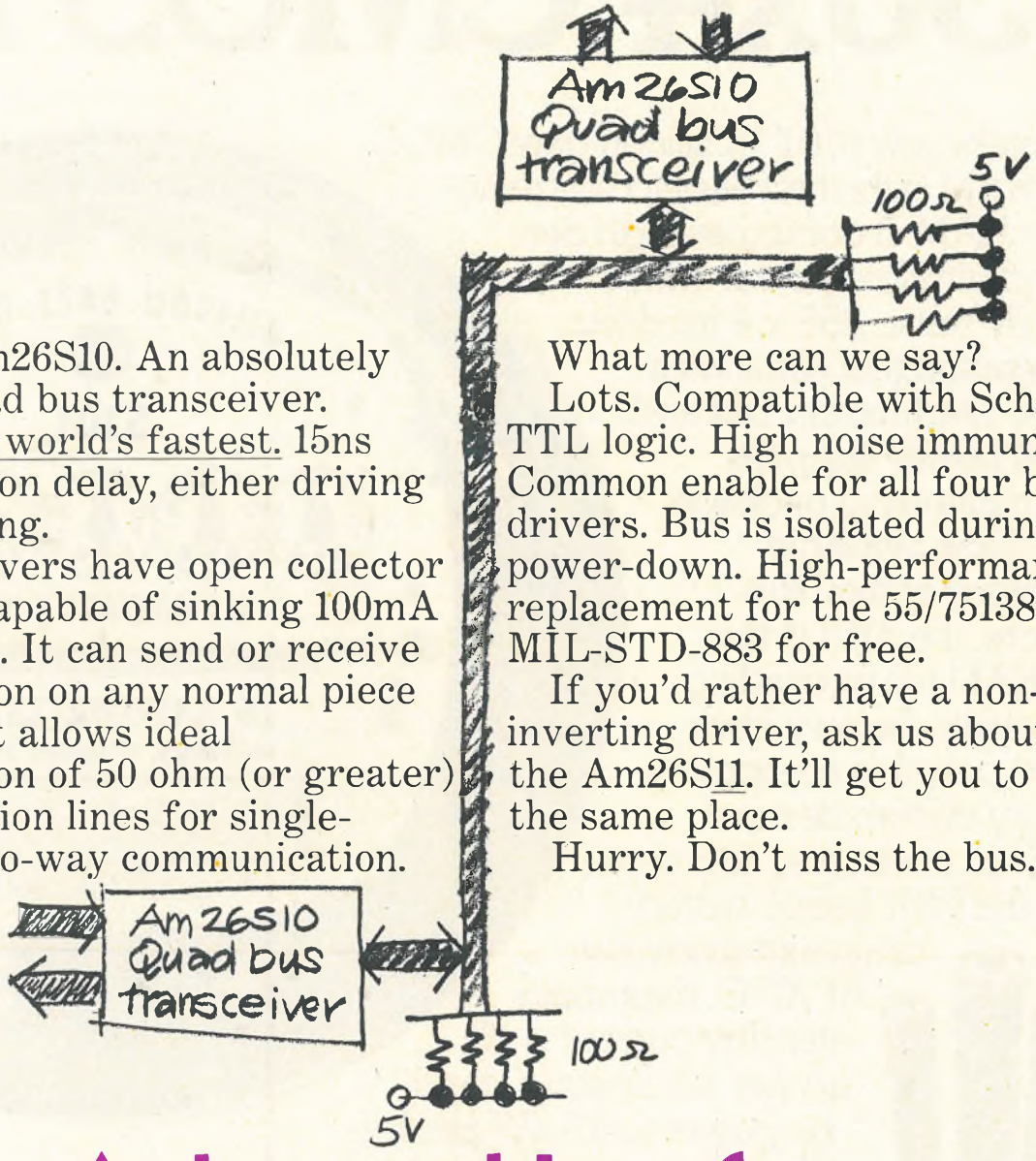
. . . and some answers

This is a complex problem, and the solution is going to be complex, too. That's because no one person or group can tackle the problem alone. The engineer, however, is in the key position. Not only does age discrimination concern him directly, but his actions can do the most to force other groups to act on his behalf. He should:

- *First of all, given the reality of the situation, take stock of his career position. Of course any successful professional is constantly making these evaluations. Yet, after years of riding the crest of technological progress, EEs may not be used to thinking in these terms.*
- *Do all he can to make his company aware that many official and unofficial company policies and practices—though management may not realize it—are, in fact, discriminatory.*
- *Demand a share in advanced projects that will challenge his abilities and add to his expertise.*
- *Take advantage of the continuing education opportunities an employer provides and do all he can to interest management in extending its support of such training.*
- *Certainly not be reticent about pointing out examples of age discrimination in hiring, promotion, or firing, especially if he is convinced management does not see the discriminatory aspect of a case.*
- *Finally, support the, so far, limited moves by such professional organizations as the IEEE—and push for more aggressive action.*

Age discrimination is not only illegal, it is wasteful. The veteran engineers should be a valuable resource, and any management that would throw away the investment it has already made in them is something less than far-sighted. What's more, a company that fails to give challenges to its older engineers is simply working out a self-fulfilling prophecy. In the words of one educator: "If someone is assumed to be over the hill and he is being given less challenging work, then he may go over the hill."

This bus is powered by pure Schottky.



The Am26S10. An absolutely super quad bus transceiver.

It's the world's fastest. 15ns propagation delay, either driving or receiving.

The drivers have open collector outputs capable of sinking 100mA at .8 volts. It can send or receive information on any normal piece of wire. It allows ideal termination of 50 ohm (or greater) transmission lines for single-ended, two-way communication.

What more can we say?

Lots. Compatible with Schottky TTL logic. High noise immunity. Common enable for all four bus drivers. Bus is isolated during power-down. High-performance replacement for the 55/75138. MIL-STD-883 for free.

If you'd rather have a non-inverting driver, ask us about the Am26S11. It'll get you to the same place.

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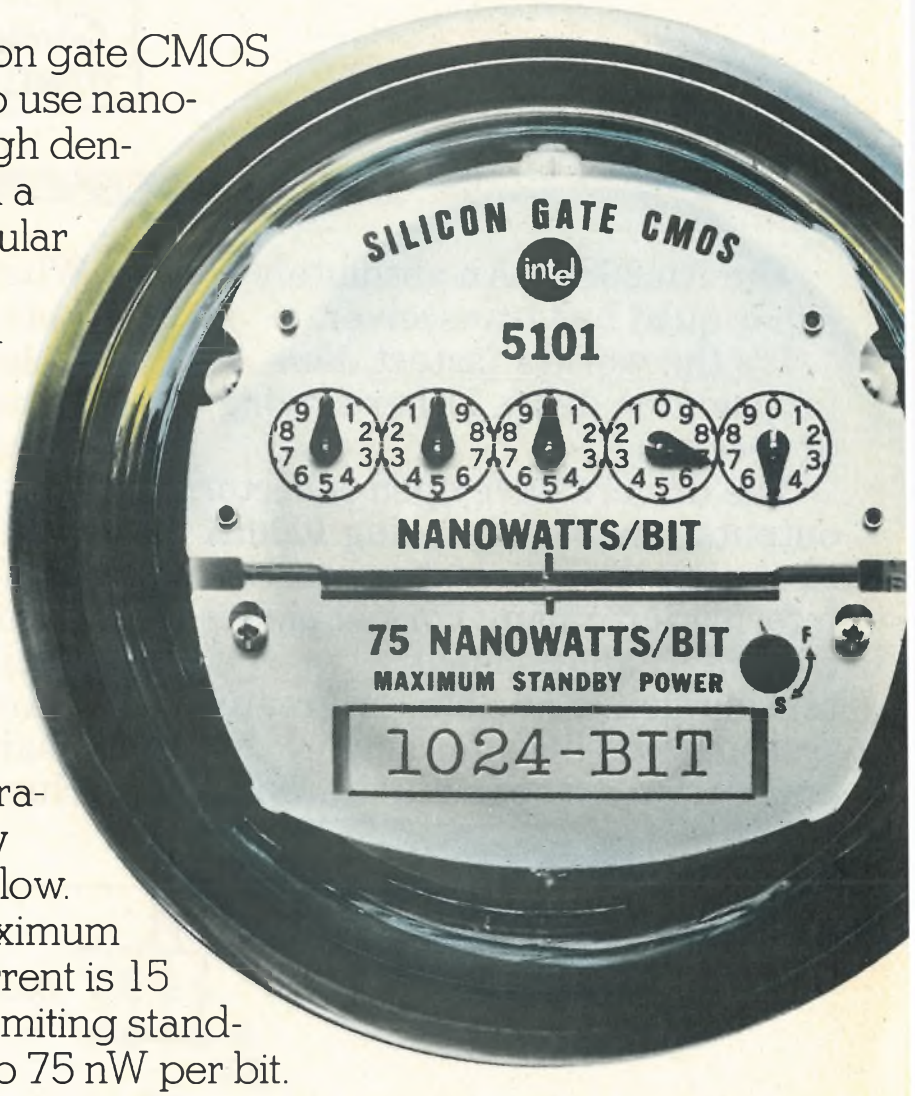
Circle 260 on reader service card

The first ava
256x4 CMOS RA

Intel's new 5101 1K silicon gate CMOS static RAM is the first easy to use nanopower RAM. It combines high density and ultralow power with a fast, fully static, 256 x 4 modular organization that eliminates clocks, interface circuits and special power supplies while minimizing package count. Now available from stock at Intel distributors, the 5101 is the ideal RAM for upgrading non-volatile, battery back-up and portable equipment memory system designs.



Even at elevated temperatures, the 5101 keeps battery drain extremely low. At 70°C, maximum standby current is 15 nA per bit, limiting standby power to 75 nW per bit. Worst case access time (and minimum cycle time) is only 650 ns over the 0°C to 70°C temperature range.

Intel distributors also stock the M5101 for military temperature range applications. At 125°C, maximum standby current is 200 nA/bit, maximum standby power 1000 nW/bit. Worst case access time for the M5101 is 800 ns over the −55°C to 125°C temperature range.

ilable nanopower M. Intel's 5101.

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INTEL'S 1K CMOS STATIC RAM FAMILY

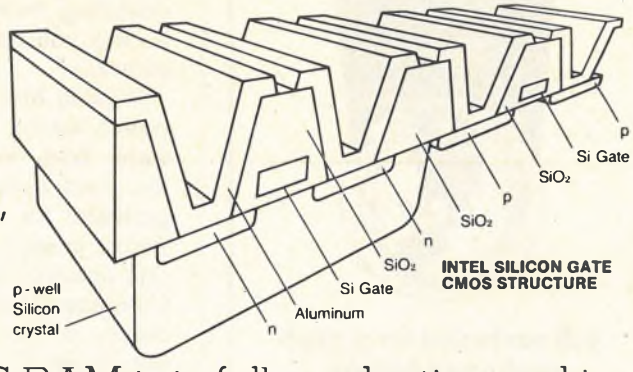
PART NO.	WORST-CASE SPEED*	SIZE	PINS	STANDBY POWER/BIT	AVAIL.
5101	650 ns	256x4	22	75 nW	Now
5101L**	650 ns	256x4	22	75 nW	Now
5101-3	650 ns	256x4	22	1 μW	Now
5101L-3**	650 ns	256x4	22	1 μW	Now
M5101-4	800 ns	256x4	22	1 μW	Now
M5101L-4**	800 ns	256x4	22	1 μW	Now
M5101-5	800 ns	256x4	22	5 μW	Now
M5101L-5**	800 ns	256x4	22	5 μW	Now

*Worst case access times and minimum cycle times are guaranteed over full operating temperature range (−55°C to +125°C for M5101-4, M5101L-4, M5101-5, M5101L-5; 0°C to +70°C for all other types).
**Guaranteed data retention at power supply voltage as low as 2V.

The easy to use 5101 is fully static, chip enable clocking is not required during address transitions. It also interfaces directly with TTL or CMOS and operates with a single +5V supply.

The 256 x 4 configuration is optimum for any memory system organization and is an ideal building block for memory expansion. You get two chip enable inputs, four data inputs, four three-state outputs with output disable control, and read/write control. The output disable pin controls bus states, making bidirectional logic unnecessary in common I/O buses.

The 5101, with its high density and ease of use, is the ideal nanopower RAM for portable instruments and microprocessors, advanced calculators, data collection devices, process controllers, POS, OCR, medical, avionics, ground support—for any equipment demanding long battery life, or non-volatility with battery back-up. The 5101 silicon gate CMOS RAM is in full production and in distributor stock, along with our other easy to use n-channel static RAMs.



INTEL SILICON GATE CMOS STRUCTURE

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People

Watson emphasizes software at Varian Data Machines

"The battle in the marketplace will be won or lost on the basis of software," says Gordon Watson, the new engineering vice president for Varian Data Machines Inc., the Irvine, Calif., minicomputer manufacturer. "Hardware at least has technology going for it," he explains, pointing out that new and improved components are continually appearing. But while hardware inadequacies can often be minimized by designing better software, "there's no way you can compensate for *bad* software."

New veep. Understanding the system is important to Varian Data Machines' Watson.

Watson brings to his engineering post a strong background in software. With Varian for more than five years, he is moving up from vice president for systems development. Before joining Varian he was corporate director of systems software for Computer Usage Corp., Dallas. His degree is in electrical engineering, but "I just like software better," he says. And he regards software development as a critical factor as he guides Varian's major thrust toward the end-user portion of the minicomputer business.

Watson plans for Varian to become a "major force" in the transaction-oriented data-base market as well as the message-switching market. This emphasis represents a big switch for the company—60% of its business at one time was with low-end original-equipment manufacturers.

'Total' system. For the data-base market, Varian recently introduced a data-base-management software system called Total, and will continue to work on specialized packages that require intimate knowledge of the applications. It takes more than salesmen to sell in the systems market, Watson observes. "You have to understand the user's problem and play it back to him with alternatives to show him you understand it."

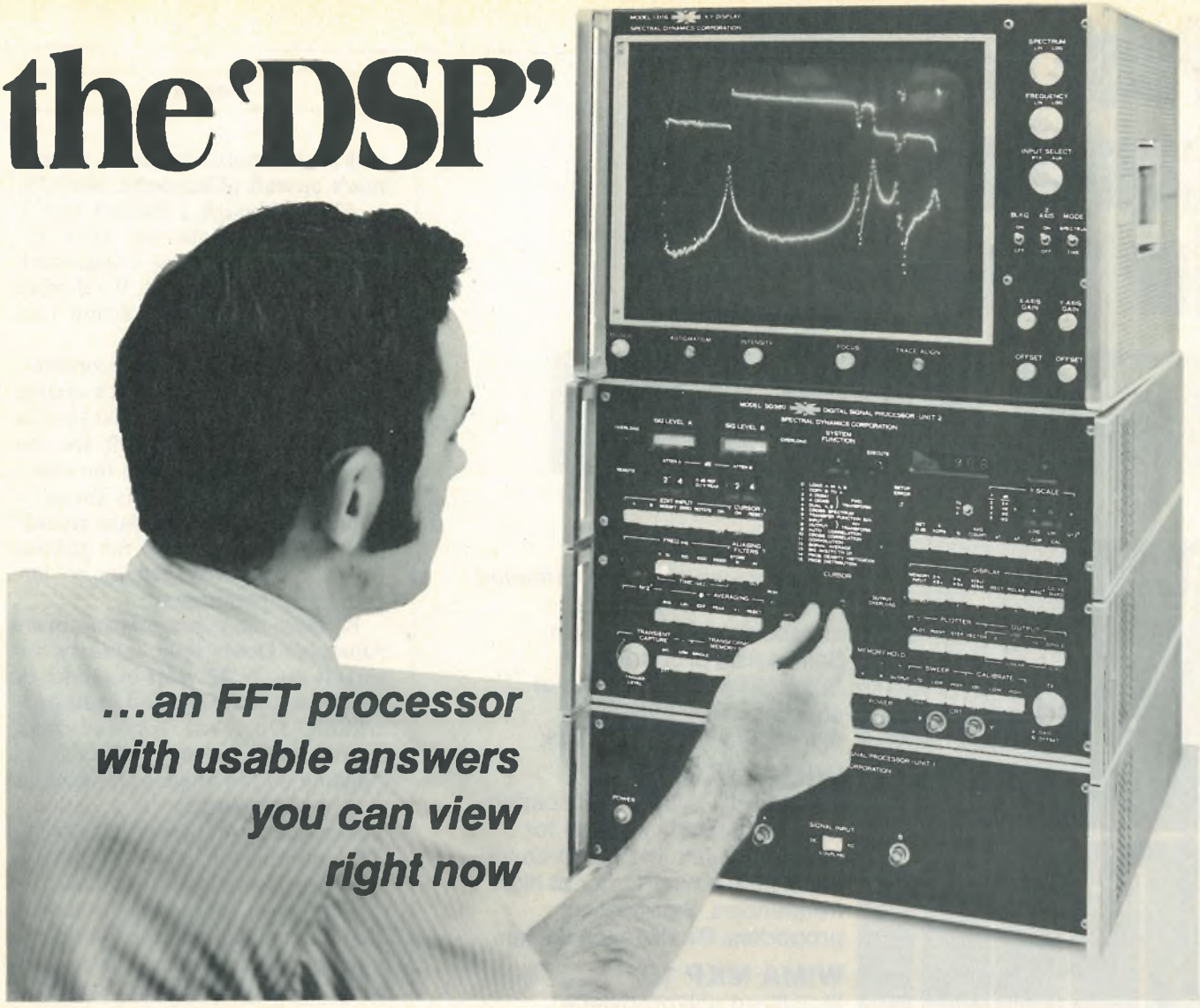
With respect to microprocessors, Watson points out that other divisions of Varian Associates, the parent company, are or will be using them. And so will Varian Data Machines. "We don't believe anyone will be a viable mini producer who doesn't support a microprocessor development"—either for peripheral equipment or for the minicomputer itself, says Watson. However, he adds that there are "strong Varian management opinions on centralizing microprocessor development." And it has not yet been decided if Watson's division will play that central role.

Data recorders are Dow's next big challenge

Despite strong criticism from the Air Line Pilots Association, James E. Dow intends to go ahead with Federal Aviation Administration plans to evaluate and later require flight-data recorders to track pilot

Mover. FAA's Dow believes new data recorders would eventually save money.

the 'DSP'



...an FFT processor with usable answers you can view right now

Transfer Function Analysis—vital in Structural Dynamics studies—as displayed by the DSP. Through "joystick" control of the intensity marker, data curves can be followed for direct, calibrated LED read-out...and inputs can also be continuously edited.

It looks, acts and operates like a single instrument. Yet the all-digital SD360 Digital Signal Processor—the "DSP"—performs a dozen different data-analysis functions covering the entire audio spectrum. It combines in "stand-alone," hardwired form all the capabilities of two Real Time Analyzers, a transfer function analyzer, analog signal conditioners and a computer.

With unmatched speed, accuracy and flexibility, here are some of the functions the DSP performs *...and displays:*

- Signal Averaging
- Single- or Dual-Channel Forward Fourier Transform Analysis
- Cross-Spectrum Analysis
- Inverse Transforms
- Cross-Correlation
- Autocorrelation
- Coherent Output Power
- Transfer Function Analysis
- Convolution
- Probability Density and Distribution

It's totally operator oriented. A front-panel "joystick" controls a cursor for automatically following oscilloscope data. Direct, *calibrated* frequency, amplitude and phase readings appear on a 6-digit LED display. For increased display resolution, you can "zoom in" with an adjustable amplitude window and set upper and lower sweep limits to view selected parts of a spectrum in detail. Or display dual-channel data on a single-channel oscilloscope.

X-Y plotters can also be used, with push-button selection of point, stepped or smoothed display.

Use either analog waveforms or digital data as input. The DSP provides continuous Real Time (without loss of data) signal processing up to a frequency of at least 25 kHz. It offers 57 analysis ranges from 10 Hz to 150 kHz full scale, with resolution as narrow as .01 Hz. A built-in averager handles up to 4096 ensembles (linear summation) and also has exponential (running) averaging and "Peak Hold" capabilities. Maximum throughput is over 300,000 words/second.

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Circle 195 on reader service card

and aircraft performance in the nation's aircraft [*Electronics*, May 29, p. 43]. "Although I haven't had a chance to evaluate the ALPA response [to a planning conference], it's not going to faze us. We'll work it out," says Dow, the acting FAA administrator.

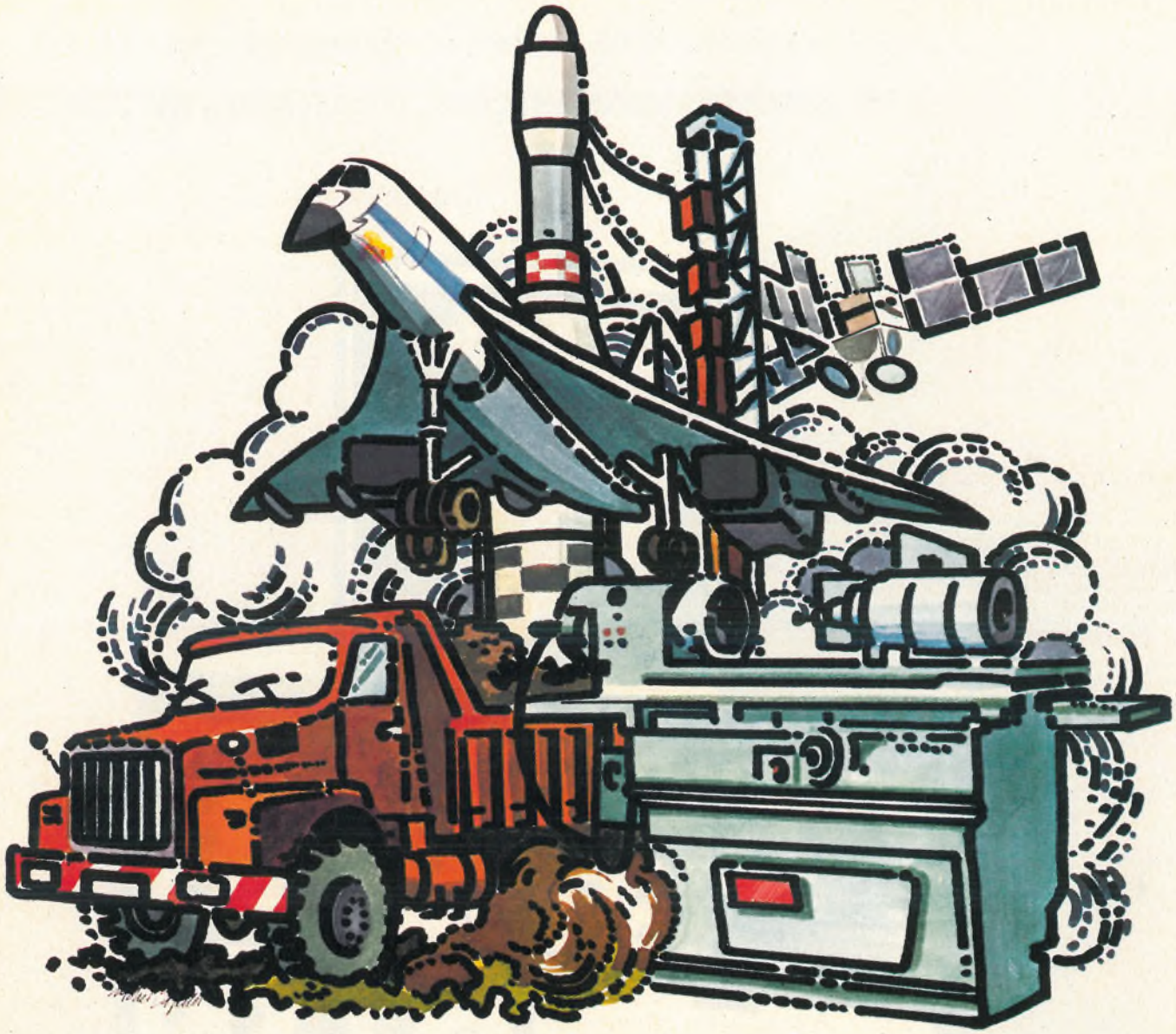
"Pilots are against the recorders—period," he points out. "It's almost an institutional position. But they're very professional and will see the light in the end." Despite the cost—estimated at $100,000 per aircraft—Dow believes that the data recorders will eventually save the airlines money, largely by helping to improve pilot performance.

Patience and pragmatism mark "Jimmie" Dow's style, industry observers say. In 32 years of service in aviation planning and administration, Dow has received high marks from industry officials for "pulling off the tough ones" such as the smooth transition to a national automated air-traffic-control system. The introduction of the flight-data recorders is another test for Dow.

The key to his success, he says, is that he "builds the bridge" between operational needs and R&D planning. Managing a technical R&D program for nontechnical users requires good communications, he says.

"It's simply a matter of making sure that the system needs are understood. I can't build hardware or draw up specifications, but I can make sure that the systems are all tied together correctly," he says. Although educated as a high-school mathematics teacher, Dow says that his lack of a technical background is not a hindrance. "It may not even be beneficial to be an engineer. An engineer tends to second-guess others. I just have to ask the right question. And the right second question," he explains with a friendly smile that belies his grizzly-bear appearance.

Dow looks forward to staying on as deputy when a successor to former FAA administrator Alexander Butterfield is named. "I know how all the pieces fit together," the acting administrator says.



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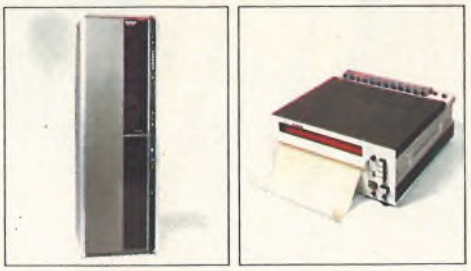

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Announces the newest generation of test and measurement instrumentation.

The NI 2001 Programmable Calculating Oscilloscope

Here is the ultimate instrument for the acquisition, processing and manipulation of electrical data. It completely eliminates the need to compromise your requirements with a jumbled array of separate instruments. The NI 2001 is a *complete* unit that combines all the capabilities of a digital oscilloscope and a microprocessor in a single mainframe. It brings you flexibility, convenience, accuracy and reliability you won't find anywhere else.

This — the first programmable calculating oscilloscope — is the product of many years of technological research and instrumentation engineering. With the advent of microprocessor technology, Norland Instruments engineers were quick to recognize the power available to the instrument designer and first applied a microprocessor to the Norland line of medical instruments. That experience ultimately led to the use of microprocessor technology in the development of the NI 2001 — the first truly new generation of test and measurement instrumentation for the industrial and scientific user.

The NI 2001 gives you the precision of a digital oscilloscope for data acquisition and display *plus* the built-in capability of a microprocessor for data reduction. You can make exact calculations of rise times, integrals, differentials, peak areas, RMS values, peak-to-peak measurements, n-point averaging, and an almost unlimited range of other operations. It increases your productivity by letting you measure, display, digitize, store and process data faster and more accurately than ever before. The NI 2001 will analyze data and, through conditional branching, function as a decision making instrument. It is easily programmable — without computer instructions — so repetitive operations can be completely automated. Its mainframe, through modular design, has provisions for a wide range of plug-in modules to let you expand your system to meet individual requirements. It can even be interfaced to control other equipment.

Now, consider the economics. Surprisingly, the NI 2001 mainframe is $8,500. The instrument shown here, with monitor and two single-channel plug-ins, can be yours for $13,400!

You've waited a long time for an instrument as versatile as the Norland Instruments NI 2001. Wait no longer. Investigate it today.

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Meetings

International Conference on Communications, IEEE, Fairmont Hotel, San Francisco, June 16–18.

Nepcon East and International Microelectronics Conference, ISCM Inc. (Chicago), New York Coliseum, New York, June 17–19.

Symposium on Computer Networks—Trends and Applications, IEEE and NBS, Gaithersburg, Md., June 18.

International Conference on Fault Tolerant Computing, IEEE, Paris, France, June 18–20.

Symposium on Computing in the Mid-70s: An Assessment, ACM and NBS, Gaithersburg, Md., June 19.

Design Automation Conference, IEEE and ACM, Statler Hilton Hotel, Boston, Mass., June 23–25.

Siggraph '75, Second Annual Conference on Computer Graphics and Interactive Techniques, ACM, Bowling Green State University, Bowling Green, Ohio, June 25–27.

Nuclear and Space Radiation Effects Conference, IEEE, Humboldt State, Arcata, Calif., July 14–17.

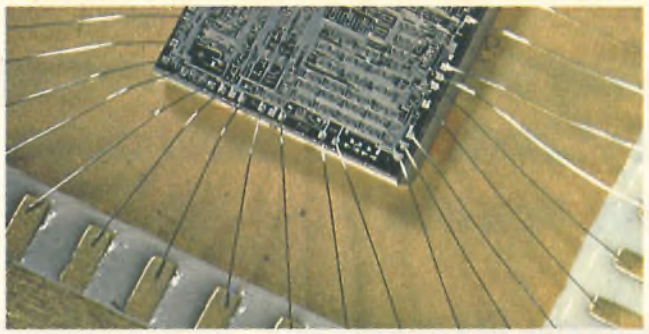
Summer Computer Simulation Conference, ISA et al, St. Francis Hotel, San Francisco, Calif., July 21–23.

Dielectric Materials, Measurements, and Applications, IEEE, Churchill College, Cambridge, England, July 21–25.

1975 Gordon Research Conference on Solid State Studies in Ceramics, Brewster Academy, Wolfeboro, N.H., Aug. 4–8.

Symposium on the Simulation of Computer Systems, NBS and ACM, Boulder, Colo., Aug. 12–14.

Tenth Intersociety Energy Conversion Engineering Conference, IEEE, University of Delaware, Newark, Del., Aug. 17–22



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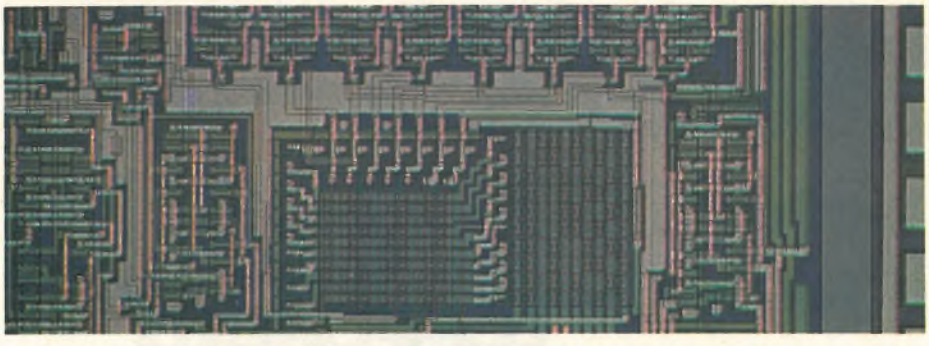

If you wanted to hook up a computer to a system that exercises electronic calculators, how would you do it?

Singer Business Machines did it simply, with Digital.

Computer on one end. Exerciser on the other. A single off-the-shelf module and a bit of cable in between. Simple. Beautiful.

The project manager at Singer designed it. He'd heard about our new M1705 module that contained two complete PDP-8 interfaces on a single card. And he knew just what to do with it. He put it to work on his current project, a computerized testing system for Singer's electronic calculators.

Using our Logic System Design Handbook as a guide, he put together a parallel interface between the PDP-8/e computer and the electronic exerciser he'd designed. Each M1705 module interfaces two exercisers. The entire operation of up to eight exercisers is controlled locally by a single operation at 30 times the speed the operation took by hand.

The M1705 interface saved Singer's project manager a lot of time. And a lot of trouble. And 40% of the cost of the interface.

If you've got an interfacing problem, we can give you the same kind of support we gave Singer. You'll find standard solutions to most of your problems in the Logic Products Handbook and the Logic Systems Design Handbook. To back up the solutions, we've got the hardware: digital and analog modules, computer interfacing modules, power supplies, cables, accessories, and wirewrap capabilities. Custom design assistance, too. And field specialists to offer advice if you get bogged down.

No one else can say nearly as much.

Which is why you'll probably want to get in touch with Digital next time you have an interfacing problem.

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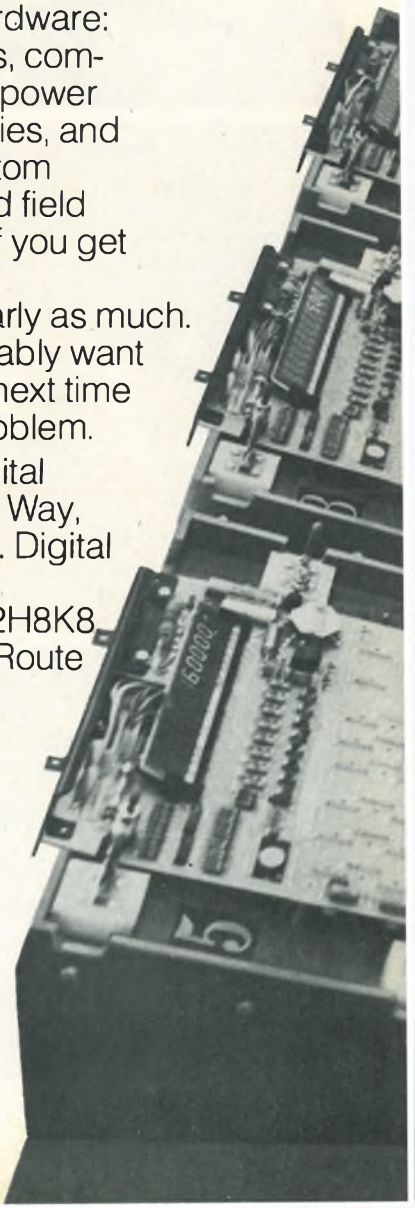

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Take another look at the flexible printed circuit, used here for a telephone subset or the zero-force mating system that cam-locks, in this instance, 156 contacts firmly in position. Plus the new 'Spectra-strip' line of flexible wiring shown above : just a few of our many new interconnection ideas and a very small part of our total interconnection capability.

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Circle 197 on reader service card

Electronics newsletter

IC makers say upturn is almost here

Most major IC makers are not yet willing to talk about a boom, **but they agree that the awaited upturn is almost here.** A National Semiconductor spokesman says there has been an increase in business across the board in the last two or three months. Significantly, he says, distributor orders are up, meaning that small companies are beginning to order, and the big buyers are expected to follow. Also, customers are asking for deliveries in 30 days, a sure sign that inventories are down. National expects to see the big upturn by September.

Intel Corp.'s marketing vice president, Jack C. Carsten, agrees that more near-term deliveries are being requested—"within the next 90 days," rather than 90 days to a year. And a spokesman for Fairchild Semiconductor expects 1976 to be a strong year, preceded for Fairchild by a "modest—under 10%—recovery in the second half of this year." At RCA's Solid State division, Ben A. Jacobi, marketing vice president, says he has seen "significant improvement" in C-MOS and bipolar sales in the second quarter.

Texas Instruments officials, now preparing their five-year projections, wouldn't comment officially, but **the company expects a year-end boom.** There is strength in consumer sales—where electronic TV tuners will become a factor and where video games and video players will be important. Microprocessors also will continue to gain, as will memory sales for computer mainframes.

RCA replaces C-MOS parts; offers tighter specs

RCA's Solid State division in Somerville, N.J., has begun recalling its CD4000 A and B series C-MOS devices from distributors and is replacing them with new devices with improved specifications and guaranteed performances. **The reason, says RCA, is confusion about inconsistent specs among devices from different makers that are supposed to be interchangeable.**

A major part of the problem, says Norman C. Turner, product director, is the proliferation of C-MOS suppliers and their failure to get together on standard specifications. And he says RCA is trying to gain a competitive edge by offering specification advantages.

Tighter A series specifications include guaranteed noise margin of 1 volt, as well as the previously guaranteed 30% supply voltage. RCA will also guarantee input leakage current of 1 microampere where no level has been guaranteed to date, and 100% test to guarantee maximum quiescent current at 15 V where devices were formerly tested to only 10 V. Improvements in the B series include a 20-V maximum rating, 100% testing to guarantee maximum quiescent current at 20 V, and guaranteed input leakage of 1 microampere.

Hughes, Ebauches in license deal for digital watches

Ebauches SA, currently the world's largest producer of mechanical movements for watches but an also-ran in the digital-watch derby, has entered a **license agreement with Hughes Aircraft Co.'s Microelectronic Products division for technology relating to electronic watches.** The Swiss firm will receive licenses both on related Hughes patents and Hughes' IC technology. Hughes, in Newport Beach, Calif., is currently the largest U.S. producer of digital watches for watch firms.

Electronics newsletter

Bendix lists MLS changes

To strengthen the scanning-beam microwave landing system's chances of being adopted as the global standard by the International Civil Aviation Organization [*Electronics,* Feb. 20, p. 78], Bendix Corp.'s communications division wants to make two significant hardware changes. First, the original Ku-band flare antenna, which airlines dislike because it means waveguide plumbing on the aircraft, **will very likely disappear in favor of altimeter inputs.** Second, instead of using C-band distance-measuring equipment as called for in the FAA's specifications, **Bendix wants to stick with the L-band DME hardware currently in use.** The changes would make for substantial cost savings for airborne and ground equipment for MLS, Bendix maintains.

Nippon Electric launches invasion of U.S. IC market

The biggest IC maker in Japan is preparing to compete head-on in the U.S. with American microcomputer and memory manufacturers. Nippon Electric Co., which had $1.6 billion in sales last year, **has formed a subsidiary and opened a sales office and warehouse** in Lexington, Mass. The subsidiary, NEC Microcomputers Inc., will initially handle the μCOM-8 microcomputer as well as a 4,096-bit random-access memory that accesses in 150 nanoseconds, plus some TTL and ECL products.

Oak bimetal strip ends relay 'kick'

Oak Industries has come up with a method that could take the inductive "kick" out of electromechanical relays. Instead of actuating the device with an induction coil, which has problems with transients, Oak has developed **a bimetallic strip that, when heated, snaps the relay contacts into a closed position.** Although slower than conventional relays, the device will be able to handle up to 5 amperes in a standard dual in-line package and should sell for $1, rather than the $1.50 charged for comparable devices. The bimetallic actuators are coated with an electrical insulation and screened with resistor patterns that heat when current is applied.

Mostek to show microcomputer

After one frustrating crack at the systems business with calculators, Mostek Corp. is headed back in again—this time with microcomputers. The firm's first product—GEMS-8 for general evaluation microcomputer system—**is an 8-bit machine that will hit the market next month.**

Originally conceived to aid users in developing software for the MK-5065 one-chip microprocessor [*Electronics*, June 27, 1974, p. 30], the $995 package can be designed into customers' applications. Mounted on one board are processor, crystal oscillator, clock-generator logic, sockets for programable-read-only-memory, 1,024-by-8-bit memory, and teletypewriter interface. The other contains 12-k-by-8-bits of add-on memory, built from 3-k random-access memories.

GEMS-8 also will be the heart of two hardware-development systems that Mostek plans to offer this fall. Both will allow users to program Mostek's multichip and one-chip calculator circuits for control applications.

The AN2538 *is* the lowest-cost line-powered 3½ digit DPM you can buy . . . with the performance and dependability you need. Big ½" LED display for long life and wide-angle viewing. Autozero for long term stability. High CMRR/NMRR for noise and ground-loop immunity. *Very* low bias current (100pA max), for error-free high-impedance. Super-regulated power supplies. All this adds up to *usable* ±0.05% accuracy.

But price and performance are only part of the breakthrough. The AN2538 takes *full* advantage of its monolithic circuitry. It runs exceptionally cool (5°C rise) and operates over −10°C to +70°C. It has the longest MTBF ever achieved in a 3½-digit DPM—enhanced by a 96-hour, 50°C burn-in cycle. Its tough LEXAN® case meets both NEMA and DIN standards. It has a universal power transformer, for worldwide use.

Last year, we broke through the interface problem with our AN2533/53 pluggable interface, premium-performance DPM . . . still the best for many applications. The AN2538 reflects Analogic's 200,000-DPM experience . . . experience unmatched by any other source.

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*Building instead of buying? The MN2301 is a complete, autozeroed, dual-slope-integrating A/D monolithic converter with multiplexed BCD output. It's your best bet for any 3½ digit DPM or DVM requirement. Attractive quantity discounts. Send for complete application data!

Pro-Log microprocessor modules reduce parts count and design time, and drop assembly costs.

Design engineers using this new approach can cut system costs up to 80%.

Choose the wrong approach to microprocessor system design and you could wind up quadrupling your total cost.

The computer-oriented approach costs big money, gives you more capability than you may need.

Semiconductor manufacturers regard microprocessor-guided systems as a form of computer typified by data processing techniques.

They promote features like interrupt, built-in control panels, program loaders, direct memory access, memory capacity and throughput. But their approach is only applicable to situations where large volumes of data must be manipulated in a job that may change from hour to hour. This kind of versatility tremendously increases system costs—you wind up buying RAM memory, canned software, and such peripheral devices as tape, card, disk, keyboard and display controllers. And you need a computer programer to design your system for you.

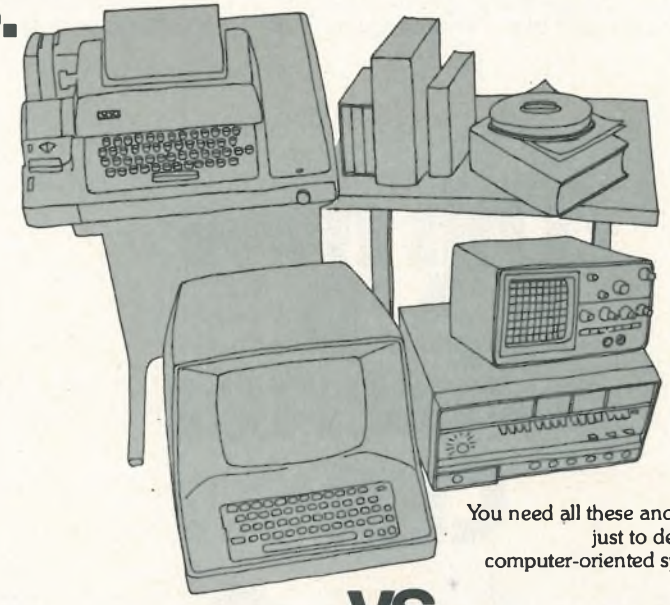
If you really need that kind of versatility, maybe you need a computer, not a microprocessor.

The Pro-Log Logic Processor approach does the job at minimum cost.

Pro-Log treats the microprocessor module as a logic processor especially suitable for dedicated control.

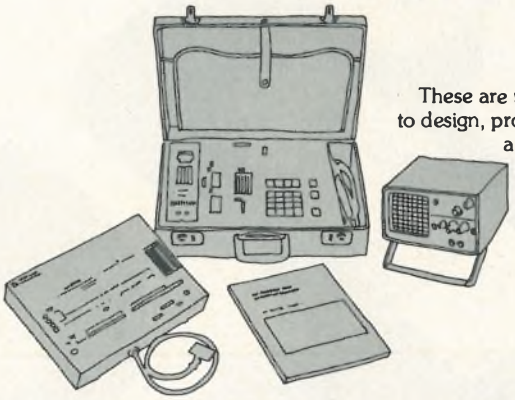
This avoids the computer-oriented requirements for software, complex peripherals and unnecessary performance. Pro-Log's microprocessor modules are normally hardwired to relay contacts, switches, push buttons, displays, or other devices instead of communicating with them through expensive controllers. Simple-to-program PROMs rather than software-directed RAMs configure Pro-Log's modules in their specific activity. Using Pro-Log's approach, system design stays with the design engineer, not the computer programer. And our approach not only enables you to design hardware but to produce it easily and maintain it in the field.

A microprocessor module, correctly applied, can replace large numbers of logic gates and timing elements as well as the sockets, power supplies, packaging, connections and wiring that go with it. By decreasing parts and interconnections, you lower assembly and rework costs, improve reliability, and cut inventory. The simplicity of microprocessor modules lets you get into high volume production quicker.



You need all these and more just to design a computer-oriented system.

VS.



These are the only tools you need to design, produce, and field-service a logic processor system: M821 system analyzer, Series 90 PROM Programer, coding form, oscilloscope.

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We've got the most complete line of microprocessor modules anywhere, including off-the-shelf delivery on modules using 4004, 8008, 4040, and 8080 CPU chips. We'll be delivering modules using the 6800 chip in the near future. We've got designer manuals, applications notes, instruments and test equipment, too.

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Pro-Log offers two microprocessor courses nationwide.

Our one-day applications course costs $100. If we don't convince you we've got the best approach to the use of microprocessor modules, just tell us so and we'll give you your money back, no questions asked.

We've also got a three day hands-on course we've given to more than 1,000 design engineers in the past two years. The only two requirements are that you know what a flip-flop and a gate are. If you do, we guarantee you'll come out of our course knowing how to design, program and use microprocessor modules because you'll have done it.

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Optical circuit combines functions in a single crystal

Experimental Bell Labs device integrates laser, waveguide, modulation on gallium-arsenide base

In a drive to integrate light-frequency circuits in semiconductor materials, Bell Laboratories researchers have scored a breakthrough. They've been able for the first time to integrate circuit functions in the combination of gallium-arsenide and aluminum-gallium-arsenide materials from which injection lasers are fabricated.

Light generated by a laser in experimental Bell devices was coupled into a waveguide and then modulated by using a reverse-biased pn junction. Moreover, it was also possible to adjust the laser-beam's divergence so that it could be coupled into an optical fiber. These capabilities are necessary if integrated optical circuits are to be built into light-frequency systems offering extremely high-capacity communications.

In fabricating the circuits, a liquid-phase epitaxy, made up of appropriate concentrations of arsenic, aluminum and other dopants in gallium melts, was grown in successive layers on a gallium-arsenide-crystal base. Franz K. Reinhart, one of the researchers, says that the basic laser structure consists of a GaAs layer no more than 1 micrometer thick, sandwiched between two slightly thicker AlGaAs layers. Reinhart, along with Ralph A. Logan, who work in Bell's Solid State Electronics Research Laboratory at Murray Hill, N.J., described the development in a paper at the Conference on Laser Engineering and Applications sponsored by the IEEE Quantum Electronics Council and the Optical Society of America at the end of May.

Transfers. The laser energy was transferred efficiently into a low-loss waveguide built inside the laser cavity by two methods. In one method, the active GaAs layer is joined during the device growth to a similar coplanar structure of a slightly different composition in which the laser light is guided without loss. In the second, Reinhart reports, a low-loss waveguide is grown under the active layer without interfering with the laser operation, and the GaAs layer is made to terminate in a smooth taper that reflects the laser energy into the adjacent waveguide, which conducts it elsewhere in the integrated circuit [*Electronics,* Jan. 24, 1974, p. 34].

With the laser energy coupled into the low-loss waveguide section, "a number of integrated components have been added to the optical circuit," report Reinhart and Logan. "An electric field was superimposed on the waveguide, using a reverse-biased pn junction to both amplitude- and intensity-modulate the laser energy." They add that "such a junction could also be operated as a laser energy detector."

A Bragg reflection grating, ion-milled onto the waveguide's exposed region, was used to lock in the laser frequency to that determined by the grating. "By smoothly increasing the waveguide thickness adjacent to the exit face, the laser beam's divergence can be reduced to the value desired" to efficiently couple the output from the laser into an optical fiber, explain the researchers.

A 100-nanosecond pulsed laser was used at a low repetition rate—up to only about 500 hertz—to avoid having to heat-sink the devices. But Reinhart soon expects to fabricate integrated monolithic optical circuits with a continuous-wave laser at room temperature that can be modulated "as readily as a gas laser."

Improvements. Further ahead are circuits for multiplexing and demultiplexing signals, which Reinhart says is "do-able in principle." Nevertheless, he points out that some significant improvements in the circuits must come before they can get out of the laboratory.

Multiple lasers will have to be grown on the same chip, and better control of double-hetero-structure-laser power levels is needed. Furthermore, distortion caused by spiking in the modulated output must be reduced, Reinhart notes. □

Consumer

Audio-video imports decline sharply

Imports of home-entertainment products fell by record percentages during the first three months of 1975, reflecting the domestic recession. New figures assembled by the U.S. Department of Commerce indicate that imports of color-TV receivers, the leading consumer import, registered a 37% drop to 157,000 units from 250,000 units

U.S. AUDIO/VIDEO PRODUCT IMPORTS
(in thousands of dollars)

Country of origin	January – March 1974	January – March 1975	% change
Japan	$ 190,223	$ 164,575	−13.5
Taiwan	86,940	66,889	−23.1
Hong Kong	24,502	17,779	−27.4
Korea	19,142	15,426	−19.4
United Kingdom	17,565	12,461	−29.1
Canada	9,130	4,299	−52.9
Singapore	8,048	7,977	−0.01
West Germany	5,980	5,866	−0.02
Brazil	5,294	7,388	+38.6
Mexico	3,141	289	−90.8
Others	1,306	1,994	+52.7
TOTAL	$ 371,271	$ 304,893	−17.9

Source: U.S. Commerce Department

during the first 1974 quarter. Monochrome-TV imports dropped nearly 39% from 1.1 million sets a year ago to 683,000 sets.

Declines in unit imports were also recorded in radio/phonograph combinations, which dropped 61%; phonographs and turntables, off 37.8%; home radios, down 35.6%; and tape recorders/players, down 15.3%. Automobile-radio imports dropped by one third to 730,000 from 1.1 million last year.

Changes. The dollar value of imports was off less sharply, however, reflecting some prices that were higher than the 1974 level. The $304.9 million value of January-through-March imports was down almost 18% (see table). On a country-by-country basis, the import figures show some significant changes. Brazil, for example, showed the only gain with its shipments, consisting of auto radios and some first-time deliveries of color-TV receivers.

Imports of monochrome-TV also underwent some major changes. In contrast, Taiwan, the leading foreign shipper, which had shown consistent quarterly gains since 1970, shipped only 683,000 sets—down by a third. Imports from Korea, almost exclusively from Korean-Japanese joint ventures, were off by nearly one-half from 113,000 to 60,000 units. Japan, apparently phasing out of monochrome production while transferring assembly operations to southeast Asia, shipped only 62,000 sets—a 53% decline. No shipments were reported from Mexico, which had delivered 29,000 sets in the first quarter of 1974.

Other countries posting declines in the value of shipments to the U.S. in 1975's first quarter included Hong Kong and Singapore (home radios are the major imported items); the United Kingdom (record players/changers/turntables), and Canada (auto radios).

Canada, formerly the leading foreign supplier of auto radios to the U.S. market, sustained the bulk of a 361,000-set decline. Shipments fell 70% from 425,000 to about 142,000 in the quarter. Auto-radio imports from Japan dropped by 50,000 to 273,000. The increase of auto radios from Brazil to 259,000 units from 174,000 last year was still far below the 398,000-set average in each of the last three quarters of 1974. □

VideoDisc aims at simple player unit

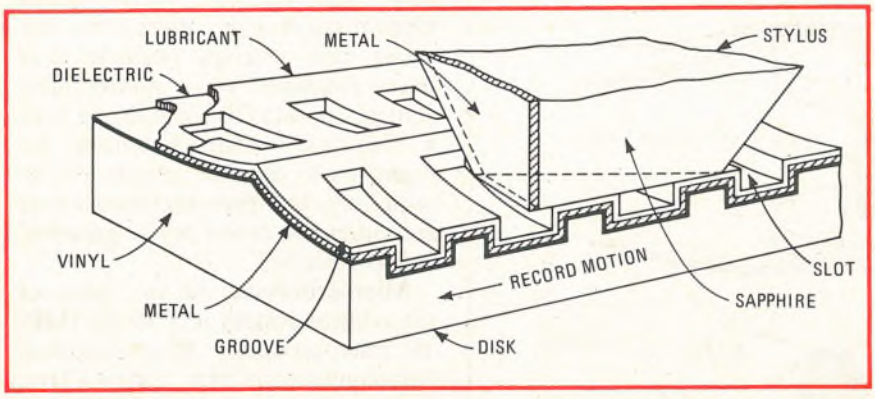
The design goal of RCA Corp. for its SelectaVision VideoDisc home-player unit was clear: simple circuitry at low cost. With its sights thus fixed on the consumer market, RCA is sallying forth in the color-TV video-disk sweepstakes with a number of interesting innovations. The formal debut is scheduled for late next year [*Electronics*, April 3, p. 72], and only recently has RCA revealed the technical details.

Jon Clemens, head of signal and player systems for the VideoDisc, lists these innovations:

- Capacitance-sensing signal retrieval, which requires metallic and dielectric coatings on a vinyl disk but results in a stylus-pickup assembly that's simpler and less expensive than the Philips/MCA laser scanner [*Electronics*, April 3, p. 72].
- A grooved disk, which eliminates an expensive servo loop otherwise needed to position the stylus.
- Operation at a relatively slow 450 revolutions per minute. More material can be packed onto a disk, and unbalance, eccentricity, and warp can be more easily handled.
- An "arm-stretcher" or moving-coil transducer—not unlike a loudspeaker—which moves the stylus along the groove to correct for disk irregularities that could cause timing errors. It contains the only electromechanical servo in the system.
- Buried subcarrier color encoding. By processing the chrominance and luminance signals through interspersed comb filters, and then adding the two signals, it's possible to pack the entire video signal into a 3-megahertz bandwidth.

The disk itself contains a spiral groove. There are 5,555 turns per inch, and the center-to-center distance between adjacent grooves is 180 microinches. Picture and sound information are contained in slots cut into the bottom of the groove. The slots vary in closeness and length along the groove, but not in depth or width. They are cut into disk masters by electron beams which, unlike light beams, can be focused as finely as the system requires.

Changes sensed. As the disk rotates, the player senses changes in capacitance caused by the slots. The capacitance is formed between the metal plating on the disk surface and the metal trailing face of the sapphire stylus (see the figure



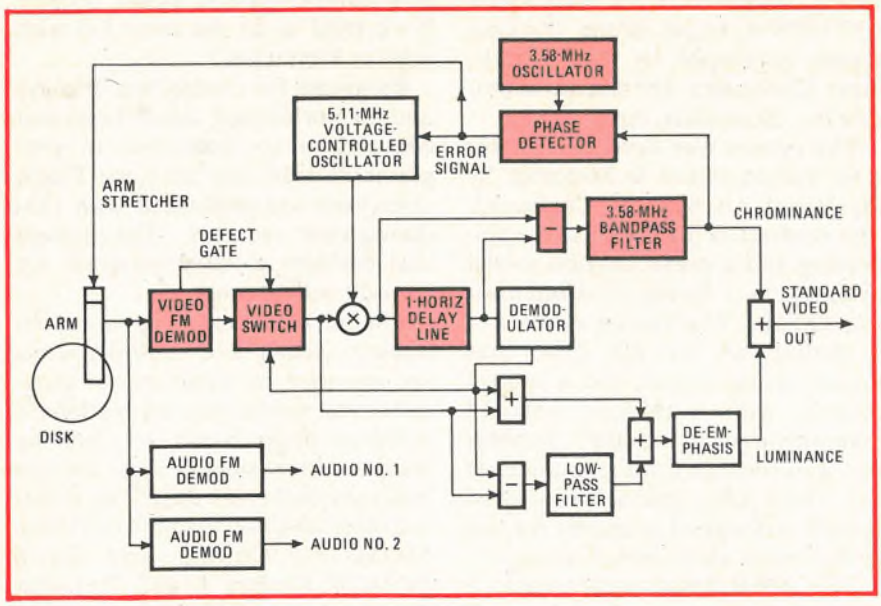
Picture store. Picture and sound information contained in slots in the video disk's grooves is sensed as changes in capacitance occurring between the player's stylus and the disk.

above). The changes are at a level of approximately 3×10^{-4} picofarad. The player converts the capacitance changes into the buried-subcarrier signal that contains picture and sound information.

The pickup arm that holds the stylus and the arm cage, shown below, is used as a resonant radio-frequency transmission line to "broadcast" the frequency-modulated signal to the player circuitry. There is no wired electrical connection to the pickup arm, making stylus and cartridge replacement simple.

The frequency modulation of the audio signals is ±50 kilohertz on carriers at 716 kHz and 905 kHz. A video fm demodulator supplies the buried-subcarrier-encoded video signal to the player decoder. The decoder amplitude-modulates the video onto a 5.11-MHz carrier. This translates the chroma subcarrier from 1.53 MHz to 3.58 MHz—the standard color subcarrier frequency—and puts the video at the correct frequency for use with an inexpensive one-horizontal-line delay line. The delay-line output can replace a defective line and will work for multiple-line dropouts, Clemens says.

The phase of the color-subcarrier burst signal is compared to a 3.58-MHz crystal-oscillator signal, and any error signal is applied to the arm stretcher. The same error signal is supplied to a 5.11-MHz voltage-controlled oscillator, which is used to reduce the color subcarrier's phase error and eliminate hue errors. □



Loop. The only mechanical servo loop in RCA's VideoDisc player controls the "arm stretcher" which positions the stylus along the axis of the grooves in the disk.

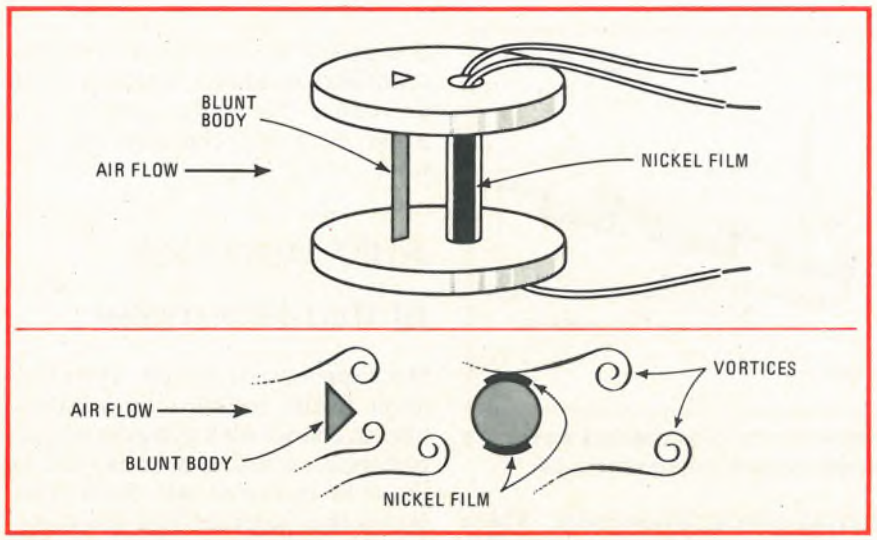
Auto firms look at thin-film meter

Microprocessor-based systems, when finally installed on automobiles to control such things as engine performance, will only be as good as the data that's fed into them. This means that accurate—and low-cost—sensors will be crucial to successful operation.

Engineers at the Electronic Products division of Corning Glass Works, Bradford, Pa., hope they have a solution to the problem of measuring the air flow needed to determine the optimum fuel/air ratio. It's a flowmeter without moving parts that's based on the phenomenon of vortex shedding, which occurs when air strikes a flat surface. The phenomenon has been applied in flowmeters in process-control systems, but these meters are much larger, and the sensing mechanism is different from Corning's.

Testing. Several automobile manufacturers are testing the Corning system, along with other air-flow measuring devices, says Corning's Meryle D. W. Adler, supervisor of resistor development. Corning would like to standardize on one size, Adler says, but each auto maker seems to want a different response characteristic. And since response depends on the blunt body's dimensions, it might be difficult to achieve this standardization, he explains. The metering technique is also applicable to fluids and gases and Corning is therefore considering marketing it as a general-purpose flowmeter.

The Corning sensor, which relies on temperature-sensitive nickel film, represents the first application of this film outside the company's temperature-sensitive resistor [*Electronics,* Oct. 3, 1974, p. 135]. The



Sensor. Cooling caused by vortexes shed at the edges of the blunt body (top) is detected by temperature-sensitive nickel film in Corning flow sensor. Formation of the vortexes alternates between the edges with a frequency directly proportional to the flow velocity.

meter contains a sharp-edged blunt body that is placed with its flat surface perpendicular to the flow path. As air flows around the body (shown in the figure), vortexes are set up—essentially, they are shed from each edge in turn. But the frequency at which the vortex formation alternates is directly proportional to the flow velocity.

Sensor. Immediately downstream from the body is a sensor consisting of two thin strips of Corning's nickel-film material deposited on a glass substrate. The films have a high temperature coefficient of resistance, low thermal mass, and a relatively large surface area so that they respond rapidly to changes in the heat-transfer characteristics of the air caused by the vortexes.

As the vortexes are shed from alternate sides of the blunt body, the films are cooled, causing an alternating change in their resistances. The strips are connected as two legs of a Wheatstone bridge so that the frequency of resistance change is detected as a voltage change at the bridge output.

This output is a sinusoidal signal, typically on the order of a few millivolts peak to peak and with a frequency that is linearly proportional to the stream velocity over a wide range of flow rates. Tests to date have produced reliable signals over the range of 5 to 330 feet per second of air flow. With a body 0.1 inch wide, the meter produces a signal of 17 hertz per foot per second of air flow. □

Military

Processors guide Navy target drones

Microprocessors are replacing analog controllers in the Navy's new AN/USW-4 target drone tracking system developed by the Government Electronics division of Motorola Inc., Scottsdale, Ariz.

The system was developed under a $3 million award to Motorola by the Naval Air Systems Command. The contract is for production engineering and a preproduction model common to a family of drone-control stations. The station consists of a shelter, an 80-inch cube that houses all electronics and a control console, with a tracking antenna manufactured by Datron Systems Inc., Chatsworth, Calif., mounted on top. The 3,300-pound self-contained system is designed primarily for use in shipboard air-defense training.

The AN/USW-4 incorporates a gyro-stabilized antenna, with sensors to determine its pitch, roll, and yaw. The control system sends flight-maneuvering signals to the drone and receives position data that's displayed on a plotter. The control operator flies the drone with a "joystick" while watching the flight path on the plotter. Consequently, the operator need never see either the drone or the gunners' actual positions.

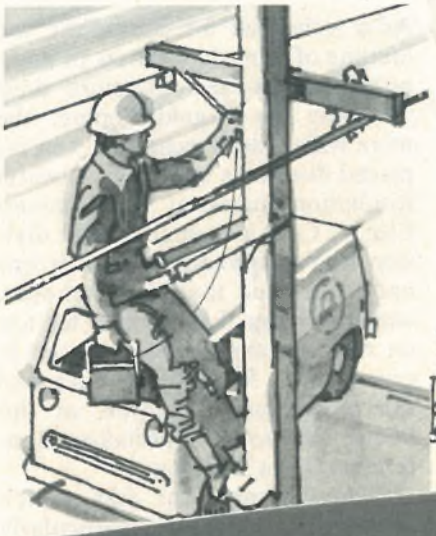
Microprocessor. At the heart of the control system is a 16-bit IMP-16 microprocessor from National Semiconductor Corp., Santa Clara, Calif., which functions both as a computer and as a controller. As a computer, it constantly calculates the drone's position from telemetry inputs; as a controller, the IMP-16 keeps the tracking antenna pointed at the drone.

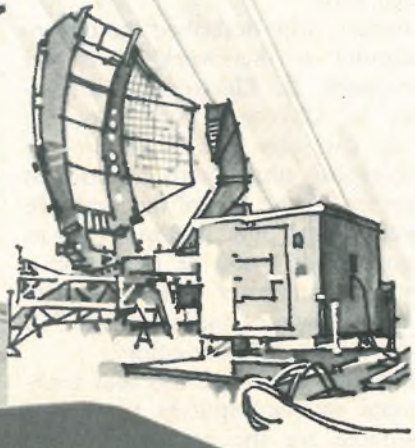
Further, the microprocessor controls the displays and lighting of appropriate switches. Previously, analog controllers were used to track and guide the drones. "The use of a microprocessor gives far greater accuracy," elaborates David Hall, a Motorola design engineer. "We chose the 16-bit microprocessor because we do so much number-crunching in the system. Some of the parameters are quite complex—even with the 16-bit devices, we occasionally have to use double precision. You can imagine how cumbersome it would become if we tried to do the same job with 4-bit or 8-bit units."

Programs for controlling displays and for performing calculations and conversions are contained in programable read-only memory. Flight operations are performed with random-access memory. The system also contains a PROM program for periodic self-testing.

The microprocessor, signal-conditioning circuits, and control circuits are mounted on three special plug-in boards, rather than on National's standard single board, to meet the Navy's dimensional requirements and environmental tests. The initial system is designed to guide Northrop MQM-74C Chukar and Ryan BQM-34 Firebee I and II target drones, but could accommodate other types of target drones used

You won't have to "baby" these cable testers.





The 1500 Series meets the most stringent environmental specifications for flight-line rated test equipment. These portable TDR Cable Testers are at home operating in a deluge or a sand storm. January in Alaska or August in Texas doesn't bother them. Bouncing around in an off-the-road repair vehicle or being doused with salt spray on board ship doesn't stop them either. They're small, self-contained, rugged, and battery operated.

Your maintenance crews will like the operational simplicity of these testers, and they will need little training to get results. You will like the compact size and low weight, which allow usage in tight spaces, and your boss will like the low cost of the 1500 Series.

The Cable Testers use TDR, a proven technique, to pin point faults to a fraction of an inch in short lines. In longer lines they resolve faults to within a yard as far away as 50,000 feet.

What can you test with this series? Just about any cable assembly from lamp cord to coax, plus a variety of broadband components (antennas, connectors, equalizers, sensors, etc.).

There are two testers. The 1502 for short lines provides fractional inch resolution and works up to 2000 feet. It uses a 110 ps step-test signal into 50-ohms. $2750. The 1503 for long lines works out to 50,000 feet. It uses impulse test signals into 50, 75, 93, or 125 ohms. $2750. Both versions are equipped for recording a "signature" of equipment characteristics using an external X-Y Recorder. Signatures can be checked on a routine basis allowing problems to be identified and corrected before catastrophic failures can occur. An optional plug-in Y-T recorder is available (option 4). Add $475 for the convenience of this built-in chart recorder.

Your Tektronix people can provide you with information or write Tektronix, Inc. P.O. Box 500, Beaverton, OR 97077 or Tektronix Limited, P.O. Box 36, St. Peter Port, Guernsey, Channel Islands now for details on performance and applications. Be sure to ask about the Plug-in Chart Recorder Option for completely self-contained signature analysis.

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Circle 33 on reader service card

For Demonstration Circle 32 on Reader Service Card.

Checkup. Motorola's Ed Cosley, left, and Bill Haney examine pre-production control console and display of the company's new AN/USW-4 microprocessor-based Drone Control System.

for gunnery practice.

Included in the data received from the drone are attitude, air speed, and altitude. Control signals to drive the antenna are computed from the antenna's azimuth and elevation angles and the ship's pitch and roll angles. Azimuth and range, as corrected by the ship's attitude, are then converted into coordinates for the plotter. □

Rockwell develops microcomputer

The Autonetics group of Rockwell International Corp. has developed a military-oriented 16-bit microcomputer module that borrows from the company's commercial units.

The fully-militarized microcomputer, aside from using a new two-chip processor, is similar to Rockwell's commercial 4-and 8-bit PPS (parallel processor system) single-chip microprocessors. The new μP-16 uses the read-only and random-access memories of the PPS, plus Rockwell's range of interface circuits. Autonetics, however, intends to sell the μP-16 only as a module, not as individual components, says John Jurison, project engineer in charge of the computer applications group at the Strategic Systems division of the Anaheim, Calif., firm.

Jurison, who described the microcomputer at this week's National Aerospace & Electronics Conference in Dayton, Ohio, says the group can now accept orders for prototyping units, with production expected by the end of the year. He expects prices of $2,000 to $2,500 in quantities of 1,000 or more for a complete computer with 8,192 bits of ROM program memory and 512 16-bit words of data memory.

Evaluated. Jurison says that commercial microcomputers were first evaluated for the application, but the need to meet military temperature and performance requirements dictated a new processor. He adds that the 16-bit word length with 50,000 operations per second throughput that was needed wasn't available elsewhere. However, the Rockwell p-MOS process, which the company is already applying to commercial products, could be militarized to meet the wide temperature specifications.

The μP-16's processor chips consist of a control unit and an arithmetic unit. Fifteen MOS large-scale-integrated devices are required for the complete computer. Jurison says the main features are its 16-bit input and output channels, fast multiply and divide instructions (95 microseconds for 16-bit multiplication) and program interrupts. Add time is 5 μs, and 76 instructions are provided. The module is contained on a board of 4 by 6 by 0.5 inches and requires 4 watts.

Jurison says the microcomputer is already scheduled for use by another group within Rockwell that is working on the military's new Navstar global positioning satellite, and other applications are being studied, as well. □

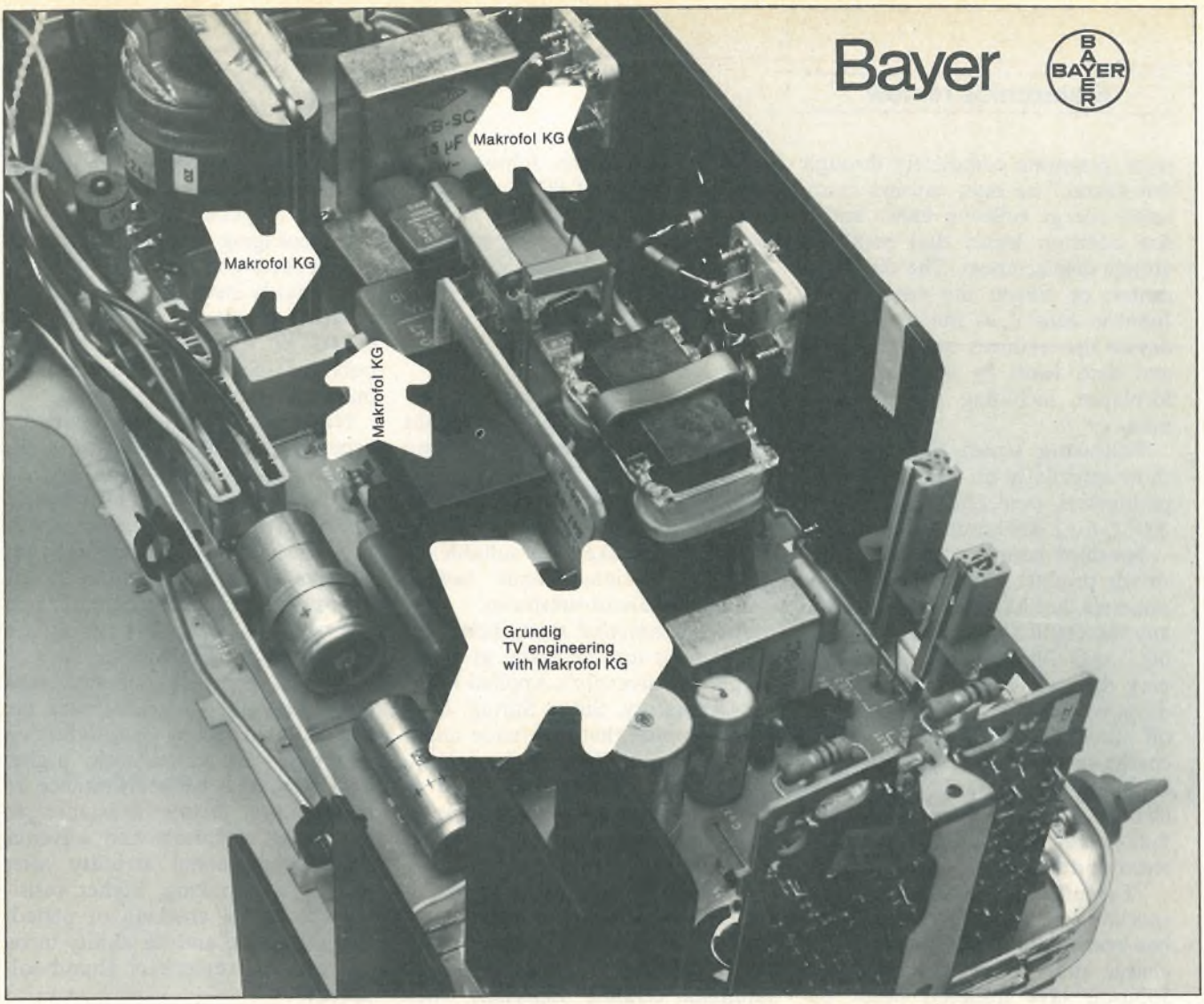
Production

Electron irradiation speeds switching

As a technique for controlling the lifetime of minority carriers in high-power diodes—and therefore their switching times—gold doping, the more widely used technique, was replaced five years ago by an electron irradiation process at Westinghouse Electric Corp.'s Semiconductor division in Youngwood, Pa. But it was only this week that Westinghouse, which developed its process for use on rectifiers and thyristors rated at greater than 50 amperes, discussed the technique in public, at the Power Electronics Specialists Conference at Los Angeles.

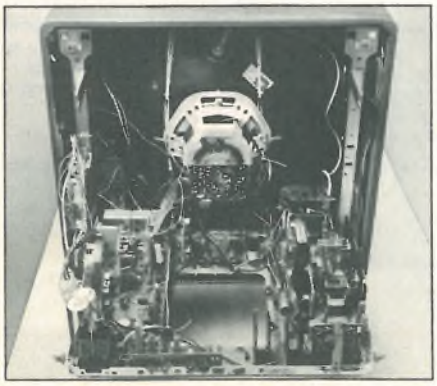
"The demand for fast switch products is increasing, particularly for such products as converters, choppers in transportation applications, and in industrial rf generation," says Joseph E. Johnson, manager of design and engineering within the Semiconductor division's operations department. He says that the division has sold more than half a million electron-irradiated devices so far, and the number of irradiated devices shipped is nearly 25% of the division's entire rectifier and thyristor output.

Megavolt range. According to Johnson, the energy level necessary to do enough displacement damage in the silicon to reduce carrier lifetime is between 1 and 3 megavolts, obtained from a Van de Graaff accelerator. "In that range the elec-



At the critical points: maximum operational safety through Makrofol KG

The substitution of electron tubes by semiconductors has resulted in an improvement of the operational safety of TV sets by reducing the heat build-up – apart from the fact that the diodes, transistors and thyristors last much longer than tubes. The most significant change, compared with earlier sets, occurred in the line deflection stage.



Grundig employ a 12 μF storage capacitor for the thyristor line deflection stage, which is made of metallized ®Makrofol KG by WIMA-Westermann. The outstanding thermal properties of Makrofol KG, and in particular the low shrinkage in the transverse direction, are the basic requirements to ensure a satisfactory and reliable contact for the capacitor, which in this case has to withstand a power load of up to 18 amp peak-peak. The low tan δ of Makrofol KG ensures a slight intrinsic temperature rise of the capacitor, in spite of the prevailing impulse circuitry.

The following demands present no problem for Makrofol KG:

1. Safe contacting under high power load as is usual with television sets fitted completely with semi-conductors.
2. Low tan δ.
3. Good capacity constancy, even at varying temperatures.

These properties are demanded of capacitors which are used to adapt the pulse shape of the line deflection voltage to the curvature of the tube, also known as the "S correction".

Capacitors made of metallized Makrofol KG by Wilhelm Westermann meet these requirements and have already proved successful in practice.

Bayer informs

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trons penetrate completely through the silicon," he says, causing many small energy collision losses and a few collision losses that result in atomic displacement. The damaged center, or silicon die vacancy, as Johnson calls it, is the part of the device that reduces carrier lifetime and thus leads to improved performance, including faster turnoff time.

Following irradiation, devices show essentially no change in their parameters, even after annealing at 200° C for 2,000 hours.

Specified parameters. "In a fast-switch product, the number of parameters that have to be specified in any successful application is increasing," says Johnson. An application may require, for example, forward drop, dynamic forward drop, turnoff time and reverse recovered charge specifications. "Balancing all of these parameters requires a very flexible fabrication technique, and that's what we think we have with electron irradiation.

"Turnoff time is the most critical specification, but increased focus has been given to reverse recovered charge and reverse recovery time." Johnson says tradeoffs occur because a specification on reverse recovered charge may mean that "you've got to deliver a faster turnoff than is nominally requested in the specification."

He also says the leakage level at a given voltage is the same both before and after irradiation. "With gold doping, leakage currents would be roughly two to four times higher at a given temperature." The significance of this, according to Johnson, is that the irradiated devices can be operated at higher temperatures, and therefore higher power levels. "We think this gives us a very significant competitive advantage." Apparently there is evidence that phosphorous vacancy exists originally, but it anneals rapidly at 125° C and is transformed into the die vacancy, so that there are no changes in the turnoff time characteristics in the finished device.

The cost of electron irradiation is about the same as gold doping—a few cents per device. Johnson also claims his yields of 90% are higher than with gold doping. □

Circuit boards give polyimide a try

Kapton, a high-temperature polyimide material made by DuPont Co., is generally known as the base for tape cable and flexible circuitry. However, the characteristics of film derivatives and glass-fiber laminates of polyimide make them suitable for multilayer printed-circuit boards and hybrid-circuit substrates.

An experimental navigational receiver built for the Navy at Johns Hopkins University's Applied Physics Laboratory, Silver Spring, Md., offers promise that polyimide might qualify eventually as a lower-cost, rugged and reliable alternative to the conventional circuit boards of epoxy glass and hybrid substrates of alumina.

"We like it," declares the laboratory's Robert Hicks. "It's more economical and, for substrates, is an easier approach to work with than [alumina] ceramic—especially when an odd shape is needed."

Hicks says the polyimide technology is being applied to other Navy programs, including operational ones of which the details cannot be revealed.

Johns Hopkins' all-polyimide hybrid packaging scheme uses multilayer boards constructed with Pyralux, a fairly new copper- or adhesive-clad Kapton, and hybrid substrates of Pyralin, a copper-clad polyimide-glass fiber laminate. Both materials are made by DuPont.

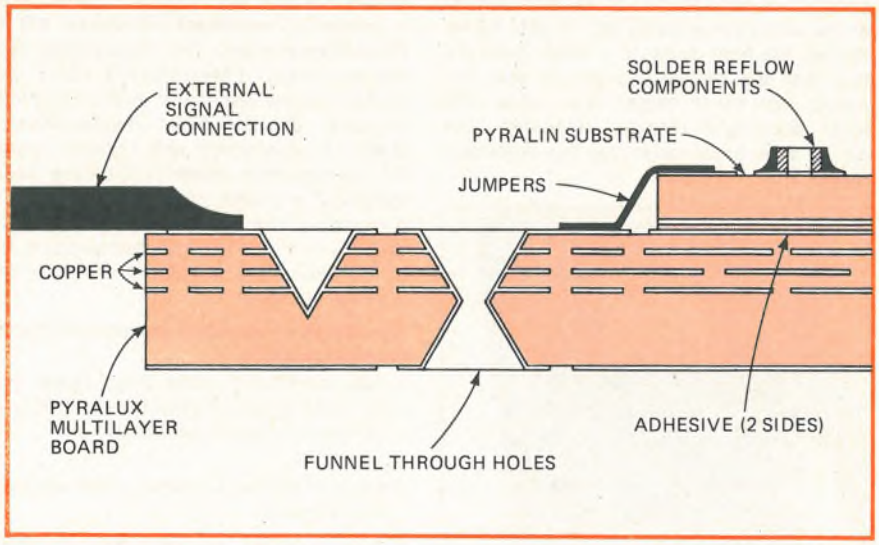
Normally, Pyralin is a relatively expensive material used for high-temperature printed-circuit boards. But for the small areas of a hybrid substrate, Pyralin is price-competitive with the alumina material conventionally used, points out Hicks. It costs about 10¢ per square inch compared to 10¢ to 70¢ per square inch for alumina substrates.

According to Hicks, advantages of either polyimide material over the conventional epoxy glass/alumina materials are: consistently higher peel strengths, better resistance to temperature, better resistance to processing chemicals and solvents, better dimensional stability after etching and baking, higher resistance to barrel cracking of plated-through holes, and an ability to be extensively reworked (hand-soldered).

A disadvantage of either material is a relatively high water absorption.

A cutaway view of one of the hybrid multilayer board assemblies is

New board. Different types of polyimide materials are being used for multilayer circuit boards and hybrid-circuit substrates. Applications at present are for military programs.



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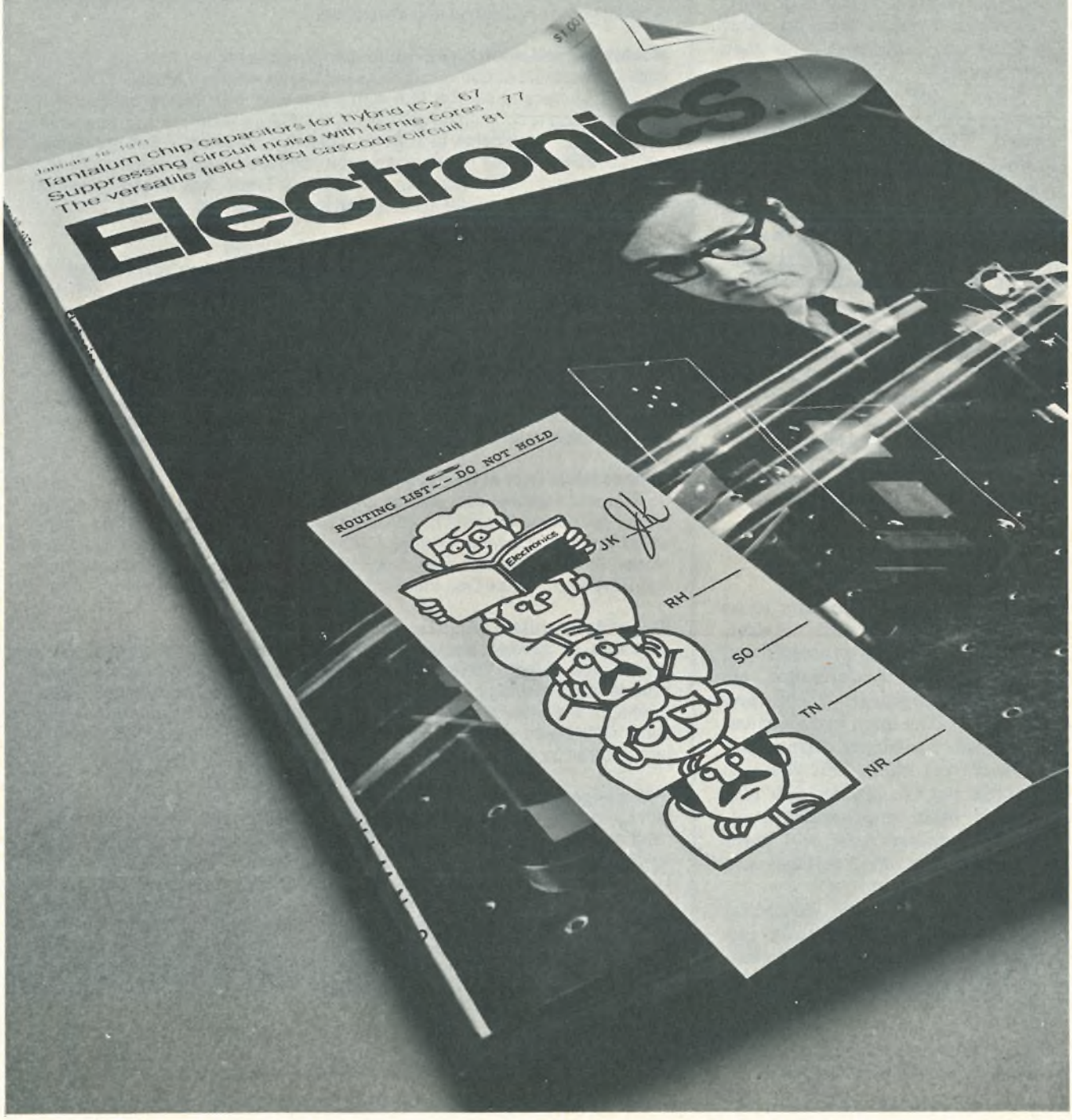


shown on page 36. Instead of firing or evaporating conductive materials (techniques customarily used in thin- and thick-film hybrids), the copper-clad Pyralin substrate has its pattern subtractively etched with a standard dry-film resist technique. All active and passive components are then reflow-soldered to the copper pattern of the substrate.

The multilayer board alternates layers of photoprinted etched copperclad Pyralux with layers of adhesive-coated Pyralux. This assembly is lined up, laminated, and then heat cured.

Novel 60° funnel-shaped through-holes are drilled in the board. These, serving to interconnect layers, are then copper-plated by an additive electroless process. Applied Physics Laboratory engineers have found the funnel-like plated-hole arrangement leads to better plating, easy inspectability and less barrel cracking. After this step, the Pyralin substrates are fixed to the multilayer board with a special adhesive, and the hybrids' interconnects are wired to board pads. □

Nitride layer ups IC performance

Adding a silicon-nitride layer to an integrated circuit can relax the stress induced by previous processes and greatly improve performance, according to engineers at Nippon Electric Co. The main improvement they sought was higher current gain at low current levels. This goal was achieved, but the nitride layer also provided other improvements, including decreased noise and lower transistor input offset voltages and currents.

Operation of NEC's industrial linear ICs has been greatly improved, not only because the absolute value of the gain has been increased, but also because uniformity has been increased. This uniformity among devices is especially important in precision applications, such

News briefs

Electronics R&D to increase

The electronics industries plan to increase research and development expenditures by 31% in the three-year period ending in 1978, according to a survey by the economics department of McGraw-Hill Publications Co. The projected increase—an average of over 10% per year—is significant when viewed alongside the more modest 6% R&D increase planned for this year and the lack of any change in R&D spending last year. The biggest increases in expenditures were being planned by manufacturers of radio and television and of semiconductors serving the industrial electronics areas. Overall, the industries indicate that by 1978, 25% of sales will result from products not yet designed and developed.

Mostek second-sources Fairchild microprocessor

With full technical support from Fairchild Semiconductor, Mostek Corp. has decided to second-source that firm's five-chip F-8 microprocessor set. "We're taking a substantial gamble on the Fairchild part; it's got an uphill market fight," comments L. J. Sevin, Mostek's president. "But the reason we chose the F-8 was the demonstrated manufacturability of the product." Using Fairchild masks, Mostek, in Carrollton, Texas, has already obtained functional central processing units from its first wafer lot.

Bowmar exits from calculator and watch business

Bowmar Instrument Corp., which filed for Chapter 11 protection under the Federal Bankruptcy Act four months ago [*Electronics*, Feb. 10, p. 36], has stopped producing calculators and digital watches. Bowmar says its financial condition does not permit it to make these products at a loss, adding that it has closed its calculator and watch assembly facilities in Nogales, Mexico, and will close its warehouse and distribution center in Nogales, Ariz. These moves by Bowmar leave it essentially with only its Industrial Products division, which produces light-emitting diodes, some electromechanical display devices, and telecommunications test instruments.

Holmes takes over at Raytheon

D. Brainerd Holmes was elected president of Raytheon Co., Lexington, Mass., to replace Thomas L. Phillips. Phillips was elected chairman of the board in place of retiring Charles F. Adams and will remain chief executive officer. As executive vice president, Holmes headed the Government Group and Raytheon Service Co., the engineering services subsidiary.

Pulsed-laser output record claimed by Sandia

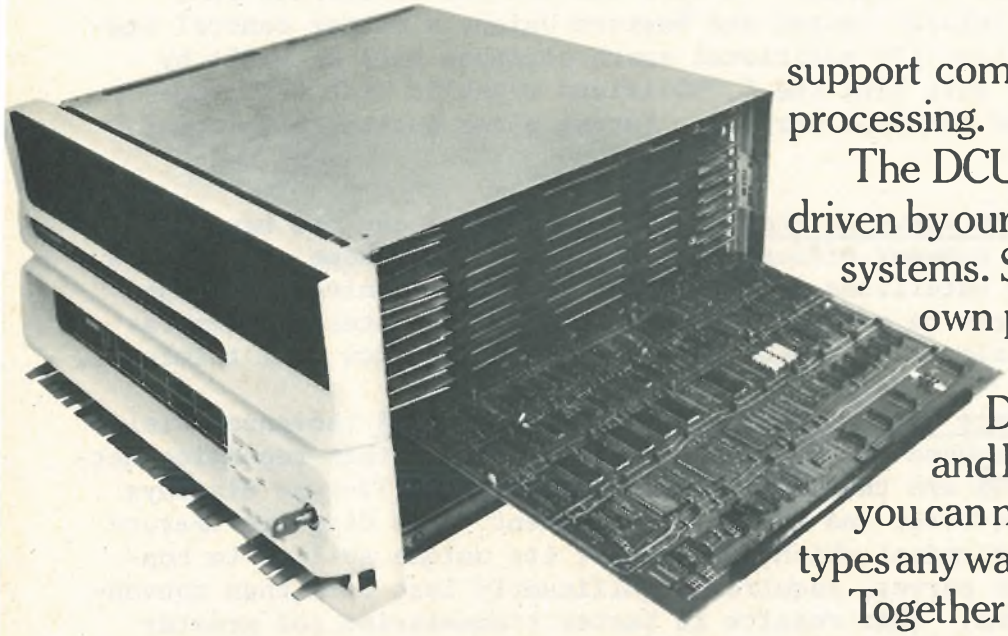
Scientists at Sandia Laboratories, Albuquerque, N.M., have produced a 4.2-kilojoule pulse of laser energy from an electron-beam-driven hydrogen-fluoride laser, making it the most energetic pulsed laser yet reported. Pulse widths for the laser ranged from 20 to 30 nanoseconds; peak power was about 200 billion watts. The 4.2-kJ pulse is nearly double the previous record pulse for a hydrogen-fluoride laser, also produced at Sandia.

IBM realigns its product development groups

IBM Corp. has realigned several of its data processing product development activities to "strengthen the company's focus on the growing importance of communications products," says Frank T. Cary, IBM chairman. The former System Development division has been designated the System Communications division to design, develop, and manufacture computer-based communications systems and terminal products. Systems development not related to communications has been assigned to the General Products division, the System Products division, and the Data Processing Product Group staff.

Advanced System Development division responsibilities for coordinating worldwide customer requirements have been reassigned, and the division discontinued.

Data General announces the one thing that may have kept you from communicating with us.



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Circle 39 on reader service card

SCIENCE/SCOPE

Indonesia's domestic communications satellite system -- first in the Eastern Hemisphere -- will be built by Hughes. It will include two satellites like those now in service for Telesat Canada and Western Union, a master control station, and nine earth stations (30 additional earth stations will be built by other contractors). They will link the 5,000-island republic with telephone, telegraph, television, and teletype service. Future plans include a national radio network.

Oil and mineral exploration crews in the Canadian wilderness can now have immediate communications with company offices and families by telephone or teletype via Telesat Canada's Anik satellites and a compact portable terminal developed by Hughes. The terminal can be erected in four hours and operates in temperatures as low as -70°F. Telesat Canada has leased five of the new mini terminals.

The National Weather Service is now testing a prototype of AFOS (Advanced Field Operating System), its proposed $40-million all-electronic weather reporting network. Key elements of AFOS are the on-site minicomputers and TV-type displays that will replace teletypewriter and facsimile equipment. The displays feature the Hughes Conographic™ terminal which, because of its unique ability to convert contour data to conic curves, requires significantly less data than conventional x-y plotting systems. This results in faster transmission and greater capacity for the network, lower storage requirements for the terminals.

Weather maps will be transmitted 20 times faster, printed matter 30 times faster than by present methods. The increased speed and capacity of AFOS will be particularly valuable for warnings of tornadoes, hurricanes, and floods. The Weather Service hopes to have about 275 of its offices automated by 1980.

R&D project leader needed. Responsibilities will include advanced device development, customer interface, presentations to top management, and establishing manufacturability. Must have PhD in solid-state physics or electrical engineering and five years of developmental work in MOS, CMOS, bipolar, and CCDs, with recent experience in silicon devices and integrated circuits. U.S. citizenship required. Please send resume and salary history to: P.A. Schneider, Hughes Aircraft Company, 500 Superior Avenue, Newport Beach, CA 92663. An equal opportunity M/F employer.

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as in digital-to-analog converters and other devices with resistor networks, as well as in precision operational amplifiers where the base current must be included in calculations and thus must be controlled.

In NEC's version of the 741 operational amplifier, voltage offset has been reduced from typically ±1 millivolt to ±0.1 mV. Offset current has been also reduced, although not as dramatically. Transistors in devices made by the new process have also been improved. Low-frequency noise in the 10–100-hertz range was reduced to about 20% of its usual value, and popcorn noise was almost completely eliminated. Generation-recombination noise, caused by lattice defects, was also reduced.

Curve. Stress in wafers is caused by the order-of-magnitude difference between the thermal coefficients of expansion of silicon (2.5×10^{-6}/°C) and silicon dioxide (3.5×10^{-7}/°C). Both the silicon wafer and the silicon-dioxide layer have the same dimensions during processing, but the silicon layer shrinks more during cooling.

Consequently, the silicon-dioxide side of the wafer ends up with larger dimensions at room temperature and is convex. The stress caused by this uneven contraction—10^7 to 10^8 dynes/cm²—decreases minority carrier lifetime and degrades transistor characteristics. Addition of the silicon-nitride layer, which has the large temperature coefficient of expansion of 3.9×10^{-6}/°C, on top of the silicon dioxide tends to restore the wafer to its original flat state.

In one experiment, a wafer with an oxide layer had a 13-meter radius of curvature and a surface stress of 17 kilograms/cm². Adding the nitride increased the radius of curvature to 116 m—which is much closer to being flat—and reduced surface stress to −2 kg/cm².

During the manufacturing process, windows are opened as if for metalization, and the nitride layer is deposited at high temperature. Then contact windows are opened, and the wafer is metalized.

Rather than etching metal to form a wiring pattern, NEC uses anodic oxidation of aluminum regions where conductor is not required. The resulting alumina provides further protection against ion contamination and has a temperature coefficient of expansion similar to the nitride layer. It does not cause or reduce stress, though, because it is formed at room temperature. This anodic oxidation process was developed at the company many years ago and is used in its logic ICs.

Engineers expect production cost of improved devices to be about 10% higher than that of conventional devices. But they think sales will rise sufficiently to cover the higher costs. Plans call for improved devices to start reaching customers within about six months. □

Commercial

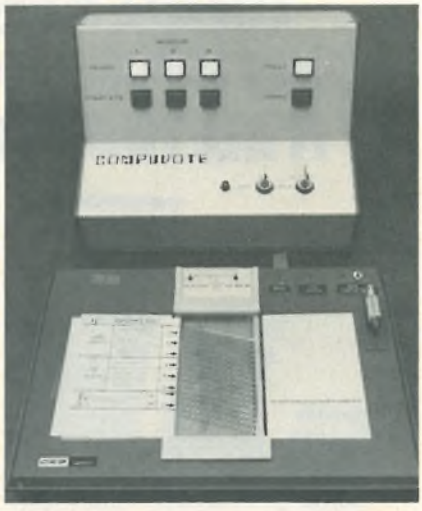
Microprocessors go to the polls

It's no longer surprising to see semiconductor microprocessors displacing a wide variety of mechanical or electromechanical parts, but are you ready for them in voting machines on election day? That could be a possibility—and cut voting costs, too—if a Beverly Hills, Calif., company is successful.

The company, Compuvote Corp., is headed by Fred L. Carter, a former chairman of the Los Angeles County election commission. His interest in microprocessor-controlled voting machines arises from studies his commission has made of voting irregularities in the county, which has almost 3 million voters.

Los Angeles County, like many other jurisdictions, presently gives every voter at its 8,000 precincts a stylus with which he punches holes in a special card. The punched cards are then transported by couriers to a central location, where some 2,000 election-day workers are needed to check the cards to make sure the perforations are cleanly made. The cards are then counted by machine.

"You can see the security problem," points out Carter, "but, in ad-



Counter. Voter selections are entered into Compuvote's microcomputer-controlled console, rear, through modified punch-card vote recorders used in Los Angeles county.

dition, 2% to 4% of the ballots can't be counted on election night because they're mutilated. And tabulation may not be finished until the next morning."

Error correction. The Compuvote system uses the same punched cards but with an added electromechanical interface to sense the holes as they are punched. The terminal can also indicate when a mistake is made—as when too many candidates are selected for an office. The card may then be exchanged for a new one. When the voting is completed, a button is pushed and the choices are entered in the memory of the local voting controller. The cards are saved for use as an audit trail in case of problems.

At the end of the election day, votes are printed out in the precinct, then chirped over telephone wires in 30 seconds to a central location. Complete returns could be posted in 80 minutes for the entire Los Angeles area. Trend precincts could be tabulated even more quickly, in response to the needs of news media. Cryptographic transmissions could be used to achieve even greater security.

The voting terminal now uses an Intel 4004 microprocessor with 1,500 bytes of programable read-only memory and 512 bytes of random-access memory. The 4004 will be replaced by a 4040; both are slow compared to some microprocessors, but the voting process is slow enough, points out Carter, for them to be quite adequate.

A five-hour battery backup for the system is included. Up to six voting terminals can be used with one controller, permitting 256 candidates or issues, and 4,000 voters per precinct. The printer is an inexpensive Seiko calculator unit.

Carter says that the system is priced under $3,000 per precinct—less than the $3,800 lever-voting machines. He estimates that the system could save Los Angeles County $150,000 to $200,000 per major election. The company is not yet in production, but Carter has made arrangements for manufacturing and is talking to companies in the voting field about his system. □

Commercial

Insurance agents want own data base

Computer terminals could soon link 33,000 independent insurance agents to data bases and insurance company offices across the country. By developing a nationwide information system for its 33,000 members, the National Association of Insurance Agents hopes to help them compete more effectively with representatives of individual insurance companies whose own representatives sell directly to the public.

As visualized by the New York-based trade association's recently formed electronic processing implementation committee, terminals in the system will range from simple push-button telephones tied to voice-response systems to combinations of cathode-ray tubes and printers. The data bases will be situated in regional service centers, which in turn will be connected by a centralized switching system to home and branch offices of the insurance companies themselves, as well as to other service organizations and data bases. Rental charges from an industry-wide system could exceed $100 million annually, predicts committee chairman Thomas E. Lane of Rapid City, S.D. Monthly terminal costs (not including service) are expected to range from $125 to $500 per agent, depending on equipment.

Competition. "We feel we're at a competitive disadvantage with the more concentrated efforts of the major direct writers and with the expected surge of competition from life insurance companies now entering the property and casualty fields," observes Lane. He sees the system as helping members stay on top of all the myriad details of the different insurance companies' policies they handle. It will also speed up the job of obtaining price quotes, processing applications and settling claims, and it will provide low-cost accounting and billing services.

Lane's committee is currently looking for a computer service firm to actually design and implement a prototype regional network and share in the cost of developing the total system. It has retained Applied Information Development of Oak Brook, Ill., a subsidiary of System Development Corp., as a special consultant.

Another firm, Electronic Data Systems Corp., Dallas, has already conducted its own independent study—not sponsored or endorsed by NAIA, but involving key members of the association and a number of property and casualty companies. The study concludes that a regional network concept is technically feasible and also economical.

NAIA is unlikely to give any one company the entire job. "If the prototype proves successful," says Lane, "the industry-wide facility that would be necessary would be too large to come under the control of a single private vendor or company."

As the network begins to take shape, Lane's committee, with the help of its consultant and prototype companies, will write a set of specifications for the local terminals. Lane expects initial implementation by late next year or early 1977. □

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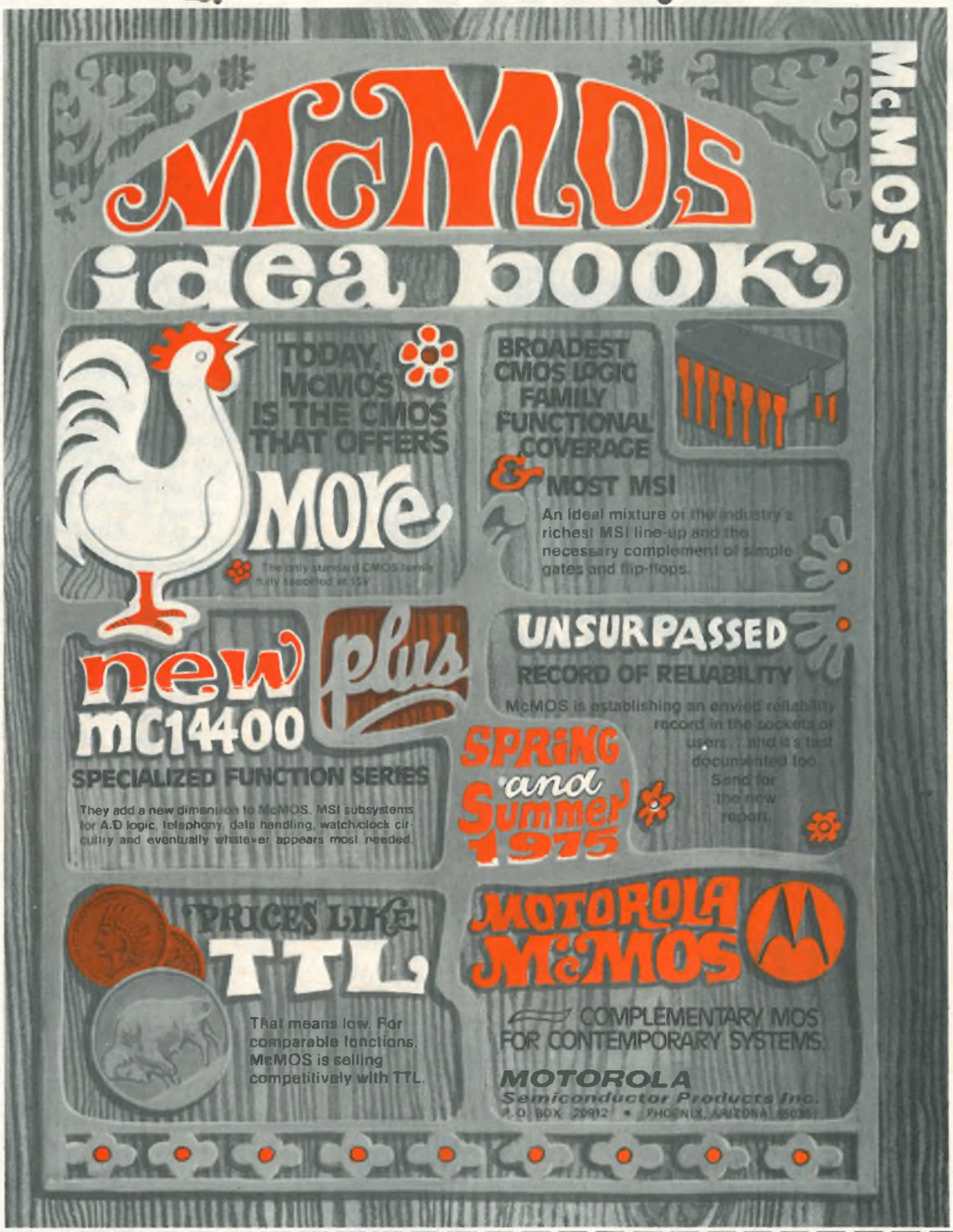

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Circle 43 on reader service card

News update

■ By putting two differently doped gallium-phosphide layers with integrated pn junctions on the same crystal, researchers at Siemens AG wound up with a variable-color light-emitting diode [April 18, 1974, p. 29]. But Siemens never went into volume production with its double-junction LEDs because the market never reached the size of, say, calculators. The reason: single-junction, monochrome LEDs have become so inexpensive that Siemens' parts, which require special drive circuitry, are unlikely to replace them.

■ New Mexico will be the first state to receive additional Federal funds for operating computer centers for processing Medicare claims, according to the Social and Rehabilitation Service of the Department of Health, Education, and Welfare [May 30, 1974, p. 49]. Twenty states, including New Mexico, received approval for 90% Federal funding for planning EDP systems, but New Mexico's plan recently also received approval for a 75% operating cost subsidy, an official says. "The typical plan proposes using an existing state computer system, to handle the chores."

■ As expected, United Technologies Corp.'s Norden division in Hartford, Conn., sold its millimeter-wave transceiver [April 18, 1974, p. 30] to Datran, the Vienna, Va.-based specialized data carrier. Norden sold eight of them, and that was it for sales. However, Lou Ebrel, design engineer in charge of applications, says the Bell System's Southern New England Telephone Co. is testing the transceiver, and that New York Telephone Co. has shown some interest in the system. Ebrel also says that several foreign concerns—both European and Far Eastern—would like to acquire the Norden equipment, but Norden won't sell to them because it would then have to support the equipment. Ebrel says Norden would like to make a market for it in the U. S. before venturing into foreign markets.

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DC Microamperes	0-50 (250 MV Drop)
DC Milliamperes	*0-0.5; 0-5; 0-50;* 0-500
DC Amperes	*0*-5 (250 MV Drop)
AC Amperes	6 ranges from 0-5 to 0-250 with optional Model 150 Amp-Clamp adapter.
DB Scale (1 MW 600 Ω Reference)	—20 to +10; —9 to +21: *—1 to +29; +11 to +41;* +19 to +49
Resistance (Standard Power)	*Rx1* (6 Ω center scale), *Rx100* (600Ω center scae), *Rx1K* (6000 Ω center scale), *Rx10K* (60,000 Ω center scale)
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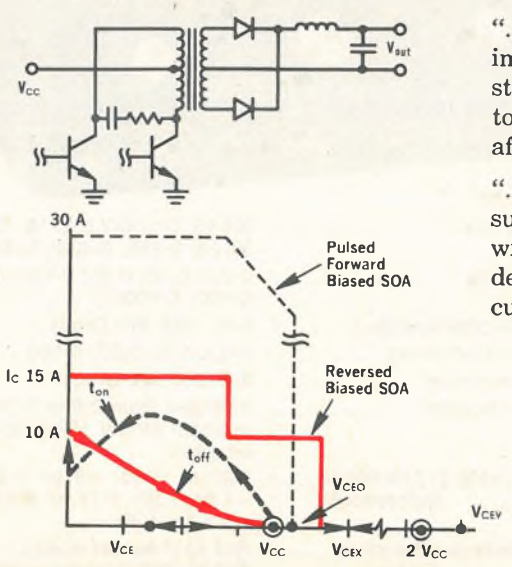

". . . both blocking voltage and sustaining voltage are important in switch-mode applications. The circuit illustrated requires high blocking capability since the transistor is subjected to a substantially higher voltage than V_{CC} after turn-off . . ."

". . . for inductive loads, high voltage and current must be sustained simultaneously during turn-off, in most cases with E-B junction reverse biased. The safe level for these devices is specified as $V_{CEX(sus)}$ at given high collector currents as shown on the reverse biased SOA curve . . ."

(from Switchmode *Designers Data Sheet*)

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SWITCHMODE	V_{CEV} V	$V_{CEX(sus)}$† @ 100°C V	I_C Cont. A	$V_{CE(sat)}$ max @ I_C, 100°C	t_f† (max) @ I_C, 100°C	PRICE
2N6542/3	650/850	350/450	5	2/3	800ns	$2.25/ 2.85
2N6544/5	650/850	350/450	8	2.5/5	900ns	3.75/ 4.75
2N6546/7	650/850	350/450	15	2.5/10	1500ns	7.50/10.75

†Clamped inductive load

What you've had in specs up to now doesn't get you there. It might even lead you astray with incomplete info.

For example, when all you've got is forward bias SOA limits (and that's all you get from everyone else) and you need to know what happens in reverse or OFF-biased for clamped inductive loads, you've got a square peg for a round hole.

Same thing when you're trying to match a high-temperature inductive load to low-temperature resistive switching specs.

Apples and oranges.

That's when all your guesswork starts — cutting and fitting that finally leaves you at a workable, but fuzzy, point in the picture . . . a design without specs. An engineering never-never land.

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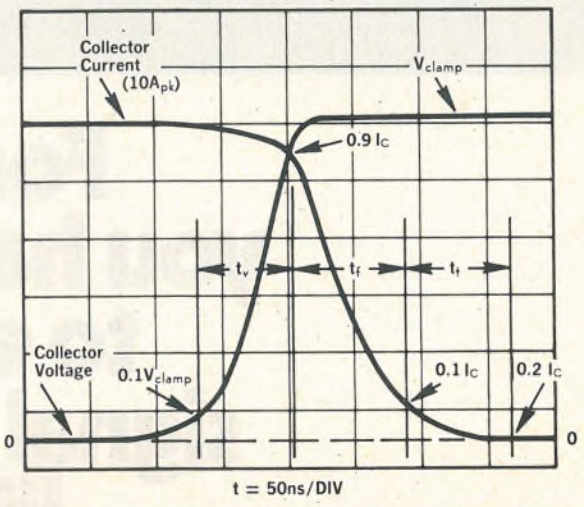
Switchmode silicon power is completely spec'd to tell you exactly how the device will operate under all operating conditions; forward, reverse, clamped inductive or resistive. Actual use conditions and real-world situations. You know how far your load lines can go and still be safe. You know what $V_{CEX(sus)}$, $V_{CE(sat)}$ and

". . . in most applications, a large percentage of total device power dissipation occurs during turn-off time and t_f is normally used as a figure of merit. There are, however, two portions of the turn-off waveform that can add losses and in some cases can be significant. The interval t_v is part of total storage time t_s and is defined as voltage switching time. During t_v, the V_{CE} voltage changes from saturation to clamp voltage while collector current has only decreased by 10%. The time t_t occurs after fall time and appears as a "tail" on the collector current waveform. Significant dissipation occurs during the total period $t_v + t_f + t_t$ . . ."

(from Switchmode *Designers Data Sheet*)

2N6546 TYPICAL TURN-OFF WAVEFORM

Clamped Inductive Load



I_{CEV} are at 100° case. You know t_s and t_c performance as a function of collector current and temperature at high inductive energy. You know precisely where you stand with secondary breakdown . . . before it happens. The unknown is known.

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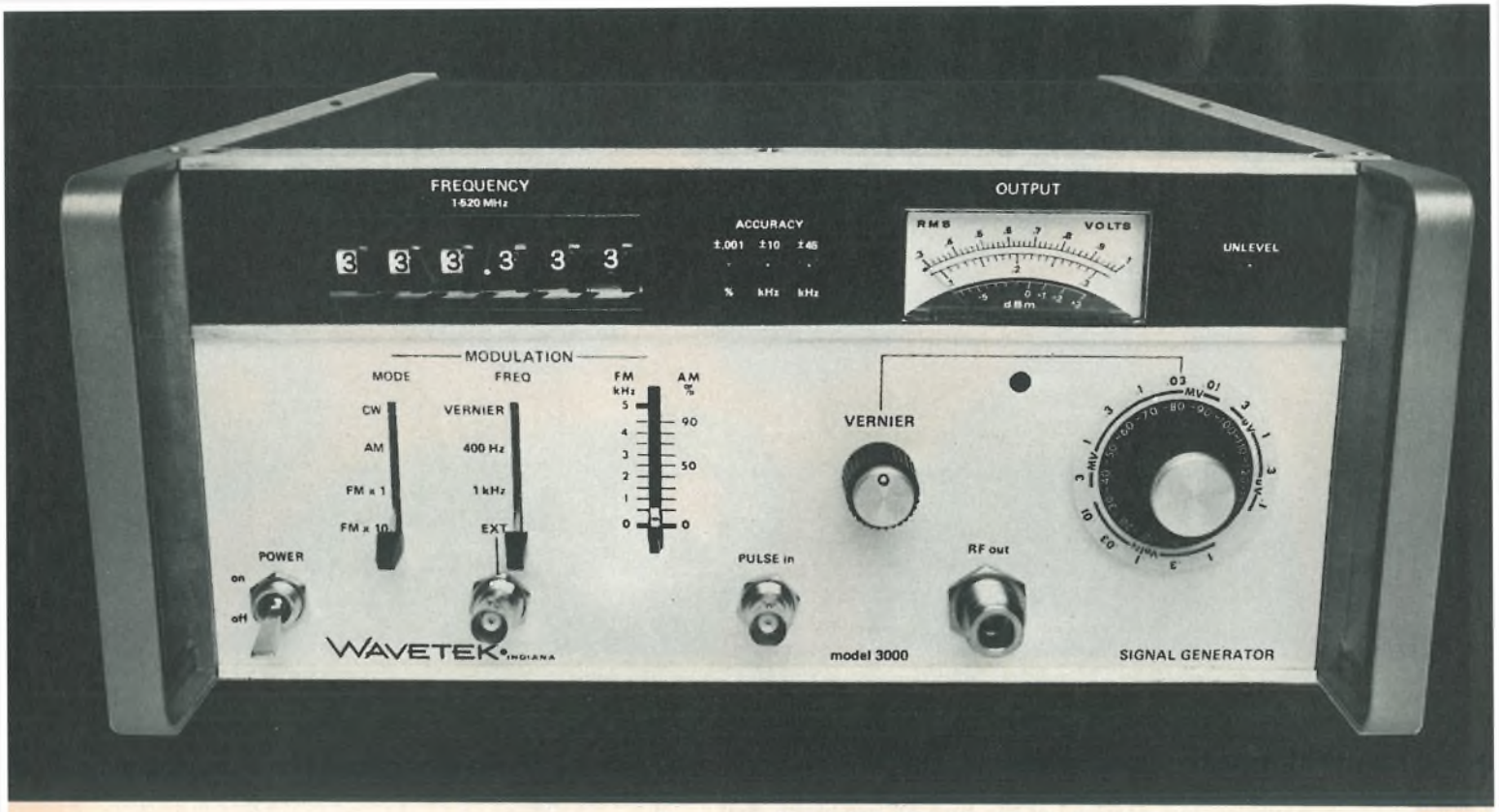

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Circle 48 on reader service card

Washington newsletter

Dataphone service expansion program put before FCC

A major expansion of AT&T's Dataphone digital data service (DDS) to at least 64 cities in late 1976 was disclosed by the company in an early June filing before the Federal Communications Commission. **In addition to existing authorization for 24 cities, of which five are operational, AT&T wants authority to construct facilities in 40 more cities by the third quarter of next year.** By the end of 1976, AT&T wants authority for Dataphone service in a total of 96 cities.

The company first offered DDS last December between Washington, Boston, Philadelphia, Chicago and New York. Most of the long-haul facilities in the latest application call for data-under-voice transmission in the lower end of the spectrum of existing microwave-relay systems.

AT&T witness forecasts 1977 inflation surge

The U.S. economy faces a resurgence of higher inflation and interest rates by 1977 and beyond as it makes a "vigorous recovery," a major bank economist has told a Federal Communications Commission hearing. Until 1977, said James J. O'Leary, vice chairman and chief economist of the U.S. Trust Co., the economy will pick up only moderately, beginning in the last quarter of this year. **O'Leary's forecast came during his appearance as an expert economic witness for American Telephone & Telegraph.** The FCC is holding hearings to assess AT&T's authorized rate of return on interstate service, a subject that evokes strong interest among the capital's communications-industry watchers.

O'Leary's estimates were challenged by FCC attorneys on grounds that AT&T is a customer of the U.S. Trust Co. However, he attributed his forecast to sharply higher Federal budget deficits.

FAA reduces scope of flight data network plan

The Federal Aviation Administration, under pressure from general-aviation interests, has scaled down its plans for an automated flight-service-station (FSS) network to replace the old 282-station system still in operation. Instead of 30 automated FSS centers, the FAA now wants 20. And instead of 3,500 CRT-terminals located at airports for pilot information, the pilots will rely on conventional-style telephone links to the FSS centers. **The revised plan would reduce total estimated cost from $120 million to $90 million, and would include about $50 million for computers and other electronic hardware.** The program would be implemented over a 10 year period, beginning in 1979. The FSS network provides weather and route information for general-aviation aircraft.

EIA urges letup on export rules

U.S. exports of electronics and telecommunications to new markets "are non-competitive with those of our Western trading partners and others" because of excessively rigid and complex Federal controls, says the Electronics Industries Association, which urgently recommends they be eased. In a seven-point position paper adopted at its June meeting, the EIA called on the government's executive and legislative branches to consolidate export authority, which is now divided among the Departments of Commerce, Defense, and State. Attributing the problem principally to excessive Federal concern with high-technology exports as a threat to national security, **EIA called for a revaluation of controls to give "realistic weight to the proven third-country availability of identical or equivalent products or technology."**

Washington commentary

Developing the land-mobile marketplace

Just about everyone agrees that the consumer market for radio-telephone service is ready for development on a large scale. Many believe that development is long overdue, having been slowed by four years of dispute before the Federal Communications Commission. In March, however, the FCC effectively wrapped up its proceedings under Docket 18262, which calls for land-mobile communications to be developed within the 115 megahertz allocated at 900 MHz [*Electronics*, May 10, 1973, p. 29].

"Now, it is pretty much up to the industry to seize the opportunities created for it at 900 MHz," concludes the FCC's Charles A. Higginbotham, chief of the Safety and Special Radio Services bureau responsible for overseeing the program. Believing that the carriers have "a vast potential market to explore," he states, "It seems to me that the opportunities for growth and service to the public for this market are virtually unlimited," since mobile radiotelephone now has the frequency resources to "bring it within the reach of the average household."

Not everyone agrees that all the loose ends that dangle from Docket 18262 and the related action under 18261—which proposed relieving the land-mobile frequency congestion a bit by permitting sharing of unused lower uhf TV channels—have been pulled together. Notable in its disagreement is the Land Mobile Communications Council, a national confederation with obvious special interests as communications users. This council is still anxious that the FCC resolve the frequency problems between the U.S. and Canada and Mexico on lower-channel sharing near the borders of the U.S. It is pushing for an early agreement.

But the FCC's Higginbotham notes that beyond the Docket 18261 decision to expand channel sharing in some areas, plus other steps to adjust other frequency sub-allocations in the 470-512-MHz band, the FCC and the users "must concentrate our attention on 900 MHz."

Cellular solution

To best develop the 900-MHz band, the FCC has blessed American Telephone & Telegraph's cellular technology, which limits mobile user transmissions to base stations within small geographic cells. Signals are automatically switched from one cell to another as a vehicle moves through them. The communications link from the vehicle is then completed over telephone lines, eliminating bandwidth congestion. Within a month of the FCC ruling on Docket 18262, AT&T told the FCC it would begin on a trial system in the Chicago area for 1978.

Since the FCC wants development of a nationwide, compatible, and fully interconnected mobile radiotelephone network, Higginbotham points out that "the commission does not plan to authorize any other type of system at 900 MHz until after the cellular approach has been given a fair chance."

Does this lock up another market for AT&T? Theoretically, it won't. But the reality is that the cellular concept is AT&T's own development, which it is pushing hard. Nevertheless, Higginbotham notes that the FCC "will be ready to accept applications for 900-MHz systems—at least in the private sector—as soon as our supplemental form is approved and type-accepted equipment is available." The competition with the Bell System is going to be tough, of course. It always is.

The international aspect

Some domestic communications equipment makers believe they will be able to compete with AT&T as the market develops, particularly in terms of hardware. But a possibly bigger threat than the Bell System, they believe, are international pressures over which they, as company managers, have no direct control. "Should we be forced to relinquish this band because of international treaty actions," notes one of them, "it will have a stifling impact upon availability of land-mobile frequencies in the future." As an example, he cites Canada, where a consulting engineering firm reportedly "has urged the Canadian Department of Communications to reallocate the vhf band to land mobile and move all television to uhf." Japan has already approved such a switch.

To counter such a possibility, some U.S. specialists would prefer to see the 900-MHz land-mobile band allocated worldwide. Such a move would not only expand the equipment market beyond U.S. borders, it should bring down hardware costs through larger production runs.

More importantly, it would necessitate the development of a viable domestic industry composed of multiple producers able to meet global competition. That requirement in itself would preclude AT&T's Western Electric Co. from locking up the domestic market.

Expansion of the 900-MHz allocation beyond U.S. borders is a proposition the Government should weigh carefully before it goes to Geneva in 1979 to negotiate global frequency allocations at the World Administrative Radio Conference.

—Ray Connolly

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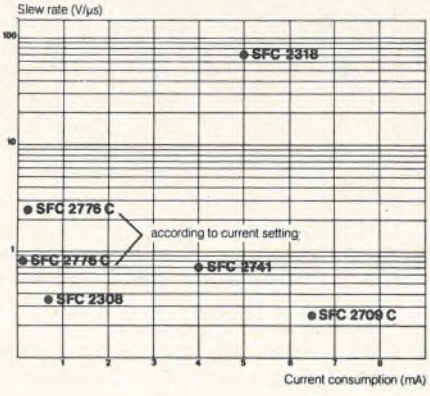

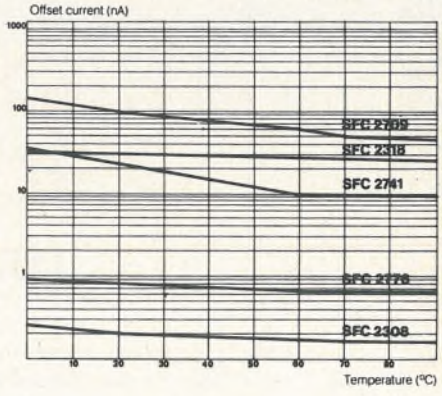

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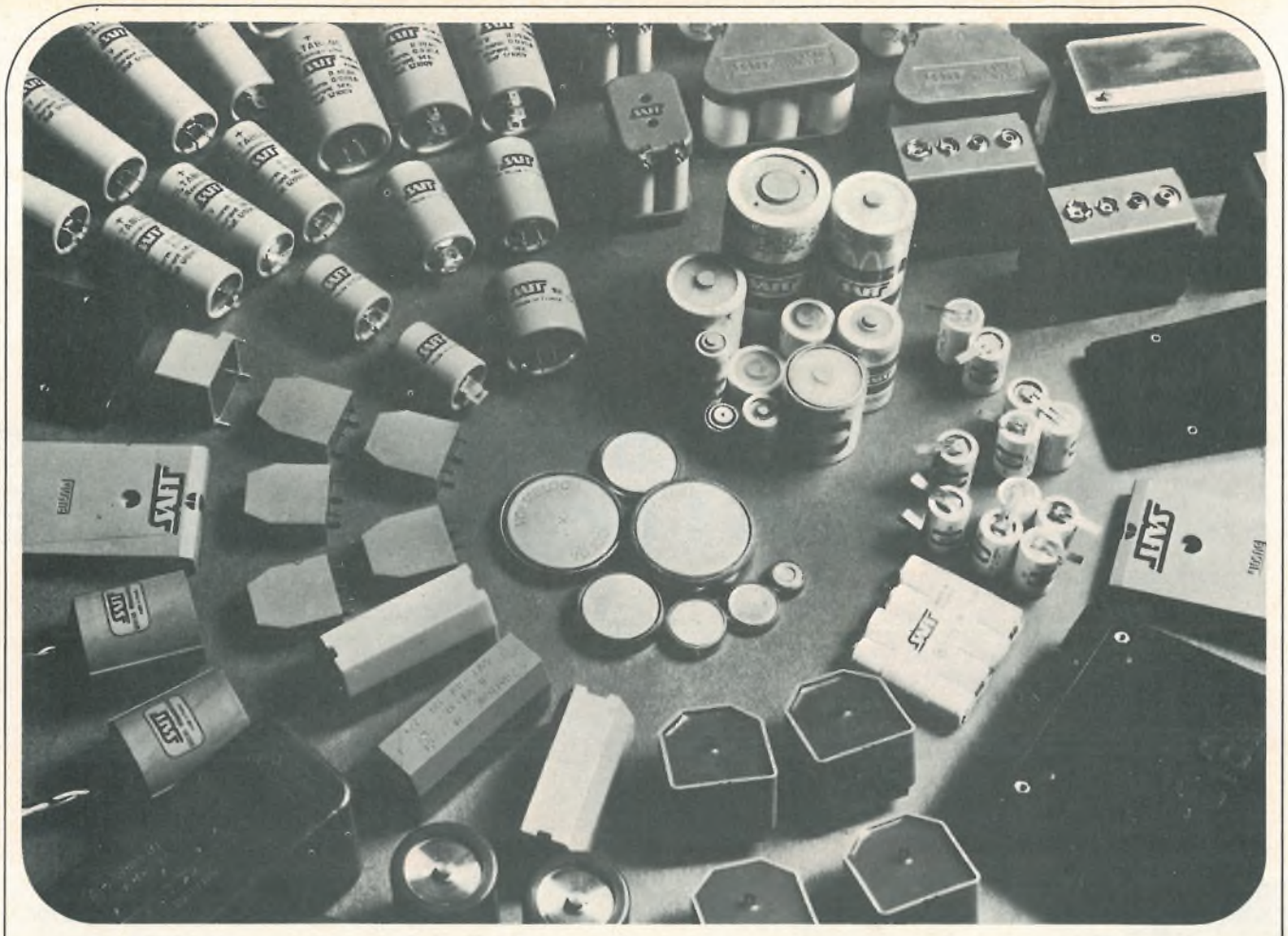
June 12, 1975

Electronics International

French chronometer reads within 1 picosecond: page 7E

Portable camera, video recorders, and links for "electronic journalism" take Montreux spotlight: page 5E



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EL.1

International newsletter

Thomson-CSF pushes color-TV displays for plane cockpits

France's Thomson-CSF is pushing hard to get its penetration color tubes into aircraft cockpits. At the Paris Air Show early this month, the French firm turned up with a prototype version of a "head-down" four-color display for military planes that can show radar maps, targets, obstacles, television images, alphanumeric instructions, and the like. **Thomson-CSF also plans eventually to switch to color in a "head-up" display developed for the Mirage,** the plane that aircraft-maker Marcel Dassault put into contention with the U.S. F-16 and F-17 for the "arms contract of the century."

Meanwhile, civil versions of a head-down system with color displays will start getting flight tests on a NORD 262 short-haul transport this fall. **The system is made up essentially of an electronic attitude-director indicator, a horizontal-situation indicator, an inertial platform, and a navigation computer.** The system's units are linked by optical fibers.

Japanese mission begins 8-plane evaluation tour

The F-18, chosen by the U.S. Navy as its next-generation fighter, has been **added to the shopping list as representative of Japan's Air Self-Defense Force start on a two-month data-collecting mission.** The selection of Japan's next mainstay fighter, coded-named FX, will come by summer 1976. Now in the running are France's Mirage-1, the British-German-Italian Multi-Role Combat Aircraft, Sweden's Viggen, and the American F-14, F-15, F-16, F-17, and F-18. **Current plans call for the field to be narrowed to three contenders** after the mission turns in its detailed report, and the final choice is to be made after a second mission reports back next spring.

UK company offers converter for TV-signal types

A brash young British company intends to challenge Marconi Communications Systems, Japan's Oki Electric Industry Co., and West Germany's Robert Bosch Fernsehanlagen for the smallish world market for digital intercontinental conversion equipment for different television-signal standards [*Electronics*, May 29, p. 82]. Although it has yet to build the hardware, **Quantel Ltd. went into the market at the late-May Montreux television show with an offer to build 625-line/50-field-to 525-line/60-field converters for about $230,000—less than half the price Marconi is asking for its DICE hardware.** Anthony Stalley, who led the Independent Broadcast Authority team that originally developed DICE and who now heads Quantel, says the slashed costs are possible because of "second thoughts" like a reorganized mass memory and mechanical improvements like printed backplanes instead of wire-wrapped connections.

Nippon Electric readies Russian wire-memory plant

A 10-million-bit-per-month plant to manufacture wire memories for minicomputers has been sold to Russia by Nippon Electric Co. Delivery is slightly behind schedule, but the company will soon turn over the plant in return for approximately $2 million. Nippon Electric says approval for the deal from the Coordinating Committee for Export Control in Paris was based on a **pledge from the Russians that they would not use the wire memories for military purposes.** The plant consists of

three types of machinery—for plating wires, for weaving wires into memory planes, and for testing completed memories. Basic technology for wire memories was developed at the research laboratory of Kokusai Denshin Denwa Co., Japan's private overseas radio and cable system.

Unidata expected to reject bid for CII-Honeywell sales

Europe's Unidata is likely to reject any early attempt by the new Franco-American computer combine, CII-Honeywell-Bull, to sell Honeywell-Bull machines through the Unidata network. Officials at Philips, partner with Germany's Siemens and Compagnie Internationale pour l'Informatique in the joint marketing organization, stress that the Unidata contract specifies that only certain CII machines may be sold.

Despite affirmations from the French that development of Unidata models 7760 and 7770 will continue at CII, Philips executives fear that Honeywell machines would soon oust any CII-designed models. "The balance will be in the hands of Honeywell in the end," says one. No clarification of the new French company's future relationship with Unidata is expected before late this summer. Meantime, Philips is making clear that it makes "no sense at all" to discuss the Unidata problem with the French until a complete report has been completed in Paris.

Siemens uses laser, hologram to solder parts on pc boards

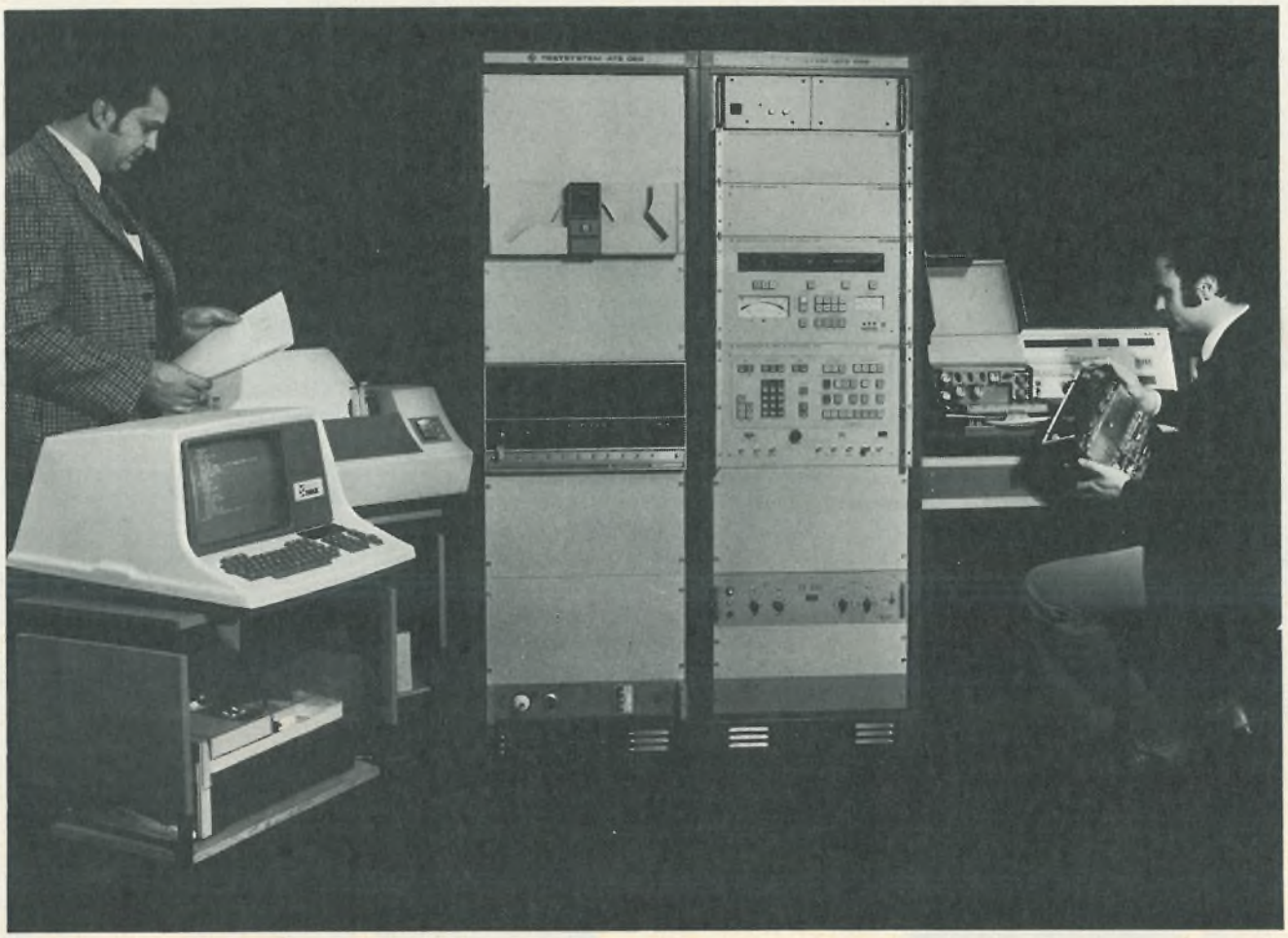
Researchers at Siemens AG have developed a laser-based soldering technique that allows a number of component connections **to be made simultaneously on a printed-circuit board in a one-step process.** First, a large-diameter laser beam is applied to a hologram, which splits it into several small-diameter partial beams. These fragments are then focused onto the transistor or IC pins to be soldered. The hologram determines into how many partial beams the orginal one is to be split and fixes the spots onto which they are to be focused. If the geometry of the setup requires it, the partial beams can also be reflected by a mirror arrangement. Thus far, the improvement in speed that the simultaneous soldering method affords over step-by-step methods has not yet been determined. But a prototype setup is expected to show the improvement to be significant.

National CSS forms time-sharing firm with French aides

National CSS Inc. of the U.S., a leader in interactive computer time-sharing, is launching a joint venture with banking and consulting partners in France. Predicting substantially faster growth in the European time-sharing and computer-services market than in its domestic market, National CSS has set up a new company, CSS France, with French project-management specialist Norbert Beyrard France and a private Paris bank, Rivaud et Cie.

National CSS is aiming to take a share of what is already a $100 million time-sharing market in France and to develop further operations within European Economic Community countries, where it expects demand to grow at a rate of at least 30% a year into the 1980s. National CSS plans to use transatlantic circuits to service European customers for another three to five years and then to add European-based hardware.

Automatic Tests on Radiotelephones



Test System ATS-A/SF: universal and rational

Following on from earlier, manually operated test assemblies for radiotelephones Rohde & Schwarz has now developed the **Automatic Test Assembly for Radio Sets SMPU** (middle of cabinet on right) which, already by itself, introduces considerable rationalization to your measurements. The SMPU contains all the required pushbutton-selected signal sources and measuring instruments. An entire test routine can be started by pressing a single button. Program cards enable the set to be operated by unskilled staff.

A **computer-controlled test system** such as the ATS-A/SF will normally be made up of individual programmable instruments. Incorporation of the SMPU brings the price of such an assembly down a long way. Setting up and measuring becomes 30 to 100 times faster than with a comparable manually operated system.

The **standard system** comprises at least one device each for data input and output, control and interfacing. Possibilities for **extension** are practically unlimited: e.g. a second test-item interface to eliminate the down-time, automatic measurement of the current drain of the device under test, high-speed tape peripherals.

Additional measuring instruments with IEC-standard (ASCII) bus need no extra interfacing. By adding other accessories you can obtain a multipurpose test system (e.g. for radiotelephones and analog modules).

The user-oriented **test language SESAM II,** developed by Rohde & Schwarz, permits clear formulation of a measurement routine, delivering a test report which can be reproduced at any time. Thus a certificate can be obtained for each test item with one operation. Statistical evaluation can also be entered into the program.

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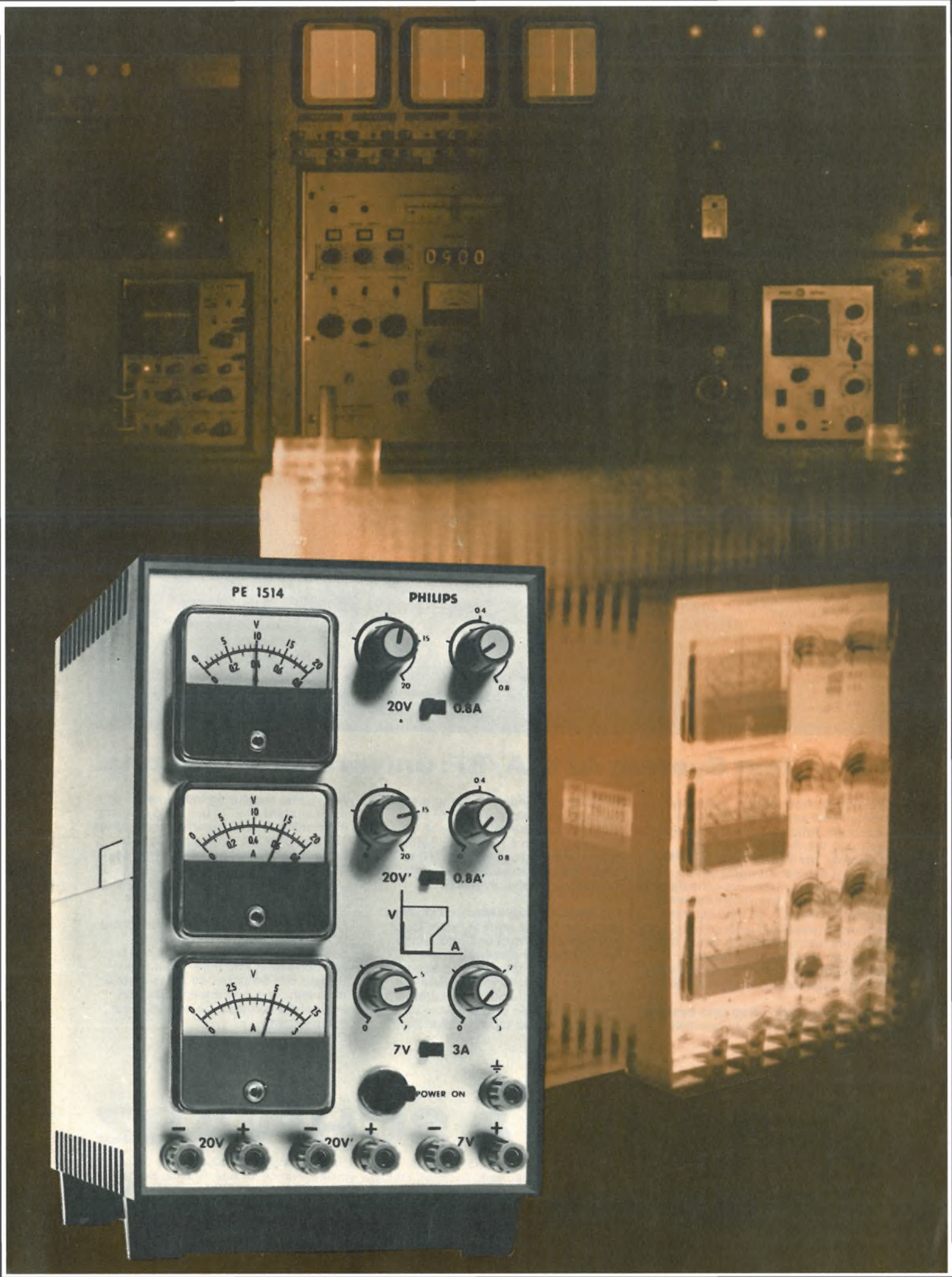
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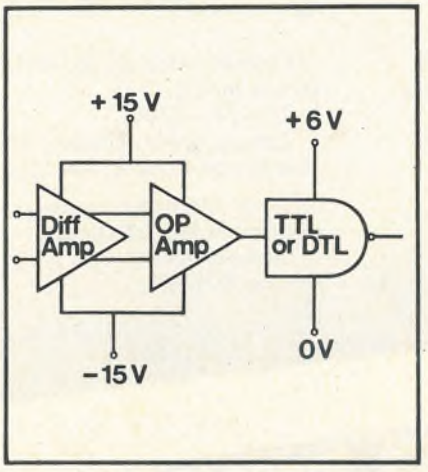
Keeping to spec is just as important as defining it. We start by using all our own components, both electrical and mechanical, and thereby maintain the tightest possible quality control. We also subject every design to a series of hard vibration, shock, humidity, life, climatic, and interference tests.

These tests are carried out by a separate laboratory and are even extended to the design of the transport package.

Only when a new design meets every one of these demanding tests does a model go into production. And once in production it still continues to receive quality control checks on a statistical basis.



The three-in-one power supply shown opposite is ideal for applications requiring positive and negative supplies e.g. op amps and linear/digital IC's.

A wide range

A wide range of laboratory and OEM power supplies meeting these seyere criteria are currently available covering outputs from 10 to 1250 W. Both series regulation and switching techniques are employed and on many models facilities such as programmable operation, remote sensing, master/slave operation and overvoltage protection are included or optionally available.

The range is thus one of the most comprehensive in Europe and certainly the most advanced.

New design concepts

While many power requirements are standard, some are special - op amps and digital and linear IC's for example, where positive and negative voltages are needed.

This particular need is met by the PE 1514 shown opposite, which combines three constant voltage/current supplies in one compact housing. Two are continuously adjustable from 0 to 20 V and 0 to 800 mA and one from 0 to 7 V and 0 to 3 A.

The PE 1514 is, of course, just one single example taken from a range of 55 models. A range that will certainly meet your special needs for either laboratory of OEM use. Please write for our shortform catalog.

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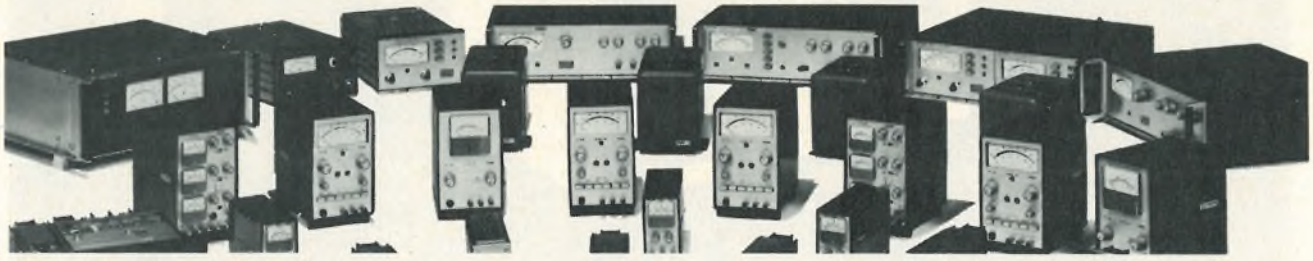

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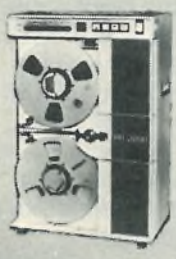

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'Electronic journalism' hardware steals show at Montreux

Portable low-light-level cameras and video-tape recorders of broadcast quality bow at symposium

The TV-broadcast engineers who flock to Montreux in late May every other year for the Swiss postal administration's International TV Symposium and Technical Exhibition are a fairly trendy group. The last time around, the "in" equipment on the exhibition floors of the Palais des Congrès at the Lake Geneva resort was station automation equipment. This year's fashion setter was hardware for "electronic journalism"—hand-held color-TV cameras and portable video tape recorders to report news on the spot, time-base correctors, and microwave links for instant relay to transmitters.

Hand-held. Most of the major broadcast-equipment makers went to Montreux with portable cameras they had already introduced at earlier broadcaster conventions in the U.S. and the UK. But joining the crowd at Montreux were Thomson-CSF and Ampex. The French firm showed the latest offspring of its TTV 1515 camera—an 8-kilogram portable with an independent monocular electronic finder; the unit can operate as far as 150 meters from the control interface. The American company checked in with a 7-kg camera head coupled to an 8-kg backpack that holds the sync and video-processing circuit cards.

Like most other portable camera heads, those of Thomson-CSF and Ampex use three 1-inch Plumbicon tubes as the image sensors. Philips, which produces the Plumbicon, went one up on its competitors at Montreux with a low-light-level version of its LDK 15 portable. Instead of the conventional Plumbicon, this camera uses a 41XQ Plumbicon/channel-electron-multiplier combination for a five-fold improvement in sensitivity. "Instead of needing 500 lux at f/2 with a conventional camera, you can do with 100 lux," asserts Lex Buren, the product-line manager for the camera. "In fact, you can get pictures at 12 lux with the extra 12-decibel gain switched in."

For the low-light-level version, the basic camera doesn't have to be altered. The channel-electron-multiplier unit is paired with a printed-circuit deflection yoke that slips into the same space as a regular wound yoke. The standard LDK15 and its base station sell for roughly $62,000. Because the light-intensifier tubes are so special, Philips rents them on an hourly basis, which usually works out to some $1,250 a month.

Recorders. As for portable recorders, West Germany's Robert Bosch Fernsehanlagen put some all-new hardware into contention at Montreux with such standbys as the 2-in. quadraplex VTRs of Ampex and RCA. The Bosch company, jointly with Philips, developed a 1-in. single-head helical-scan VTR for studio work and showed it at Montreux in 1973. Philips has stuck to the scheme for its BCR series of recorders, but Fernseh has dropped it. "The tape interchangeability wasn't good," maintains Hubert Foerster, the chief engineer for Fernseh's VTR activities.

Lightweight. Philips' portable camera grabs image on 50-lux lighting.

Fernseh achieved compatibility between 1-in. tapes recorded on different machines of the same make by shifting to a two-head helical scan and segmented fields. The two heads, running at 150 revolutions per second, alternately record or play back segmented fields of 52 lines. Six track segments make up a field. Because of the two heads, the track length is comparatively short, only 80 millimeters, and the track angle less acute, only 14°. These factors count heavily on compatibility, Foerster points out.

Fernseh has three versions of its new machines. There's a 20-kg portable—the BCN20—with the tape reels stacked one above the other, which sells for roughly $32,000 and makes broadcast quality recordings up to 52 minutes long. Next comes the BCN 40, mainly for outside-broadcast-van use. It has side-by-side reels and records up to 95 minutes but has no time-base correction. The top of the line is the BCN 50 studio version, a $60,000 unit with correction electronics.

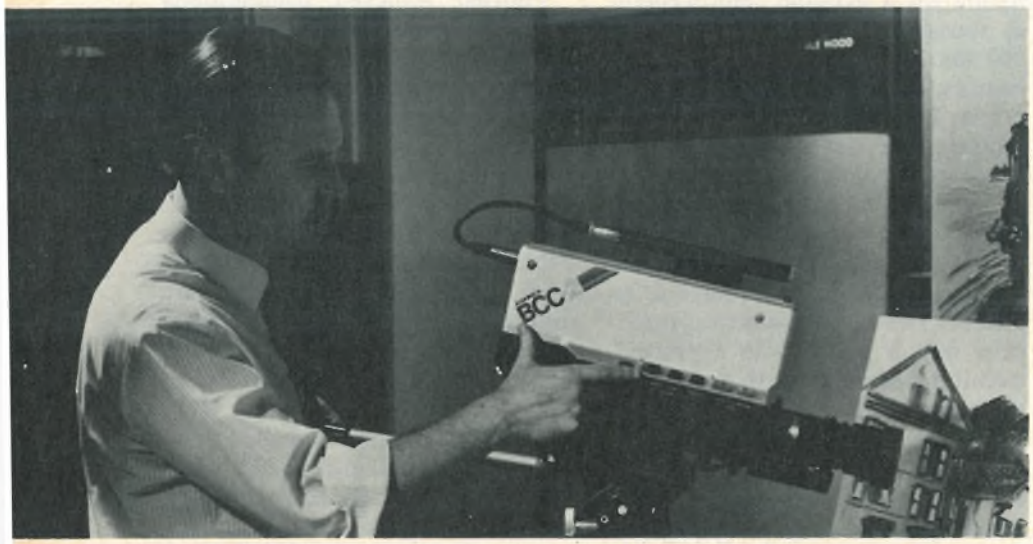
To get their reporting back to the studio, electronic-age newsgatherers long have used portable microwave lines. More and more, they're moving up to the 12-gigahertz band, where there's more frequency elbow room. To help them get up there with little fuss, Thomson-CSF developed its TM 313 portable link and

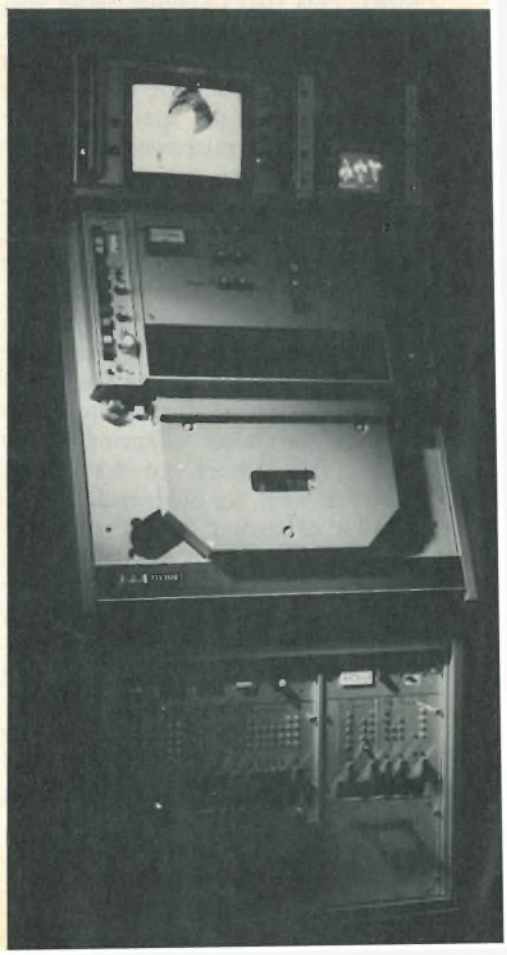
showed it to the broadcast community for the first time at Montreux. The link has an offset antenna for easy aiming—"You don't have strong side lobes to trouble you," says Jacques Montagne, a Thomson-CSF sales engineer. And to ease coming up on a channel in the 11.7/13.25 GHz band, the unit has knob selection of four center frequencies spaced at 28-megahertz intervals. The link can relay a video channel and two sound channels for at least 30 kilometers with a signal-to-noise ratio typically better than 67 dB.

Obviously, it wasn't all electronics newsgathering hardware at Montreux 75. Some of the other noteworthy equipment debuts:

■ Siemens' Interplex single-tube color camera, for industrial and medical closed-circuit-TV systems. The camera faceplate has a stripe filter made of red-stop stripes and blue-stop stripes oriented in a criss-cross layout with the stripes at a 22° angle to one another. As the vidicon tube scans behind this filter, a multiplexed red-blue-green signal with a bandwidth of 5 MHz is picked off, with the luminance information coming from transparent interstices between the stop stripes. This multiplexed signal has blanking and sync bursts added to it and as such can drive a black-and-white monitor. For a color monitor, there's decoding circuitry. Joseph Bohn, the development engineer for the Interplex, says the camera will hit the market next year carrying a price tag of some $6,000. First versions will have an antimony sulfide target for operation at light levels of 1,000 lux. A version with a silicon diode matrix sensitive enough for 200-lux operation will follow.

■ AEG-Telefunken's prototype 100-watt, 12-gigahertz TV transmitter. AEG-Telefunken developed this hardware for the German post office, which is thinking about using band-six frequencies to distribute





Scene stealers. Ampex has rounded out its "electronic journalism" kit with a 7-kilogram portable camera (above). Thomson-CSF's 12-gigahertz link (right) features knob selection of four transmission frequencies. A Siemens color camera (upper right) has only one tube. Sprocketless servo drive allows Thomson-CSF's telecine (far right) to handle 16- and 35-mm film.

programs to community antennas rather than wiring up big German cities with cable. Siemens and the ITT subsidiary Standard Elektrik Lorenz are also working on 12-GHz transmitter designs for the project. All use a special klystron developed by Valvo, a Philips-group firm.

■ Rank Cintel's Mark 3 flying-spot telecine. "It does with complex electronics what our early equipment did with complex optics," says John Kerr, a Rank Cintel sales engineer. Each frame of the motion picture film has to be scanned twice to get two interlaced TV fields, and earlier Rank telecines used two lens systems to keep the flying spot moving properly over the moving film. The Mark 3 uses signals from a capstan drive with servo control paired with optical readout of the film sprocket holes to keep the scan of the flying spot synchronized with the film. The upshot: a telecine that because the drive is sprocketless can handle 16- and 35-mm film and goes for about 10% less—at some $72,000—than earlier models. □

France

Chronometer reads at 1 picosecond

Nuclear fusion programs are moving into sharper focus everywhere as the oil crisis speeds the search for alternative energy forms. Laser fusion projects in particular are prompting development of new electronic measuring hardware capable of handling signals in the picosecond range. With the help of the French atomic energy commission, France's Thomson-CSF is now well advanced with the design of a chronometer that should be available to outside customers early next year.

A full-scale industrial prototype is now being put together at Thomson-CSF's department of special instrumentation applications near Paris, and the sales effort is scheduled to begin this summer. The company claims that it will be the first to offer an instrument capable of measurement within less than 1 picosecond. Indeed, laboratory tests on a working model have already achieved a resolution of 0.5 picosecond.

Some oscilloscopes have been claimed to give resolutions in the picosecond range, but Thomson-CSF engineers note that their practical experience has been that even the very best are limited to about 20 picoseconds. The Thomson-CSF team figures that a chronometer has some basic advantages over all other measuring routes, such as optical analysis of an electrical signal or direct optical measurement through use of an electronic camera. For a start, explains project engineer Gabriel Lejeune, the noise level is reduced through the electrical simplicity of the equipment, and, in addition, the measurement itself is obtained directly through a straightforward analog-to-digital converter.

The measuring operation is started and stopped by flip-flops that control a pair of Schottky diodes. They, in turn, switch the output of a constant-current generator onto a capacitor that integrates the current. The integrated signal is amplified and then fed into an analog memory. At that stage, a multi-channel analyzer can be plugged in to trace the curve of the measured signal before it is passed on to the d-a converter and switched through to the final result display.

Obstacles. Lejeune says the heart of the problem is in the handling of the input signal at the flip-flop and current generator stages. His team used fast transistors from outside suppliers and some new Schottky low-leakage, low-noise diodes developed by Thomson-CSF's own components research laboratories in France. "The studies consisted essentially of searching for the best signal-to-noise relationship at all levels of the circuit," Lejeune told a Paris conference on metrology late last month. He added that this had to be achieved in "avoiding too many concessions on linearity."

Such concessions are all too easy to make, however. A tiny change of a millimeter or so in the length of one or other of the connecting cables in the instrument can alter the displayed result by tens of picoseconds. Similarly, Lejeune explains, great care has to be taken to control beat stability and other factors that could interface with the resolution and general performance. To solve that problem, Lejeune is getting ready to fit his working model and prototype with an Intel 8080 microprocessor chip to control those variable parameters automatically.

Sensing. That approach should be enough to get a viable measuring instrument onto the market. But Lejeune's studies do not end there. In cooperation with another French-based laboratory, Laboratoire de l''Electronique et de Physique Appliqueé—a Philips subsidiary, the Thomson-CSF team is trying to work out a way to develop a suitable sensor that will pick up the signal to be measured from the source.

The key to that problem may be a development of an existing LEP photodiode that has already given a resolution of 5 picoseconds. Next month, the Thomson-CSF engineers will also start on the tricky problem of defining the "instants" or profile of the section of signal to be fed into the chronometer. That will be no easy task since in laser measurements every signal is different, thus ruling out sampling or repetitive analysis. □

Japan

Panafacom markets 16-bit processor

Control of computer peripherals and of communications devices were among the applications Panafacom Ltd. had in mind when it developed the Panafacom L-16A, a three-chip 16-bit microprocessor set built with silicon-gate n-channel MOS technology [*Electronics*, May 1, p. 26]. And so it is that such Panafacom shareholders as the Matsushita Group, Fujitsu Ltd., and Fuji Electric Co. will use it in numerical control, intelligent terminals, optical

character readers, and cash dispensers.

Panafacom will not be in the business of selling the chips individually—at least not initially—when it begins deliveries in September. The PFL-16A will be sold as a component minicomputer, along with a gamut of optional components. Orders that are big enough, however, might persuade the company to sell the 40-pin chips separately.

Extras. The package does constitute a minicomputer, says a company spokesman, because it has the basic minicomputer architecture, including three levels of priority interrupt and status word. Besides the circuit board built around the three-chip set, Panafacom will offer boards that include memories for almost any configuration within the capacity of the 64-kiloword central processing unit. It will also offer a power supply, a cabinet to house up to 12 boards, program support service, and step-up minicomputers.

Minimum component configuration consists of the CPU board, an integrated circuit RAM board, and a subchannel adapter board. The subchannel adapter IC provides a eight-bit-plus-parity interface for peripheral equipment. Up to 32 subchannels can be connected to one CPU.

For high-speed transfer of data, direct memory-access control boards are available, providing a maximum of eight channels per CPU. Each direct memory-access channel can be divided into four subchannels. All interfaces are transistor-transistor-logic compatible. Other boards available include a CPU option, core memory, programable read-only-memory, panel control, basic input-output control, channel connection, communications-line control, PROM writer, bus amplifier, and power supply.

One-chip CPU. The chip designers went all out to use the most advanced semiconductor technology because their goal was to put the entire CPU on a single chip while maintaining high performance and high speed. They say that MOS is more realistic than one of the more exotic technologies such as integrated-injection logic. Thus the designers are probably the first to combine the use of silicon-gate n-channel MOS with an enhancement-depletion configuration and LOCOS—local oxidation of silicon—fabrication in a microprocessor chip set.

Silicon-gate and n-channel approaches are well-known for reducing size while maintaining high speed in MOS devices. In addition, using an enhancement driver and a depletion load provides either a two-fold increase in speed or enables the designer to maintain the same speed while halving dimensions. Part of this improvement comes from elimination of the voltage-supply lines to the gates of enhancement loads, but most is provided by the superior characteristics of the depletion load. Typical rise time in gates used in this microprocessor is 40 nanoseconds, and fall time is 10 nanoseconds.

No microprogram was included, which is another reason for the system's speed, and the 33 instructions all have the same one-word length. Thus, this microprocessor differs from many others in not being designed to emulate existing systems. It was designed to operate from its own software, which among other things emphasizes a connection with larger Panafacom minicomputers.

In many respects it is similar to earlier MACC-7/L made by Matsushita Communication, but it includes five general registers in place of that machine's accumulator. Thus the microprocessor scores about the same in many benchmark tests despite its reduced size and cost. □

Denmark

Former Rank employees make color-TV receivers

A new company in Denmark, formed by former employees of a shut-down television-receiver manufacturer, plans to market two new color sets in Europe before the end of the year. The company, which for now calls itself 3F, has taken over the Rank-Arena TV-receiver plant at Horsens, Denmark. Britain's Rank Organisation had closed down this subsidiary on Feb. 1, citing high production costs.

Rank-Arena produced a 20-inch color set and had, at the time of closing, developed a 22-in. set that was basically a further development of the smaller model. The 20-in. set is built around a Toshiba color tube, and 3F will probably also use Toshiba components in its 22-in. model, which is practically ready to go, and a larger 26-in. set that is to be introduced within a year.

Production. Production is scheduled to begin on the first two sets during the autumn and to reach an annual rate of 50,000 units—the plant's capacity—by the end of 1976. The new manufacturer plans to remain primarily a production company and rely on a Danish company to market the sets in Scandinavia and Western Europe.

By mid-May, 3F had not lined up its sales agents, but an official said the two new sets would be sold in Europe through "normal sales channels." The company is not aiming at price competition, he added. The brand name has not been chosen, but it won't be 3F.

Competitors have been skeptical about the chances of a new TV-set producer making a go of competition on the European market, but officials of the new company insist that their research indicates a good market potential for all the sets that 3F can produce.

Competition. Rank bought out Arena some years ago, thereby leaving only one independent manufacturer, Bang and Olufsen, in Denmark. B&O concentrates on record players, but it also has a sizable TV-set output. The receivers are built around Philips tubes.

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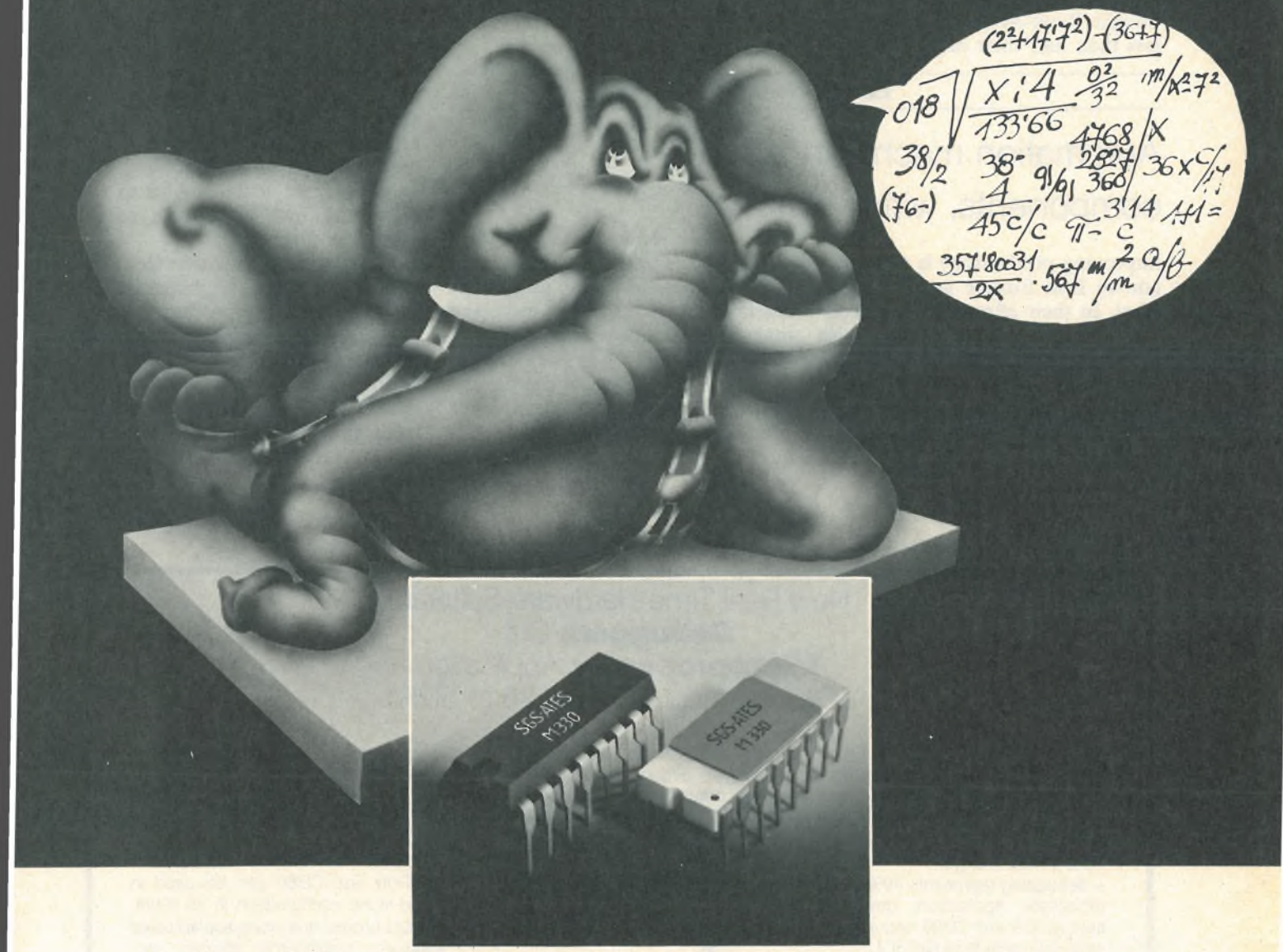

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ing when a handful of Rank-Arena's 600-odd employees began making plans to continue production. But the new company claims to have sold enough shares of stock to both residents in the Horsens area and others to cover initial production costs. The city of Horsens bought Rank-Arena's buildings for less than half their original $5 million cost and has agreed to lease them to 3F.

The new company then bought Rank's production machinery at a favorable price and obtained production rights to Rank's projected 22-in. color set. Rank, however, has held onto production rights for its 20-in. set and a smaller 18-in. model that was also being produced. □

East Germany

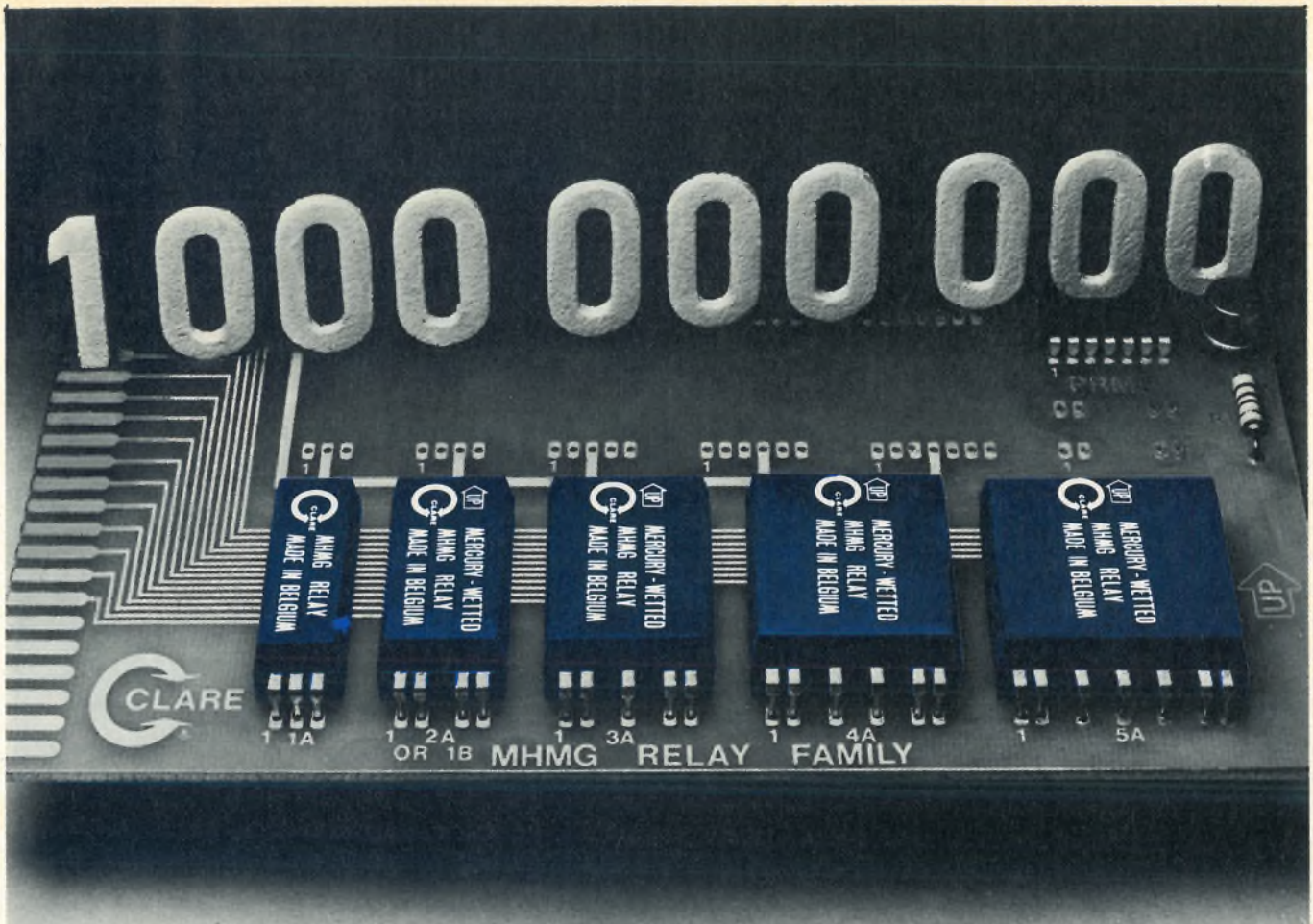
Automation machinery speeds components, wiring output

Improving productivity is as important in East Europe as it is in the West. In their efforts to raise product output per worker, electronics producers, particularly in highly industrialized East Germany, seem to have made enormous strides.

Productivity, according to its electrical/electronics industry, measured in terms of hourly output per assembly-line worker, has increased many-fold in recent years—from an index of 100 in 1955 to one of 526 in 1973. For some years during the 1970s, the annual rise in employee productivity translates into an impressive 7.4%, including both the 1970/71 and the 1972/73 periods. And judging by government proclamations, there will be no let up in goading the industry to keep up its pace during the years to come.

The motives behind this productivity drive are understandable. For one thing, there is the need to export more to the Soviet Union, the electronics industries' biggest customer. Additional exports are almost mandatory to pay the higher prices for oil that the Soviets, like the Arabs, are now demanding. For another, there is the motive to sell more products to obtain sorely needed Western cash.

Automation gear. Aside from figures and motives, the industries' efforts in improving productivity can also be gauged by the automated machinery being built. One East German firm, VEB Elektromat, stands out with its automatic equipment for production of electronic



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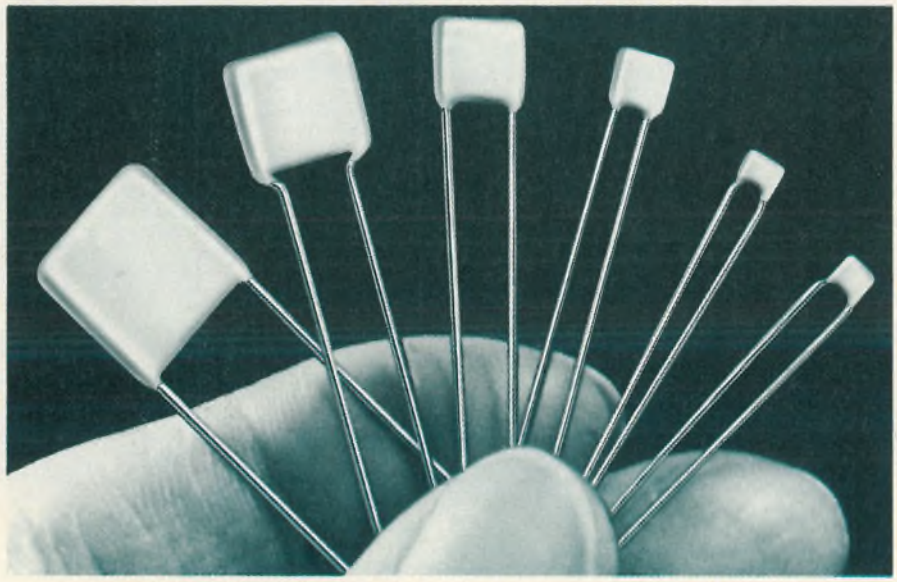

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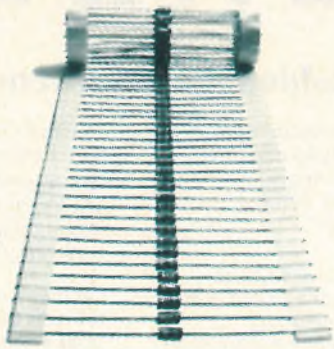

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components. The Dresden-based company prides itself on selling in Western countries.

Among automatic systems that Elektromat has recently developed and introduced is a bonder that can handle up to 2,500 wire bonds on integrated-circuit chips per hour. Another system is an automatic cable-harness-forming machine capable of operating at 16 meters of wire per minute. Still another is an IC-adjustment and exposure system that charges, positions, and exposes well over 100 substrates per hour.

Significantly, the bonder has about 80 mechanical, electrical, optical, and pneumatic modules, which can be assembled and reassembled into six equipment variations. Three are for uses as automatic or semiautomatic chip bonders and three as wire bonders.

Bonding. The system is designed for handling eutectic chip-bonding and flip-chip-bonding techniques with ultrasound and low frequencies, as well as wire-bonding with thermocompression and ultrasound techniques. The modules include units for device transport, magazining, control and adjustment, generator and oscillator units for ultrasound and low-frequency signals, and protective gas-supply units, heating units, and the like. The modules allow changing any of the six system variations to process the latest type of discrete components and integrated circuits. The equipment can also handle multichip and hybrid circuits.

Fitted with a stereomicroscope from VEB Carl Zeiss of Jena, the big East German optical-equipment maker, the bonding system can process chips ranging from 0.35 by 0.35 millimeters to 3 by 3 mm. The larger chips are wire-bonded, by thermo-compression as fast as 2,500 bonds per hour. The hourly rate for chip-bonding, with automatic feed, is from 500 to 1,000 chips of sizes ranging from 1 by 1 to 3 by 3 mm. For chips as small as 0.5 by 0.5 mm, the bonding rate is 1,400 per hour.

Harness-forming. The automatic cable-harness-forming machine takes advantage of Elektromat's ex-

pertise in this type of equipment, which dates back to the early 1960s. The new harness-former, the KL 394/2, automatically routes the wires and forms a harness around them on a so-called laying board, on which pins determine the configuration of the harness. A laying drum, with the board clamped to it, moves back and forth as the wires, which come from stationary laying fingers over the drum, are laid between the pins on the board.

Drum motion and such auxiliary functions as fastening the wire ends, wire-cutting, changing the wiring plane, and selecting the type of wire, are controlled by a program contained on an eight-track punched tape. A tape reader feeds all data necessary for harness manufacture to the machine. The accuracy of wire-positioning is within ±1 mm, and the distance between selectable coordinates on the board is five mm. As many as 30 different wire types and sizes, from 0.3 to 1.2 mm in diameter, can be used with the machine.

The KL 394/2 equipment is many times more productive than manual harness-forming operations, Elektromat says. The increase results not only from the equipment's speed of 16 meters of wire per minute, but also because a semi-skilled worker is all that is required to supervise the operation of several machines.

Exposure control. The adjustment and exposure system, designated 2105, enables the semiconductor substrate's position to be adjusted accurately within 0.3 micrometers. After adjustment, the substrate is exposed for an electronically controlled period. The setting range for the mask in the X-Y direction is within ±2 mm, and the rotational setting is within ±5°. Although for initial exposures, the productivity is more than 100 substrates per hour, the rate for subsequent exposures is around 50 substrates per hour. These rates include the time for charging, adjusting, exposing, and discharging the substrates when the exposure time is about 5 seconds for each. □

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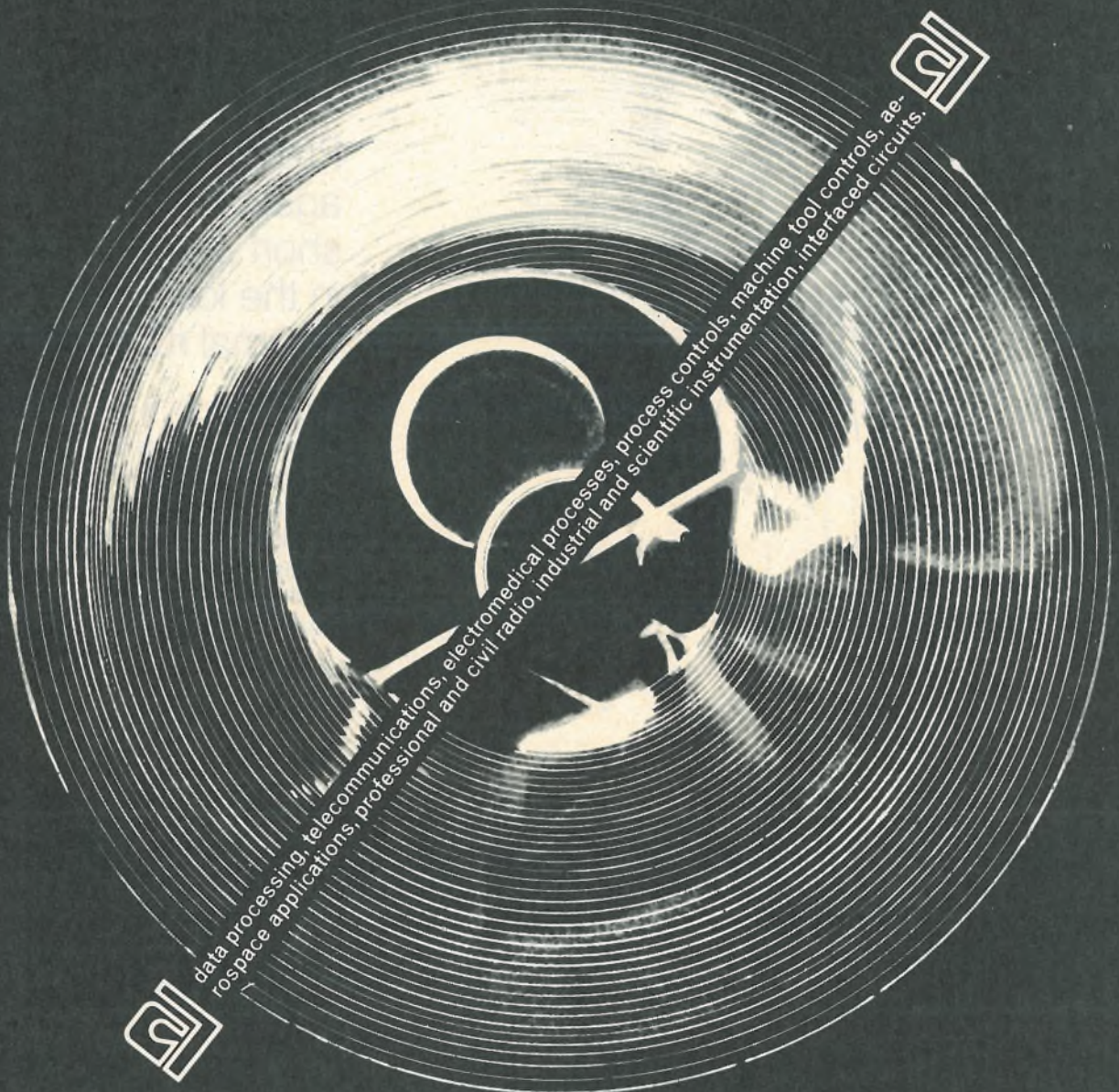

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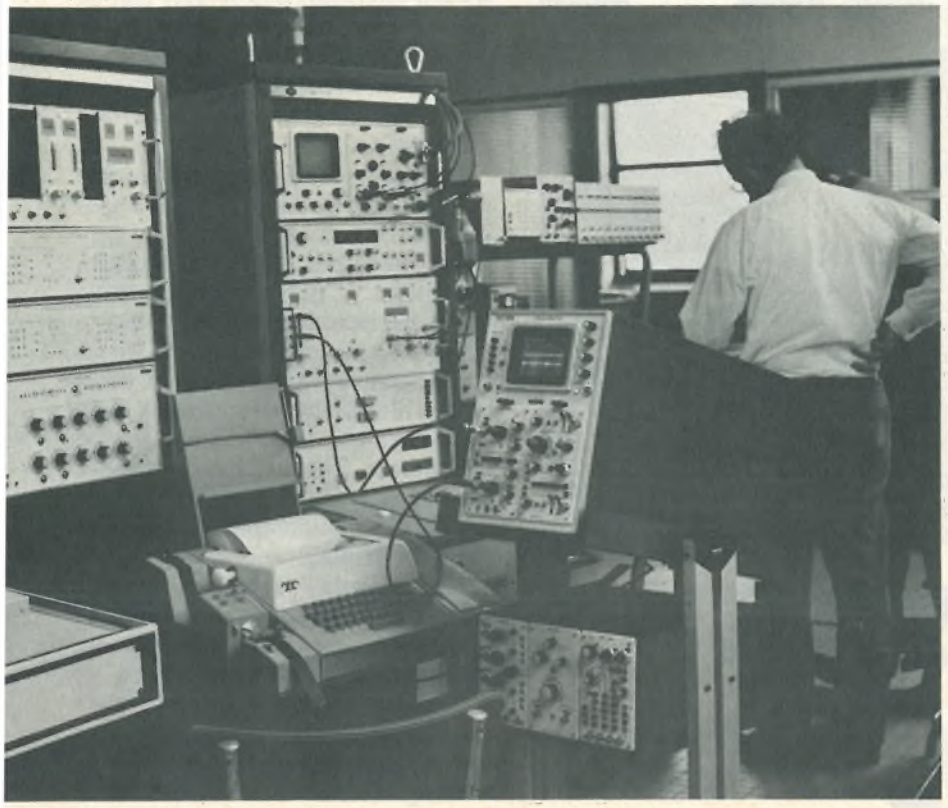


Testing tester. Racks of hardware for French air force's automatic board-tester undergo their own checkouts. Scope in foreground is not part of the system.

Tester checks both analog and digital pc-board circuits

by Arthur Erikson, Managing Editor, International

French air force buys variation of analyzer that has minicomputer to test avionics gear

When an automatic test system goes for more than $200,000, the assumption is that it's a custom design. But when the French Air Force went shopping for a versatile, sophisticated, printed-circuit-board tester for its Ambérieu third-echelon maintenance center, it ended up essentially with standard instruments. "The equipment we will deliver toward the end of the year is a variant on our 9250-series pc-board testers," says Yves le Peutrec, a marketing engineer for Schlumberger Instruments and Systems.

Obviously, this latest version of the 9250 series of automatic test equipment adds up to a lot more than a few racksful of programable instruments hooked together. The air force's Service Technique des Transmissions de l'Air (STTA) has to troubleshoot scores of different pc boards to maintain the French arsenal of avionics equipment—some of the most sophisticated anywhere. About 30% of the boards are hybrids containing both analog and digital circuits. To handle them all, the tester needs a head with 72 contact pins. Because of the complexity and the variety, Schlumberger has substituted a Mitra 15 minicomputer for the 4,096-word memory that ordinarily goes with 9250 series testers. The Mitra 15 has 16,384 bits of main memory plus a disk unit of 800 kilobytes.

Although the full equipment list for the four 19-inch racks that make up racks for the STTA 9250 tester isn't being detailed, its general makeup is no secret. The testing sequences on boards are carried out under control of an STP1291 controller, which interfaces the Mitra 15 with the test instruments. Stimuli for the tests come from four main sources. For static tests, an ALS690 measuring power supply forces voltages or currents onto test pins and determines if what flows out of its terminals falls in the right range. A pair of TFC602A functional testers takes care of the logic circuits, applying high and low levels to input pins and checking the results against the board's truth table.

Fast. For dynamic tests on logic, a model 250 programable pulse generator wrings out logic circuits with pulses having rise and fall times as fast as 5 nanoseconds. Finally, for analog tests, there's a 4000-series synthesizer-generator.

Responses of pc boards to all these stimuli are registered by the tester's measuring instruments. The main ones are a 58-series oscilloscope with a companion digital display, a frequency meter, and a digital voltmeter. Everything is programable; control instructions and data are distributed over an 8-bit bus. "It is very much like the standard IEC bus," says le Peutrec. However, parts of the system need

special interfaces before they can be hung on the bus. The Mitra 15, for example, has 16-bit words, and the frequency instruments as many as four 16-bit words for programing purposes.

During test sequences, the routine of static and dynamic tests for a specific board locates faults, at the very least, down to a functional block in the circuitry. But sometimes, STTA wants the troubleshooting process to go all the way to a specific pin on an IC package. So, once inside a functional block, the tester needs help from the operator. He has to probe test points, but he does so under step-by-step instructions that show up on the minicomputer's cathode-ray-tube display.

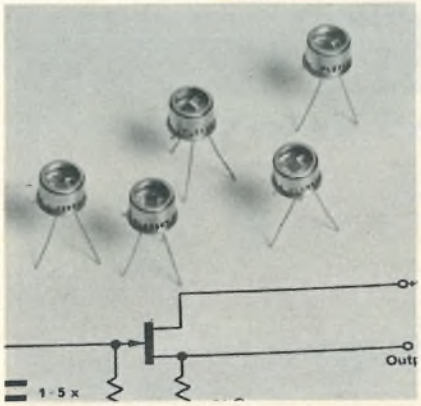
This display comes into play when programs for trouble-shooting themselves are being worked on. Philippe Eschenbrenner, head of ATE marketing for Schlumberger's St. Etienne center, points out, "For analog systems, the hard part is making the measurements; it takes a lot of hardware to get pulses of 2 or 3 nanoseconds back and forth to the connector pins. For logic circuits, the measurements are easy, but the software gets complicated."

Smoothing job. Schlumberger will supply programs for some two dozen specific boards when it delivers the tester to the Ambérieu base, near Lyons. But the equipment is designed to smooth the job of programing test routines by air force technicians. "They can do everything in plain language," Eschenbrenner explains. Changes in test routines can be fed into the computer in plain language by teletypewriter or by the console on the display unit. The computer takes care of the machine language for the corrections. With the 800-kilobyte disk unit, the Mitra 15 can hold about 60 average test-routine programs, although that number is not the limit. The memory is loaded by a punched-paper tape, and there can be an additional whole library of tapes.

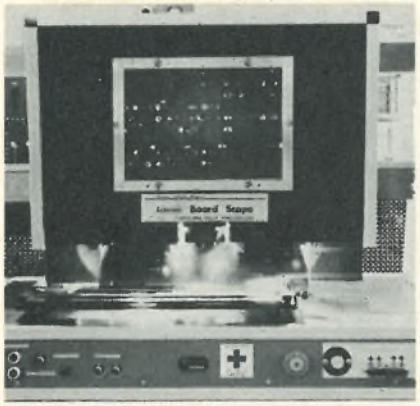
The STTA opted for a sophisticated, expensive tester—Schlumberger won't reveal the exact fig-

ure—because its already tough maintenance problem is compounded by a high turnover of technicians. Along with the ordinary rotation of career personnel, many technicians are citizens fulfilling their military-service requirement. Manufacturers of professional electronics equipment generally don't face problems as tough as does the STTA, but Schlumberger figures that computer-controlled 9250 testers have a market, anyway, because of their versatility and troubleshooting speed.

Schlumberger Instruments and Systems, 5 Rue Daguerre, 42030 St. Etienne Cedex, France [441]

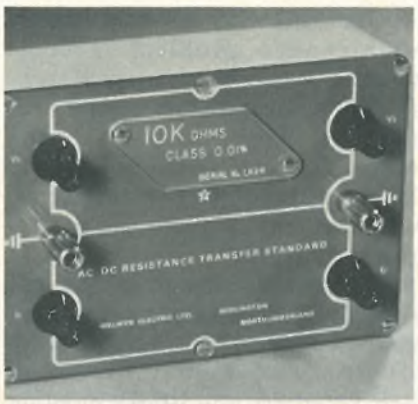


Broadband infrared detector model PPC 522 is intended for intrusion-detection, fire-alarm, and similar applications. The unit contains a pyroelectric ceramic element and a J-FET preamplifier. Plessey Optoelectronics and Microwave Unit, Wood Burcote Way, Towcester, Northants., England [443]



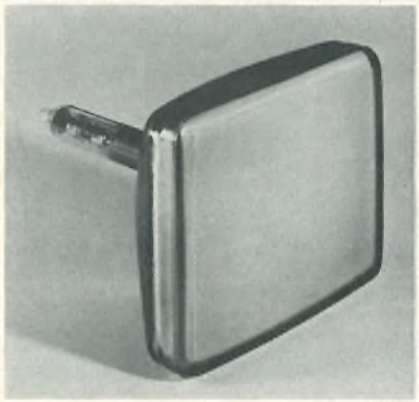
A printed-circuit-board inspection tool, the Board Scope, provides a close look at holes, solder fillets, and joints on a large, easy-to-see screen. The device can be programed for automatic scanning. Japan Solder Mfg. Co., Ltd., 1-11-3 Kinshi, Sumida-ku, Tokyo 130, Japan [444]

New products international



A line of dc and ac/dc resistance transfer standards covers the resistance range extending from 1 ohm to 1 teraohm. Prices for the standards start at 45 pounds, and optional extras are available. Welwyn Electric Ltd., Bedlington, Northumberland, NE22 7AA, England [445]

Toshniwal data generator type EE 401 is a single-channel 16-bit instrument that puts out user-selected 16-bit words at rates up to 10 MHz. Various sync commands are also provided. Scientific & Industrial Instruments Co., B-14, Industrial Estate, Pologround, Indore-3, India [446]



Measuring 19 cm on the diagonal, cathode-ray-tube model M19-100W has a low-power heater that pulls only 75 mA at 11 V. The tube has a 90° deflection angle. Thorn Radio Valves and Tubes Ltd., Mollison Ave., Brimsdown, Enfield, Middlesex EN3 7NS, England [447]

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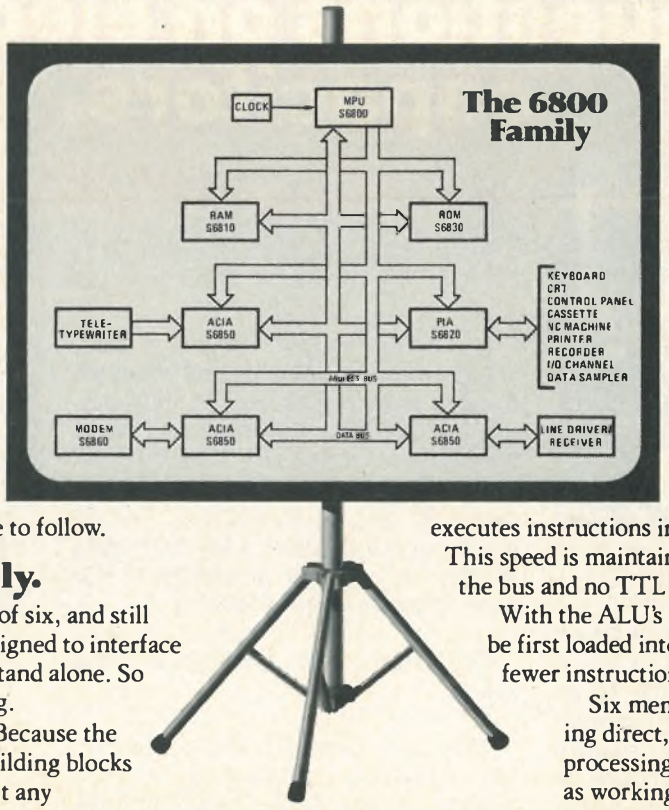

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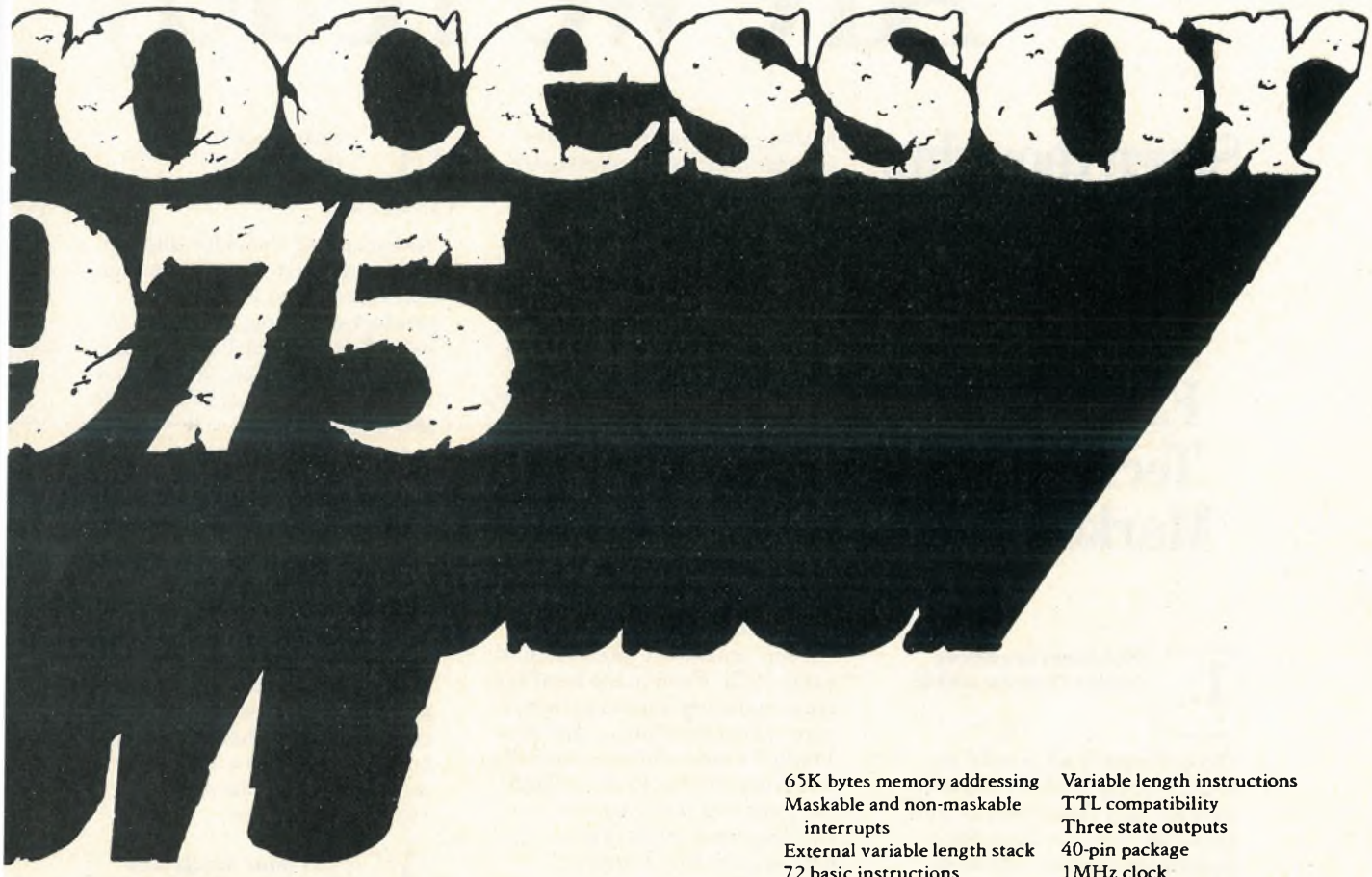
"...the most sophisticated of these new single-chip devices."

IEEE Spectrum



65K bytes memory addressing	Variable length instructions
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External variable length stack	40-pin package
72 basic instructions	1MHz clock
Six addressing modes	Single +5 volt power

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"A boom is on the Are we ready

Seven thoughts on preparing for the next boom in the Electronics Technology Marketplace.

1. ***The boom is coming sooner than we think.***

The evidence is all around us. Many segments of the market have already found bottom and are on the way up. Inventory liquidation has been the most rapid in the history of our economy, and the pipelines are almost empty. Federal monetary policy has become extremely stimulative. Interest rates are down, and industry can afford to invest in the instrumentation and modernization it needs. Productivity is increasing. And our most reliable lead indicator —the market—has been booming for six months. No matter what data you look at, it now seems definite that we are in for a *very sharp* economic upturn, and that short of another Arab oil embargo or a drastic tightening of the money supply by the Fed, nothing can stop it. If you are not planning for an electronics economy that is booming by year-end, you will be 'way too late to take advantage of it.

2. ***Be glad you're in the electronics business.***

In terms of *real product demand*, the recession has been slight or non-existent in many sectors of the Electronics Technology Market. For example, a major instrumentation manufacturer just reported on its most recent six months: Incoming orders up 11%, sales up 14%, profits up 21%—compared with the "boom" market of late 1973 and early 1974. Even in the hard-hit semiconductor industry, there is a good deal of evidence that *real product usage* will be essentially flat from 1974 to 1975, and that the apparent boom-bust in bookings and shipments is entirely due to inventory.

Considering that the economy as a whole has experienced its sharpest recession since the '30's, the electronics market has performed extremely well. It will far outperform the economy during the recovery—especially if *we are ready* for the boom.

3. ***Start now to build inventories.***

Sound crazy? Consider this: an important part of the boom and subsequent bust was based on product shortages, which led to panic buying, which in turn led to panic production, and thus to inflated inventories. *Let's not do this again.*

It shouldn't take any genius to figure out what products the market would need for a sharp year-end recovery, and it wouldn't be a super-gutsy decision to start now to build toward that level. But let's also be sensible. Ideally, each company should build only toward the market share it can legitimately expect to get. Otherwise, we'll have everybody building to get 50% market share, and it will be August, 1974 all over again.

4. ***Get your marketing house in order.***

In the last boom, marketing and sales people spent a major part of their time *killing snakes*—expediting their factories, and hand-holding their customers. Let's not do that again either.

Now is the time to organize and mechanize your marketing and distribution operations, your communications, and your

way. for prosperity?"

service functions so your sales staff can be free to do what it does best—*close orders*. A quick review—painful as it may be—of the problems you had during the last boom should tell you what changes to make.

5. *Unload some old ideas.*

One of the reasons we keep making the same mistakes each time the economic cycle repeats itself is that we keep clinging to our old ideas, articles of faith, corporate dogma, and former solutions. I wish I had a dollar for every knee-jerk statement I've heard about share of market ("we know all our customers"), market coverage ("80% of our business comes from 20% of our customers"), forecasting ("the resistor market will grow 7% per year through 1983"), market development ("we have a planning department for that"), target audiences ("we want to reach the design engineer"), ad budgets ("we spend 2.3% of sales"), etc., etc.

Consider spending some time in a cool, quiet, dark place—rethinking all the things you "know," and tossing out those that are beginning to look a little tired. And you'd better do it *now*—because the business cycles are coming faster and sharper, and the old ideas just aren't good enough anymore. And because in a few months you're going to be too busy to do it at all.

6. *Start now to broaden your markets for 1976.*

One of the important lessons of the 1974-75 downturn is that companies which had broadened their markets during the boom outperformed their competitors in the bust—by *very* wide margins. It doesn't much matter whether the broadening was in customer base, product/service mix, or geography.

One of the best ways to get ready for the next boom is to turn on your marketing operation *now*, and turn it on with the main objective of finding new customers. One way you could do this is to hire more salesmen. Now is the time, because it will take months of training before they can be productive, and also because in six months *everybody* will have decided to hire, and good people will be hard to find.

The other thing you can do is turn on your advertising. Think about that for a moment. Advertising is the cheapest, most efficient way to help new customers *find you*, and you can turn it on in a couple of weeks without any training at all. Besides, you can turn it on now before the market gets cluttered with messages—in six months, *everybody* will be advertising again.

7. *Be glad you're not in my business.*

Do electronics companies cut advertising in a recession? Do they ever. In the first 5 months of 1975, the advertising page pool for which Electronics competes is down a whopping 26% from last year. Our market share is substantially up, but that's small comfort.

Yet when all the smoke clears away, and the 1974-75 recession is studied, we will learn again what every recession of the past has taught us: Companies which maintain or increase their advertising investments in recessions make more profit *during* the recessions, and come out of the recession with improved market share—compared with companies that cut.

In other words, companies which take a long, consistent view of their markets and their marketing objectives do well in good times *and* bad.

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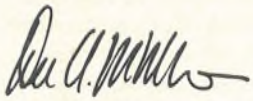
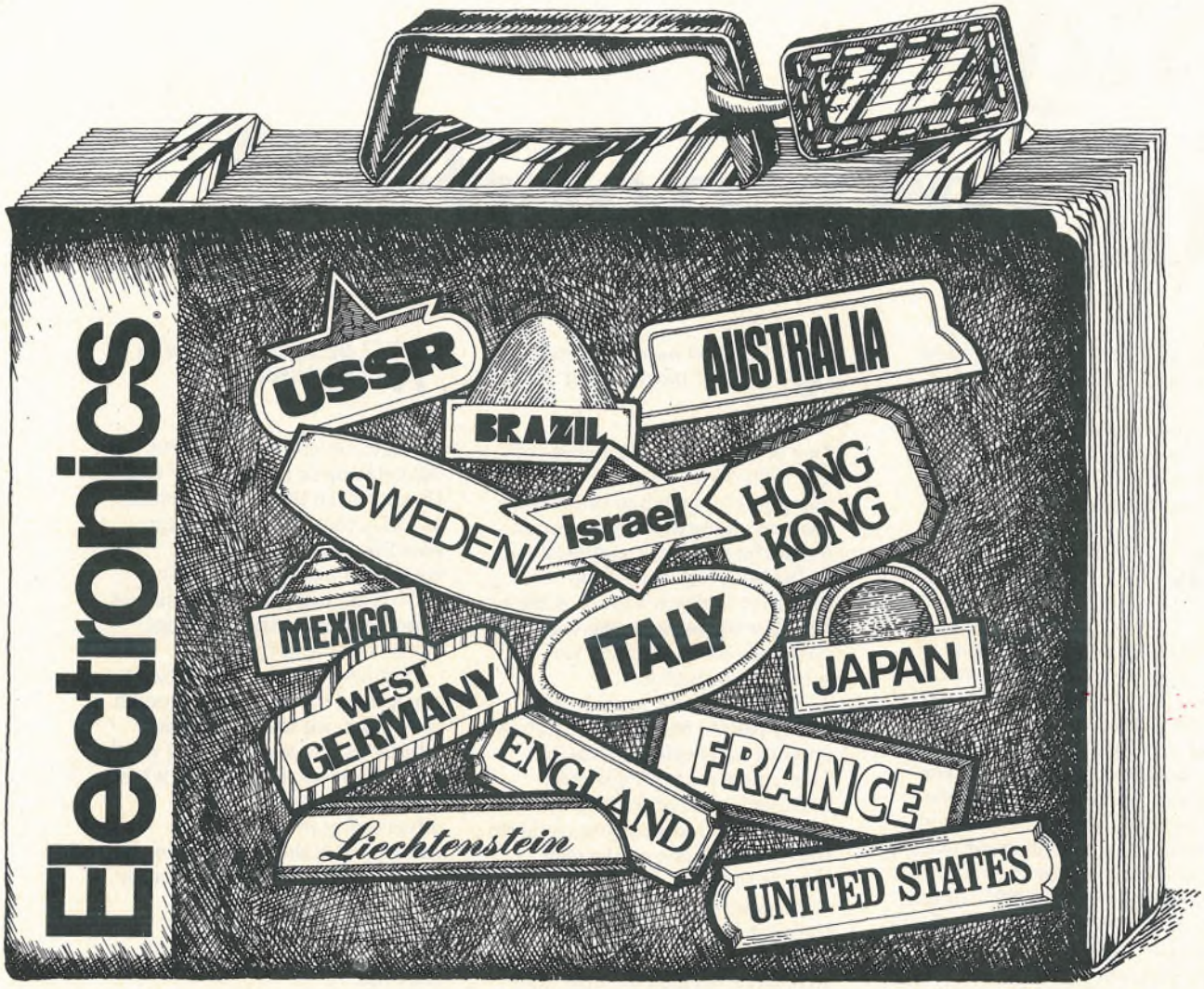


Daniel A. McMillan III
Publisher

This is the Seventh of a series of editorials on advertising, marketing, and planning in the Electronics Technology Marketplace. Your comments are welcome.



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Circle 207 on reader service card

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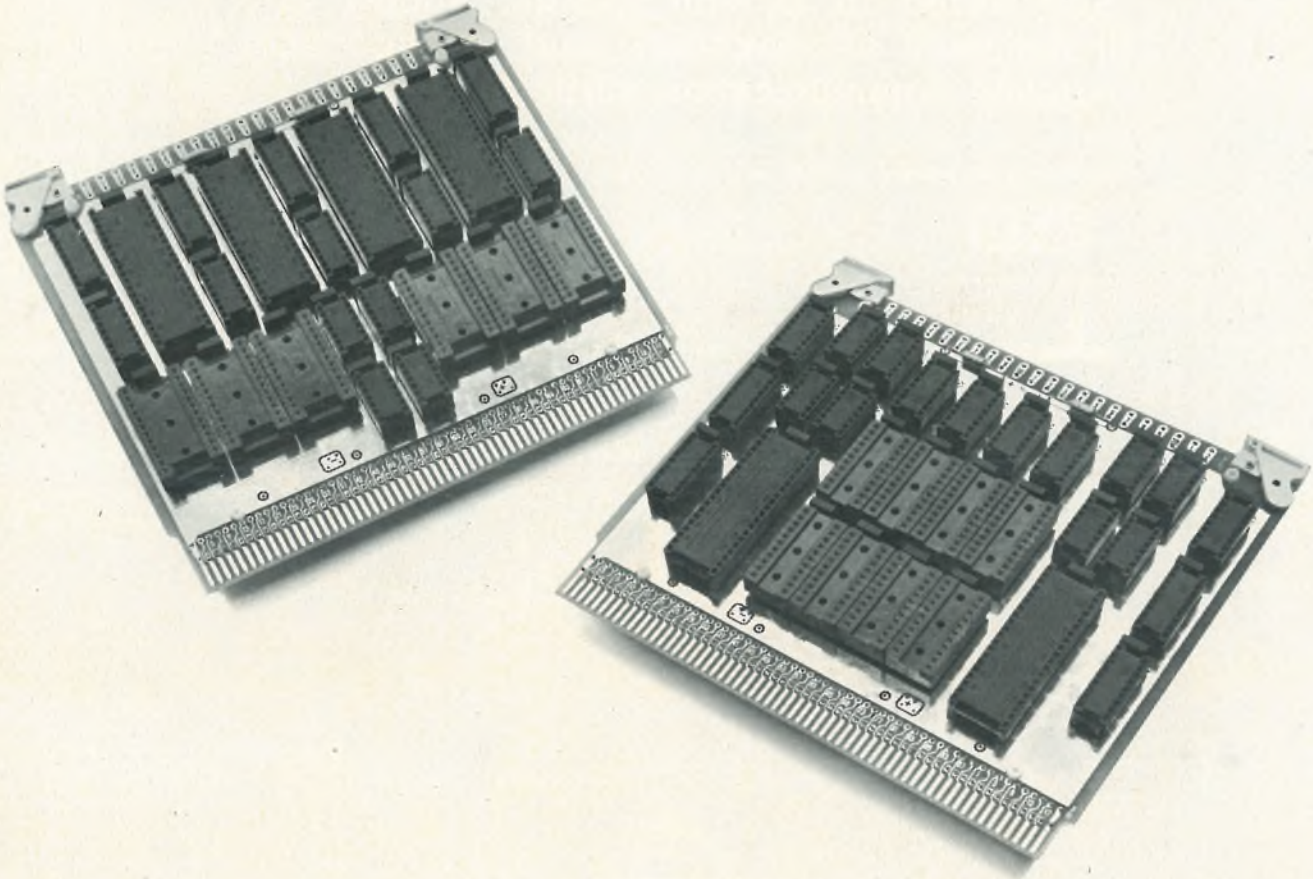
New socket cards for microprocessors.



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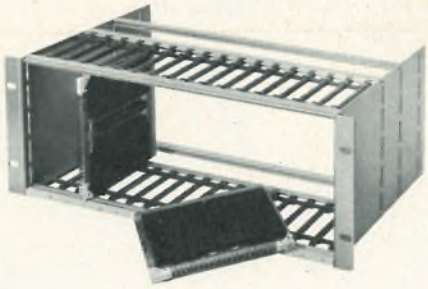

In addition, both cards provide a good ground plane for high-speed operation. They include a ceramic monolithic bypass capacitor at every socket, and provision for bypassing other voltages that may be required for chips. Power can be connected to various pins on LSI chips by means of solder tabs. And each card includes 22 built-in test points.

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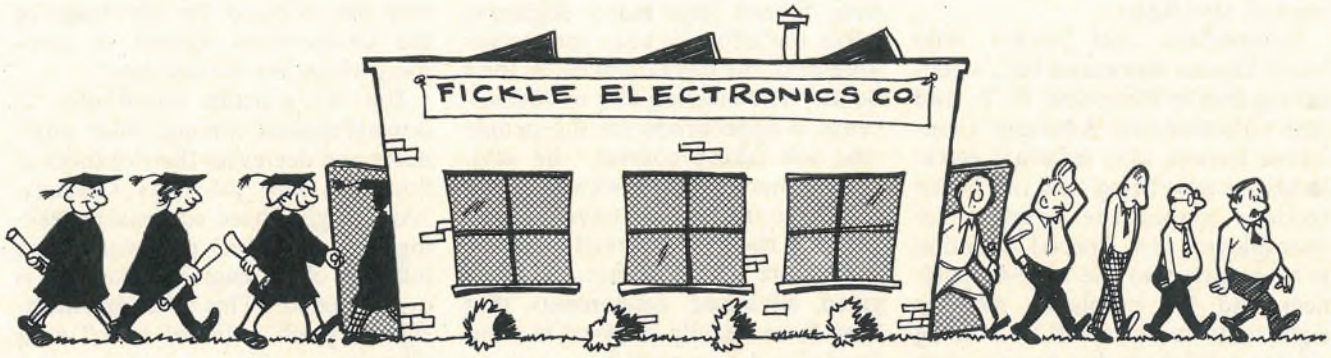

For EEs, insecurity begins at 40

IEEE report finds 'massive age discrimination' in the industry; institute plans position statement on employment practices

by Ron Schneiderman, New York bureau manager

Discrimination, an age-old problem, is becoming an old-age problem in the electronics industries. And for EEs, "old age" begins at 40. Senior engineers who are 40 and older face "massive age discrimination," according to data compiled by the Institute of Electrical and Electronics Engineers in its new manpower study, "The EE at Mid-Career—Prospects and Problems."

"Investigations, interviews, and general experience seem to point to the fact that engineers approaching their mid-career often suffer from one form of age discrimination or another." The electronic-equipment industry, in particular, shows "a substantial discriminatory bias against older engineers." That's the conclusion of Robert A. Rivers, president of Aircom Inc. of Union, N. H., and an IEEE director, who writes about age-discrimination patterns in the report [*Electronics*, May 15, p. 40].

Indeed, surveys taken earlier this year of the institute's 120,000 U. S. members, but not reflected in Rivers' data, indicates that a significant number of EEs feel discriminated against because of their ages—in promotions and layoffs, as well as in hiring.

The institute is planning some action, but it's questionable if industry will be moved by any IEEE action to change such practices, if and where they exist. IEEE general manager H. A. Schulke Jr. says that the *ad hoc* Committee for Professional Opportunities for Senior Engineers formed last July and recently absorbed into the IEEE Manpower Planning Committee, is "shaping up a statement—a true IEEE position" on age discrimination and senior-engineer employment practices.

The IEEE executive committee will get a draft of the position paper at its next meeting later this month. "If we like it, we'll release at that time," says Schulke. "If not, if there is some wording in there that some committee members don't like, then we'll have to rewrite it and take it before the board of directors, who are meeting in September."

Reassessment. Also, another survey is in the works. This one, to be mailed out to some 10,000 IEEE members over the next three months, will ask specific questions designed to more accurately assess age-discrimination practices—if any—in particularly hard-hit areas of industry unemployment, such as the vicinities of San Francisco Bay and Boston, as well as Long Island in New York State.

In addition, James J. Rago Jr., a former engineer and now a psychologist with the Cleveland State University College of Business Administration, and an IEEE Manpower Planning Committee member, is proposing a pilot program for the IEEE, aimed at helping older engineers determine for themselves how to maintain and market their engineering skills.

The program—primarily a set of questionnaires—will also help the engineer establish his own "early-warning system." Most important, says Rago, "an individual assuming responsibility for his own career needs to have data as to his organizational [market] situation and his responses to it."

Rago says his research into "apparent and concealed" obsolescence situations, across-the-board cutbacks, pension-dollar reductions, and high-salary eliminations has led him to believe that the dismissed older engineer "is not appropriately valuable. The judged-obsolete individual no longer has the market value within the organizational system he once had—an intolerable divergence has opened between himself and those in authority to judge him." An early-warning system for the mid-career engineer to "assess

his vulnerability to catastrophe" is needed, says Rago.

Meanwhile, Joel Snyder, who heads Snyder Associates Inc., a consulting firm in Plainview, N. Y., and IEEE's Professional Activities Committee liaison, says informal workshops are now being held in 12 IEEE sections across the country for unemployed EEs. Special attention is being given to the over-40 engineer and his problems. Another eight to 10 sections will be holding similar workshops by August, says Snyder.

Reasons. Donald D. French, director of continuing education at Northeastern University in Boston, points out that there are a number of reasons age discrimination is a problem in the electronics industries. One is that as the engineer ages, his salary increases as well, and he must remain aware of his cost-effectiveness.

But the responsibility of keeping an engineer in the mainstream of technology does not belong to the individual alone, says French. "The company he works for must also see to it that he is being used to the maximum. If someone is assumed to be over the hill and he is being given less-challenging work, then he may go over the hill."

Another organization fault may rest in the division of work: "The young hotshots will demand and receive the exciting, challenging projects and leave the drudges to the older people just because they are older."

As director of continuing education, French says many engineers make the effort to keep themselves abreast of the developments in their fields. "The ongoing fear of obsolescence is appropriate for the people who are taking courses," he says. "But, generally, those who do make the effort are also the ones who are active in their professional societies, read more than average, and are given advanced assignments that keep them heavily involved in a variety of updating work."

David Goldman, vice president of the Massachusetts Society of Professional Engineers, also talks about cost-effectiveness, but he refers to it as the engineer's "half-life," which he pegs at 10 to 12 years. "Unless an engineer keeps himself up with technology, his training is obsolete after about 15 years." Goldman also notes a correlation between age and continuing education. "The older a guy gets, the less he may want to go back to school—it's a self-defeating process."

Hans C. Cherney, personnel planning manager for IBM Corp.'s System Products division laboratory at Poughkeepsie, N. Y., and chairman of IEEE's Manpower Planning and Member Employment Committee, believes, as do others, that government and industry procurement practices "probably make one of the most detrimental contributions to the problems confronting the older engineer. The requirement to accept the lowest bid gives the bidder employing lower-paid engineers a cost advantage. This does not always turn out to be to the advantage of the Government agency or company which lets the contract."

But the practice contributes to unemployment among older engineers and decreases their chances of finding a new job, says Cherney. "Amazingly, those companies seeking new (younger) personnel often tell the older engineer that he is overqualified." This is "a very short-sighted profit point of view," adds Cherney.

Defensive. Understandably, individual companies are defensive about the issue. The response from a spokesman for Rockwell International Corp. is, "our policies prohibit discrimination on any basis, including race, sex, creed, as well as age." But most companies simply decline to comment on age discrimination, apparently on the theory that anything they don't say won't hurt them. Even the U. S. Labor Department says it is not aware of any age discrimination in the electronics industries, but is quick to add that it has no data to support the IEEE Manpower Planning Committee's findings one way or the other.

IEEE directors and companies, meanwhile, are keeping a close watch on the New York State Division of Human Relations' hearings into charges of age discrimination that were recently brought against Sperry Rand Corp.'s Sperry division in Great Neck, N. Y., by 64 of 88 engineers laid off in January. A state-agency spokesman says an initial investigation has justified scheduling the hearings. The New York Society of Professional Engineers has filed a friend-of-the-court brief in the Sperry case, while the IEEE has decided to stay out of it.

Curiously, Aircom's Rivers says he could find major instances of age discrimination only in the electronic-equipment industries. "In the aerospace industry, they lay off older people when they have to, but they hire them back." Laments Rivers, "it used to be said that engineering was a good career for life. That's not true any more." □

'Not the youngest anything'

"Mid-career is the time when you take stock. It's the time when you go from being the youngest everything to not being the youngest anything." Those opening lines, essentially, set the tone for the new 298-page IEEE manpower report, "The EE at Mid-Career—Prospects and Problems."

The report starts from a base of general trends and outlook in the influence of electronic technology and current aspects of demand patterns in EE employment. It delves into personal aspects such as problems of professional aging, character at mid-career, and dissatisfaction.

The survey also deals with over-specialization problems and corporate-policy influences. And it covers the considerations of EE educational requirements and the changing demands of the technology and the industry. Continuing education is discussed at some length, and a detailed look is taken into education's impact on job performance and its rewards. The report also sets some ground rules for self-evaluation. The soft-cover book is available from IEEE Inc., 345 East 47th St., New York, N. Y. 10017. Prices are $15 to members and $25 to nonmembers.

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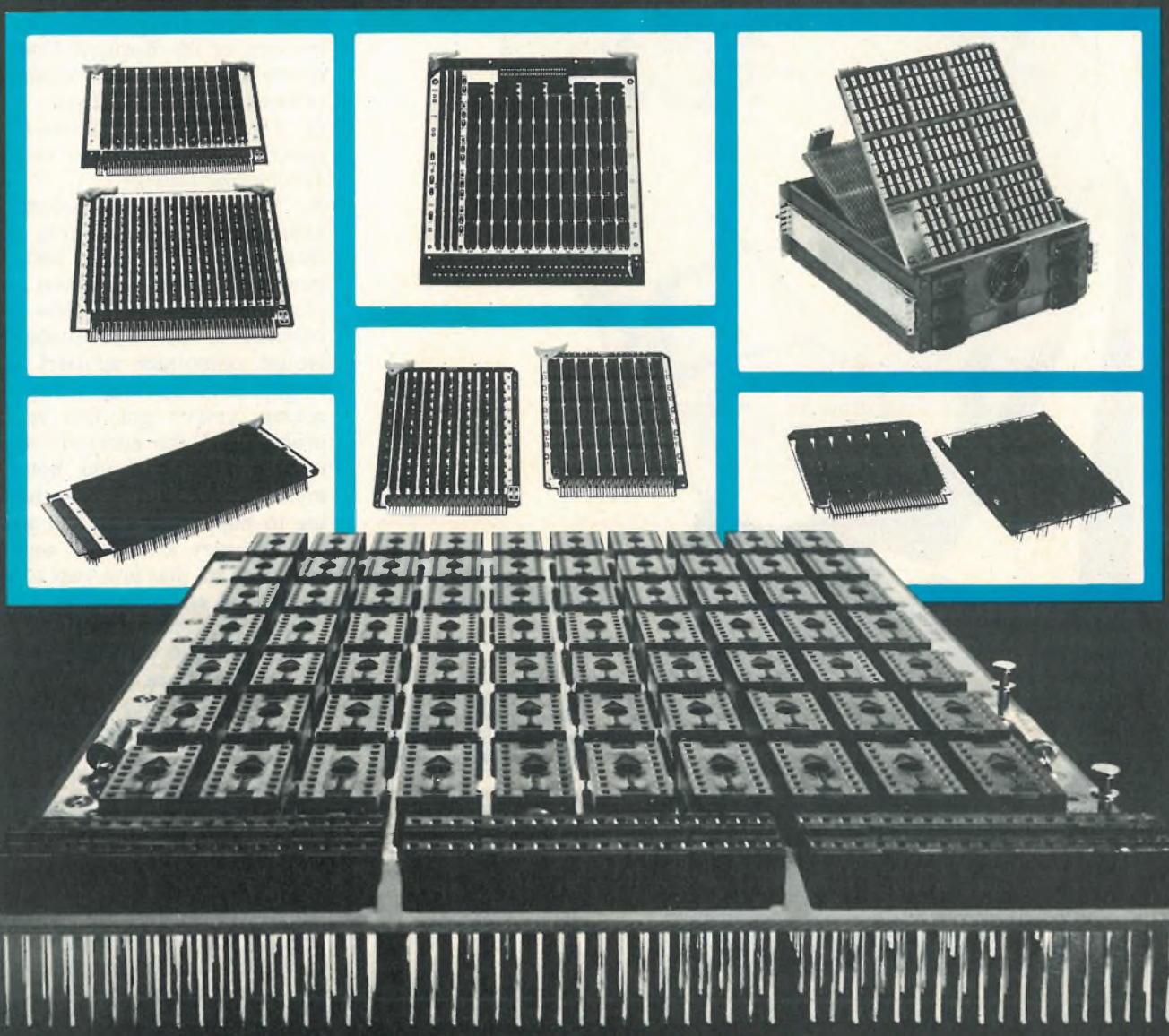

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Probing the news

PACKARD

The former Deputy Defense Secretary takes a close look from both sides at the relationship between Government and industry and how it is changing

Few leaders of the electronics industries have also been top Federal officials. One of them is David Packard. At 62, the chairman and cofounder of Hewlett-Packard Co. is being increasingly regarded as a White House insider with closer ties to President Gerald Ford than he had to Richard Nixon, whom he served for three years until 1971 as Deputy Secretary of Defense. In a recent interview with *Electronics*, Packard smiled, but did not deny reports that he will head the Republican fund-raising effort in President Ford's drive for the 1976 nomination and election.

As an electronics engineer who has served as both industrial entrepreneur and Government policymaker, Packard has developed some sharply defined views on the direction of the nation's economy, its technology policies, and the relationships between those people in the electronics industries and Government. Packard volunteered those views after his participation in a meeting of the Business Council, a national blue-ribbon organization of some 200 top executives.

Q.: There are increasing reports of an upturn in the national economy. What's your feeling?

A.: Well, there were mixed views expressed at this meeting of the Business Council about that. Some people thought the upturn in employment will be pretty slow. On the other hand, Alan Greenspan [White House economics adviser] said it might be surprisingly rapid. Of course, you've got two real key problems in the economy—the automobile industry and housing. I myself don't see anything that's going to happen to turn the automobile industry around in any short term. I think that in a year to a year and a half, the automobile industry could turn around. I don't see how it can happen this year.

Q.: Looking back on your Pentagon years, did you enjoy the experience? How would you compare it with private industry?

A.: Well, though we had some difficult problems and there were times when I questioned whether I had made the right decision in coming to Government, it was, overall, a very worthwhile exposure to the problems of our Government, and I am very glad I was able to do it.

Q.: In the relationship between the U.S. Government and electronics firms, you have seen the problems from both sides of the fence. How do you assess the Defense Department's operations in terms of its relations with industry and what the public gets for its defense dollars?

A.: I think the relationships between the DOD and industry have been fairly good, considering the complexity and magnitude of the problem. There has been a very strong trend toward the use of more standard commercial articles, with prices negotiated on the basis of market-established prices. That is a sound program. When you get into the other end of the spectrum—into very large development and pro-

curement programs—these, of necessity, have to be especially tailored.

They are often very complex programs, and one would like to normalize them, so to speak—that is, handle them in the same way large commercial jobs are handled—but it is very difficult to do that. A number of devices have been tried. The concept of total-package procurement was that if you could get a bid to do the whole job on some sort of competitive basis or a negotiated basis, that would work. But there was one severe shortcoming—it had to do with the central proposition that you simply cannot establish the price of a new weapon before it has been developed. You don't know what is going to be included in its capability.

Q.: How do you react to public concern about weapons cost? How do you view reports that the B-1, for example, will now cost upwards of $80 million, or that program development costs for an Awacs could hit $110 million each, or that one interceptor aircraft will cost $20 million?

A.: There is a great tendency to look at the cost of some of these new weapons without thinking in terms of their capability. You cannot isolate the question on the basis of cost only. For example, if a given weapon were to cost twice as much as another but were 10 times as effective, it would be a good bargain. And that is exactly what is happening in a great many instances. It is not the cost of the individual weapon; it's really what it cost to achieve a particular military objective. Another important aspect has to do with our view of how we value human life. We ought to consider that if it costs more lives to use less costly weapons, that is not a very good course for us to take.

It was for that reason that we had to make some changes which recognized that the development period should be administered with some flexibility—that it should be done under some cost-incentive-contract structure so that, as problems are encountered in the development, you have the opportunity to trade off performance for cost or performance for time. That was essentially the way the Air Force F-15 fighter contract was structured, and I think that program worked out very well.

The other approach, which is actually even better when it can be used, is a prototype program under which you select two contractors—you could hardly ever justify more than two—and give them the general-performance requirements of the new device, and then let them each develop it with as much freedom as possible. This was done with the Air Force A-10 close-air-support plane and the lightweight fighter.

Q.: Do you believe that the U.S. has too much of its high technology committed to defense?

A.: Let me answer that by going back a little. If you look at what has happened since World War 2, there is no doubt that the very high level of spending in electronics for radar, for microwave communications, and for a number of related areas, has been an impetus that brought about the development of some very important devices. You can start with the klystron tube or the magnetron traveling-wave tube. There were very few applications for TWTs outside the military in those early days.

In a more general sense, the very high level of electronics activity supported by the military generated a tremendously strong components industry here in the U.S. This was developed partly because of the large-volume requirements of the military and partly also by their high-quality requirements.

Moreover, military people were very wise after World War 2 to recognize that it would be to their advantage to support research and development. A good deal of that R&D was supported in colleges and universities and generally was broadly based—not oriented to specific weapons, but to the development of technology.

Q.: Do you believe that commonality of weapons among the individual services is desirable?

A.: Commonality is a very desirable thing if you start first with our NATO forces. It would be very helpful if all of our NATO allies and we had the same weapons. The procurement costs are likely to be less; interchangeability among forces is enhanced, and the support is made much easier.

Q.: What are your feelings about the balance between American high technology for defense and such nondefense applications as medical electronics, high-speed ground transportation, and other areas where R&D is not as heavily funded by the Government?

A.: The balance is much better than it was maybe 10 or 15 or 20 years ago. There is a great deal of very important high technology, particularly in electronics, that is supported by the private sector and doesn't depend upon military support. Our own company, for example, this year is spending $80 million to $85 million in R&D. About $200,000 of that will be Government-supported. For the rest of it, we are spending our own money on programs we think are important for the future. Bell Laboratories and IBM and a number of others are doing a tremendous amount of work in large-scale-integrated circuitry that is quite independent of Government support.

This is not to say that there are not some areas where Government support is important. In satellite communications, we are, mind you, just beginning to get to the point where it can be supported by commercial, nongovernment business. This was not possible five years ago, but we are just about at that juncture now. So, I see the trend as going in a very positive direction in that the electronics industries are less reliant on Federal R&D support now than they were 10 years ago. And I see no reason now why that trend shouldn't continue.

Q.: When you reflect on your experiences within the DOD, what do you consider to be the key issues there that the electronics industries could do, and should be doing, more about?

A.: Well, I think first, that industry and the DOD ought to continue to work to find ways to increase the efficiency of the procurement process. We spent a good deal of time on that issue while I was there. I think we made some progress, but I don't think we made as much as we should have. In particular, I think the fly-before-you-buy concept is something that ought to be pursued. It is off to a good start, but experience will show some ways that it can be improved. □

Companies

Mostek trims its sails

Texas semiconductor maker, having dropped financially draining calculator operation, places hopes on its 16-pin 4-k RAM

by Larry Armstrong, Midwest bureau manager

L. J. Sevin has bet his company, Mostek Corp., on the 4,096-bit random-access memory, and the outcome depends on whether or not it will be able to produce its 16-pin version of the 4,096-bit part. In that respect, the Carrollton, Texas, semiconductor maker finds itself in the same boat as many other 4-k manufacturers with fabrication problems. But Mostek also suffered from the millstone of its calculator subsidiary, Corvus—since dropped—around its neck, a disappearing market for its highly successful 4006 dynamic 1,024-bit RAM, and a serious fire at its wafer-fabrication facility in Texas.

Mostek actually had an early lead in the 4-k race as Texas Instruments Inc. had process problems with its 22-pin part. But as TI worked out its bugs, Mostek developed reliability problems, forcing it to lose the market back to TI and Intel Corp. And industry observers believe that 90% of today's shipments are still 22-pin parts.

All this trouble adds up to a projected second-quarter loss—its first since 1971. President Sevin, a conservative, yet outspoken Texan, believes that 4-k yield problems have been solved. "Given product availability, which we haven't had, and given an improvement in the economy, we will get back on the growth track," he says. "It won't be the explosive one we had before—I'm not going to let that happen again—but it will be 15% or 20% a year." First-quarter profits were $645,000; last year they were $4.2 million.

Mostek lost what was sizable business from Hewlett-Packard Co. because of surface-reliability problems, but the firm is known to be shipping 4-k RAMs to Digital Equipment Corp., Burroughs Corp., NCR Corp., Control Data Corp., Sycor Inc., and Datapoint Inc. Sevin expects to sell $1 million worth of 4-k parts this year, or about a quarter of a total market he estimates at slightly over 4 million units. He will not divulge the firm's shipping rate, but industry sources put Mostek's current output at 5,000 to 10,000 parts per week. However, skeptical observers point out that Mostek would have to produce 20,000 parts a week for a year to reach 1 million—a tall order.

Mostek's standard production part is a 150-by-176-mil metal-gate chip that's barely making money for its developers. "Our friends across town [TI] have brought prices down, so the 4-k is not going to be a big bonanza for us." Sevin comments, "But the part's now marginally profitable." Sevin has high hopes for a photo-reduced version going into production. It measures 127 by 149 mils, yielding half again as many possible good dice per wafer as the current production part. And, significantly, Mostek has changed the substrate bias to −5 volts, instead of the earlier −9 V, making it compatible with Intel, Motorola, and Fairchild second-source versions.

Processing. Some of Mostek's problems apparently stemmed from the firm's SPIN—for self-aligned polysilicon interconnect n-channel—process [*Electronics*, Dec. 18, 1972, p. 30]. While it yields a tiny, contactless cell, the complex metal-gate process uses either seven or nine masking steps, depending on who's counting. "It's uniquely suited for one-transistor cells, and will also be used in our 16-k RAM," scheduled for first-quarter 1976 sampling, says Robert B. Palmer, vice president of Mostek's computer-products group.

In a new model 200-ns 4-k RAM, which will be sampled later this

Checking. Berry Cash, left, executive vice president, and L.J. Sevin, president, show off Mostek's checkbook calculator.

year, Mostek has eschewed SPIN and gone to silicon-gate n-channel. "Our fast 4-k will be a complete redesign," Palmer says. "We went to silicon gate to get immediate second-sourcing for the high-speed version.

Memories accounted for just about half of Mostek's $60-million sales last year. A mere 50,000 4-k devices contributed to that, but by far the dominant part was the firm's proprietary 4006 dynamic 1-k RAM, of which it shipped more than 4 million units, estimates Sal Accardo, a vice president and analyst for William D. Witter Inc., the Wall Street institutional-brokerage firm.

Prices and also the profits on the 2102 static RAM, however, dipped as the firm was moving production of that static RAM from Dallas to Massachusetts and back again. Mostek's plans call for process improvements that will allow 2102 profitability, even at today's prices, which run as low as $1.75 each in plastic packages.

Dumping Corvus. Yield problems on the 4-k RAM were not Mostek's only woes last year. Corvus Corp., its consumer-products subsidiary, lost an estimated pretax $2.3 million, Accardo says. The decision to get out of Corvus was purely a financial one. Rights to manufacture the calculator line, and to market under the Corvus label, went to Colex Ltd., Hong Kong, a long-time chip customer. Mostek retained the digital clocks as well as a checkbook calculator [*Electronics*, April 3, p. 40], products that it will market under the Mostek brand name.

Bad business forecasting and a 1973 decision to expand front-end capacity led Mostek to the outright purchase of a $2.6 million plant in Lowell, Mass., a building that's now up for sale. At the same time it purchased its Carrollton facility for $1.5 million cash, and spent an additional $2 million on capital improvements. But working off the Corvus inventory and refinancing the Carrollton plant has put it back in a comfortable cash flow position. It's paid off all debt against its $7.5 million line of credit, and has accumulated "substantial" cash reserves, says Vin Prothro, financial vice president. □

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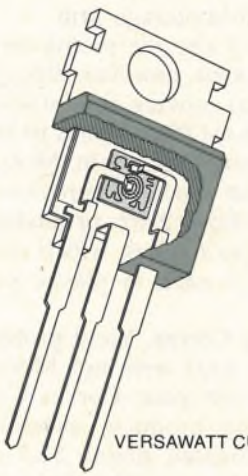

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Type	Beta	Vceo	NPN/PNP
	TO-3 hermetic package		
RCA8350/50A/50B	1000 @ 5A	40/60/80	PNP
2N6383/84/85	1000 @ 5A	40/60/80	NPN
2N6055/56	750 @ 4A	60/80	NPN
RCA1B07/08	1000 @ 5A	80	NPN/PNP
	Plastic VERSAWATT: cost- and space-saving		
RCA8203/3A*/3B*	1000 @ 3A/1000 @ 5A*	40/60/80	PNP
2N6386/87*/88*	1000 @ 3A/1000 @ 5A*	40/60/80	NPN
2N6530/32/33*	1000 @ 5A/1000 @ 3A*	80/100/120	NPN
2N6531	500 @ 3A	100	NPN
RCA120/21/22	1000 @ 3A	60/80/100	NPN
RCA125/126	1000 @ 3A	60/80	NPN
	TO-66: space-saving hermetic		
2N6534/36/37*	1000 @ 5A/1000 @ 3A*	80/100/120	NPN
2N6535	500 @ 3A	100	NPN

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transistors alone.

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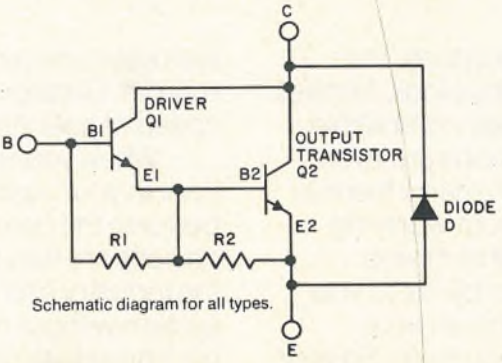

Schematic diagram for all types.

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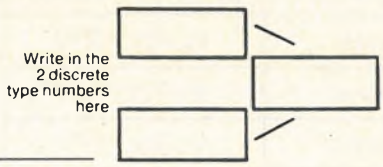

Application:_____

New design? ☐ Old design? ☐

Est. annual requirements_____

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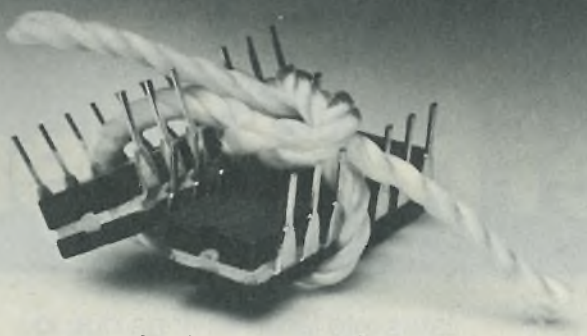

The 54C/74C and the 4000 series

Actually, it's no great surprise. The 54C/74C and the 4000 series logic families have always been electrically compatible and now many of the functions are even pin-compatible, so you can marry them in your very own system without worrying about a family feud. You'll find mixing these two CMOS series beneficial to you in many ways. First, you'll have more available functions to choose from. So your chances of finding the right one are better. This will minimize the number of CMOS devices you need to implement the logic. And second, you can take advantage of the best personality traits of each series to optimize your system's performance. Key features such as higher guaranteed noise margin. Greater output drive. And higher speed of specific CMOS functions.

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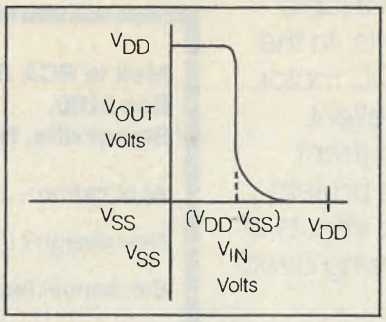
DEVICE	OUTPUT SINK CURRENT	MINIMUM
4102A	I_{OL} (V_{OL} = 0.5V)	0.06 ma
4042A	I_{DN} (V_{OL} = 0.5V)	0.20 ma
4001A	I_{OL} (V_{OL} = 0.4V)	0.30 ma
All 54C/74C	I_O (V_{OL} = 0.4V)	0.36 ma
4071B	I_{DN} (V_{OL} = 0.4V)	0.40 ma

This illustrates some of the variations in output drive current specified in the 4000 series, and how the 54C/74C fits within the range.



This CMOS transfer characteristic for single level gate functions is for all CMOS logic families. It is the commonality of this characteristic which is the basis of CMOS inter-family compatibility.

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Photovoltaics

Federal funding picture brightens

Pressure from industry and Congress leads to vast increase in proposed solar-cell procurement, and silicon gets the call

by Larry Marion, Washington bureau

Production of photovoltaic cells for terrestrial power generation will probably jump by three to four orders of magnitude by 1985. That will happen if a drastically revised internal 10-year research-and-development project plan, to be sent to Congress before June 30, is approved by the Ford Administration and Congress.

Officials of the Energy Research and Development Administration have established a goal of achieving industry production equivalent to 500 to 1,000 megawatts a year by 1985, compared to the current annual production equivalent of 100 kilowatts by single-crystal silicon cells.

But ERDA's action, which backs silicon technology and relegates gallium arsenide and cadmium sulfide to laboratory status, has dismayed and puzzled companies working in those thin-film technologies. It also has left them questioning the wisdom of the decision. In the words of Lawrence W. James, a scientist at Varian Associates, the decision is a "very serious" mistake.

At least for the silicon people, the money is on the way, says Rep. Mike McCormack (D-Wash.). Rep. McCormack told industry officials at a recent conference, "We have recommended an appropriation of close to $150 million [for all solar energy work] for fiscal year 1976." Photovoltaic R&D will receive $29.5 million, up from $8 million in 1975, he noted, if the Senate and the Ford Administration go along with his energy R&D subcommittee.

New role. Leonard Magid, director of ERDA's photovoltaics branch, says, "Our new role is to get industry involvement in photocell production as soon as possible." A more modest photovoltaics R&D plan was presented to industry officials in February, but that plan was "hopelessly misguided," says one 10-year veteran of industry's research into low-cost silicon research.

Joseph Lindmayer, president of Solarex Corp., Rockville, Md., a major producer of photovoltaic cells for terrestrial use, says, "that type of plan totally violated the economics of the situation. But the [ERDA] philosophy has changed. They are now paying more attention to economics instead of technology. More than 50% of the challenge is economic."

Triple time. To meet that challenge, Magid and his staff have prepared a new plan that "greatly accelerates" the prior plan by "stimulating" the industry to increase production and thereby reduce prices. To reduce the price of solar-cell power from $20 per watt now to 50 cents by 1979, ERDA officials hope to buy enough solar cells to produce nearly 2 MW in the next four years—three times the February projection. ERDA's Magid says, "We want to boost production by a factor of 2.7 to 3 each year."

To further guarantee a market for solar-cell producers, ERDA has enlisted other Federal agencies. The Defense Department, the Coast Guard, and the National Oceanographic and Atmospheric Administration are reviewing their remote-

SOLAR-CELL PLANNING GOALS

	FISCAL YEAR 1976	77	78	79	80	81	82	83	84	85
Engineering and analysis		Prelim. design specs		Detailed design specs						
Demonstrations	75 kW	300 kW	500 kW	1 MW	2 MW	4 MW	7 MW	10 MW		
Large-scale production	75 kW	150 kW	250 kW	500 kW	1 MW	2 MW	3 MW	4 MW		
Test and standards	Test facility operating			Solar cell performance specs						
R&D (other than silicon)					10% efficiency thin film (demo)					$100–$300/kW thin film feasibility (demo)

Targets. This chart of planning milestones for solar cells shows the responsibilities of NASA's Lewis Research Center in color. Other work is to be done at JPL.

location-power needs to determine where solar-energy technologies could be applied.

ERDA's decision will mean work for two NASA installations. The massive test-and-evaluation program will be based on a research project at NASA's Jet Propulsion Laboratory. That project, in which 10 requests for proposals went out in February [*Electronics*, March 6, p. 29], involves R&D aimed at reducing the cost of generating electricity with silicon cells. And NASA's Lewis Research Center will buy additional solar cells along with other components, such as direct-to-alternate-current converters, and package them with JPL procurements. Lewis will test, evaluate, and write specifications for cells and systems to be used by other agencies.

As for advanced-technology cells—thin-film-semiconductor compounds, such as CdS and GaAs—they will receive research funding from the National Science Foundation, Magid says, though this may change if technology improves. "At this point in time, advanced-technology research is still in NSF. There will be a lot of basic research, but no demonstration and development."

However, for those making thin-film cells, ERDA's decision is controversial. They are predicting 10% efficient thin-film cells in 1980. The Institute of Energy Conversion at the University of Delaware has achieved 7% efficiency, and Karl Boer, institute head, says 10% is within reach.

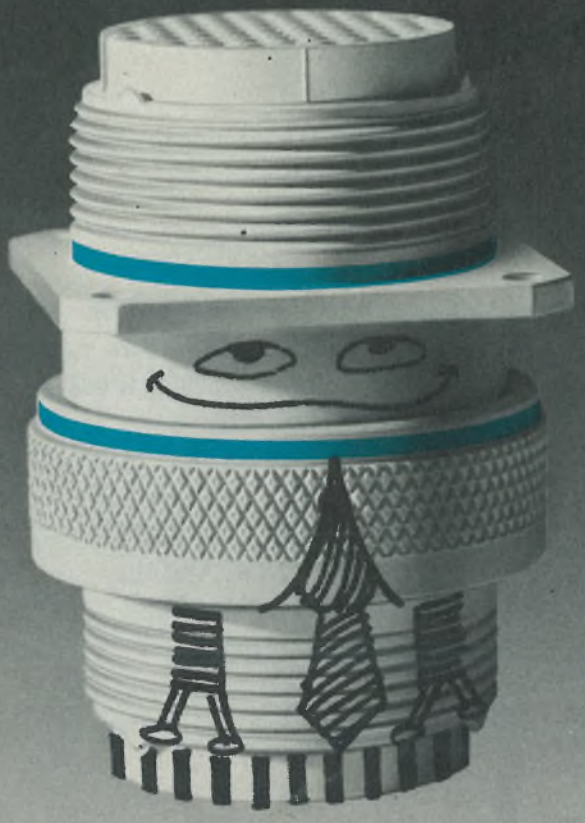
Advanced technology is too far away, counter silicon makers. Arthur I. Mlavsky, chief scientist at Mobil Tyco Energy Corp., says, "The silicon cell is proven without dispute. The real key is, how does one make a system inexpensive?" Gene Ralph, vice president of Spectrolab, Sylmar, Calif., formerly the Heliotek division of Textron, which was recently purchased by Hughes Satellite Corp., says, "Industry has to think about today. To get funds, you can't work with a gallium arsenide or cadmium sulfide or other concepts. You can't get much business out of it." Ralph says, "With present technology, $2-a-watt solar cells is a goal in our pocket." Cells at 18% are "right around the corner," he adds. Lindmayer says that his cells have broken the 20% efficiency barrier. □

Is ERDA making a mistake?

When the U.S. Energy Research and Development Administration decided to put its short-term money on silicon for developing photovoltaic cells, the reaction at Varian Associates was bewilderment.

Lawrence W. James, one of the investigators on Varian's gallium-arsenide concentrator solar-cell project, says, "When we talked to officials of both ERDA and the National Science Foundation at the photovoltaic conference in May, I thought they were going to give as much attention to gallium arsenide as they have to silicon—financially. If ERDA is going to be the main channel for funding, and that is devoted to silicon, while NSF picks up the so-called 'esoteric' cells, I think it is a mistake, and a very serious one."

"The fact is," he says, "we are producing high-efficiency gallium-arsenide cells on a pilot line and will be building a working array by summer. We could start manufacturing cells now for any sort of field-developmental work." To get costs down to what is considered the break-even point with conventional power plants—$500 per kilowatt at peak—all that would be necessary is a shift to production-line volumes, James says. Referring to a paper on the economics of concentrator arrays by B.L. Slater from NASA's Lewis Research Center, James breaks down the $500-per-kilowatt peak into $200/kW for the gallium-arsenide cells and $300/kW for the reflector and/or lens-array system. This comes to roughly 20 cents per watt for the cells, 30 cents/W for the array, and 50 cents/W for the entire system. Instead of looking for silicon or cadmium-sulfide cells of the lowest possible cost per square meter, says James, "we should be looking for cells capable of operating with solar concentration with the lowest possible cost per watt of power output."



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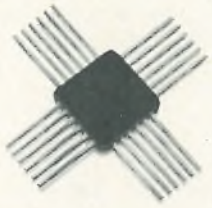


The first sub-nanosecond standard ECL series is here.

F100K.

The F100K family represents a quantum advance in ECL performance and ease of design.

Developed in cooperation with major mainframe manufacturers, this remarkable new ECL series will benefit many other maximum data-rate systems as well—including processors, instrumentation and digital communications.

And of the 24 F100K devices initially scheduled for production, 8 are available now.

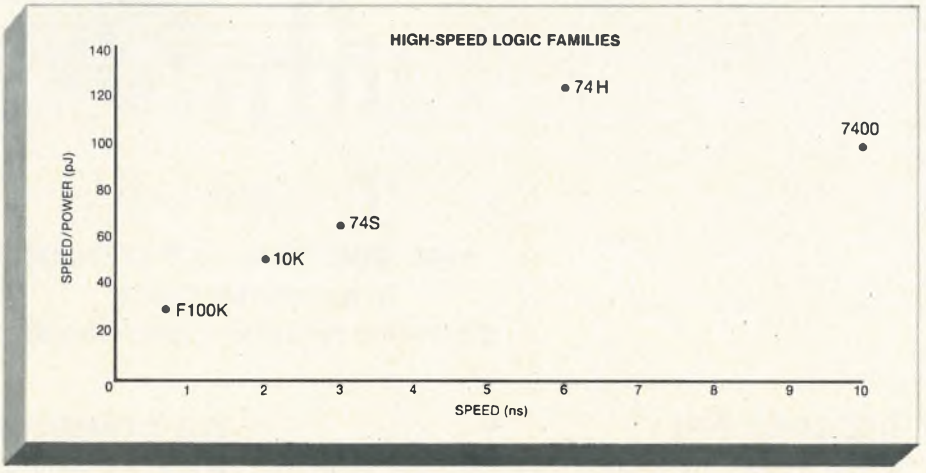
F100K. The first standard family of superspeed ECL.

What makes F100K so advantageous to use?

1. *Speed, of course.* Instead of the typical 2.0 ns for conventional 10K ECL gates, the typical speed for F100K is 0.7 ns. With a minimum of 0.4 ns and a maximum of 0.95 ns.

2. *Speed/power.* Despite its blazing speed, F100K affords a speed/power product of just 28 pJ for SSI functions—about half the level of conventional 10K.

For more optimized MSI and LSI functions, the typical propagation delay actually drops below 0.5 ns. And the speed/power product falls below 5.0 pJ per gate.



3. *Full compensation.* Because F100K is fully compensated for temperature and voltage variations, the family provides almost constant DC noise margins for a more reliable system. It also provides a tighter AC window for faster clock rates with fewer timing problems.

4. *Manageable edge rates.* The gate current specified for the F100K series provides a rise and fall time about equal to propagation delay. In fact, noise-generating dV/dt is slower than in Schottky logic families.

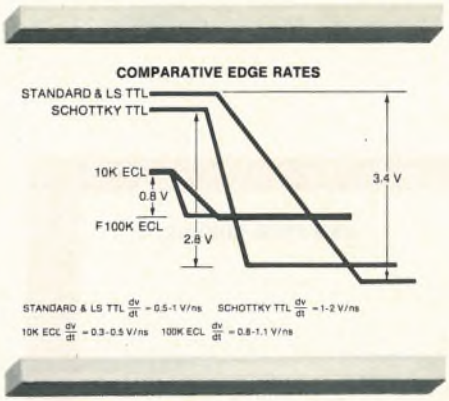
5. *Isoplanar II fabrication.* Designed primarily for MSI and LSI complexity with a minimum of SSI functions, the F100K series is produced by Fairchild's high-density Isoplanar II process—proven for high performance as well as high yield and dependable delivery.

6. *Compatibility.* Due to voltage compensation and standard logic levels, F100K is compatible with existing slower ECL families.

7. *Memory available.* No need to worry. The F100415, a 1024x1 RAM, will be available this Quarter.

24-pins. The shape of ECL to come.

To these basic advantages, the F100K's universal 24-pin package contributes an addi-

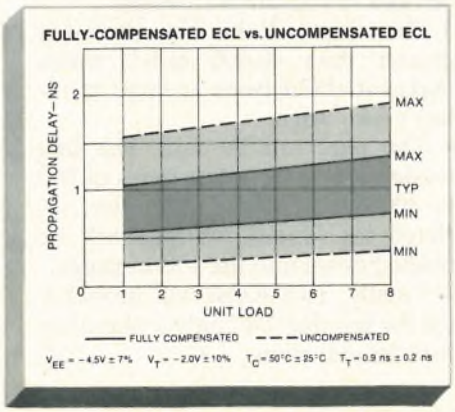


tional list of benefits. Among these are:

8. The first package format oriented to the I/O and performance requirements of super high-speed MSI/LSI.

9. The opportunity for gate densities 50% higher than conventional 10K ECL.

10. The ability to gain more flexible use from multi-purpose functions—for a simplified device inventory. For example, the 24-pin F100K Quint Gate F100102 can replace the functions of any one of four different quad gates in 10K ECL—with greater logic density besides.



The family that's planned together plays better.

Because our F100K series was planned with the cooperation of major users, it has been designed throughout with the user in mind.

For example:

11. Common pins are always placed at the same pin location. To allow maximum use of CAD in board layout.

12. All functions flow through the package without crossover. Outputs are always located in the same general pin area. Inputs, too.

13. Inverting outputs between independent functions are placed adjacent wherever possible to permit maximum use of the wired-or tie, even at sub-nanosecond speeds.

14. Wherever possible, mode control pins are provided to change the character of the functions. They may be controlled by standard logic levels or may be hard-wired to ground or power supply.

In fact:

Without exception, pin-outs have been assigned on the basis of system requirements and performance—not fabrication convenience.

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Fairchild F100K ECL Series

DEVICE	DESCRIPTION	1K	AVAILABILITY
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100102FC	QUINT OR/NOR	4.50	NOW
100107FC	QUINT EXC OR/NOR	7.15	NOW
100114FC	QUINT LINE RECEIVER	5.75	NOW
100117FC	TRIPLE 2-WIDE OAI	8.00	NOW
100118FC	5-WIDE OAI	6.23	NOW
100150FC	HEX D LATCH	10.70	NOW
100151FC	HEX D FLIP FLOP	13.35	NOW
100112FC	LINE DRIVER		3RD QTR 1975
100123FC	BUS DRIVER		2ND QTR 1975
100130FC	TRIPLE D LATCH		2ND QTR 1975
100131FC	TRIPLE D FLIP FLOP		2ND QTR 1975
100136FC	COUNTING REGISTER		1ST QTR 1976
100141FC	8-BIT SHIFT REGISTER		3RD QTR 1975
100145FC	16 x 4 R/W REGISTER FILE		4TH QTR 1975
100155FC	QUAD MUX/LATCH		3RD QTR 1975
100158FC	8-BIT SHIFT MATRIX		3RD QTR 1975
100160FC	DUAL 9-BIT PARITY		3RD QTR 1975
100164FC	16-BIT MULTIPLEXER		3RD QTR 1975
100165FC	PRIORITY ENCODER		3RD QTR 1975
100170FC	MULTI-PURPOSE DEMUX/DECODE		3RD QTR 1975
100171FC	TRIPLE MUX w/ENABLE		2ND QTR 1975
100181FC	ALU		1ST QTR 1976
100415FC	1024 X 1 RAM		2ND QTR 1975

For more detailed information on the entire F100K series, write or call your Fairchild Sales Office, Distributor or Representative right now.

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Memories

The 16-k RAM is coming

As an inexpensive and easy-to-use large-capacity part, it could steal market thunder from 4-k devices

by Laurence Altman, Solid State Editor

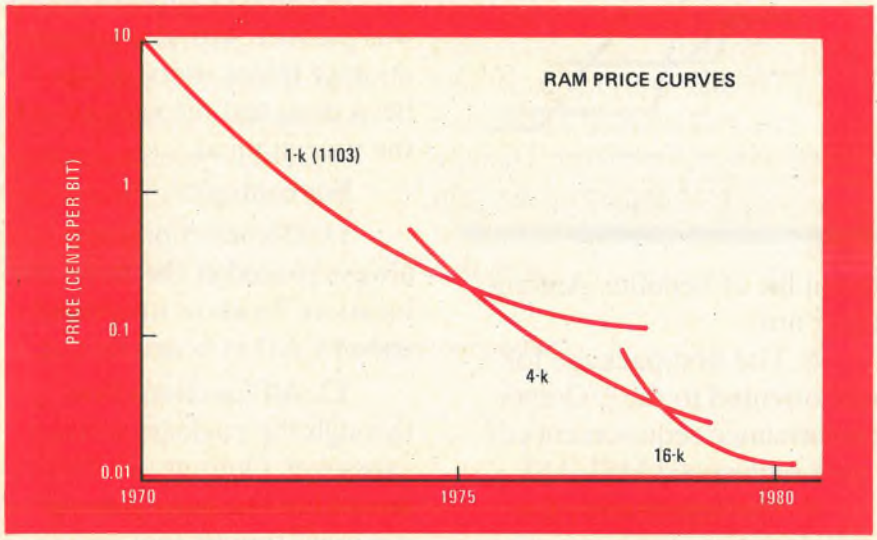
The memory industry is beginning to talk seriously about the 16,384-bit random-access memory. Not that the big RAM is about to burst on the scene in volume, but 16-k development programs are far more advanced than most people have thought. Gordon Moore, Intel Corp. president, says a 16-k device "may emerge before the end of the year—either from here or somewhere else."

When the device does make its appearance, even in prototype form, it will cause major reprecussions among suppliers and users. That's because the 16-k RAM clearly will be the cheapest main memory for the next five years. And it will deliver mass blocks of randomly accessible bits of memory on a single easy-to-use chip in a package everyone is familiar with.

But just as this will bring joy to users of the 16-k product, it could have dire consequences for manufacturers still struggling to get their 4,096-bit units into volume production—much in the way the 4-k RAM slowed the growth of the 1103 1-k-memory market.

Why so fast? Suppliers have been able to move fast on the 16-k design because they have made such rapid progress on the n-channel silicon-gate process, which can be quickly reworked into a 16-k format. Equally important, the industry has learned to build larger and larger defect-free chips—especially ones containing memory—at good yields, so that a 200-by-200-mil memory chip is well within the production capability of a modern facility for fabricating silicon-gate devices.

Perhaps most responsible for the solid foundation of today's 16-k programs is an apparent agreement on a package type—something that's still not yet settled for the 4-k RAM. Most manufacturers now agree that the splintering of the market as 4-k package types proliferated slowed the utilization of the memories.



The consensus on package type for the big RAM is a 16-pin multiplexed design. Since most users—especially mainframe-memory builders—want maximum board density, the 16-pin design seems optimum, especially since the 16-k part would have to be multiplexed, anyway, if it is mounted in an 18-pin package. Of course, the possibility remains for a nonmultiplexed 16-k version—an option still apparently on the minds of designers at TI, who have not yet committed themselves to a 16-k package type.

Specifications. Memory designers disagree over just when the 16-k RAM will become a volume product, but they are in surprising agreement on its technical details. They are:

- The 16-k RAM will be built with a single-transistor or switch-capacitor-cell design by an advanced n-channel silicon-gate process that's been tightened so that cell sizes will be in the range of 1 to 2 square mils, or about half the size of today's 4-k memory cells.
- The device will probably be put in a 16-pin package—with multiplexed inputs and common data-input/outputs—sort of, as Moore puts it "a combination of Mostek's 16-pin and TI's 18-pin 4-k design."
- The chip will be big, probably greater than 40,000 mils^2, which makes it about twice as large as today's 4-k design.
- The part will be fast. The first models will have access times of 200 to 300 nanoseconds, and, later, selected high-speed versions will be pushed down into the 150-ns range.
- Finally, 16-k RAMs will probably sell for less than $10 only a year after their introduction. □

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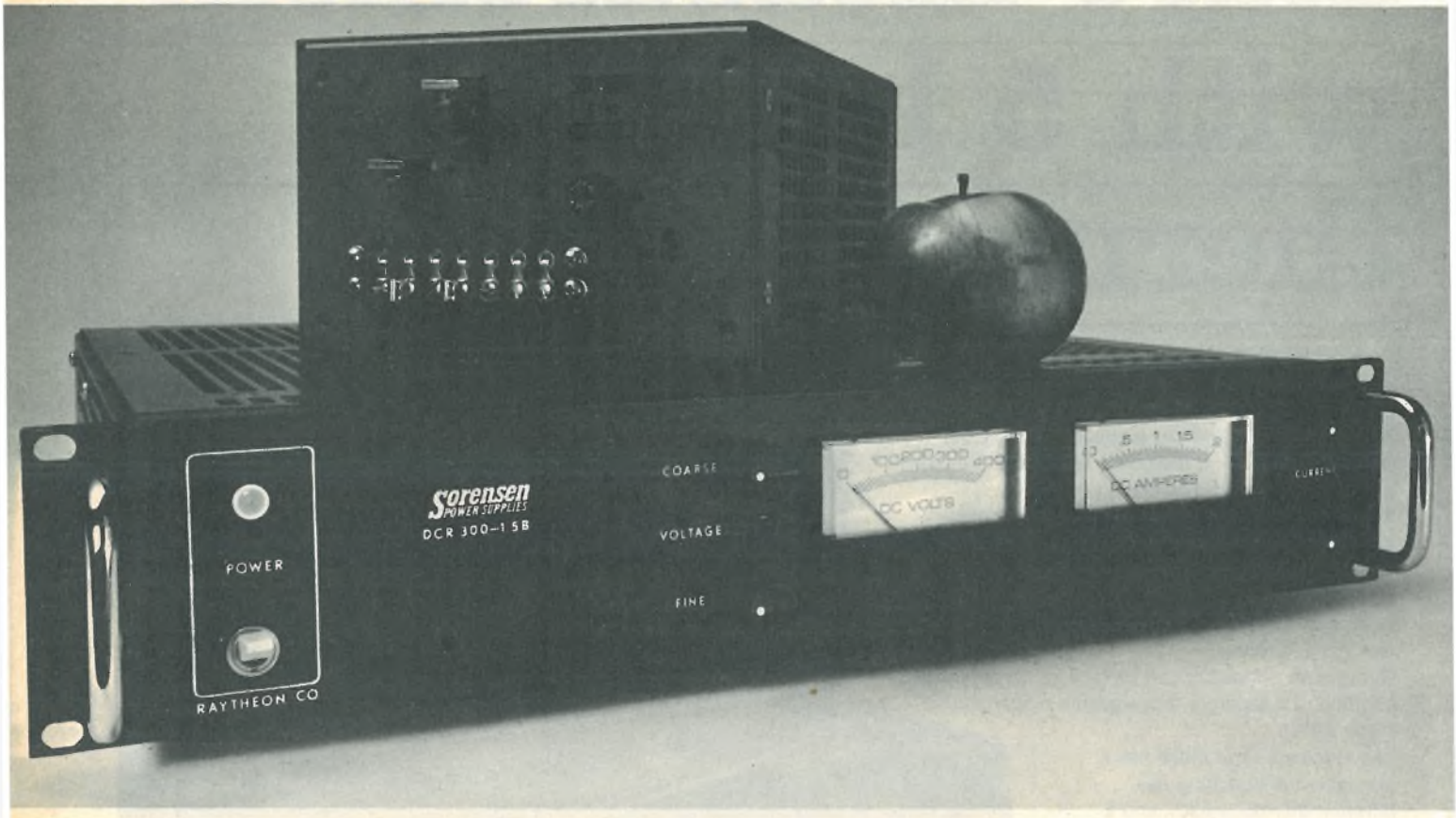

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That's why we've decided to go over a few socket basics.

THE REASONS... AND THE RISKS.

All sockets serve basically the same purpose: they allow you to replace ICs without damaging either the IC or the PC board. In so doing, they make both design changes and field service economically feasible for you and your customer.

There's only one problem. When a socket fails, troubleshooting can be a nightmare – to a point where you'd have been better off without sockets in the first place. So it pays to be sure that the sockets you buy are right for your application.

CHOOSING THE RIGHT SOCKET.

Buying the right socket is much more than a matter of profile and price. It's matching the right one to the demands of your application.

For low-cost, high-volume products where the risk and consequences of socket failure are minimal – and where repeated IC insertion and high retention aren't required – buy the cheapest sockets that will do the job properly.

But for high-shock and vibration environments, or other situations where performance is critical, by all means get the best sockets money can buy.

At Augat, we understand these differences. That's why we make sockets for both needs, in the widest range of sizes and specifications in the industry – from 6 to 40 contacts, on .300", .400", and .600" centers. These include low-profile, LED, and test sockets, socket carrier assemblies, and more – with PC, wire-wrapping, and solder pocket terminations.

And thanks to high-volume, automated production economies, these sockets are priced competitively despite many features you can't get elsewhere.

SMALL POINTS MAKE A BIG DIFFERENCE.

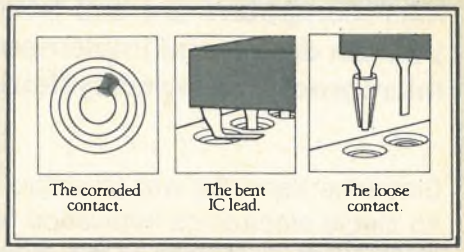
It's amazing how the finer points of socket construction can affect reliability.

Take the material the contacts are made of. For repeated IC insertion and good retention no other material can match the beryllium copper used in all Augat PC sockets. Cost alone leads other producers to use other materials.

The Augat method since 1965.

Designs vary, too. Among low-priced sockets, Augat's new low-profile series grip the IC lead along *both* flat sides, rather than by the edge, for best contact. And they'll take the full range of lead sizes, too.

Among premium sockets, Augat's Series 500 and 700 are the only ones in the world to include the two-piece machined contact assembly designed and perfected by Augat. While stamped "equivalents" abound, their looser tolerances have given rise to a series of pitfalls avoided by the Augat design:



The corroded contact. The bent IC lead. The loose contact.

In the important matter of flow soldering, both series again provide a decisive edge. The closed-end construction completely eliminates the possibility of flux or solder wicking.

These distinctions may seem small. But taken together, they're a good indication of how well the sockets you buy will stand up under long-term use. And in a market flooded with lookalikes, they're something to shop for.

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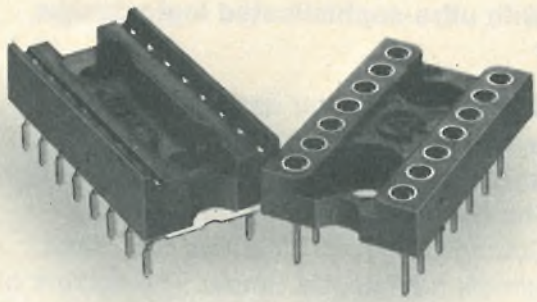

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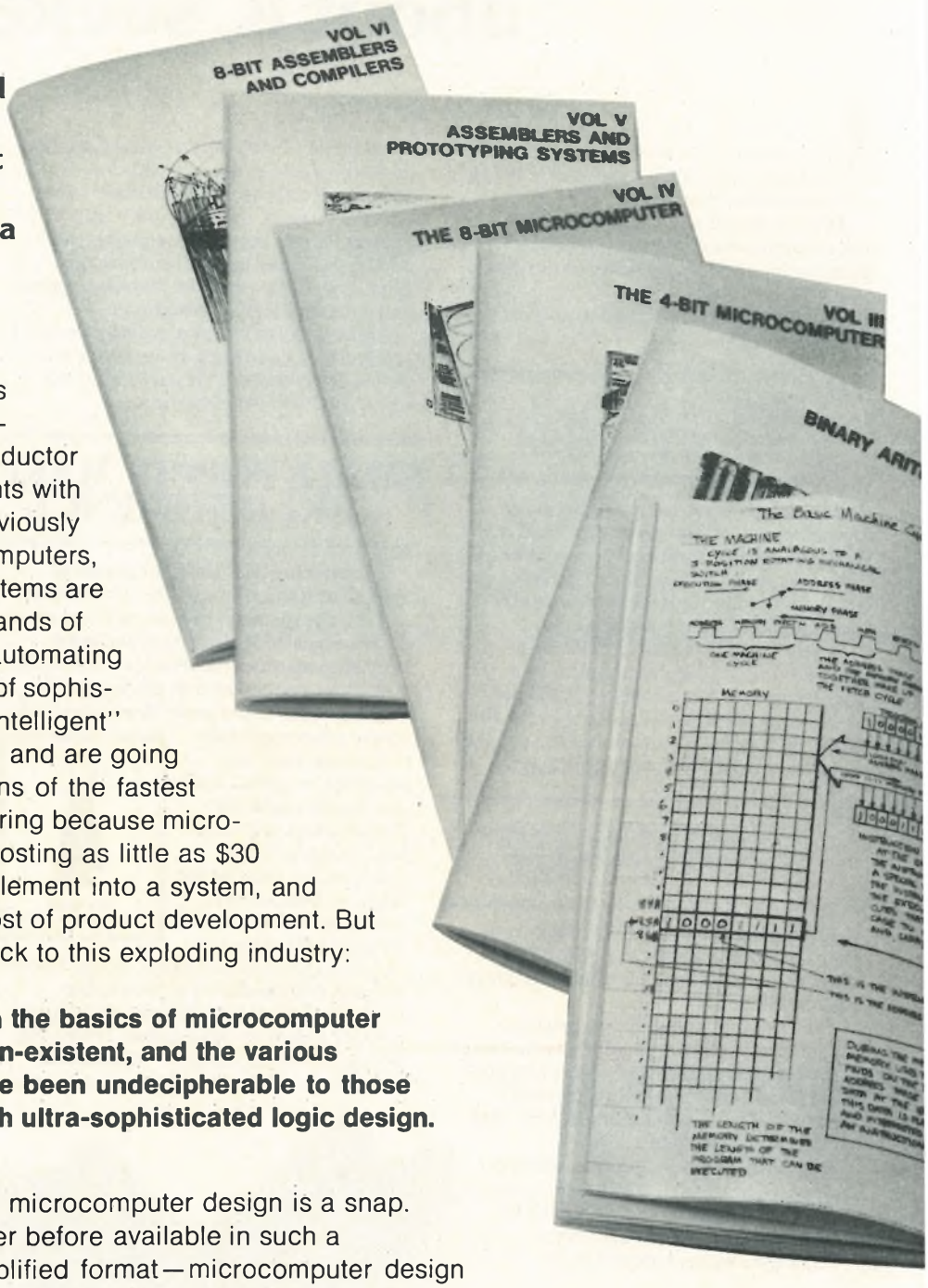

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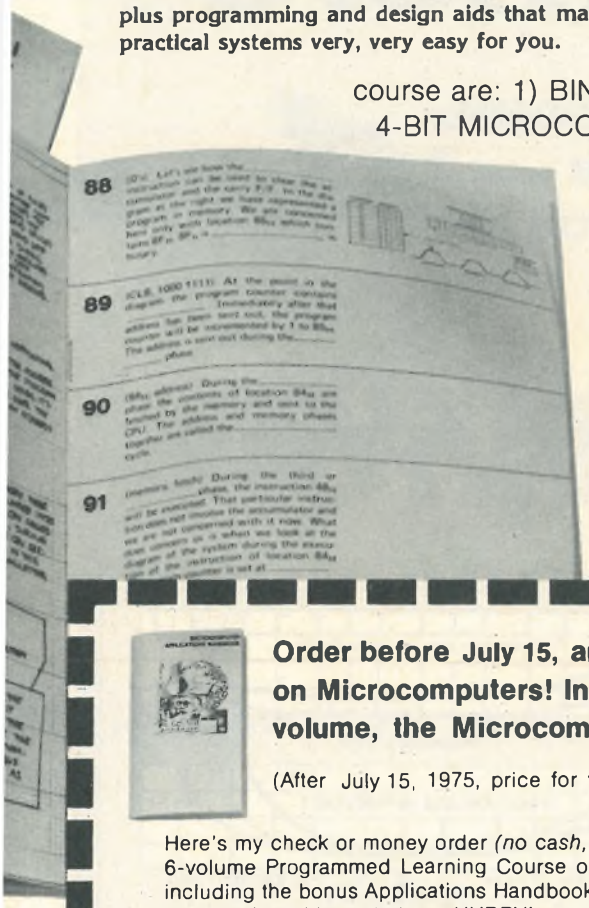

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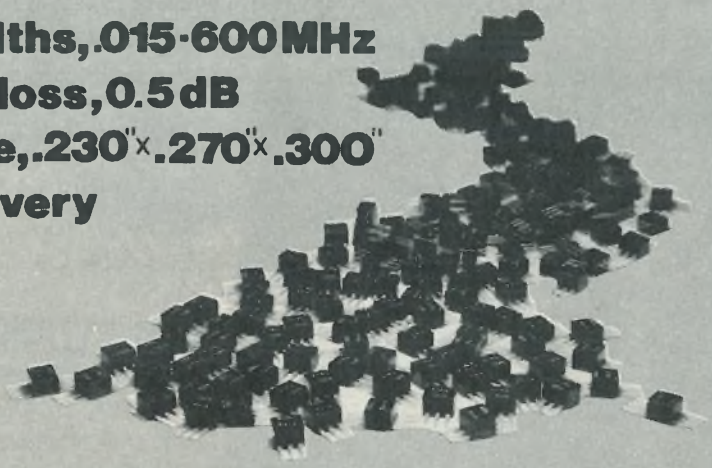

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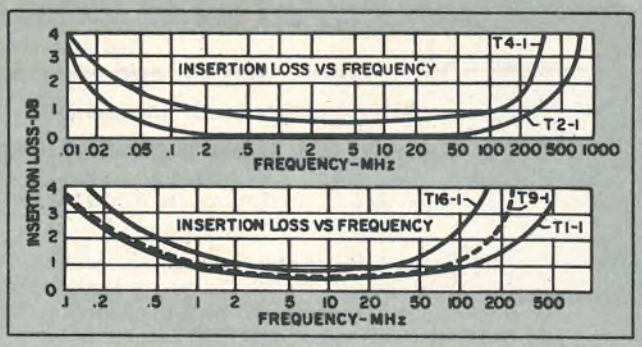

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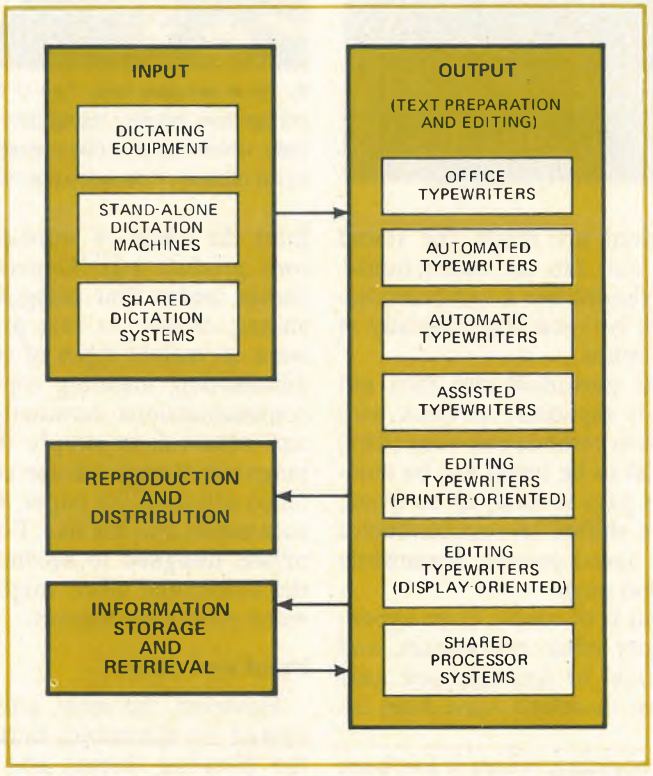
Word processing transforms office paperwork routine

Escalating cost of handling business correspondence spells out vigorous future for electronics-based systems that are replacing traditional equipment, and the market has barely been touched

by Gerald M. Walker, *Associate Editor*

☐ One of the last holdouts against automation has been the business office, with its managers, secretaries, typists, file clerks, and steno takers. But office procedures are on the threshold of important large-scale changes that have recently been made possible by high-efficiency electronics-based equipment.

The office-equipment industry has entered a period marked by application of electronic technology, a period that promises rapid market growth under the banner of "word processing." That term has been around since 1964 when International Business Machines coined it for the introduction of the first sophisticated editing typewriter using magnetic tape for storage and automatic control. IBM has easily been the dominant figure in the word-processing market ever since that time.



1. Words in, words out. The total word-processing market today covers these four categories. But most of the competitive action and product development in the last year has been in the input (dictation) and output (text preparation and editing) equipment.

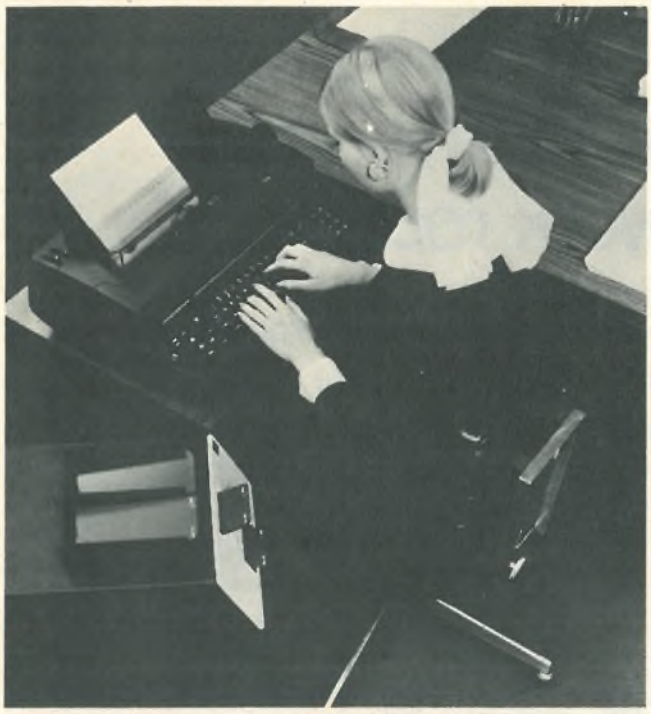
What is word processing? The definition can be as general or specific as the market itself. It differs from data processing in that the equipment does not deal with computations, but rather the handling of business correspondence, forms, contracts, legal documents, even medical histories.

In the traditional office, the boss who generates correspondence usually either dictates to a secretary, writes a rough draft in long hand, or records the information on a dictating machine. Once typed, at about 50 words per minute, the correspondence is often edited and retyped, again at 50 words per minute. The secretary may correct minor errors with various erasure liquids and cards. Long documents may go through editing and retyping a number of times before a final version is ready. Larger offices may have typing pools to do the heavy transcription work. But hiring the necessary office personnel did not become a major burden until salaries and fringe benefits began to increase at a faster pace, so much so that today correspondence can cost a company anywhere from $5 to $10 a page.

Word-processing systems offer a new line of equipment to speed up these routines, to reduce office personnel, and to manipulate the outflow of paperwork more flexibly than is possible in the traditional setting. All of the traditional hardware has been changed. Dictation may now be made into shared electronic-controlled recording machines that also monitor the entry and transcription of the contents, or into desk-top machines that can be actuated remotely for accepting dictation over the telephone, or to a hand-held unit while out of the office.

Typing, editing, retyping, and correcting correspondence has been speeded enormously with the introduction of automated equipment. And the quality of the finished letter or document has been improved because corrections are done electronically and the typing done automatically.

Machines are now available with up to 8,000 bits of memory with which to store letters, from first draft to



2. From number one. Two of the important word-processing machines from industry-leader IBM's extensive line are the Mag Card II (left), which has an 8,000-character memory, and the Memory Typewriter (above), a desk-top machine with 4-k memory.

last. If changes and corrections are made, the stored contents—including spacing and tab set instructions—can be changed using the keyboard like a computer terminal. Then the final version is typed automatically at speeds up to 350 words per minute.

All this means that fewer personnel can turn out more correspondence. This is especially obvious with word-processing units that have cathode-ray-tube (CRT) displays on which the material to be typed can be composed and corrected. When a page is ready to be typed, the contents of its screen are shifted to semiconductor memory which feeds a high speed printer. Meanwhile the operator goes on to the next page.

Word-processing equipment is of course more expensive than standard heavy-duty office typewriters, and the training of office personnel to use this new gear takes longer. The payoff must therefore come from increased productivity.

Like EDP systems, word processing, where it has been applied, alters the structure and procedures of the typical office paper mill, but more on this later. Conceptually the characteristics of the equipment—and much of the industry's jargon—is somewhere between the computer world and the traditional office. Moreover, in the last year, new, more powerful machines have begun to appear. Application of microprocessors for control and memory, floppy disks for storage, and advanced cathode ray tubes have entered word processing equipment design.

All of the signs thus point to steady growth of word processing; electronics technology moves in on yet another established electro-mechanical field. For the companies that have been trying to get this market off the ground for the last decade, the necessary ingredients—lower cost, greater equipment capability, and user interest—are finally beginning to coalesce.

Different office-equipment companies expand or limit the scope of word-processing according to their own product mix. Generally, the equipment (Fig. 1) comes under four categories: input, or dictating machines; output, or text preparation and editing hardware or various types of typewriters; reproduction and distribution, meaning copiers, printing machines, and communications terminals; and information storage and retrieval, or simply the "files." (The files may be magnetic storage.) Some companies would also include office supplies like paper, typewriter ribbon, equipment accessories and the like. For that matter, even office furniture, designed to accommodate the new structure of the automated office, might be considered a part of the word-processing market.

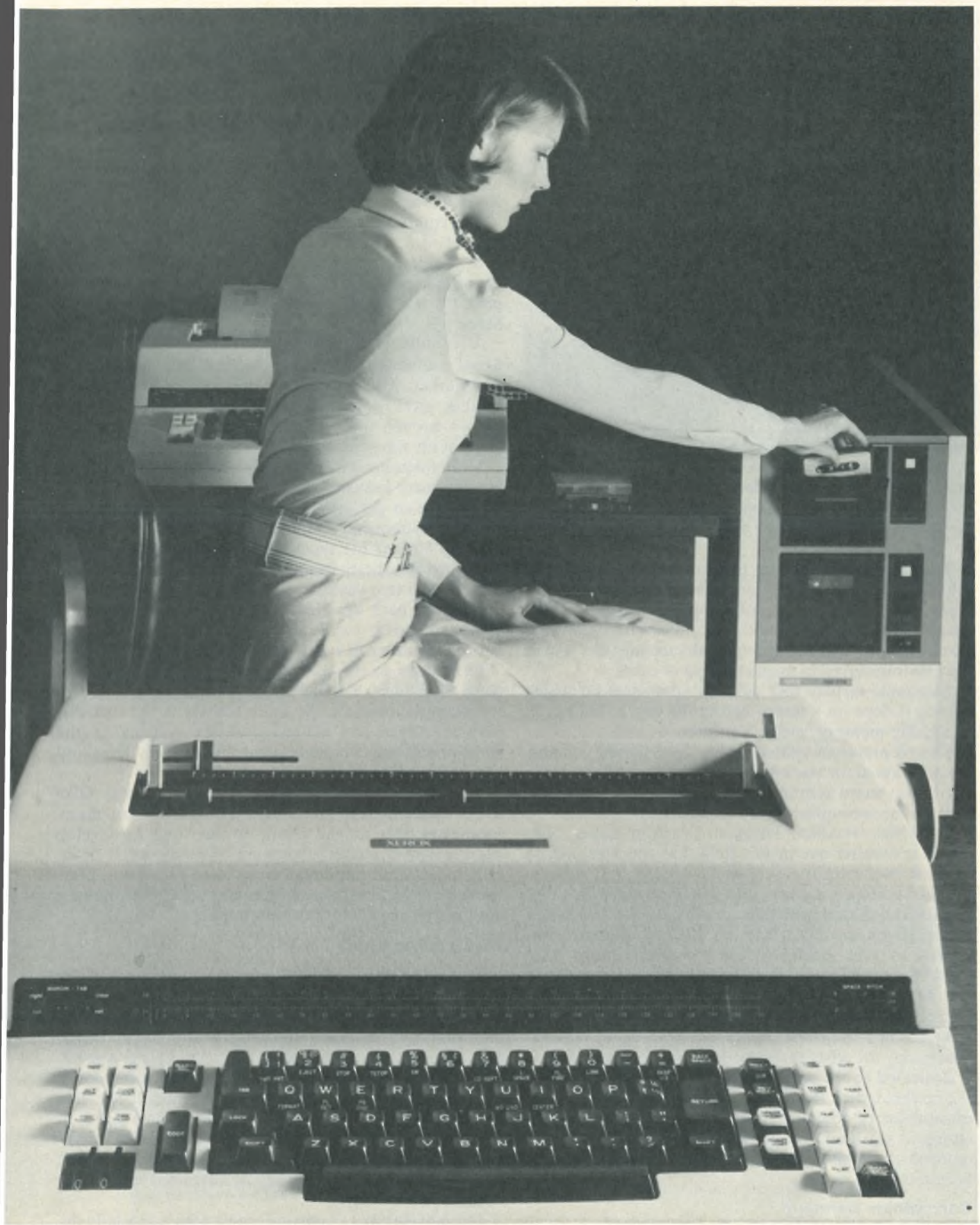
Input and output

However, the most activity and the greatest impact caused by electronics during the last year has been in the dictating (input) and typing-editing (output) segments of this business.

By far the larger of the two markets is in the output side—in typing-editing machines. In fact, even if the $3,000 to $20,000 electronics-based machines had never been developed, the typewriter market would be a big one. About a million heavy-duty machines a year will be sold between 1975 and 1980, according to industry estimates. Annual dollar value during this six-year span should be about $500 million to $700 million. But on top of this base is the newer group of machines, which, it is estimated, will be worth over a billion dollars a year by 1980.

The latter breed of machines, in ascending order of cost and complexity, include:

- Typewriter units that have some kind of storage—either magnetic tape or card—that facilitates the revision of text before automatically preparing finished correspondence.



3. Enter Xerox. Entry into word processing of the office-copier giant, Xerox, with its Model 800 is heating up the competition with the other giant, IBM. Their combined efforts are bound to spread word processing to more potential users and expand the total size of the market.

4. Typing by phone. Among the automated typewriters with communications capability is this Redactron unit. It performs information merging and editing using telephone-transmitted information. Advantage of system is ability to use data from various offices.

- Printer-oriented (having printed hard-copy outputs) editing typewriters that permit the merger of material from two sources—tape and magnetic cards, for example—and that permit revision and reforming of long documents, or that have semiconductor memory which may be transferred to magnetic tape or cards.
- Electronic display CRT editing typewriters on which editing is done on a screen before the text is "dumped" to a buffer memory feeding a printer.
- Shared processor systems using time-shared computers programed for text editing and the control of a number of keyboard terminals on which inputs and printouts can be accomplished independently.

IBM Office Products Division, Franklin Lakes, N.J., which is number one in this field, has concentrated on the first two categories—magnetic-storage and printer-oriented editing machines—but will likely develop a CRT display and shared processor systems, too, as the market grows. Right now IBM's line has 10 distinct models anchored by four machines: the Communications Mag Card "Selectric" typewriter, the Memory typewriter, the IBM Mag Card II with built-in 8-k memory, and the Correcting "Selectric" typewriter. In addition, the company has two "Selectric" composers to prepare camera-ready copy for offset reproduction (Fig. 2). The IBM line is dedicated to the widest portion of the word-processing market today; that is, the segment covering the largest number of potential users. Typically, IBM has been strong in marketing, customer training, and the development of systems incorporating its hardware into office procedures.

Competition warming

Yet, despite the imposing presence of IBM, the market for electronic-based typewriters has hardly been scratched. Only about 3.5% of the estimated 4.2 million active heavy-duty office typewriter stations have been converted to the newer machines. So the lure is tempting. Indeed a number of companies have come on stream with magnetic tape and card equipment linked to standard IBM typewriters, which one scornful business machine executive calls, "souped-up Selectrics."

But since last fall, another big gun has been in the text-editing/preparation competition against IBM: Xerox Office Systems division, operating out of Dallas. Xerox entered the field with the Xerox 800 (Fig. 3). So, instead of a word-processing market composed of IBM and a score of relative small fry, plus a dozen or more firms tip-toeing among the product categories not occupied by the giant, competition now promises to be fierce.

A contest between two companies with vast national marketing capabilities cannot help but expand the market. And although a shakeout of some of the smaller guys is inevitable, most observers feel that there's enough room to accommodate many competitors not the financial equals of IBM or Xerox.

Manufacturers without a previous foothold in the office-products industry, however, would find it almost impossible to get into word-processing competition at this point because of the large investment required. Around 80% of the typewriter business is lease rather than buy, so a hefty front-end bankroll is vital. There is also the fact that customers expect considerable training and service back up. Finally, the technology supporting word processing is starting to move rapidly so that any entrant would need a solid engineering capability.

Firms now in the business will more than likely expand their lines, a trend already under way. There is, for example, bound to be more activity in the CRT display machines and shared-processor systems as the word-processing companies consolidate their bases and begin upgrading their customers.

Incidentally, while everyone in the business talks about educating the great majority of new users, many businesses have moved ahead on their own to develop expertise in evaluating hardware and systems. It probably means that more and more word-processing users will buy from a variety of vendors rather than hand a kind of "turnkey" order to one supplier.

Who's doing what?

Just about every competitor in the typing end of the market has had to contend with comparisons between their equipment and that of IBM. It is not surprising then that the Xerox 800 invites very specific and favorable comparisons with IBM in terms of output speeds. It's not surprising either that Xerox started with an aim on the same broad-base portion of the market that IBM has followed—the lower-price, higher-volume units. It also appears that Xerox will follow the same conservative approach to sales and product development as IBM, as there is no dazzling display of advanced technology in the new Xerox gear.

The 800 features a control console with a specially designed microprocessor similar to the Intel 8080 but without generalized instructions. Because it is a special-

purpose microprocessor, the controller design is simplified within a 1,000-byte scratch-pad memory divided into read-write and read-only segments. The arithmetic logic unit is on one chip with an I/O buffer. This controls all the typewriter operations, including ribbon advance and printer transport.

As each line of type is "played out" (printed) from the buffered memory, the microprocessor is programed to read the next line when the printer is moving from left to right. If the next line is a complete line, the printer is instructed to type that line backwards from right to left. Printing speeds of up to 350 words per minute are possible when the machine is in this "reverse printing" mode. Actually this speed is not a new capability, because the 800 uses a printer developed by Diablo Systems for computers. Printing backwards has always been possible, and with the microprocessor available it was a simple matter to program this mode into the machine.

Redactron Corp., although producing only a little over $16 million in revenue last year, has been one of the most aggressive word-processing companies in the application of electronics technology, particularly in its early use of MOS/LSI design. It has positioned itself a little differently from the majority of companies fighting IBM by concentrating not only on text generation, but on data filing, that is, distributing information captured at the typewriter to computer storage. Thus, to its line of automated typewriters, Redactron has added a data converter that provides bidirectional conversion of typewriter magnetic storage devices to computer-compatible tape. Cassette conversion is accomplished at 900 characters per second, card conversion at 300 characters per second. Conversion is performed on a direct-image basis, each character exactly as read. If desired, however, the information may be recorded in the nine-channel ASCII Code.

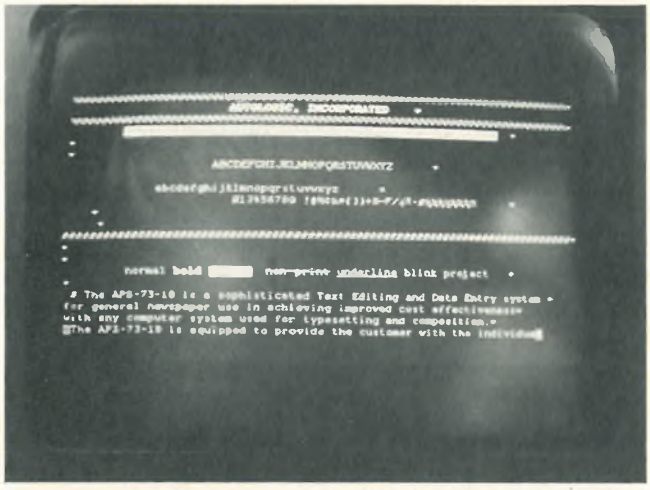
Redactron also has communicating typewriters for high-speed point-to-point contact over telephone lines from one unit (Fig. 4) to another at 300 characters per second, or for conversational communication over phone lines at 14.8 characters per second. The latter is designed for interactive exchange between typewriters in real-time situations, where for example, information is used to update a remote, active file, or where information in a central file is needed immediately at another location.

The machines also interface with TWX and Telex networks. They operate at a maximum TWX speed of 10 characters per second or at Telex speed of 6.6 characters per second.

More recently Redactron has announced development of a 1,000-line-resolution CRT display (Fig. 5). The display is 60 lines by 84 characters, generated in a raster scan rather than as vector-types.

Typing on a tube

CRT-based equipment is expected to pick up in popularity in the coming years. Installations of these machines could climb from under 10,000 units this year to about 110,000 units in 1983, according to the market research firm Frost & Sullivan Inc., New York. Projected



5. CRT words. Redactron's Series 500 CRT monitor uses a raster-scan tube rather than vector character generation, and has 1,000-line resolution. It will be used in the company's forthcoming line of video display automated typewriters.

revenues from sale and rental of stand-alone display machines will pass $1 billion by the end of this decade, according to another researcher, Creative Strategies Inc., San Jose, Calif.

The CRT's main advantages can be summed up in one word: versatility. What's on the screen is exactly what the operator has punched on the keyboard. The operator can not only correct individual words by manipulating the keyboard, but also shift words, sentences, and whole paragraphs as desired. There is usually no need for preliminary drafts as with the card and tape typewriters because of the ease of using the CRT display. Even though the equipment resembles computer terminals in outward appearance, operators usually need to learn fewer computer-like procedures than with other automated typewriters. The major drawback is that the CRT machines are many times more expensive than the other automated machines.

Not many CRT display manufacturers are active now, but more are sure to make the scene. Wang Laboratories, Inc., Tewksbury, Mass., in April expanded its word-processing equipment to include a video display. Wang's original System 1222 consisted of a typewriter station, cassette station, an optional work/storage station and console extensions. It has a line buffer to provide true insertion and deletion by reorganizing each line in the buffer memory rather than whole pages of text. This means the operator can make corrections, add or delete words, or transpose words in the same sequence used on a standard typewriter; the machine carries out the instructions without need for additional operator training.

A Wang spokesman observes that printer-based systems are inexpensive compared to $16,000 to $20,000 CRT machines, but that the screen types are easier to use. The new system 1222 is a combination of Wang's dual-cassette typewriter and a viewing screen so that it produces a typewritten copy and a screen image for review before the final version is printed.

Three other companies that have been selling display-type units for a few years now are Linolex Corp. of

North Billerica, Mass.; Vydec of Whippany, N.J.; and Lexitron Corp. of Canoga Park, Calif. All are small companies, but Linolex was recently purchased by 3M Co. and Vydec has considerable financial backing from Exxon Corp.

Lexitron has two CRT-based text editing systems. One, the Videotype Model 911 (Fig. 6) uses IBM Executive typewriters which feature proportional spacing. It operates at 150 words per minute and costs $17,950. The Model 921 uses a Diablo printer and puts out 360 to 400 words per minute. It costs $20,250.

Lexitron is just coming out with a similar system, but without the printers, just the CRT, keyboard, processor, and cassette tape. It's priced about $5,000 less than the other printer units.

An unusual aspect of the Lexitron display is that the text as it appears on the screen looks very much like a sheet of typing paper rolling up and out of the typewriter. There's even a roll bar handle at each side of the screen to move the lines up and down. So the text emerges from the bottom of the 8½-by-11-inch CRT and the lines move upward, simulating typewritten pages. The CRT holds a total of 7,200 characters. It's also possible to control the display from the keyboard, and the words can be switched to appear from the top down as in a conventional computer display.

Vydec's CRT Editor System, at $15,500, is unusual in that it uses a floppy disk, rather than tape or cards, to store keyboard output (Fig. 7). The floppy disk, says a company spokesman, combines the flexibility of easy access (which the tape does not have) and the ease of filing that the card offers. In operation the information on the CRT is transferred to a buffered semiconductor "scratch-pad" memory, which feeds a high-speed Qume printer. (Qume printers are very much like the Diablo types in design.) The screen, a 15-inch diagonal tube, has a 60-cycles-per-second refresh rate and holds 64 lines of 97 characters each.

The advantage of the display-type word processors over the magnetic-storage/print-out equipment, editing versatility, means there is no rough draft in the usual sense because the hard copy is not run off until the page is corrected on the screen. To make any change on the CRT the operator simply uses the keyboard to position a cursor at the spot where a change is to be made and then executes the change. The user can control brightness of the screen, underline words, "draw" vertical lines, double or single space and even reverse the image to get light letters on a dark background.

Word processing by computer

While word processors owe much of their technology to computers, they are essentially stand-alone machines. The only direct interface with computers is through a converter to store magnetic tape or card data in a computer memory. However, there is the option of shifting the control logic of the stand-alone units to a central computer and simply putting the operator's printer typewriter on a time-shared hook up.

To date, these shared-logic systems have not been attractive to many word-processor users because of the inconveniences of waiting in line for shared time, or because of the printer down-time should the central computer fail.

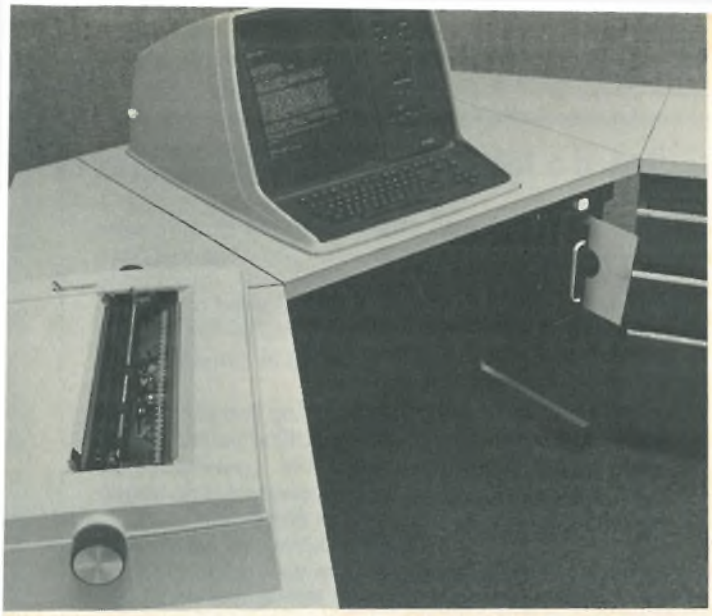
6. Video words. The Lexitron Videotype Text Processor Model 911 features a display that's oriented like a standard typewriter. When the operator types or turns the "roll-bar" handles on the side, the text "rolls up" from the bottom of the screen.

But there are certain companies with large amounts of documents to edit and move around, and for whom a time-shared word-processing hookup becomes very appealing. One equipment maker has called these applications the "rarefied air of word processing." The market in "rarefied air" is said to be only $20 million today, but will be worth as much as $350 million by the end of the '70's.

One company specializing in time-shared word processing is Bowne Time Sharing Inc., New York, which grew out of a software business originally offered by Service Bureau Corp. until IBM spun it off in 1969. Thereafter, Bowne took the service bureau concept and translated it into a word-processing service called Word/One. The key change was to shift from data calculation to document manipulation.

Bowne leases keyboard terminals and provides programs for text editing and the like. In document management, users approach "data-base" control from computer memory of a size not possible with stand-alone machines. Even though future stand-alone units will carry more editing logic, computer control of documents with the potential of a national communications network will increase the need for time-shared word processing, Bowne believes. Thus a large part of this company's investment will be in establishing and extending communications networks.

Shared logic systems, however, need not be time-shared in the service-bureau sense of the word. LCS Corp. of Springfield, Mass., for example, was started in 1970 by a group of lawyers dissatisfied with their magnetic tape, stand-alone machine. The LCS Compu-Text is a shared-logic system consisting of a Digital Equip-



7. Screened words. Using a floppy disk for data storage, the Vydec 1145 has a vector-drawn CRT display for text editing. When the letter is ready for typing, the information is "dumped" into a buffered-memory controller which runs a high speed printer.

ment Corp. PDP-8E minicomputer and an IBM "Selectric" typewriter. The minicomputer stores lengthy legal documents that are chopped up to prepare standardized texts rather than retyped. This boiler-plating routine is so important in law firms that even a 150-word-per-minute typewriter can't deliver fast enough. Although the system put together by the company was originally aimed at law offices, other users who must handle large amounts of standard documentation at high speed have become interested. LCS does not manufacture or service. What it does do is supply the hardware, training, and back-up assistance. Since the DEC minicomputer and the IBM typewriters have not been modified, their makers are still responsible for service maintenance even though the hardware is sold as part of the LCS system.

Slicing a smaller pie

The input side of word processing is a much smaller market than the output side, but there are fewer competitors slicing up the pie.

The external appearance of dictation equipment has not changed as radically as typing equipment, as far as the user is concerned. There's still a microphone or its equivalent (some hook the telephone into a dictating system). The changes have occurred in the over-all arrangements in taking dictation. There are now centralized dictation stations, or "tanks." In these systems input and output is measured automatically so that transcription work loads may be evenly distributed among transcribers.

Also, the familiar desk-top dictation recorders are being used for more communications tasks than just letters because the old belt-type machines are being replaced by more flexible cassette tape recorders. And in today's word-processing environment, the busy executive may routinely carry a personal, hand-held dictation machine, or else he can telephone to a 24-hour central dictation recorder to convey information to his office from outside.

According to a report from Frost & Sullivan, shipments of all types of dictation equipment will grow by 22% from 486,000 units in 1974 to 593,000 units in 1979. The value of these shipments, Frost & Sullivan estimates, based on retail or installed prices, will rise by 24% from $188 million in 1974 to $234 million in 1979.

These figures cover portables, desk-top units, individual "tanks" and centralized systems. Right now the desk tops and portables are almost even in percentage of units sold; 51% and 47% respectively. These percentages will change only slightly by 1979, says Frost & Sullivan, to 47% for portables, 45% for desk tops. Assisting the growth of portables undoubtedly will be the ability to communicate dictation by telephone from the field to an automatic office recorder at any time of day.

Before long the distinctions between portables and desk-top units will probably disappear, while the individual tanks and central systems will also merge into something called "group systems." This means that people will be using personal machines for making "notes" and reminders, and group systems for lengthy, formal dictation. Equipment coming on the market in the last year or so has emphasized this trend.

In dictation equipment, IBM Office Products division once again has a dominant role. In fact IBM is the only major word processing company to offer both input and output systems, not to mention office copiers. The main reasons other word processing firms have not seen fit to straddle input and output systems are that dictation does not offer the same profit potential as output equipment, users are not necessarily attuned to buying a complete input and output line of products from one supplier, and marketing both types of equipment requires vast resources. In addition, the technologies of both are widely divergent.

The major technological debate in the dictation-equipment business is the choice of recording media. These are split among tape cassettes, endless-loop tanks, and the old standby—recording belts. Last March, however, IBM added yet another recording format with its 6:5 Cartridge System (Fig. 8).

Each cartridge holds 25 magnetic disks, each a little over 3 inches in diameter. Each disk stores six minutes of dictation, which IBM says should accommodate 94% of all dictation sessions. A desk-top recorder will handle two cartridges, or 50 disks, thereby providing up to five hours of total recording capacity—hence the name 6:5 for six minutes per disk, five hours per machine.

The 6:5 is actually a series of products that not only includes a basic recorder and transcriber, but a shared microphone recording arrangement, telephone-to-recorder hook ups, and a telephone message taker. A portable recorder that accepts the magnetic cartridges is due on the market in 1976. Prices begin at $645 for the recorder, $645 for the transcribing unit, $750 for the remote systems, and $575 for the portable.

Why did IBM choose to push a completely different recording media into the dictation arena? According to the company the cartridge format offered ease of operation, reliability, and the systems flexibility it was searching for. All audio recording techniques were analyzed, including magnetic bubbles, before deciding

on the disk/cartridge configuration. But competitors see the IBM move as a ploy that will only muddy a market already muddied by competing recording media. It's still too early to tell how users will respond.

Tanks for the memory

Dictaphone Corp., Rye, N.Y., which traces its beginning to the original Bell and Tainter invention, has evolved recently into applying more and more electronics thanks to the reception given its original "thought tank" systems. At the beginning of this year, the company brought out the Thought Tank System 193. Designed to increase productivity in offices with high-volume dictation and transcription requirements (Fig. 9). System 193 complements Dictaphone's earlier thought tank system developed for individual use.

The thought tank consists of a mike or a phone to transmit dictation to the recording "tank," a rectangular box containing tape drives and an endless loop tape. When the user is dictating, the secretary can start transcribing immediately from the beginning of the endless loop while the boss can continue to dictate further down the loop. It's also possible to switch to other tanks should dictation exceed the 60-minute capacity of one tank.

The heart of the System 193 is a monitoring console called the Word Controller. The console monitors the transcriptions being done by as many as eight typing stations. It keeps the office manager informed of the word-processing center's daily input, output, backlog, and individual output rates of the typing staff. The manager can then govern the flow of work being typed by checking the console.

The console contains an analog computer built around two quad op amps and several discrete components; the next generation will most likely convert to digital electronics and a programed microprocessor to monitor all typing stations.

Another feature in the 193 is an automatic means of eliminating those pauses during dictation that could slow down the typist during transcription. And it works without clipping words after the break in speech. The "on and off" for pauses is accomplished with a standard voice-actuating switch, VOX circuit. Clipping protection is done with a bucket-brigade delay line. No matter when the VOX circuit starts the recording, all the sound goes through the bucket brigade. In playback none of the words are lost if the voice-actuating switch fails to turn on in the right instant, because the sound delayed in passing through the bucket brigade is on the tape.

In other words, the bucket brigade reconstructs any sound that might be lost in the slow start up of the voice actuating switch. Sometimes this arrangement introduces unwanted sounds, but it does ensure that there are no clipped words.

Lanier Business Products, Atlanta, Ga., has an endless-loop dictation system called the Nyematic VIP system. It features an "electronic note pad" for the secretary's desk that is basically a light indicator built into a desk holder. When dictation begins, the light on the pad holder alerts the secretary to begin transcription. The light goes out when the secretary has completed whatever playback is required.

Lanier is also enthusiastic about its new $1,595 Tel-Edisette, a central dictation system that has automatic loading and recording of 12 standard cassettes (Fig. 10). A Work Unit Programer allows the word-processing-center manager to select from one to nine separate dictation inputs per cassette, ranging from a single dictation for one cassette done for rush work to continuous dictation from three to six remote positions using all 12 cassettes in order.

Because of the multiple uses to which the Tel-Edisette system will be put, there are a number of fail-safe features designed to help prevent confusion in the word-processing center. An anti-reverse feature prevents other dictators from listening or backing up into the dic-

'Take a letter, and bring the CRT'

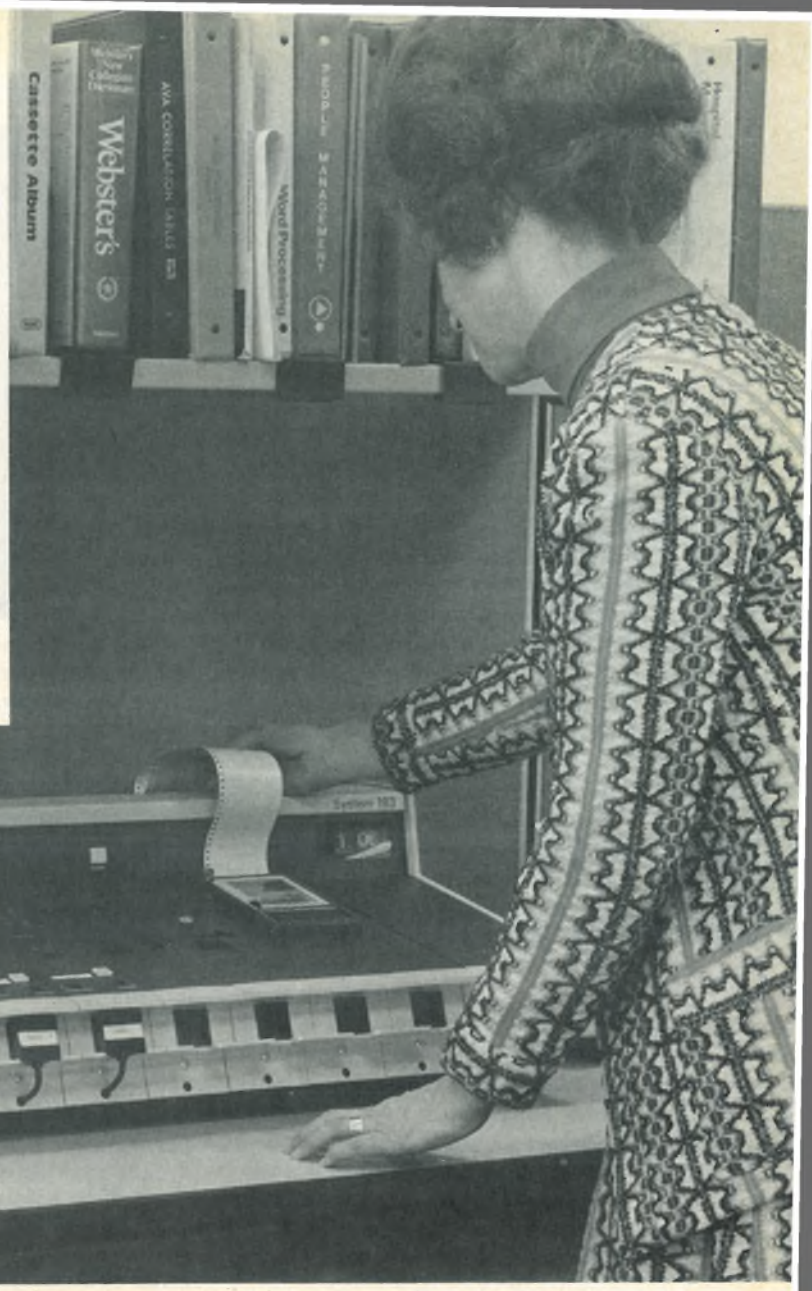
Many secretaries view word processing as a monster of automation, but hostile attitudes show signs of moderating as more companies adopt word processing and more secretaries become accustomed to the systems. In many cases, women's rights advocates have come to recognize word processing as potentially liberating.

On the plus side, word-processing systems, when properly organized, establish new office hierarchies of typists and administrative assistants, opening a new career path for secretaries. One individual is no longer so completely tied to the career of one boss.

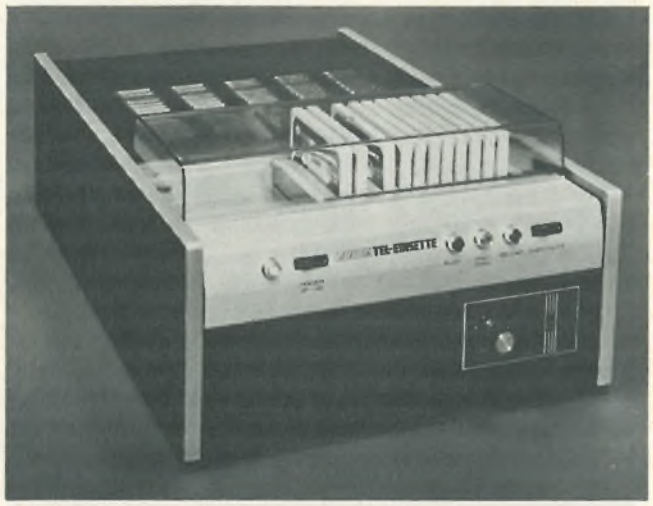
On the other hand, some secretaries have castigated typing centers as little more than glorified typing pools, impersonal and isolated. Administrative assistants may find themselves cut off from other career paths. They note that many women enter businesses as secretaries or "girl Fridays" with ambitions to move out into other roles. The word processing set-up may not accommodate these desires.

In the end, successful management of a word processing center is like management in any other field—dependent on the motivation and desires of the individuals involved. The point is that the need for adjustments can't be ignored.

8. Disk dictation. The new IBM 6:5 Cartridge System for dictation employs magnetic disks, each disk holding six minutes of dictation, and 25 disks to a recording cartridge. Each recorder will hold two cartridges, thereby providing up to five hours of total capacity.



9. Thought control. Dictaphone's new Thought Tank System 193 provides the ability to set up a word processing center serving several correspondence originators with a centralized transcribing operation. Here a marketing manager at the company's Rye, N.Y. headquarters (top, left) dictates over the telephone-like mike to the thought-tank Word Controller console which monitors incoming and completed dictation. The Word Controller supervisor (above) can direct dictation to the correspondence secretary (left) from the console. Other administrative secretaries use individual thought tanks to handle short messages or requests, such as arranging travel reservations.



10. Talkative. A central dictation machine, the new Lanier Tel-Edisette, holds 12 standard audio cassettes that can be used in any of nine different recording modes covering one dictation per cassette, dictation shared with others, or telephone messages.

tation of another user in the shared mode. Antiforward automatically stops the machine and provides a "ready" tone after the dictator listens to or reviews the last word dictated.

When a dictator hangs up the telephone-mike before completely listening to all dictation, the Tel-Edisette automatically runs the tape forward to the end of the dictation and stops. A lockout feature prevents dictation during the changing of a cassette and an automatic search moves by empty cassette positions until a tape is loaded into one of the 12 positions.

The Tel-Edisette provides for audio and light warning to the dictator when the end of recording time on a cassette is near, and another audio and light provide a warning when the recorder is completely full. In addition, a jammed cassette can be ejected and another cassette reloaded automatically.

. . . but does it all work?

As mentioned earlier, installation of a word processing system to gain the full benefits in productivity promised by the equipment usually alters the traditional office. There have been a number of failures along the way, particularly in the early days, as a result of poor planning in the transitional stage.

A large New York advertising agency threw in the towel, reverting to its old slow-but-sure methods. An airline rushed into one mode of word processing only to find it wasn't the best way to go, and had to switch to a second type of equipment and system. An electrical/electronics conglomerate found that concepts that worked well for departments with a large volume of form-letter correspondence did not work well in departments that handled a wider variety of correspondence.

But on the whole, the small percentage of companies that have gone through a shakedown cruise with word-processing systems have realized the promised benefits. Some offices have been able to reduce secretarial payrolls or to free secretaries for less routine tasks, and at the same time handle bigger work loads. Word processing appears to be delivering on two main goals, increased output and higher quality of correspondence at greater speed than before.

Productivity statistics are tossed around liberally by word-processing companies. For example, average typing speed for a complete job has been estimated to be 10 words per minute for conventional typing, 30 for magnetic-tape automatic typewriters, and 2,000 by computer-assisted word processing.

One office using CRT display equipment increased lines typed per day from 20% to 25%; and nine operators in one year did the work that previously would have required more than 30 typists. In another case, an industrial trade association using automated typing equipment has claimed a productivity increase of 50% to 100% in a year.

As for dictation systems, an airline boosted throughput of dictated correspondence by 57% in its first year using a centralized installation. A manufacturer using a tank-type system speeded turnaround time—the time elapsed between dictation and finished work—from a day or more to 2½ hours. Some letters are almost ready as soon as the dictation is finished. A state-government agency cut 13 secretaries from a staff of 20, but manages to put out the same amount of correspondence from 60 authors. These are just a few examples.

Changes precipitated by word processing can involve a whole company, a single department, or one typing station, depending on how elaborate the system. IBM, for one, has put a great deal of planning into how to arrange a word-processing center and has initiated variations of its basic plans at various IBM facilities. Essentially, the IBM plan divides the secretarial force into typists and administrators; some do only correspondence, using automated machines, while others function as aids to the "principals," the managers who are the source of the correspondence output.

This plan has many possibilities. In a big office, the typists could end up at a formal central pool. Administrative secretaries or assistants could become managers, taking over some of the details previously done by their bosses. At smaller operations, secretaries may alternate between typing and administrative tasks or some may be typists, some administrators, and others may swing between both functions.

Another user of its own word processing system is Dictaphone, which has installed a System 193 at corporate headquarters in Rye, N.Y. Here, too, one group of secretaries specializes in transcribing dictation under the guidance of a supervisor, while another group of secretaries acts as administrative assistants to department principals.

To establish such word processing programs, physical changes are imperative. Different types of office furniture, even completely remodeled rooms, are important in setting up efficient arrangements for typists and administrative assistants. Word processing not only changes the way an office runs, it changes how it looks. The many manufacturers, banking on the belief that companies will pay more to automate the office, are confident that word processing will change other people's paperwork into a profitable business. □

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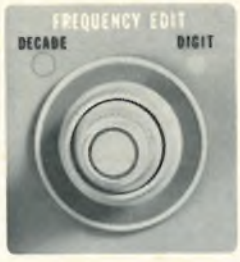
A sophisticated bench oscillator that's easy to use.



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Monostable's pulse width is programable

by C.F. Reeves
Del Mar, Calif.

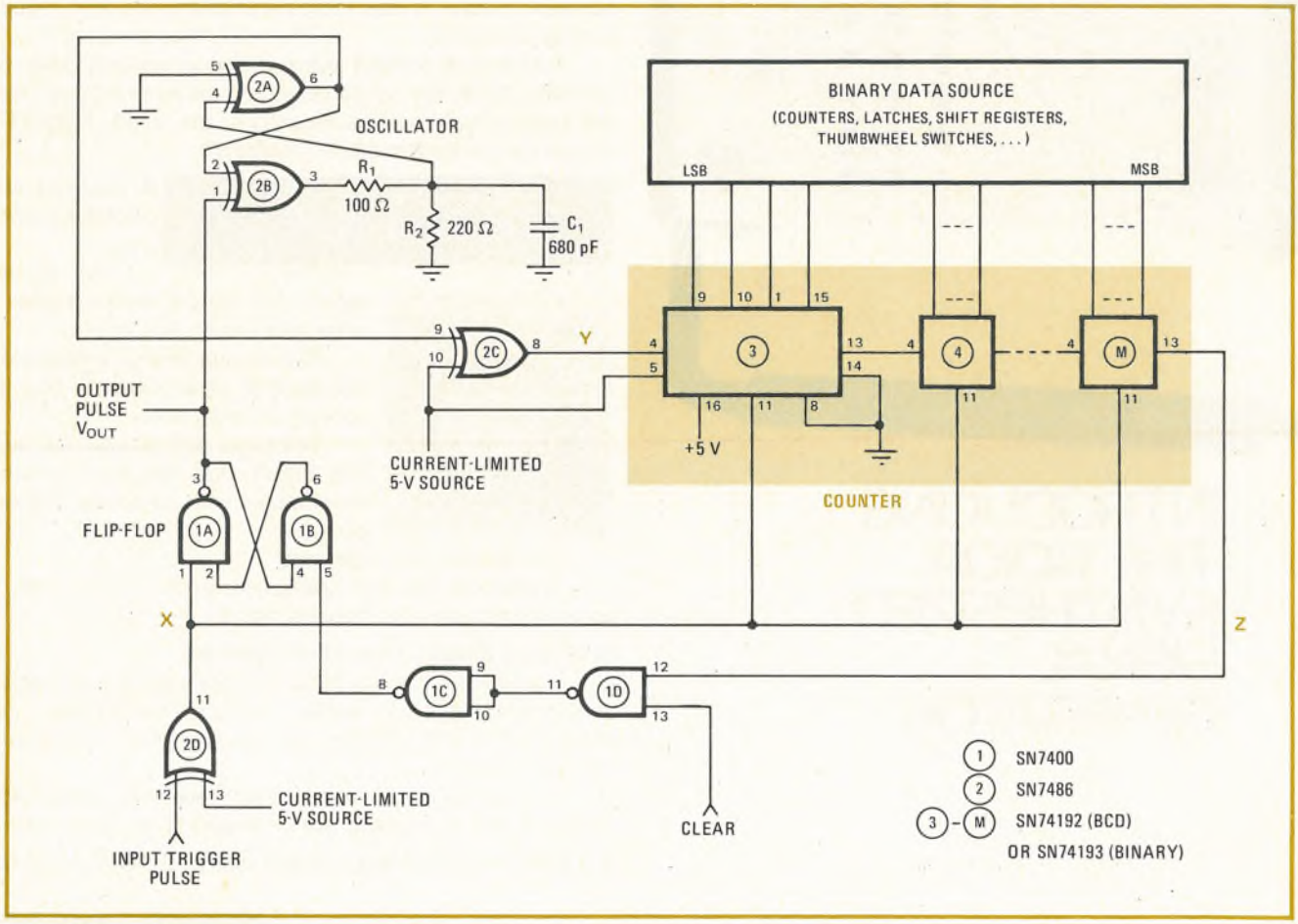
Variable-width pulses are required in many systems, and the widespread use of microprocessors as control elements makes numerical control of the pulse widths increasingly important. A numerically controlled one-shot multivibrator can be built that is particularly useful when the pulse-width range required is impractical or unattainable with conventional RC-time-constant one-shots.

For each input trigger pulse, the circuit produces an output pulse whose width is determined by an input binary number. The number may be taken from binary or binary-coded-decimal (BCD) sources such as shift registers, counters, bistable latches, thumbwheel switches, or the like.

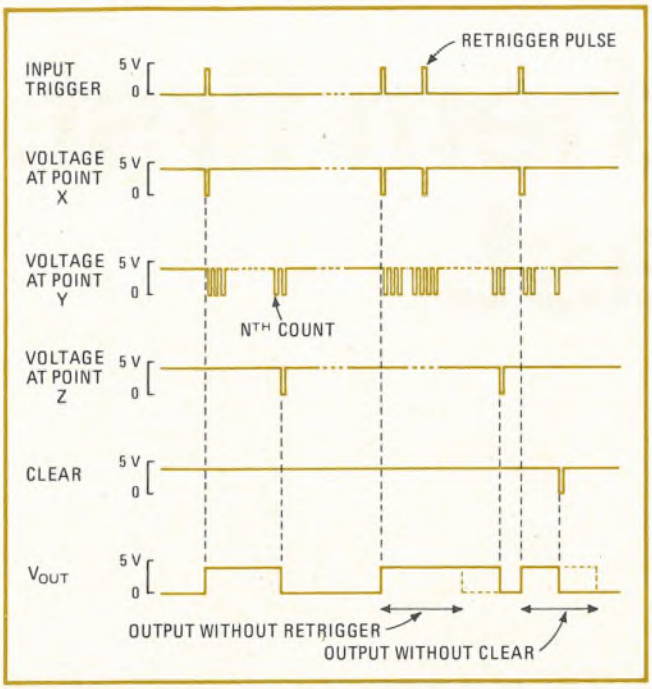
Functionally, the circuit is identical to the conventional one-shot in that it has one stable state and one temporary or quasistable state. The fundamental difference lies in the timing element that determines how long the circuit can remain in the quasistable state. In the conventional one-shot, this monostable period is set by the time constant of a resistor-capacitor network. The circuit shown here sets the monostable period by counting a preselected number of periods of a clock oscillator.

The range is thus limited only by the number of counter stages used. In Fig. 1 gates 2A and 2B form a clock oscillator that is gated on by a high logic level at pin 1. Resistors R_1 and R_2 and capacitor C_1 set the frequency at 10 megahertz. Gate 2C is an inverting buffer for the output pulses from the clock.

The input trigger pulse loads the counter chain (components 3 through M) with the number supplied by the binary data source. Simultaneously the trigger sets an



1. By the numbers. Binary number set into counter from data source determines duration of output pulse from this monostable circuit when input trigger pulse is applied. Output voltage V_{OUT} is high while counter counts the given number of cycles from the oscillator, as shown in Fig. 2. Typical applications for this circuit include variable-time-delay generation and pulse-code modulation.



2. Count. Waveforms for one-shot multivibrator in Fig. 1 illustrate operation. Input trigger makes V_{OUT} high and starts oscillator. Counter counts N cycles of oscillation (where N is decimal value of binary number set on counter by control source), then makes V_{OUT} low and stops oscillator. A trigger pulse applied during operation prolongs output pulse through countdown of newly loaded number. Output can be cut off at any time by grounding the clear terminal.

R/S flip-flop (1A and 1B), the output of which gates on the 10-MHz clock oscillator. The clock pulses cause the counter chain to count down to zero, whereupon the borrow pulse is generated at point Z. The borrow pulse resets the R/S flip-flop, disabling the clock oscillator and terminating the output pulse.

The width of the output pulse is determined by the binary input data and the clock frequency according to the following relationship:

$$PW = (N+1)/f_c$$

where N is the decimal value of the binary input number, and f_c is the clock frequency. The numerator is (N+1) instead of N because the counter generates the borrow pulse when leaving the zero state rather than when entering it. The output pulse-width range is determined by the number of 4-bit counter stages, K, and is expressed as $1:10^K$ for BCD input data and $1:16^K$ for binary input data. As the waveforms of Fig. 2 show, the one-shot is retriggerable. When an input trigger pulse occurs while the counter chain is counting down from a previous trigger, the chain simply reloads with the value of the binary data source and begins a new countdown. The result is a single elongated pulse. An additional circuit feature is that the output pulse may be terminated at any time by applying the logic zero to the "clear" input terminal. □

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.

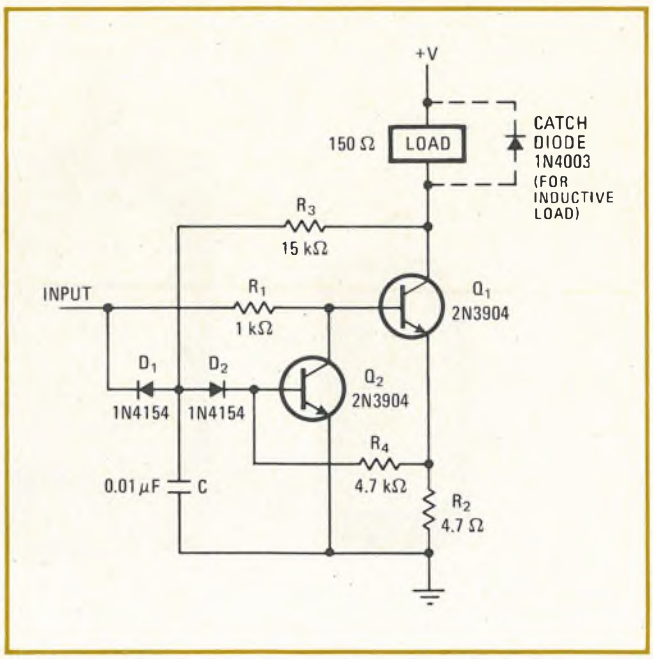
Current and power limiter protects switching transistor

by R.M. Stitt
Burr-Brown Research Corp., Tucson, Ariz.

Although a switching transistor dissipates little power in normal operation, it must be protected from destructive current and power overloads. Current-limiting alone is not sufficient protection; power-limiting is also necessary. But fortunately, a few components can be added to conventional current-limiting circuitry to provide power-limiting. A voltage rise across a transistor is sensed and used to cut down the drive current.

To understand why current-limiting alone fails to provide adequate protection, consider a switching transistor controlling a 100-ohm load connected to a 100-volt supply. The power dissipated in the load might be about 100 watts, but the maximum power dissipated in the transistor is merely the load current times the transistor's saturation voltage (if switching losses are neglected). The load current is about 1 ampere, so the transistor dissipates less than 1 W. A designer might use a 3-W device and provide a current-limiting level of 1.5 amperes.

Suppose, however, that the load is short-circuited so



Two-way protection. Switching transistor Q_1 is protected against excess current and/or excess power dissipation. If load current approaches limit, IR_2 drop turns on transistor Q_2 to shunt base drive from Q_1. A voltage rise across Q_1 acts through R_3 to turn on Q_2 and turn off Q_1. Capacitor C provides delay that allows Q_2 to saturate with each new cycle, and lets power-limiter ignore transient high currents. Diodes D_1 and D_2 reset power-limiter when input is low.

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that the collector of the switching transistor is connected directly to the 100-V supply. Then the transistor dissipates 150 W, which destroys it.

To prevent this destruction, a power-limiter is required. Power-limiting can be added to a standard current-limiter by use of only four simple components. In Fig. 1, Q is the switching transistor, and the conventional current-limiter is formed by Q_2, R_2, and R_4. The power-limiter consists of capacitor C, diodes D_1 and D_2, and resistor R_3. To illustrate the operation of the circuit, assume that Q_1 is saturated and in normal operation. As the load current increases, the voltage drop across R_2 increases, turning on transistor Q_2 and thus shunting drive current away from the base of Q_1. Therefore, Q_1 begins to come out of saturation, so its collector voltage rises. This voltage across Q_1 further turns on Q_2 through R_3 and regeneratively turns off Q_1.

Diodes D_1 and D_2 form a switch so that the collector voltage of Q_1 is sampled only when its input is high. This switch also resets the power-limiting circuitry with each cycle of the input. The value of capacitor C is chosen to give the power-limiting portion of the circuit a turn-on delay, allowing time for Q_2 to become saturated. This delay also permits higher current transients to flow during switching, such as those that might occur in a switching regulator in which the catch diode must be discharged during each cycle.

The current-limiting portion of the circuitry is active at all times, protecting the switching transistor from current overloads. The circuit was set up to be driven by a TTL-level signal and to switch a 100-mA load at 400 Hz to +15 V. The protection circuit can easily be modified for nearly any input and output configuration. If a pnp-transistor switch is to be protected, transistor Q_2 should also be a pnp, and the polarities of D_1 and D_2 should be reversed. □

Compact dc-dc converter yields ±15 V from +5 V

by Thomas Durgavich
Massachusetts Institute of Technology, Cambridge, Mass.

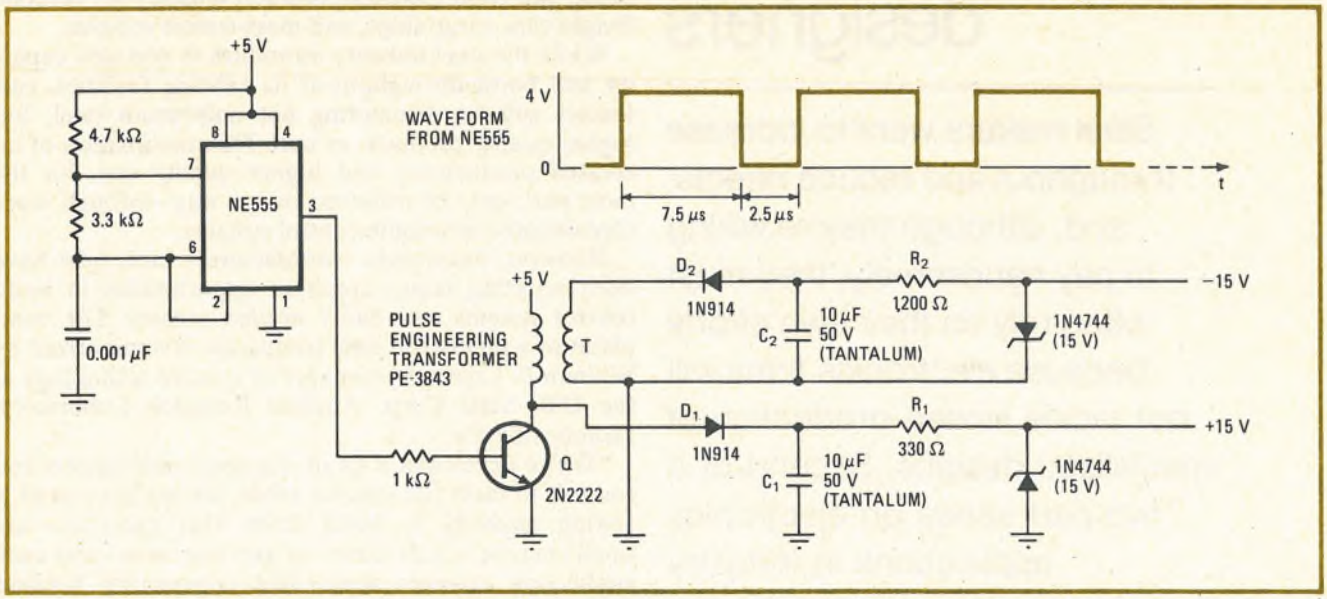
Many digital systems use a few operational amplifiers that require voltages of +15 V and −15 V, when all other elements require only 5 V. Both the +15 V and −15 V can be supplied at 10 milliamperes by a dc-to-dc converter that is compact enough to be built right on a printed-circuit board.

In this circuit, the NE555 operates as an astable multivibrator at 100 kilohertz with a 75% duty cycle. The value of frequency need not be exact, but this waveform has been found to optimize operation of the circuit.

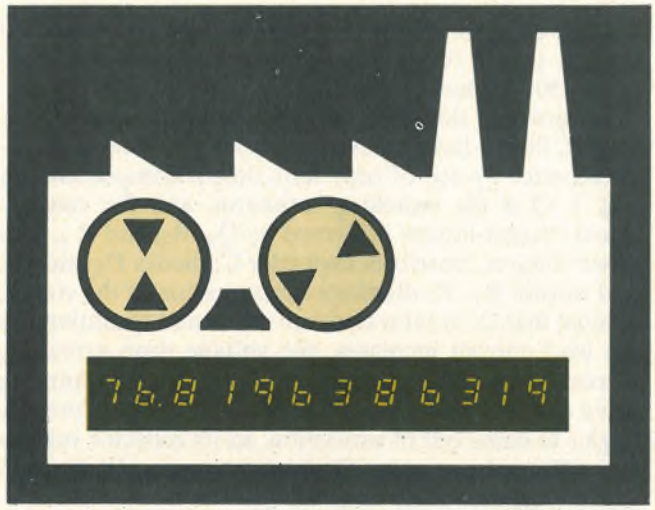
The pulse train from the multivibrator drives the base of transistor Q to switch current on and off in the primary coil of transformer T. When the current is switched off, a spike of about 20 V occurs at the collector of Q. This voltage, rectified by D_1 and filtered by C_1 and R_1, is regulated by a simple zener-diode regulator to yield +15 V.

Simultaneously, a voltage spike appears across the secondary coil of transformer T. Because the transformer provides dc isolation, the higher-voltage end of the coil can be grounded to make the pulse negative. This voltage is also rectified, filtered, and regulated to yield −15 V.

This circuit is ideal when space is critical because small low-valued tantalum capacitors and a tiny pulse transformer replace the larger components that would be used in a conventional ±15-V supply. □



Space saver. Bipolar dc-to-dc converter operates from 5 volts and produces ±15 volts to supply op amps. Major advantage over conventional supply is small size, allowing assembly right on circuit board with other elements of system that it serves.



Part 2
Steel's special problems beckon control-system designers

Steel makers want to increase throughput and reduce rejects; and, although they're willing to pay handsomely, they must often rely on their own efforts because electronics firms will not tackle limited production of specialized designs. Second of a five-part series on electronics applications in industry

by Margaret A. Maas, *Industrial Editor*

☐ For electronics firms, there's gold in the iron and steel industry. Although there is only a handful of major steel companies and each requires no more than a half dozen of any one control system, the total value of those systems can add up to an impressive tab. And the industry will be spending more than ever during the next two years.

The McGraw-Hill Economics Department estimates that the iron and steel industry's capital spending budget in 1976 will be just about double its 1974 expenditures. This leap upward is being stimulated chiefly by two events. The removal of price controls last year made it profitable for steel companies to expand, and anticipated future demand for the metal has made it imperative that they begin expansion now.

Although the steel industry expects depressed demand throughout 1975, the American Iron and Steel Institute predicts a worldwide shortage by 1985. Major contributors to the increasing shortage will be demands from oil and gas producers for new refineries and pipe lines, from the coal industry for more mining equipment, and from the transportation industry for railroad freight cars, cargo ships, and mass-transit vehicles.

While the steel industry scrambles to add new capacity and boost throughput at its existing facilities, customers will be demanding not only more steel, but higher-quality products, as well. The combination of increased productivity and higher quality can, for the most part, only be achieved in one way—through more sophisticated electronic-control systems.

However, electronics manufacturers until now have been rejecting many apparent opportunities to build control systems and badly needed sensors. The complaint of a number of steel companies is summarized by William E. Coleman, manager of systems technology at the U.S. Steel Corp. Applied Research Laboratory, Monroeville, Pa.:

"We've developed a lot of electronic instruments and controls to meet our specific needs, but we have trouble getting anybody to build them. Our quantities are small—maybe a half dozen of any one item—and each application requires some field engineering because each mill is a little different. We're not in the electronics business; we're in the steel business. And what we really

need is a specialty electronics company that would be willing to custom-build our designs. For the most part, no one wants to do custom work."

On the positive side, however, a few electronics manufacturers are working with steel companies to develop systems to increase the accuracy of controls in rolling mills, reduce the rejection rate of the finished product, save increasingly expensive zinc in the galvanizing operation, and even to save excessive charges on electrical power by controlling equipment loads.

Controlling the rolling mill

Probably the most prevalent piece of steel equipment is the rolling mill. There are perhaps 2,000 rolling mills in North America, each a target for gage controls, ranging from a $45,000 microprocessor system to a multimillion-dollar computerized operation. Since the hot mill is the most highly automated piece of equipment in a steel facility, it is doubtful that any new hot mill would be built today that wouldn't be computer controlled.

Gage control depends predominantly on accurate control of the rolling mill where about 80% of all steel eventually ends up. Rolling—literally squeezing metal between a set of rolls—converts ingots into strip, bar, rod, plate, I-beam, and other shapes. An ingot that starts out 40 inches thick may eventually end up 0.005 in. thick or even thinner. Until the steel reaches about 0.2 in. thick, it is rolled hot—usually at about 2,400°F—because hot steel is more plastic and therefore easier to roll than cold.

Accurate gage control at the rolling mill depends on a number of factors that are interrelated in a strongly nonlinear fashion. These factors include the initial thickness, the gap between the work rolls, the roll force, the temperature of the steel, strip tension, the type of alloy, mill speed, and the stiffness of the mill.

Mill conditions are not static. As the roll force increases, the mill stand in which the rolls are mounted literally stretches like a spring. At the same time, rolls wear and become eccentric, while changes in temperature stretch or shrink both the product and the mill.

The incentive behind gage controls is theoretical minimum weight. Theoretical minimum weight, adopted in 1970, lets the buyer specify the length, width, and thickness of the sheet, and a plus tolerance on each dimension. The supplier may not roll below the specified dimensions, but his products may be slightly larger.

The buyer pays only for the minimum weight of the steel specified by the nominal dimensions. If the steel falls below these dimensions, it is rejected, but if it is above, the supplier must bear the cost of the extra steel. The result, declares the U. S. Steel's Coleman, is that "the whole industry is in the throes of trying to make a major step in gage control."

Adapting to the facts

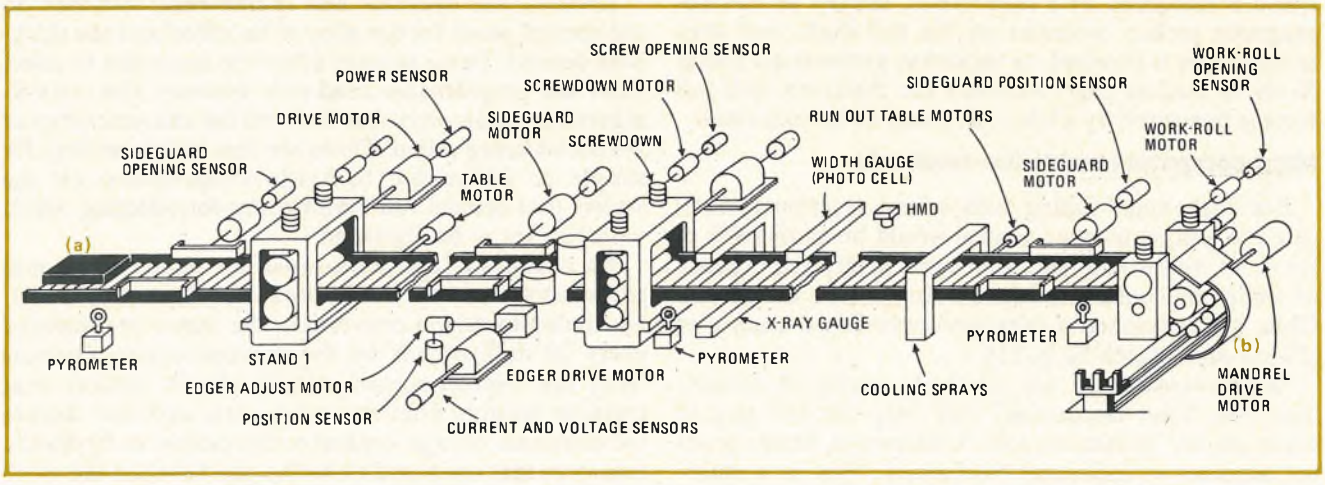
One way to handle the complex interrelationships among mill variables is through adaptive control systems such as those built by the Westinghouse Electric Corp. Industry Systems division, Pittsburgh, Pa. Initially, the operator enters, usually through a cathode-ray-tube terminal, the material thickness, the alloy, and set point. Then, by means of a complex mathematical model, the Westinghouse W2500 process-control computer calculates the initial mill conditions and adjusts roll gap and roll speed accordingly (Fig. 1).

As the strip passes through the first stand, a thickness gage measures the material and compares it to the target thickness for the first stand. If the thickness is off target, the computer calculates the necessary adjustments to succeeding stands in order to compensate for the error. The system times the corrections so that they are made just as the off-gage strip arrives at a stand.

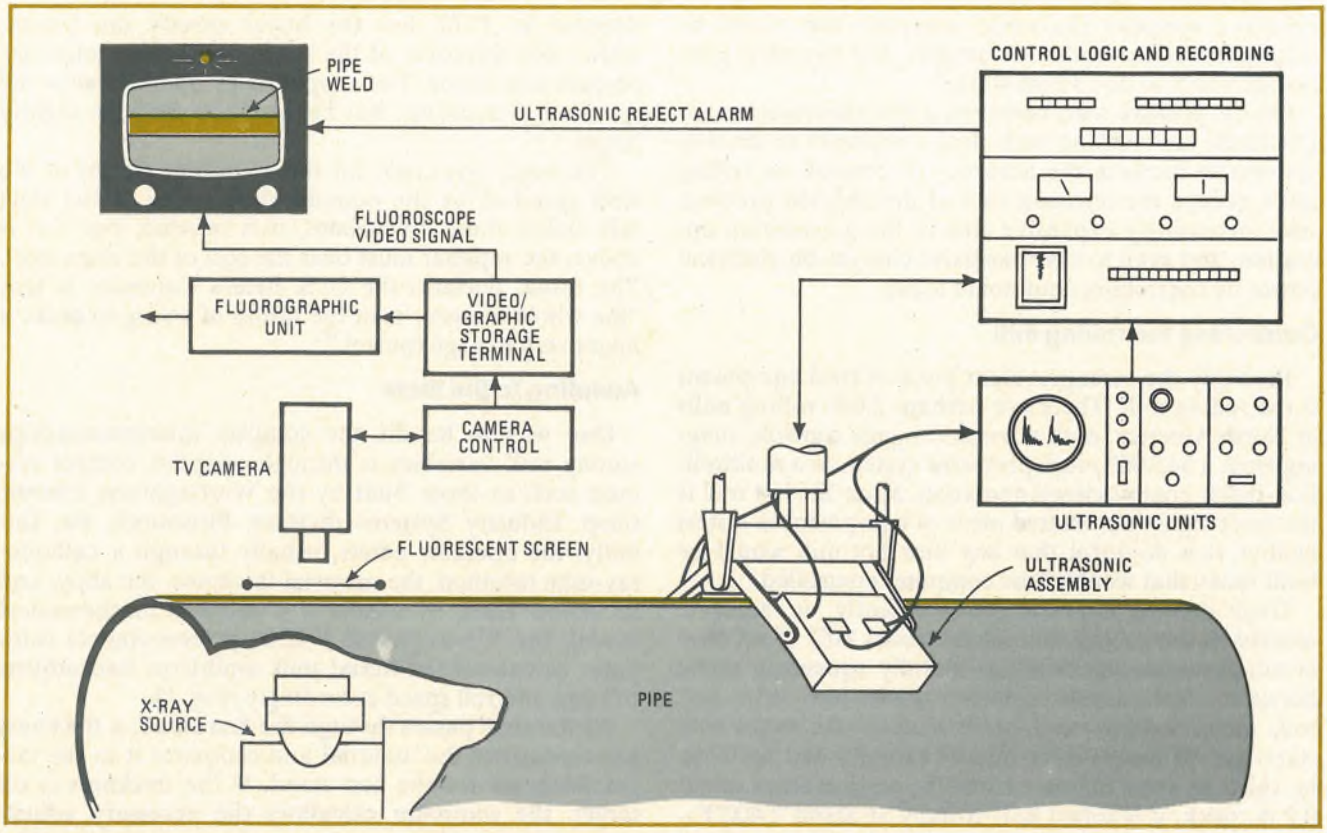
At the same time, the system uses the initial output to recalculate the equation variables and then readjusts the settings on the first stand for incoming material. This procedure is repeated continuously throughout the rolling operation.

Basically, thickness in a hot mill is controlled by adjusting the roll gap. Tension, which is a function of line speed and the gap setting on each stand, is held constant by a looper, a roll that moves up and down to take up any slack in the metal.

In a cold mill, both roll gap and strip tension are manipulated to get the desired thickness. Some companies



1. Hot strip mill. Steel enters mill as slab (a) and exits in strip form (b). Sensor inputs to the computer-control system include pyrometers for temperature measurement, X-ray gages for thickness measurements, and load cells to sense roll force.



2. Tandem inspection. After a flaw in the pipe weld is detected by the ultrasonic transducers, the rejection signal is stored in a shift-register memory until the rejected area is in view of the fluoroscope. At that point, the signal triggers an alarm on the TV screen, and simultaneously, a cursor appears on the screen to call the operator's attention to the defect. Inconsequential weld variations will not trigger an alarm.

use a tensiometer to adjust strip tension. A tensiometer is a roll mounted a few inches higher than the plane in which the strip is traveling. As the strip passes over this raised roll, tension on the strip creates a downward force, which is sensed by a load cell mounted in the bearing housing.

Other sensor inputs to the computer include roll gap, which is measured either by a linear variable differential transformer on the hydraulic cylinder of the electrohydraulically controlled roll or by a pulse tachometer that counts the revolutions of motor-driven screws. Strip speed is measured by a tachometer, usually an electromagnetic pickup mounted on the roll shaft, and strip temperature is detected by radiation pyrometers. Either X-ray or nuclear gages measure the thickness, and roll force is measured by a load cell mounted in each stand.

Microcomputers tackle the small mill

For single-stand rolling mills, where a computer dedicated to automatic gage control would be an overkill or for older multistand mills that can't justify the expense of computer control, Industrial Nucleonics, Columbus, Ohio, has developed a microprocessor-based controller [*Electronics*, March 20, p. 31].

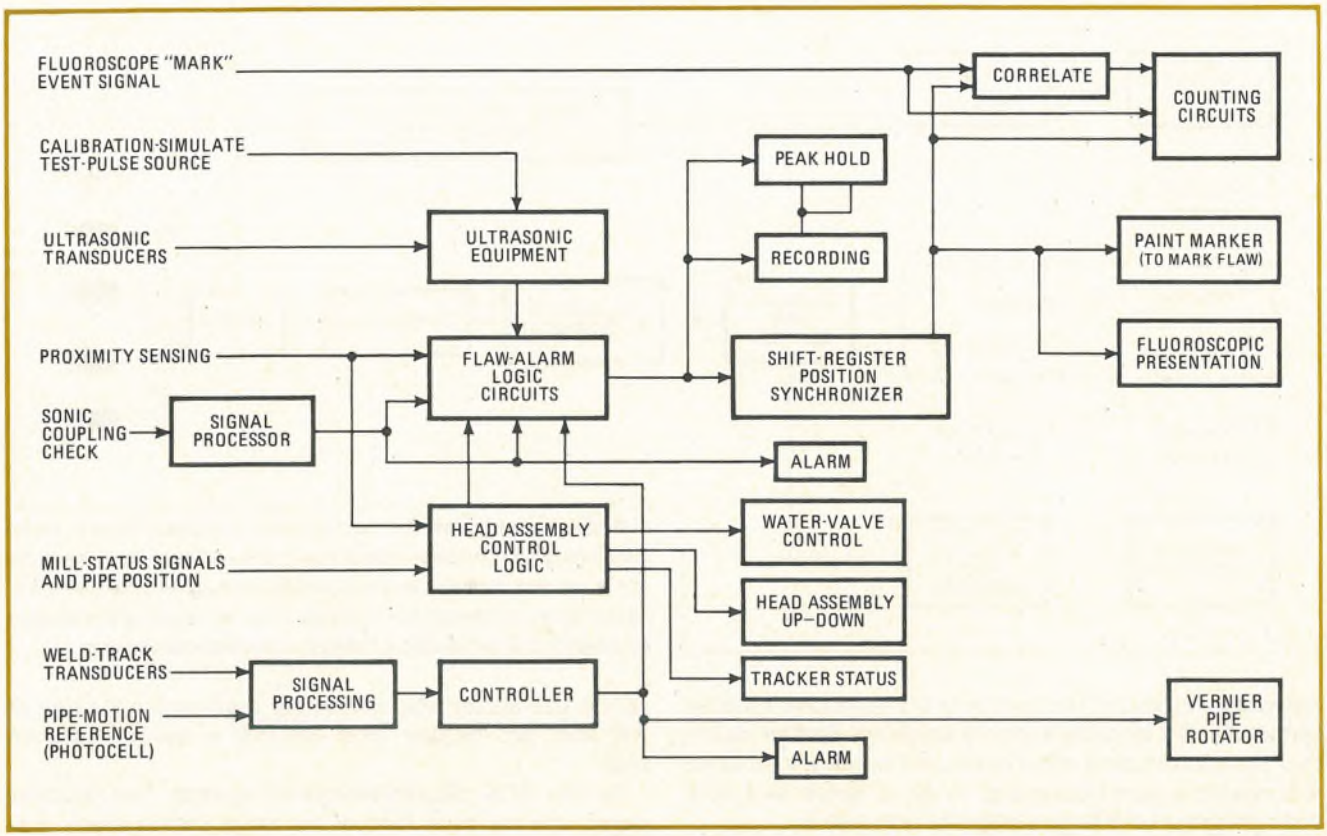
"Single-stand mills are relatively simple to control; there are fewer interactions and only one roll gap to worry about," points out John Underwood, senior product engineer at Industrial Nucleonics. "But in a multistand mill, any change to roll-separating force, interstand tension, or strip thickness has intertwining effects, that can send thickness transients echoing up and down the mill. You have to walk a tight line between instability and suboptimal control."

The Industrial Nucleonics controller is used in conjunction with the company's Accuracy 510 nucleonic thickness gage. The thickness gage contains an isotope source whose emission is measured by an ion chamber. As the radiation penetrates the steel, the ion chamber is conditioned to provide a voltage proportional to the deviation from the thickness set point. Typically, thicknesses from 0.0005 to 0.5 in. are measured.

Initially, the operator sets thumbwheel switches on the control panel for the alloy to be rolled and the thickness desired. These settings allow the controller to select from the programable read-only memory the control-algorithm parameters that best suit the characteristics of the metal being rolled. There are also switch settings for simple or differential backlash compensation on the screws that control roll loading and for selecting which variables are to be displayed.

An analog multiplexer samples the gage output, mill speed, motor currents, roll force, and sheet tension. After analog-to-digital conversion, the inputs are scanned every 20 milliseconds by the microprocessor. Outputs from the microprocessor control the dc motors that regulate tension from the entry reels and also dictate the time and voltage applied to the motors or hydraulic actuators that open and close the gap between the work rolls.

In addition to the gage and controller modules, which



3. System status. One check on operating conditions is the sonic coupling signal sent from the inactive ultrasonic receiver that picks up energy transmitted through the pipe by the active transmitter. Welds are automatically tracked, and the system counts both the number of pipes tested and the number of defects located. Defect signal also triggers a paint sprayer to mark the position of flaw.

can be purchased separately, Industrial Nucleonics also offers a microprocessor-based target-optimization module. The logic in the module computes the actual thickness range produced by the mill, compares it with the customer's order tolerance, and then automatically shifts the gage target to the most economical setting within tolerance set point.

Cooling to order

As the hot strip leaves the last stand, it travels 400 to 500 feet over a runout table to the coiling reel. As it traverses the table, the strip, which is about 1,600°F at this point, is cooled by water sprays. Typically, there are five separately controlled spray banks above and below the runout table.

The cooling temperature is carefully specified by the customer because it affects the metallurgical properties of the steel. If it is not carefully controlled, the coil could be rejected. Regulating cooling sprays on the runout table of a hot-strip mill sounds like a simple task, but it is not. Many variables affect the process nonlinearly.

A cooling temperature-control system tested at Armco Steel used a learning network developed by Adaptronics, McLean, Va. A learning network carries mathematical modeling a step further than does the adaptive-control method.

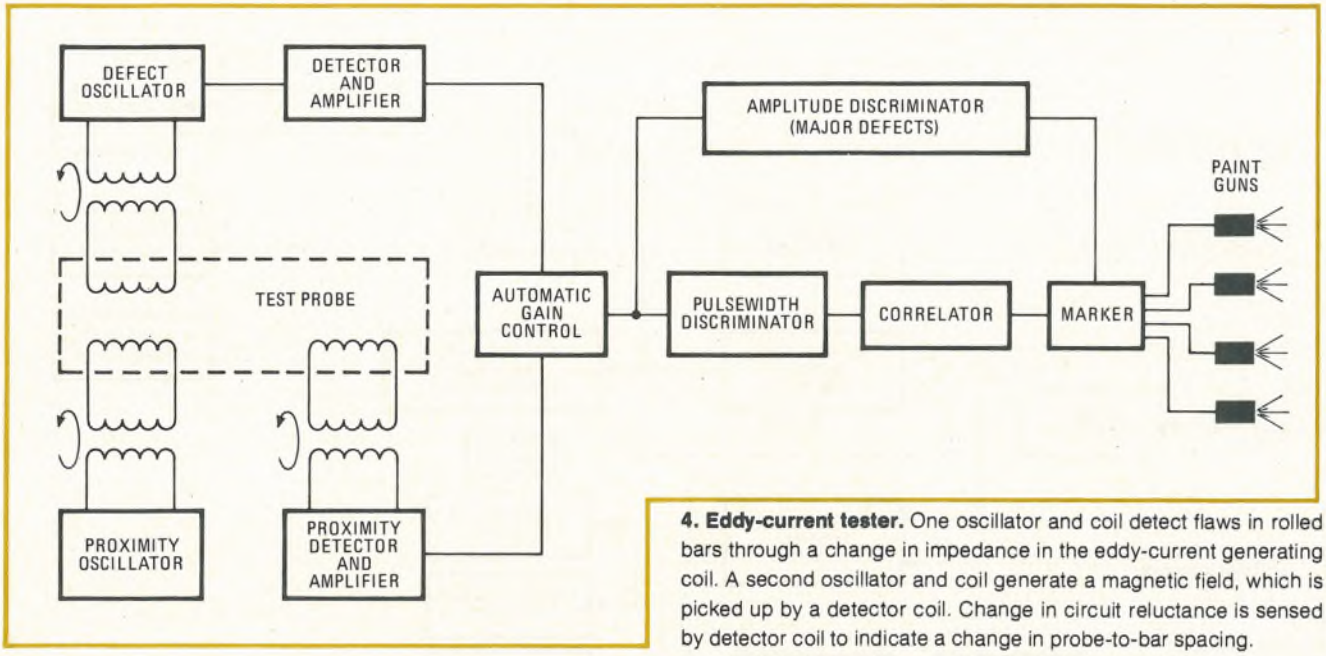
The network, which now exists as a software program, is fed input variables and their associated outputs. Based on this data, the network not only decides how the variables are interrelated, but also decides whether or not the variables are significant. If new sensor data becomes available, the learning network may reconstruct the algorithm completely.

Unlike adaptive control, input data can be any variable that may be related to the output—not merely the standard process measurements such as temperature, pressure, flow, and speed. Data may be colors, sounds, vibrations or any process variable—an advantage in processes where there is no way to instrument the conventional variables.

"At Armco," says Roger Barron, president of Adaptronics, "the system, which was programed on an IBM 1800 process-control computer, had seven inputs—desired coiling temperature, the finishing temperature as the strip exits the last stand (the difference between these two temperatures represents the heat that must be removed), the speed and thickness of the strip, its width, its hardness, and the number and configuration of the sprays chosen from eight above the table and seven underneath it."

Based on assumed initial conditions, the sprays were preset. When the strip emerged from the last stand, the prediction was repeated according to actual temperature and speed of the strip. If the measured variables deviated in any way, the number of sprays was modified.

So far, Adaptronics only sells the learning network in software form, but it is also building a hardware/software version. The hardware will be modular



4. Eddy-current tester. One oscillator and coil detect flaws in rolled bars through a change in impedance in the eddy-current generating coil. A second oscillator and coil generate a magnetic field, which is picked up by a detector coil. Change in circuit reluctance is sensed by detector coil to indicate a change in probe-to-bar spacing.

computing elements that perform the repetitive kinds of arithmetic the learning network employs. Barron claims that the combination of software and hardware modules will enable a small computer to do as much as a software program on a large computer now can do.

"A typical network will take anywhere from a handful to hundreds of modules, depending on the complexity of the math model," Barron says. Each module will handle two inputs and have one output. Once the modules are all interconnected, the result will be a special-purpose computer to be used with a regular central-processing unit. The CPU will supervise the repetitive calculations performed by the modules, while it performs the nonrepetitive type of calculations itself.

Saving zinc in galvanizing

To prevent corrosion, the rolled strip is often coated with a protective layer of zinc. Galvanizing involves passing steel through a molten-zinc bath at speeds ranging from 55 to 700 feet per minute. As the strip emerges from the bath, air knives—essentially channels through which low-pressure ambient-temperature air is directed—blow the molten zinc to the desired thickness. Regulating air pressure controls thickness of the coating, and adjusting the knife position controls distribution of the coating.

There are only 330 galvanizers in the entire world, but a global shortage of zinc has these galvanizers excitedly eyeing the zinc-saving benefits of computerized coating control. The cost of a computerized system may range from $300,000 to more than $1 million, making a dollar total sufficiently attractive to induce Honeywell and U.S. Steel to work out a cooperative marketing arrangement for such a system [*Electronics*, Feb. 6, p. 46]. The computerized system is based on a control algorithm and software developed by U. S. Steel for a Honeywell process-control computer.

Jim Bell, Honeywell's acting manager of metal, mining, and ceramic sales, claims, "This system will save a galvanizer who is running a 60-inch-wide line at 500 feet per minute over $50,000 a month—just on zinc."

In the U.S. Steel/Honeywell system, two nuclear gages, one on each side of the strip, continuously traverse the strip, sampling the thickness every half second on the forward pass. The nuclear gages interface directly to the computer, producing binary-coded-decimal signals proportional to the thickness.

On the return traverse, the computer uses the accumulated gage measurements to calculate the average coating weight on each side, the total weight for both sides, and the coating weight at the test locations specified by the American Society of Testing Materials. In addition, the computer compares the measured thickness to the target thickness and uses the resulting error signal to calculate the necessary adjustments to both knife pressure and knife position.

Sensor inputs to the computer include air pressure, which is measured by a transistorized pressure transducer, and knife position, which is sensed by a potentiometer. To determine line speed, the computer counts contact closures of a reed switch actuated by a magnet mounted on the drive rolls.

Inspecting critically

Detecting flaws during the manufacture of steel is more critical for some applications than for others. Offshore oil rigs and trans-Alaskan pipelines face severe environments, and failures could be catastrophic, not only to the environment, but also to human life.

Now, U.S. Steel, in cooperation with Imagex Inc., Mentor, Ohio, has developed a tandem ultrasonic and fluoroscopic test system that tests welded pipe to American Petroleum Institute and Arctic specifications. The system has nearly eliminated false alarms produced by inconsequential weld variations.

To detect flaws in pipe, the pipe is rolled into position over an X-ray source that is mounted on a long boom

extending down the center of the pipe (Figs. 2 and 3). As the pipe comes into position, a photocell senses where the end is and establishes the zero position for determining flaw location. The ultrasonic head comes down automatically and centers itself over the weld.

Inside the head are two transmitter/receivers—one pair for each side of the weld. As the head rides along the pipe, plastic shoes restrain the water that serves as a sonic coupling between the pipe and transducer.

Since the two transmitter/receivers share the same pulse/receiver module in the ultrasonic analyzer, they are connected into a simple multiplex system that operates them alternately. As one transducer transmits, part of the energy passes through the pipe to the opposite receiver, which picks up the transmission and signals the system diagnostics that a good sonic coupling exists between the opposite transducer and the pipe.

As the pipe begins moving, a magnetic pickup mounted on the drive rolls calculates the length of the weld that has passed the X-ray source. The weld is kept in position over the source by a specially designed weld tracker—two metal cones that ride the weld with their apexes almost touching. Each cone drives a digital tachometer, and as long as the weld is in position, the counts from the two tachometers are equal.

If the weld skews, say to the left, the weld will ride a larger diameter on the cone at the left than on the cone at the right. This size difference causes the cone on the left to slow down and the one on the right to speed up. For correction, rotatable guide rolls mounted along the pipe rotate the pipe counter-clockwise until the tachometer counts are again equal.

As the ultrasonic system scans the weld, a flaw counter is triggered by any imperfection causing a signal in excess of the limit set by the American Petroleum Institute standards. This signal is stored in a shift-register memory until the flaw is in view of the fluoroscope. At that point, the signal trips an alarm lamp, and a cursor appears on the fluoroscopic screen. The cursor follows the imperfection and alerts the operator to examine that area with particular care. In addition, a 35-millimeter camera, upon command, takes pictures of the flaw. The pictures are comparable to conventional radiographs, but cost a fraction of the time and money required to produce a radiograph.

Testing rolled bars

To inspect rolled bars traveling up to 150 feet per minute, John Hoffman of Bethlehem Steel's Homer Research Laboratories, Bethlehem, Pa., designed an inspection system that uses eddy currents generated by a high-frequency oscillator. The eddy-current probe rotates in a helical path around the moving bar at speeds up to 1,600 revolutions per minute. Its maximum speed depends on the bar diameter. As the probe rotates, it is held at a minimum preset distance from the bar.

The probe is located inside a floating head that can move plus or minus a half inch vertically or horizontally to accommodate bars that are not straight. The probe, rotated by a variable-speed motor, is coupled to the defect-detection circuits through one channel of a three-channel rotary transformer that rotates with the probe.

A high-frequency oscillator drives the test-probe coils and generates eddy currents on the bar surface. A defect disrupts the orderly flow of eddy currents; the deeper the defect, the greater the disruption. The defect is detected as a change in impedance in the test probe's coil, which is amplified and filtered to produce a signal that has an amplitude proportional to the defect depth.

To prevent variations in the distance between probe and bar from affecting the defect-signal amplitude, thereby resulting in an erroneous assessment of defect depth, automatic-gain-control circuits are used. Automatic gain control is achieved by a second oscillator and coil that are sensitive to spacing, rather than to defects. As the distance between bar and probe varies, the reluctance path between the coil and bar changes. This change is detected, and the signal automatically varies the gain to provide a constant test sensitivity (Fig. 4).

One of the difficulties in testing with eddy currents is distinguishing between defect signals and noise caused by surface roughness, scale, electrical interference, and short, shallow defects that are not large enough for rejection. Bethlehem Steel overcomes this by analyzing signals by means of pulse-width discrimination and signal correlation. The pulse-width discriminator (Fig. 5) identifies as a defect any eddy-current signal that exceeds a preset amplitude and also decreases in amplitude from its peak value to half its peak value in less than a predetermined time.

Harmful surface defects, such as seams, are longitudinal or continuous and will therefore be detected by the rotating probe at approximately the same circumferential position on the bar for successive probe scans. (Fig. 6) Defects that are deep but short are processed by conventional amplitude discrimination. They can be readily detected because the signals they produce greatly exceed the amplitude of noise signals or correlated signals from seams.

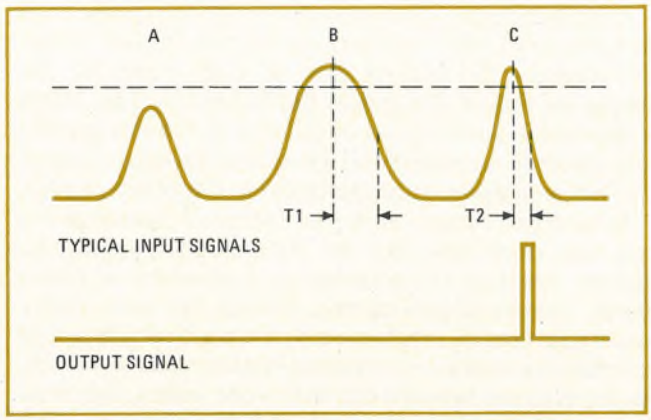
Savings on power

Steel production, particularly in electric-arc furnaces, consumes vast amounts of electricity. To prevent excessive loads on the generating facilities, utilities "encourage" large customers to stay below a certain power usage level by levying a surcharge when they exceed it. Known as a peak-demand billing, the process includes the basic energy cost plus a surcharge which is based on the highest amount of energy used in any demand interval over the entire month.

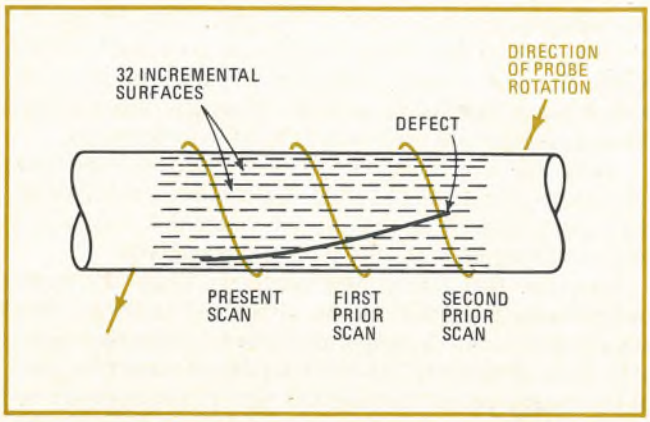
One way to hold peak demand, and therefore surcharges, to the lowest possible level is to use a power-demand controller such as the system offered by Leeds & Northrup Co., North Wales, Pa. "The people who have the most obvious need for this are those who consume irregular amounts of energy," points out Jim Stewart, L&N application specialist.

Inputs to the power-demand controller are two signals supplied by the power company—an end-of-interval pulse and a kilowatt-hour pulse. The end-of-interval pulse marks the end of each time interval over which peak demand is calculated for that customer, while the kilowatt-hour pulse signals each kilowatt hour used.

The controller, a special-purpose, hard-wired com-



5. Pulse-width discriminator. In eddy-current testing, signal A, generated by shallow surface scratches in bars does not exceed a preset amplitude. Signal B, which is characteristic of loose surface scale, exceeds the amplitude, but does not decay fast enough. Signal C from a typical surface defect, exceeds preset limit and also falls off to half the peak value in less than the preset period.



6. Locating the probe. As eddy-current probe rotates around an advancing bar, an encoder divides bar circumference into 32 increments. When defect signal is delivered by the pulse-width discriminator, the increment and scan number are stored, and the circuits correlate the present defect signal with signals for the same position in a preselected number of previous scans.

puter, continuously calculates an allowable average-power consumption, based on the contracted peak-power limit, the power already consumed, and the time remaining in the interval. If power consumption is projected to exceed the demand limit, the controller begins shedding loads in a preset fashion. The system begins by shutting off the least critical loads first—for example, air-conditioning or a nonessential furnace.

To prevent unnecessary cycling, the system does not shed loads the instant the average allowable power is exceeded. Instead, it delays control action until as close to the end of the interval as possible. In that way, normal cyclical variations in loads may compensate for high demand earlier in the interval.

"Though power-demand control has been around for years, it has only been in recent years that the system has become economically justifiable for the smaller user," says Stewart. "With the declining cost of solid-state devices, we have been able to cut our price by almost a third in the last six years. This factor, combined with the rising cost of energy, has greatly expanded the field of application."

Seeking sensors

Probably the product having the greatest potential for development in the steel industry is the sensor. Unfortunately, the temperature of molten steel can be measured only intermittently by disposable thermocouples. "It would be fantastic if we could economically measure the temperature of molten steel continuously," says U.S. Steel's Coleman. "Typically we would want to measure 3,000°F within 10°."

Still another problem occurs in rolling ingots. When steel is cast, the top of the ingot will shrink underneath the skin, leaving an invisible void called a pipe. This void must be cut off before the ingot is rolled. If not, it will propagate down the strip as the material goes through the mill, and literally blow the mill apart.

Operators usually can tell from experience where to cut, but the cuts are made conservatively to make sure that the entire void is removed. Steel companies need some technique to locate these voids accurately to save steel. X-rays will not penetrate a 40-inch-thick ingot, and ultrasonic sounding has not been satisfactory.

Still another sensor is needed to determine the solid/liquid steel interface in a continuous casting. In continuous casting, molten steel flows into a bottomless water-cooled mold. As it leaves the mold, a thin skin of solidified steel surrounds the still-liquid center.

The semisolid strand, as it is called, is withdrawn from the mold by rotating pinch rolls. If it is withdrawn too fast, the skin is too thin, and there is danger of puncturing it, causing molten steel to flow out onto to floor. However, no sensor has been developed that can determine the interface between the molten steel and the solidified skin.

"I want better optical tools for dimensional measurements," says Sam Prellwitz, U.S. Steel's section supervisor of measurement research. "There are laser systems for measuring the diameter of wire and rod, but I would like a method that could simultaneously and inexpensively measure the cross-sectional dimensions of a rolled shape like an I- or H-beam—the width and thickness of the flanges, the thickness of the web, the orientation of the flange with respect to the web, whether it's bent or toed out. But the problem is cost-effectiveness."

Prellwitz suggests that microprocessor technology may open new possibilities for instrument manufacturers in the steel industry. "I hope to see the instrument supplier use more microprocessor technology to overcome some of the inherent linearity problems of transducers. For example, the whole range of temperature sensors is inherently nonlinear. You could linearize them with a micro by plugging in a ROM with the proper data for that thermistor."

Whether it's for a single sensor or a complete computerized control system, the iron and steel industry represents one of the healthier long-term customers for electronics firms. The industry's needs are unique, and, for many applications, the unit counts are low. But for the companies willing to specialize, the iron and steel industry is a ready and willing customer. □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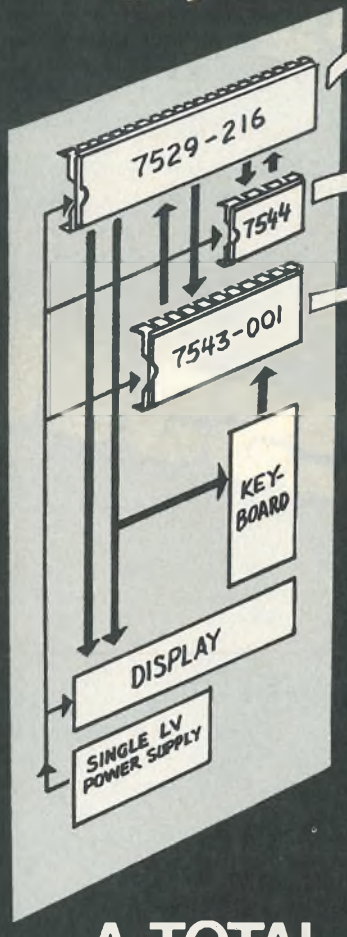

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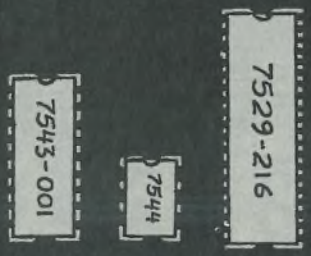

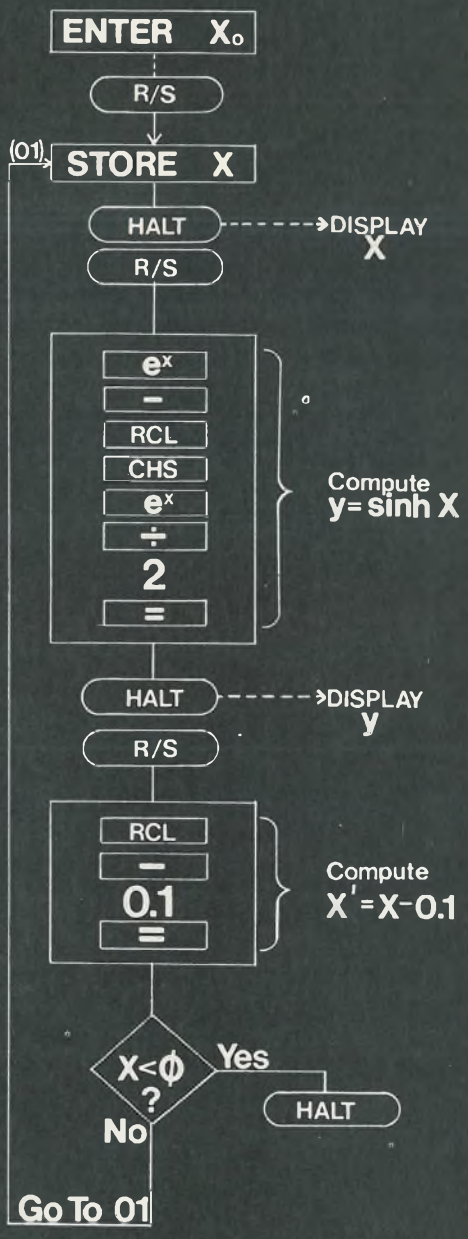

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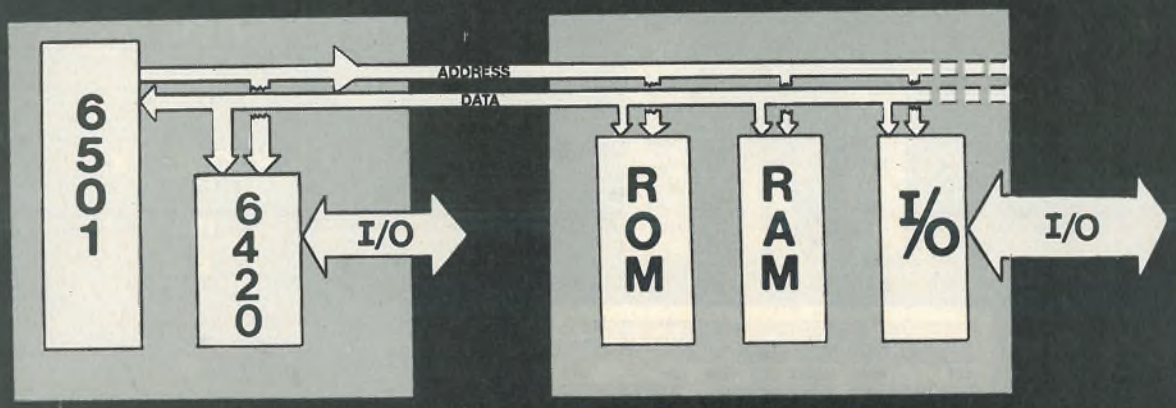

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Sapphire brings out the best in C-MOS

When thin-film silicon on sapphire substrates replaces bulk silicon, complementary-metal-oxide-semiconductor technology achieves much better performance; costs should drop as volume rises

by S. Sheffield Eaton, *RCA Solid State Division, Somerville, N.J.*

Semiconductor manufacturers are in the midst of a technological controversy, and its outcome will affect the way digital circuits are built in the future. The debate concerns whether a silicon-on-sapphire materials system, in combination with metal-oxide-semiconductor technology, is a practical means for achieving high-performance large-scale integration.

SOS is particularly attractive for complementary-MOS designs, and less so for n-channel MOS designs, because it allows the chip designer to add LSI levels of speed and density to the low power, ease of use, and noise-immunity of C-MOS. Indeed, established C-MOS manufacturers like RCA's Solid State division, Somerville, N.J., and Solid-State Scientific Inc., Montgomeryville, Pa., have already built C-MOS-on-sapphire random-access memories and high-speed counters and timers. They are also well along on the single-chip microprocessors and peripheral circuits needed to make up an entire microcomputer system.

The controversy does not center on whether SOS offers high LSI performance, which it undoubtedly does, but on whether this performance is worth the extra trouble and expense of obtaining and processing the thin-film sapphire substrates.

Opponents of the technology note that sapphire substrates today cost up to 10 times more than equivalent bulk silicon substrates. Supporters of SOS reply that a substantial increase in demand will reduce this price, which in any case is offset by the economies of simpler device processing and more relaxed fabricating rules.

The argument has become more heated with the appearance of other circuit techniques—integrated injection logic and LSI forms of transistor-transistor and emitter-coupled logic—which lend themselves to conventional silicon processing and which many semiconductor manufacturers believe may provide high LSI performance at less cost than SOS. Proponents of this view include Texas Instruments, National Semiconductor, Fairchild Semiconductor, and others, and they point to the new I^2L microprocessors and memories [*Electronics*, Feb. 6, p. 83] and Schottky TTL and ECL LSI processors as proof that the new and improved forms of bipolar logic are the way to go.

There the debate rests. The next few years will see who wins.

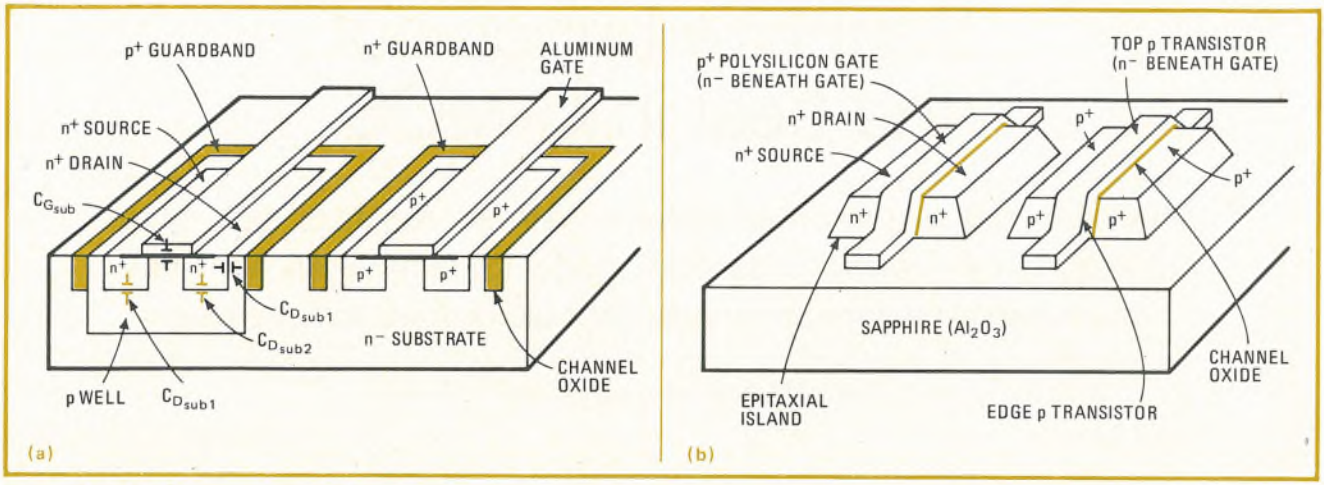
The article that starts below presents the case for silicon-on-sapphire C-MOS designs, comparing them with conventional C-MOS technology. Also presented is the range of products achievable with SOS and the performance specifications they either attain or can be expected to attain. Finally, some of the problems associated with SOS are presented, and some solutions to them given. —Laurence Altman

☐ Complementary-MOS circuits built on sapphire substrates have several advantages over those built on bulk silicon. They are faster, they have tighter, smaller circuit features, and, once the starting material has been prepared and polished, they are easier to build.

They are faster because the insulating sapphire reduces junction and other parasitic capacitance that slows down the operation of bulk silicon circuits. They are half the size because three levels of interconnect allow tight packing of devices and because the guard-bands generally used for transistor isolation in bulk silicon substrates are eliminated. Yet the process requires only a third the steps of conventional C-MOS.

The simplicity of the process should eventually make the cost of C-MOS-on-sapphire circuits competitive with, and maybe lower than, that of bulk C-MOS circuits, even though unpolished sapphire substrates in large quantities presently cost about six to seven times more than the others. Also lowering the cost will be higher yields, again because of the simpler processing but also because silicon-on-sapphire circuit operation is little affected by mask and oxide defects over inactive sapphire regions.

Speed and power, the principal measures of device performance, depend on the amount of transistor current available and the magnitude of the internal node



1. How sapphire helps. The capacitance between drain and substrate and between gate and source-drain diffusion in the bulk-silicon C-MOS structure (a) slows down operation. In sapphire, low-capacitance transistor (b) is smaller and faster.

TABLE 1: CAPACITANCES IN BULK AND SOS TRANSISTORS

Capacitance source	Symbol	Capacitance		Units
		Aluminum-gate bulk	Silicon-gate SOS	
Gate-substrate	$C_{G_{sub}}$	0.25	0.25	pF/mil^2
Drain-substrate (sidewall)	$C_{D_{sub1}}$	0.1	–	pF/mil^2
Drain-substrate (base)	$C_{D_{sub2}}$	0.1	–	pF/mil^2
Gate-drain	C_{GD}	0.04	0.01	pF/mil

capacitance that this current must charge and discharge. For a given current, the amount of power required to operate the transistor is proportional to the value of this node capacitance—the smaller, the better. Also, for a given internal resistance, the transistor RC time constant is proportional to the capacitance, and the lower the capacitance, the faster the transistor operation.

Fewer stray picofarads

Figure 1 shows cross sections of C-MOS transistors on bulk silicon and sapphire substrates and labels all the important internal capacitances, values for which are listed in Table 1. These values demonstrate that an SOS transistor has very much less node capacitance than a bulk transistor. In fact, almost all its capacitance is that between gate and substrate (C_{Gsub}), which is the only capacitance necessary for the proper operation of an MOS circuit—any other capacitance merely increases power dissipation and slows switching speed. In contrast, nearly half the capacitance of an aluminum-gate bulk transistor is parasitic.

Over the years several methods have evolved for reducing the parasitic capacitance. Perhaps the most significant is the self-aligned silicon-gate process, which increases available current by lowering transistor threshold voltages and decreases gate-to-drain or Miller capacitance by eliminating much of the gate-to-drain overlap. Nevertheless, this and other bulk processes still suffer from the large drain-to-substrate capacitance that occurs along the base and edges of the drain diffusions.

In the SOS process, however, the drain-to-substrate capacitance is negligible. As shown in Fig. 1b, the diffusion capacitance of the SOS transistor is almost entirely eliminated because the diffusions are driven down to the sapphire and the transistors are formed in the resulting islands of silicon. Consequently, the junction capacitance remaining along the channel periphery is many orders of magnitude below the gate-to-substrate capacitance. Since almost all the capacitance associated with each internal circuit node is due to the essential gate capacitance, the self-aligned silicon-gate SOS process has the lowest value of parasitic capacitance in all of today's MOS technology.

Nor does this achievement depend on complex processing. First, an intrinsic silicon epitaxial layer is deposited over the entire sapphire substrate and implanted with n-type impurities. Next, islands of silicon are defined where transistors are desired. Polysilicon gates, doped and defined above a thermally grown channel oxide, are then used as a mask for the source and drain diffusions. Lastly, a thick layer of oxide is deposited over the entire wafer, and contacts are opened to the diffusions and gates. The thick oxide minimizes crossover capacitance between the final metalization and the underlying polysilicon gates, which can also be used as an additional interconnect level. In all only six photomasks are required, including a final mask for bond pad openings in the protective oxide layer.

How SOS transistors operate

Unlike bulk C-MOS processes, in which all p and n transistors share a substrate, each SOS transistor has its own substrate insulated electrically from the others by the sapphire—no direct connection is made to any substrate. But substrate potentials remain fixed (at least in the dc case) for standard enhancement-type transistors at one diode drop below or above the source potential. Since source and substrate voltages move together, the dependence of the threshold voltage on source potential, which is often a problem in bulk silicon processes, is eliminated.

In bulk MOS processes, transistors can operate in either enhancement or depletion modes. SOS processes, however, add a third type of operation called deep depletion. Figure 1b shows the structure of SOS enhancement-type p and deep-depletion n transistors.

While the operation of the SOS p-channel transistor is governed by the usual depletion and inversion regions formed in the substrate, the SOS n-channel transistor works quite differently. The same n-type substrate used for the p-channel transistors is also used between the standard n^+ source and drain diffusions. With zero gate voltage (OFF condition), the contact potential difference of -0.8 V between the p^+ gate and n^- substrate is enough to fully deplete the epitaxial layer down to its full depth. The threshold voltage then becomes the positive gate voltage at which the depletion region depth is just equal to the epitaxial layer thickness. More positive gate voltage then shrinks the depletion region and accumulates the charge on the surface, allowing more and more current to flow (Fig. 2).

A deep-depletion process, in which a single substrate type and concentration suffices for both p and n transistors, is primarily selected for its simplicity and also to obtain low p- and n-threshold voltages of about half a volt. But there is also a more complex, double-epitaxial process, in which islands for the p-channel transistor are defined in a uniformly doped n-type epitaxial layer. A masking oxide then protects these islands while n-channel transistors are being defined in a second p-doped epitaxial layer.

For either deep-depletion or double-epitaxial silicon-gate processes, three levels of interconnect are possible, giving the designer plenty of flexibility in laying out an LSI circuit. The aluminum metalization, polysilicon gate layer, and silicon islands defined in the epitaxial layer can all be used for interconnections. The polysilicon and epitaxial layers cannot cross, however, if they are intended to be electrically independent of each other; otherwise, the potential of the polysilicon would modulate the conductivity of any underlying silicon, which in the self-aligned process must be lightly doped.

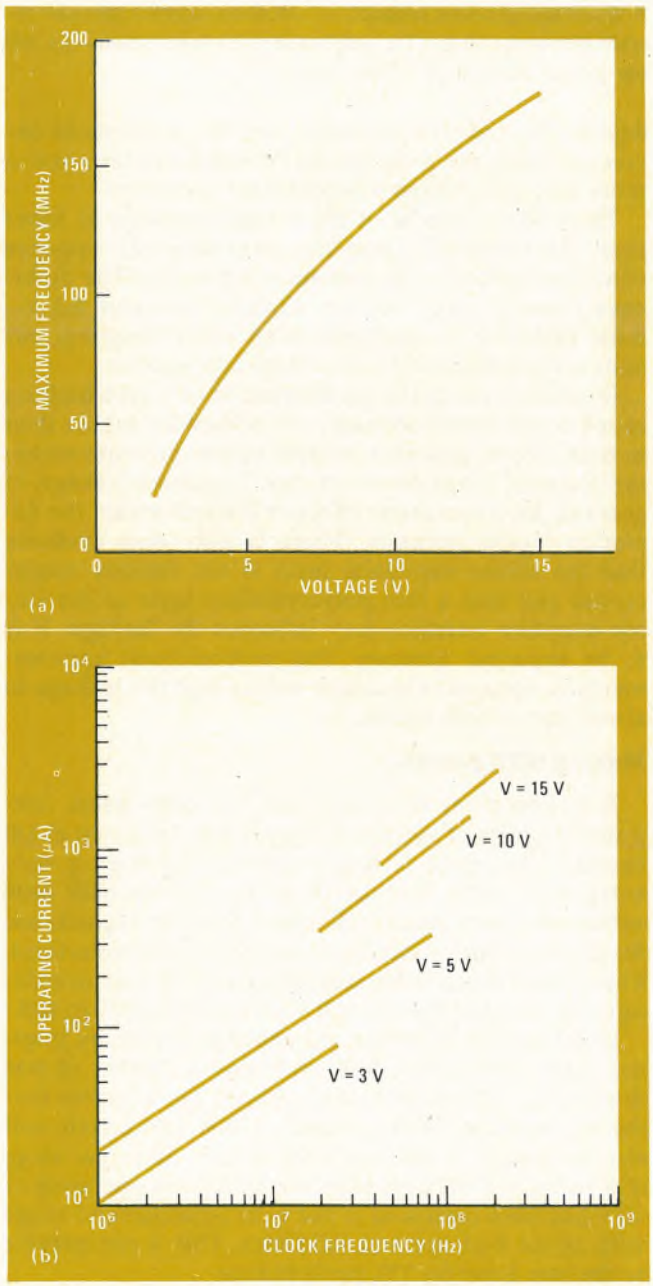
All three interconnection layers can be placed over sapphire, eliminating the capacitance between the interconnections and the diffusions that is present in most bulk processes. Capacitance remains, however, between interconnection lines located on the same level. For example, two metal lines spaced 0.3 mil apart produce approximately 0.002 picofarad per mil. Even this small amount, taken together with crossover capacitance, may be equivalent to the gate capacitance of small transistors and can reduce the speed of an SOS circuit if care is not exercised in layout.

SOS transistor characteristics

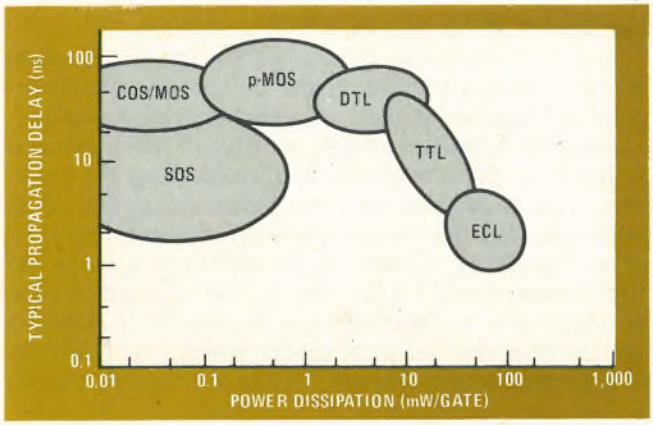
For high-speed capability it is also desirable to maximize the current available from a given transistor geometry. This in turn is a function of the carrier mobility in the epitaxial layer or, more specifically, the surface channel mobility. Conflicting data comparing SOS mobility to that of bulk silicon has been published in recent years. In practice, the current available from SOS transistors appears to be equal to or slightly less than the current obtainable from bulk transistors.

Another important design parameter is transistor threshold voltage, which affects the speed of digital circuits and determines their minimum operating voltage.

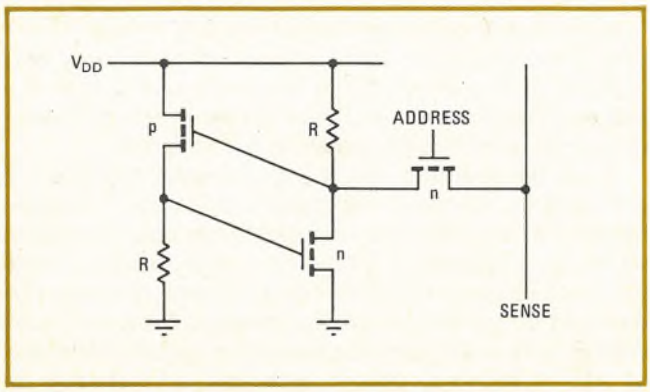
Each SOS transistor actually consists of two transistors in parallel—one conventionally formed along the top of the silicon island and the other formed along the island edge (Fig. 1b). The island edges are sloped in the [111] crystal plane as opposed to the [100] plane along the top. Now, it is well known that the fixed charge (Q_{SS}) in an oxide that is thermally grown over [111] silicon is greater than the charge in oxides grown over [100] silicon. Consequently, a lower voltage is necessary to fully



2. Quick counter. At 10 V, silicon-on-sapphire dynamic counter has a frequency of 130 MHz (a). Of course, at high frequencies power consumption goes up. The relationship of operating current to frequency is shown in (b) for several values of supply voltage.



3. Good speed-power product. A C-MOS-on-sapphire gate can operate almost as fast as a TTL gate but at much lower power—0.1 mW per gate for SOS but 10 mW per gate for TTL.



4. Fast. A C-MOS-on-sapphire, 1,024-bit, static random-access memory can operate at less than a 100-ns access time. Future designs may adopt a compact Siemens cell that substitutes two resistors for two of the five transistors in a conventional cell.

deplete the epitaxial substrate, and the n threshold decreases. Also, the p threshold increases because now a more negative voltage is required for inversion.

Thus, the threshold of the n edge transistor is lower than the threshold along the top, while the opposite condition holds for the p-channel transistor. The difference between edge and top thresholds—about 0.3 V—must therefore be accommodated when designing circuits for low-threshold low-voltage applications.

In practice the quiescent dissipation of C-MOS built on sapphire substrates appears to be somewhat higher than in bulk C-MOS, probably because carrier lifetimes within the epitaxial substrate are shorter. Transistor leakage, in general, decreases as the effective lifetime within the depletion region increases. There is also some evidence that the silicon expitaxial layer is not entirely single-crystal and that a thin polycrystalline layer at the silicon-sapphire interface may influence the leakage. It is to be expected, however, that technological improvements in epitaxial deposition will reduce the leakage to about that of bulk C-MOS.

Making SOS pay off

It is important to realize that the high-speed, low-power promise of SOS technology is best exploited in LSI circuits. The speed of single gates or flip-flops is only marginally better than in those made with bulk MOS substrates, since nearly all speed-limiting capacitance for these circuits arises from external interconnections. Therefore it would offer only a slight advantage to redesign the standard SSI and MSI 4000 C-MOS family in SOS.

In LSI circuits, however, the speed is limited by internal node capacitance, and since this is smaller in SOS than in any other present-day technology, it follows that the power-stage delay product of SOS LSI circuits will also be lowest. In fact, the propagation delay per stage of a string of C-MOS-on-sapphire NOR gates operating at 10 V has been measured in the 1- to 2-nanosecond range with about 4-ns rise and fall times. This is comparable to the best Schottky TTL performance.

Figure 2, which shows speed and power characteristics for SOS dynamic counters operating at various supply voltages, indicates that speeds to 80 megahertz are possible at 5 V with a power consumption of only about 2 milliwatts. Standard TTL counter circuits, by contrast, operate to about 30 MHz with power consumption in the 200-mW range. Power-stage delay products for various technologies are compared in Fig. 3.

An attractive feature of SOS circuits is their retention of nearly all the assets of bulk C-MOS circuitry—operation from a single power supply, low quiescent dissipation, high noise immunity, tolerance of temperature variations, and high input impedance. In addition, SOS offers complete isolation between transistors and interconnects, a lower power-stage delay product, higher radiation resistance, and about double the density.

Essential for LSI purposes, this high density results from the design freedom provided by three layers of interconnects and from the use of silicon islands, the spaces between which can be much narrower than the discretely diffused guardbands of standard C-MOS. Also helpful is the elimination of gate overlap in silicon-gate processes and the smaller size of the transistors, which can be as tiny as is consistent with reliable photoresist definition of the silicon islands and gates.

To illustrate the end result, the smallest possible C-MOS-on-sapphire inverter, complete with contacts to its gate, drain, source, and output, occupies about 2 mil^2, as against the 4 mil^2 of a bulk C-MOS inverter.

Applying SOS

When all the tradeoffs are taken into account, the areas where C-MOS-on-sapphire technology can best be applied are in timekeeping, memories, microprocessors, high-speed counters, level shifters, and multiplexing. All these applications require a high degree of circuit complexity plus fast, low-power operation.

Timekeeping applications that rely on quartz crystal oscillators for high accuracy have traditionally used C-MOS frequency dividers for low-power operation. The power consumption is most severely restricted in wristwatches, where a 32-kilohertz crystal is typically chosen to obtain the 15-to-20-microampere maximum operating current necessary for a year's battery life.

But this crystal frequency is not optimum from either a cost or performance standpoint. High frequency AT- or SL-cut crystals above 1 MHz offer two to three times lower cost, higher Q, and improved shock, aging, and

temperature characteristics. Small SL-cut crystals are currently available at 1 MHz, but to retain the advantages of AT-cut crystals in wristwatch sizes, a crystal frequency of 4 MHz or greater at present appears necessary. C-MOS-on-sapphire frequency dividers with transistor thresholds as low as 0.05 V have been operated at speeds up to 25 MHz at 1.6 V. Circuits with more conservative thresholds of half a volt typically run to 8 MHz and operate at about 5 μA at 1.6 V and 4 MHz. Total crystal oscillator and counter power consumption averages about 12 μW at 4MHz and 7.5 μW for a single-cell 1-MHz system.

One 4-MHz timing chip (the RCA TA6778) has a 23-stage SOS counter and oscillator. One output is provided after the seventh counting stage to drive standard 32-kHz bulk timekeeping circuits. Two other outputs are provided at 0.5 hertz for driving stepping motors. The frequency of all outputs may be adjusted digitally; 122-part-per-million steps for each binary increment are applied to three control pins for a total of 854 ppm. Speeds to 80 MHz are possible with a 5-V supply.

Besides wristwatches, other timekeeping applications include wall clocks and auto clocks. In both, SOS circuitry offers low-power operation using high-frequency AT-cut crystals. (The use of these conventional, low-cost crystals is possible because the restrictions on size are removed.) The RCA TA6779 is an example of a device intended for single-cell clock applications. It has two outputs at 32 kHz for driving synchronous clock motors. Another circuit is planned for driving stepping motors.

SOS memories and microprocessors

For SOS chips, the most important single application may yet prove to be memories. Dominating the memory market today are bipolar devices, fabricated with transistor-transistor logic, emitter-coupled logic, or Schottky TTL, and bulk MOS devices, which use mainly n-MOS and C-MOS and may be static or dynamic in operation. Now MOS memories can be further subdivided into those with bulk and those with insulating substrates.

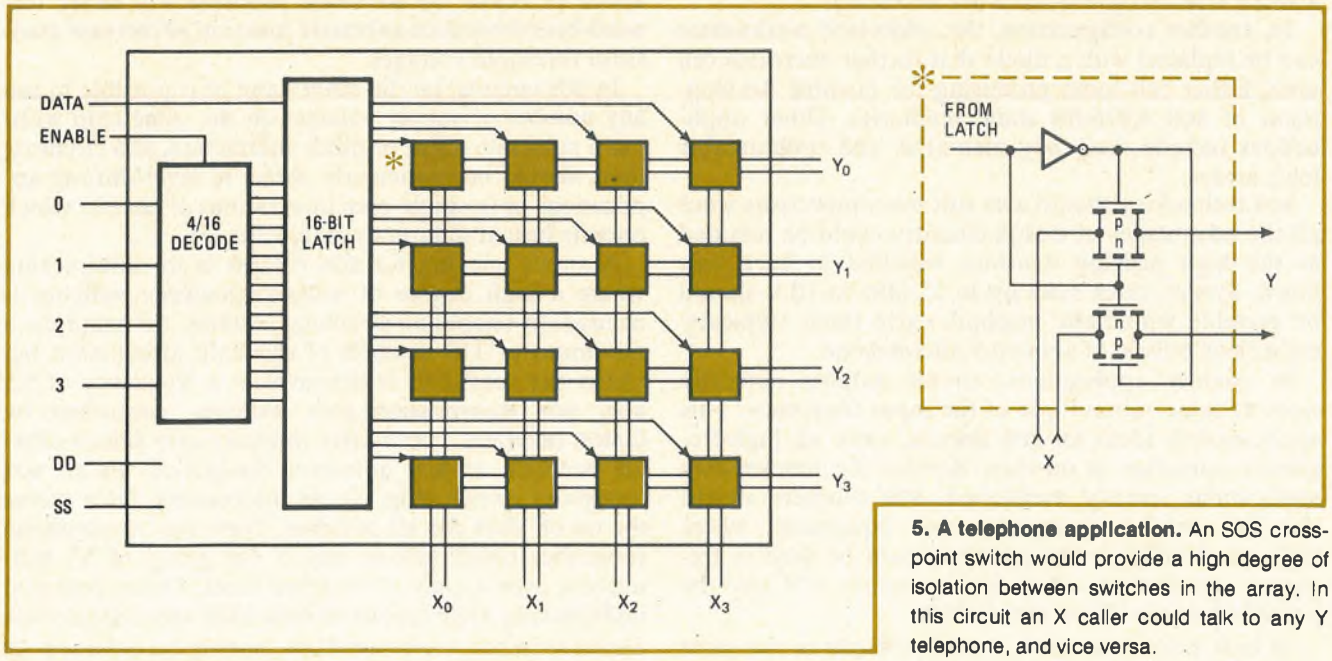
Table 2 lists the different advantages of each memory type, including the RCA TA6780 SOS device. Scheduled for introduction in 1975, the TA6780 should operate at access and cycle times of 100 nanoseconds, close to that of bipolar memories but with a fortieth of the power consumption. Other advantages include low standby dissipation, a property that is inherent in C-MOS circuitry and virtually solves the problem of memory volatility. A small backup battery is enough to keep cell information intact, and the main power supply is no longer essential. Nor is the voltage of the backup critical since memory retention is relatively independent of the supply voltage. In short, no other memory technology has all the desirable SOS characteristics of high speed, low power, wide operating temperature range, and ease of use.

Tradeoffs between these characteristics have of course to be made in the design of SOS memories. The RCA TA6780 1024X1 developmental memory strikes a balance between speed and ease of use. Applications include cache memories, point-of-sale terminals, peripherals, calculators, microprocessors, and minicomputers.

Other types of SOS memories, for example, a 20-to-30-ns, 16-word-by-4-bit memory would be useful in small cache memories requiring very high speed. Penetration into the mainframe market also will be possible as the price of SOS memories decreases.

To minimize memory-cell density in bulk MOS circuits, many manufacturers have used dynamic cells that must be refreshed periodically to restore cell information. When this approach is used with SOS technology, a higher refresh rate is required due to the higher source-drain transistor leakage. Still, new techniques may yet eliminate or ease this restriction, and the memory cell developed by Siemens presently appears promising.

Nicknamed "ESFI" for "epitaxial silicon films on insulators," the cell substitutes two isolated resistors for two transistors in a conventional five-transistor cell (Fig.



5. A telephone application. An SOS crosspoint switch would provide a high degree of isolation between switches in the array. In this circuit an X caller could talk to any Y telephone, and vice versa.

TABLE 2: VARIOUS MEMORY TYPES AND PROCESSES

Memory type	Access time (ns)	Read cycle time (ns)	Operating dissipation (mW)	Standby dissipation (mW)	Power supplies (V)	Peripheral circuitry required	Output	Temperature range (°C)	Approximate price (100-k quantity) (¢/bit)	Pulsed chip select	Number of pins
Bipolar Schottky 256-bit 3100	60	70	650	650	5	None	Three-state	0 to 75	1.5	No	16
Bipolar TTL 1,024-bit 93415	90	100	650	650	5	Pull-up load	Open collector	0 to 75	1.0	No	16
Bipolar ECL 1,024-bit 95415	45 (typ)	55 (typ)	650	650	−5.2 −2	Pull-down load	Open emitter	0 to 75	1.3	No	16
Static n-MOS 1,024-bit 2102-1	500	500	300	300	5	None	Three-state	0 to 70	0.5	No	16
Charge pump n-MOS 1,024-bit 7001	60	180	650	0.5	15 8 −3	−Charge pump oscillator −Sense amplifier −Chip select driver	Differential open drains	0 to 70	0.7	Yes	22
Dynamic n-MOS 4,096-bit 7004	150	300	500	0.4	12 5 −5	−Circuitry for 64 cycle refresh −Sense amplifier	Differential	0 to 70	0.2	–	22
Static bulk C-MOS 256-bit CD4061	380	550	40 at 10 V and 1-μs cycle time	0.1 at 10 V	Single supply 3–15	None	Three-state	−55 to 125	6	Yes	16
Static SOS C-MOS* 1,024-bit TA6780	120	130	15 at 10 V and 1-μs cycle time	1 at 10 V	Single supply 3 – 12	None	Three-state or open drain	−20 to 85	1	No	16

All data is worst case except where noted. *Specifications are objective.

4). The cell becomes much smaller since fewer crossovers and contacts are needed and since the resistors, electrically isolated by nature of the SOS process, occupy a small area. No guardbands are necessary.

In another configuration, the addressed n-transistor can be replaced with a diode that further decreases cell area. Either cell looks promising for possible development of SOS 4,096-bit static memories. Other applications include read-only memories and programable logic arrays.

SOS technology should also suit microprocessors since all the advantages of C-MOS circuitry could be retained at the high packing densities required to keep cost down. System clock rates up to 15 MHz at 10 V should be possible with basic machine cycle times (typically eight clock pulses) of about 0.5 microsecond.

In counter applications, circuit outputs normally clock at some submultiple of the input frequency. This application is ideal for SOS circuits, since all high-frequency operation is on-chip. Besides the timekeeping applications already mentioned, SOS counters should also be useful in communication equipment where high-speed divide-by-N counters could be used in frequency synthesizers. Portable operation will also be possible because of low power drain.

In bulk silicon circuits it is often difficult to use more than one supply voltage on the same chip since, for many transistors, the wafer itself forms a common substrate. Source voltage is then restricted because voltages above or below the substrate potential will either forward-bias the source-substrate junction or increase transistor threshold voltages.

In SOS circuits, on the other hand, it is possible to use any number of supply voltages on the same chip without a substrate effect or diode interaction. SOS circuitry, then, should be particularly useful in level-shifting applications or in single-chip integrations of circuits which operate best at different supply voltages.

Another opening for SOS circuits is in multiplexing where a high degree of isolation between switches is needed. In telephone switching systems, for example, a minimum of 110 decibels of crosstalk attenuation between any terminals is desirable at a frequency of 1.5 kHz. SOS transmission gate switches, controlled by C-MOS inverters, could offer sapphire and silicon-dioxide isolation at low quiescent dissipation. In an SOS crosspoint switch (Fig. 5), an addressable latch stores the on-off data for all switches. Then any X telephone subscriber could talk to any Y (or group of Y) subscribers over a pair of switched lines. Other potential multiplexing applications include high-speed single-line digital switches, which need low on-chip capacitance. □

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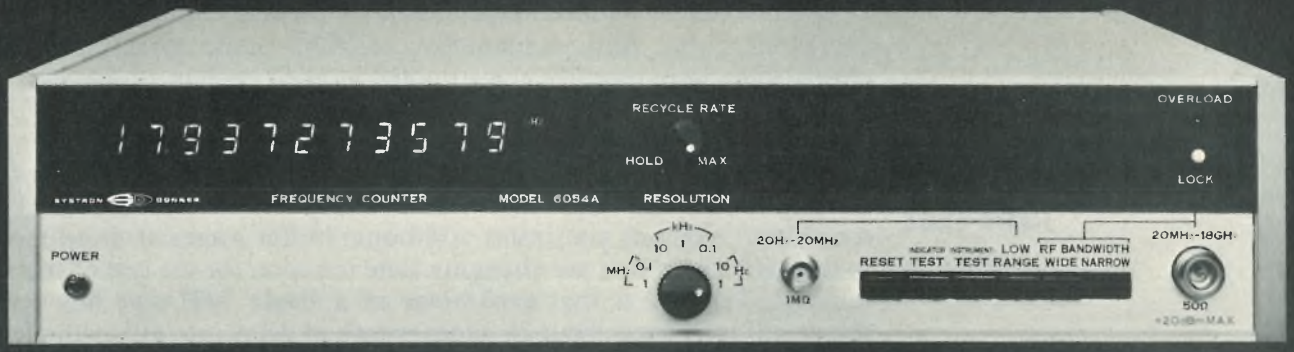

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Engineer's newsletter

4-k RAMs to cost $6 by December

Designers of memory systems will be glad to know that 4,096-bit RAM prices are moving briskly downwards in step with the learning curve, despite some suppliers' difficulty in producing the chips in volume. **The memories are selling at about $8 each in 10,000 lots and should reach $6 each by year end.** Estimates now are that they'll settle at under $4 within the next two years, helped along by pressure from the oncoming 16,384-bit parts. And incidentally, 1,024-bit static RAMs are really cheap—they were recently being quoted at $1.65 each in 10,000 lots.

Exorcizing logic-race conditions

Need a simple way of overcoming the perennial problem of logic race in long chains? Brother Thomas McGahee, of Don Bosco Tech, Boston, Mass., suggests you insert additional buffer stages at those inputs to the logic chain that are changing state too soon for the rest of the system. McGahee says that **each stage of a single 7407-type hex buffer driver will introduce about 20 nanoseconds of delay** into either the leading or the trailing edge of every incoming waveform.

Sockets can replace burn-in fixtures

Burning in large quantities of components or IC? **Before ordering special fixtures, consider using solderless "breadboard" sockets and buss strips.** The sockets accept almost any component, and to wire busses and sockets you simply push stripped No. 22 solid wire into the holes. Setting an example, Continental Specialties, the New Haven, Conn., manufacturer of these breadboard items, burns in many of its own LED logic-state indicator clips by plugging them into fixtures built out of its own sockets and busses, meters, and power supplies. All sockets and buss strips are completely reusable.

Lasers can seal electronic packages

How can you hermetically seal a hybrid-IC package with a really hot heat source without damaging bonded-lead wires? And how can you seal the case of a lithium battery which has an insulating separator made out of polyethylene, a material with a low melting point? Answer: use a pulsed laser system.

Laser welders can achieve a power density of greater than 10^6 W/cm^2 for short pulses. For this reason, **accurate laser sealing need not heat adjacent areas excessively or harm temperature-sensitive material internally.** Other information on the uses of pulsed lasers is contained in a series of application notes from Raytheon Company, Laser Advanced Development Center, 130 Second Avenue, Waltham, Mass. 02154.

Pinning down the calculator market in Europe

If your company is involved in calculators and associated components, your export and international marketing people might be interested in a new study of the European market. It covers all types of calculators (table-top, pocket, and so on), **defines the market by country, equipment segment and category, examines the distribution channels,** and gives names and addresses of major customers.

The 90-page study comes complete with graphs and charts. It can be bought from Creative Strategies GmbH, 12 Stiftstrasse, 6200-Wiesbaden, West Germany. **—Stephen E. Scrupski**

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Circle 123 on reader service card

Low-cost optical sensor overcomes ambient light

by Helge H. Mortensen
National Semiconductor Corp., Santa Clara, Calif.

A low-cost solid-state optical system can be useful for measurements of light transmission or reflection in medical applications, in the manufacture of paper, textiles, and paint, and in smoke detection. This optical measurement system, which uses the conventional light-chopping technique to overcome ambient light and electrical noise, can be built for about $13.

The system (Fig. 1) consists of a light-emitting-diode source, a photodiode sensor, operational amplifier A_1, driven by the sensor, integrator operational amplifier A_2, which is connected to the output from A_1 only when the LED is off, and op amp A_3, which is connected to the output from A_1 when the LED is on. A clock drives transistor Q to turn the LED on and off, and also drives field-effect-transistor switches S_1 and S_2 to connect either A_2 or A_3 to the A_1 output.

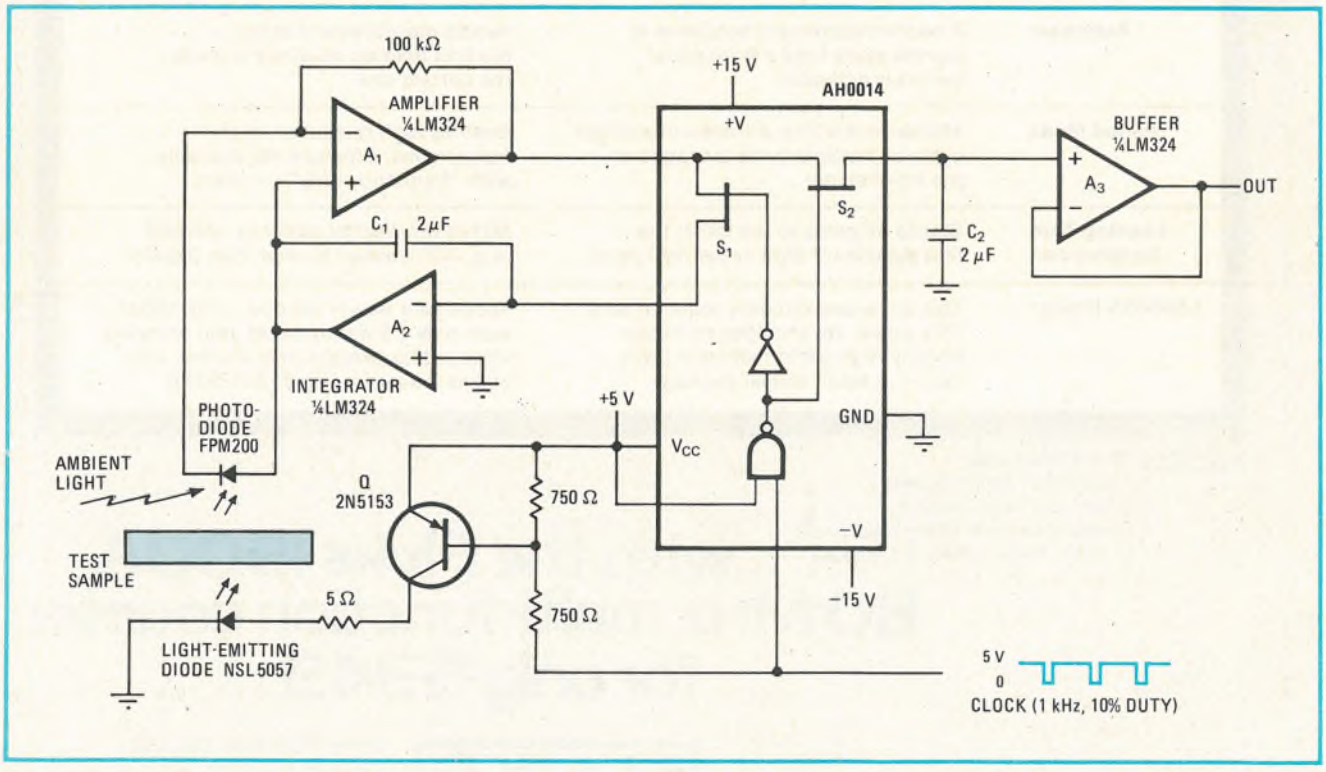
The waveforms in Fig. 2 illustrate the operation of the system. When the LED is on, the material being tested transmits some light to the sensor. The transmitted light, plus ambient light, produces a photosensor current that is converted and amplified in A_1. Electrical noise also contributes to the output from A_1.

To make the system insensitive to the ambient light and electrical pickup, the output from A_1 when the LED is off is fed to the integrator, consisting of A_2 and C_1. The integrator output is applied to the non-inverting terminal of A_1 as an offset voltage to cancel the unwanted output, reducing the voltage from A_1 to zero when the LED is off.

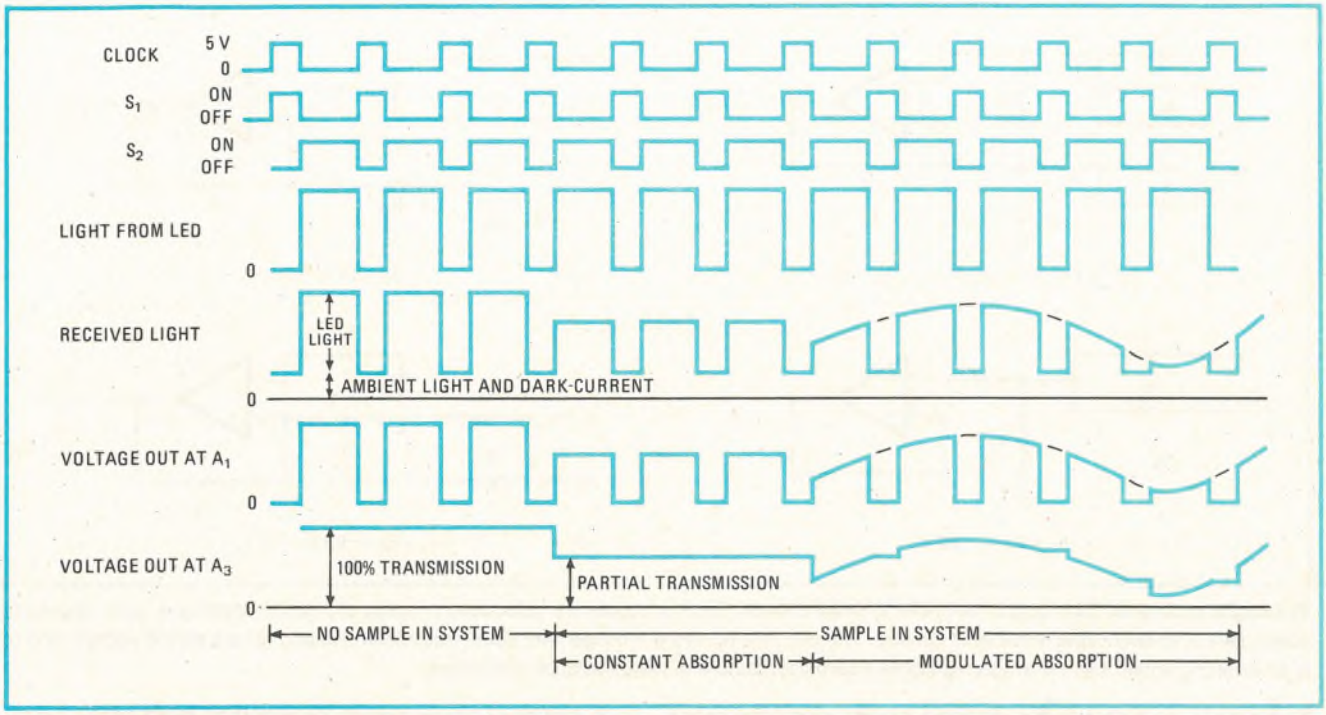
When the clock turns the LED on again, it also opens S_1 to disconnect the integrator from the A_1 output. However, capacitor C_1 holds the offset voltage on the noninverting terminal, so that the net voltage from A_1 results only from the LED light.

The effect of the integrator is to measure the magnitude of the ambient light and noise while the LED is off, remember this magnitude, and subtract it from the incoming signal when the LED is on. The output from A_2 is a measure of the ambient light and noise.

While the LED is on, FET switch S_2 is closed, so the output from A_1 is applied to capacitor C_2. The capacitor holds this voltage during the off period, while S_2 is open. Thus S_2 and C_2 constitute a sample-and-hold circuit. Amplifier A_3 serves as a simple output buffer, delivering the over-all output signal to whatever indicating meter or control circuit is to be driven by the optoelectronic measurement system. □



1. Keeping it light. Despite presence of ambient light, optoelectronic measurement system accurately indicates optical absorption or reflection by test sample. (For reflection measurement, geometry is changed so that LED light bounces from sample to sensor, instead of passing through sample.) Effects of stray light and electrical noise generate offset voltage that is subtracted from total voltage when LED is on.



2. Chopping it right. Timing diagrams and waveforms illustrate operation of optoelectronic sensing and measurement system. Amplifier output is connected to integrator while LED is off, and integrator generates offset voltage to cancel outputs caused by ambient light and spurious voltages. When LED is on, amplifier output is connected to sample-and-hold and buffer, but offset still cancels background signals. (Proportions of timing diagrams are distorted for clarity. To avoid excessive dissipation, actual duty cycle of LED is 0.1.)

Calculating resistances for sum and difference networks

by D. Sheingold
Analog Devices Inc., Norwood, Mass.

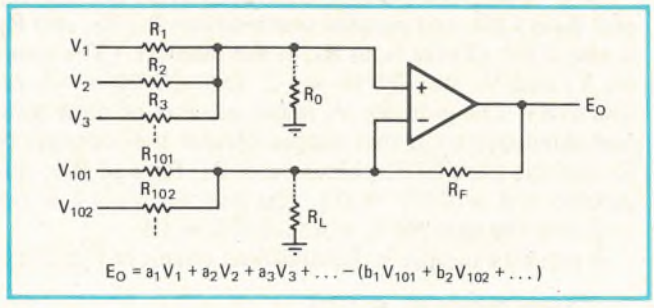
Whenever signals must be added and/or subtracted, a few simple computations will yield resistance values that provide equal resistive loading at the two inputs of an operational amplifier to minimize offset-current errors. The loading resistance can have any desired value.

Figure 1 shows the general sum or difference network; it produces an output voltage given by

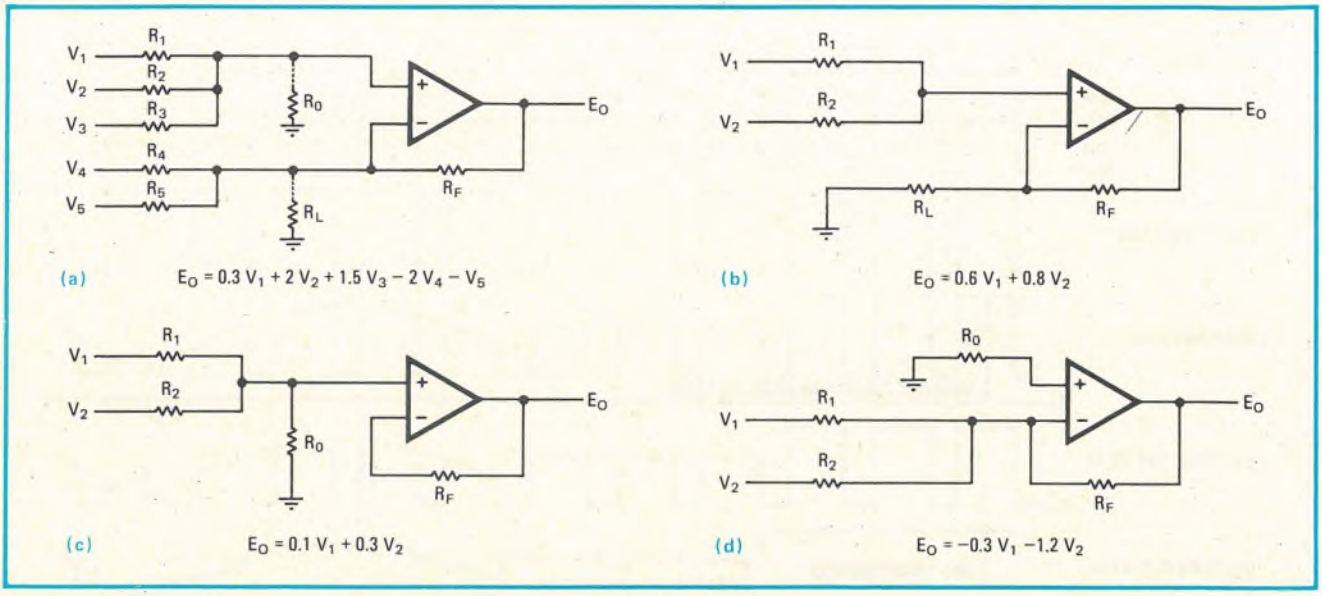
$$E_O = a_1V_1 + a_2V_2 + \ldots - (b_1V_{101} + b_2V_{102} + \ldots)$$

where the Vs are input voltages. The voltages that are to be added (V_1, V_2, V_3 . . .) are applied to the noninverting terminal of the operational amplifier through resistors R_1, R_2, . . . , and the voltages that are to be subtracted (V_{101}, V_{102}, . . .) are applied to the inverting terminal through resistors R_{101}, R_{102}, ... Shunt resistor R_0 or R_L and feedback resistor R_F complete the network. The values of all the resistors are found by these simple rules:

- Decide what composite load resistance, R_p, should be presented to the input terminals of the op amp. A value of 5 kilohms for R_p provides good bandwidth and low noise pickup without too much loading of the input sources or the output.
- Add up the positive coefficients (call this sum Σa).
- Add up the negative coefficients (call this sum Σb), and add 1.00.
- If Σa is greater than $(1+\Sigma b)$, the network must include an R_L (for gain). If Σa is less than $(1+\Sigma b)$, the network must include an R_0 (for attenuation). If Σa is equal to $(1+\Sigma b)$, neither R_L nor R_0 is used.
- Find R_F by taking the larger of Σa or $(1+\Sigma b)$, and multiplying it by R_p. (The number that multiplies R_p here is called the closed-loop gain or "noise gain.")



1. Summing circuit. Output voltage from operational amplifier is sum of positive and negative terms that are related to input voltages by positive or negative coefficients. Signs of terms depend on which input terminal is fed, and magnitudes of terms depend on voltages and resistances. Simple procedure determines resistance values that yield the desired output while making op-amp input terminals see equal resistive loadings of any desired level. Circuit may include balancing resistor R_0 or R_L or neither, but never requires both.



2. Sample problems. Examples in text refer to these circuits. Resistor values are calculated on basis of 5-kilohm loading, a value chosen for convenience, at each input terminal of op amp. The circuit in (a) is the most general adder-subtractor; (b) and (c) are simple adders; and (d) is an inverting adder. Each example highlights a particular feature of the calculation procedure.

- R_L or R_0 is equal to R_F divided by the absolute value of $(1 + \Sigma b - \Sigma a)$.
- The value of each of the other resistances is found by dividing R_F by the associated coefficient: i.e. $R_1 = R_F/a_1$, $R_{102} = R_F/b_{102}$, and so forth.

As an example, the resistors for the network in Fig. 2(a) can be found by following the above rules:

Choose $R_p = 5\ k\Omega$
$\Sigma a = 3.8$
$(1 + \Sigma b) = 4.0$
$(1 + \Sigma b) - \Sigma a = 0.2$ *(An R_0 is needed.)*
$R_F = 4 \times 5\ k\Omega = 20\ k\Omega$ *(Closed-loop gain is 4.)*
$R_0 = 20/0.2 = 100\ k\Omega$
$R_1 = 20/0.3 = 66.7\ k\Omega$
$R_2 = 20/2 = 10\ k\Omega$
$R_3 = 20/1.5 = 13.3\ k\Omega$
$R_4 = 20/2 = 10\ k\Omega$
$R_5 = 20/1 = 20\ k\Omega$

As a check, the parallel combination of R_1, R_2, R_3, and R_0 is 5 kΩ, and parallel combination R_4, R_5, and R_F is also 5 kΩ. (There is no R_L in the network.) The gains for V_4 and V_5 are $-20/10 = -2$, and $-20/20 = -1$, respectively. The gain for V_1 is the product of noise gain and attenuation (in the voltage divider that consists of R_1 and the parallel combination of R_2, R_3, and R_0); this product is $4 \times 0.075 = 0.3$. The gain for V_2 is $4 \times 0.5 = 2$, and the gain for V_3 is $4 \times 0.375 = 1.5$.

A second example is the summing circuit in Fig. 2(b).

Again choose $R_p = 5\ k\Omega$
$\Sigma a = 1.4$
$(1 + \Sigma b) = 1 + 0 = 1.0$
$\Sigma a - (1 + \Sigma b) = 0.4$ *(An R_L is needed.)*
$R_F = 1.4 \times 5\ k\Omega = 7\ k\Omega$ *(Noise gain is 1.4).*
$R_L = 7/0.4 = 17.5\ k\Omega$
$R_1 = 7/0.6 = 11.7\ k\Omega$
$R_2 = 7/0.8 = 8.8\ k\Omega$

A check of these results shows that both input terminals are loaded by parallel resistance combinations equivalent to 5 kΩ, the gain for V_1 is $1.4 \times 0.428 = 0.6$, and the gain for V_2 is $1.4 \times 0.57 = 0.8$.

Another summation problem is shown in Fig. 2(c).

Let $R_p = 5\ k\Omega$
$\Sigma a = 0.4$
$(1 + \Sigma b) = 1$
$(1 + \Sigma b) - \Sigma a = 0.6$ *(An R_0 is needed.)*
$R_F = 1 \times 5\ k\Omega = 5\ k\Omega$ *(Noise gain is 1.)*
$R_0 = 5/0.6 = 8.3\ k\Omega$
$R_1 = 5/0.1 = 50\ k\Omega$
$R_2 = 5/0.3 = 16.7\ k\Omega$

The load on the inverting terminal is only R_F, which is 5 kΩ. The load on the noninverting terminal, consisting of the parallel combination of R_0, R_1, and R_2, is also 5 kΩ. The gain for V_1 is the product of noise gain multiplied by attenuation, or $1 \times 5.5/55 = 0.1$. The gain for V_2 is $1 \times 7.1/23.8 = 0.3$.

The last example, which is not as trivial as it looks, is the calculation of resistances for the inverting adder in Fig. 2(d).

Let $R_p = 5\ k\Omega$
$\Sigma a = 0$
$(1 + \Sigma b) = 2.5$
$(1 + \Sigma b) - \Sigma a = 2.5$ *(R_0 is needed.)*
$R_F = 2.5 \times 5\ k\Omega = 12.5\ k\Omega$ *(Noise gain is 2.5.)*
$R_0 = 12.5/2.5 = 5\ k\Omega$
$R_1 = 12.5/0.3 = 41.7\ k\Omega$
$R_2 = 12.5/1.2 = 10.4\ k\Omega$

A check of these results shows R_1, R_2, and R_F in parallel have a total resistance of 5 kΩ. Gain for V_1 is $-2.5 \times 0.02 = -0.3$, and gain for V_2 is $-2.5 \times 0.48 = -1.2$. □

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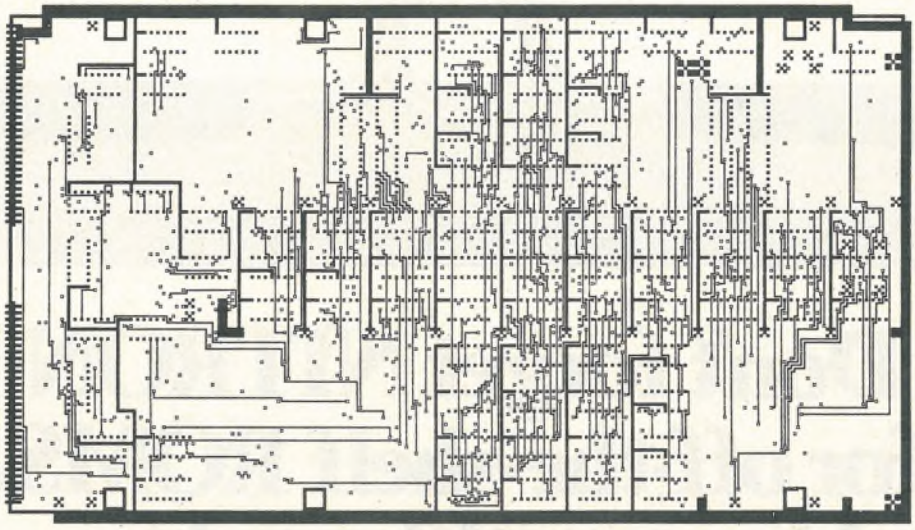

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GOULD

Spectrum analyzer operates in real time

Analysis ranges of single-channel instrument extend from 0 to 20 hertz to 0 to 100 kHz, and an on-line bandwidth of 5 kHz is standard

by Andy Santoni, Instrumentation Editor

Spectrum analysis can be useful in locating such problems as signal-frequency dropouts in transmission lines or vibration and noise in mechanical systems. The technique can also be applied in signal-pattern-recognition studies or in analyzing communications systems such as those using frequency-shift-keying methods.

To get the most out of spectrum-analysis techniques in these applications, the instrumentation must operate in real time. Spectra must be measured at once, without delays for frequency sweeping.

The model FFT 512/S from Rockland Systems Corp. is a single-channel real-time spectrum analyzer with 12 analysis ranges from only 0 to 20 hertz at the low end to 0 to 100 kilohertz. Corresponding nominal resolution varies from 0.05 to 250 Hz. Standard real-time bandwidth is 5 kHz, and real-time bandwidth of 10 kHz is a $2,090 option.

The basic unit, which measures 8¾ inches high, 17 in. wide and 21 in. deep, is priced at $7,900. Using a fast Fourier transform time- to frequency-domain-conversion technique, the model FFT 512/S accepts analog or digital inputs and produces both digital and analog outputs to drive such peripherals as a chart recorder.

Within the instrument, calculations are performed by a 74181 transistor-transistor-logic 4-bit arithmetic/logic unit operating under control of a programable read-only memory. This design yields higher-speed data-handling capability than presently available microprocessor chips, says Joseph Flink, Rockland system's vice president for product development.

The processor calculates 512 spectral lines for any input signal, and 400 of these lines, uniformly spaced for any analysis bandwidth selected, are displayed. This method reduces aliasing errors that can be caused by insufficient sampling of high-frequency waveforms. An alternate mode permits two separate 200-sample analyses to be performed and compared.

As a $980 option, the FFT 512/S can include a ⅓-octave mode. In this mode, the analyzer can simulate 33 filters, each ⅓-octave wide, from 25 Hz to 40 kHz.

A cursor is provided, and alphanumeric readout of the cursor's position is displayed on a 10-by-8-centimeter CRT screen. The amplitude readout is calibrated with respect to the input signal in rms volts or with respect to a reference signal selected by the operator. Frequency is measured in hertz or cycles per minute. An auxiliary cursor identifies harmonics or sidebands of the main cursor's frequency.

For analog signals, the linear dynamic range of the FFT 512/S is greater than 66 decibels, and the minimum detectable dynamic range is typically 70 dB. Dynamic range for digital signals is 72 dB. Input signals from 0.5 microvolt rms to 32 V rms can be measured.

Data analysis can be continuous or triggered either when the signal crosses a selectable threshold or when an external pulse is applied. When the data provides the trigger, a selectable pre- or post-trigger offset is available.

The spectrum analyzer can be expanded to perform cross-channel analysis by combining two model FFT 512/S units with the $7,400 model FFT 512/C cross-channel adapter.

Rockland Systems Corp., 230 West Nyack Rd., West Nyack, N. Y. 10994 [338]

IC/diode tandem sharpens fm tuning

Combination of voltage-stabilizer chip and reference diode minimizes inaccuracies and drift in high-fidelity receivers

by John Gosch, Frankfurt bureau manager

If a new component both saves customers some money and makes equipment perform better, then it looks like a winner. And that's what Philips in the Netherlands thinks it has with its multistabilizer integrated circuit TCA750 and the associated temperature-compensated voltage reference diode BZV38. The combination, from the company's Electronic Components and Materials division (Elcoma) in Eindhoven, helps minimize inaccuracies and drift in the tuning circuitry in high-fidelity fm receivers.

If modern varactor tuners are to operate properly, the voltage applied to them must be stabilized against changes in both temperature and input voltage to less than 0.5%. Further, the stabilizing time must be less than 1 second.

When used with the BZV38 reference diode, the IC not only provides a stable tuning voltage with a short stabilizing time, but also supplies stabilized voltages for the rest of the receiver circuitry. Discrete stabilized power supplies are no longer needed. The IC also generates automatic frequency-control signals.

Once produced in volume, the combination will cost less than the discrete components it replaces. The TCA750 multistabilizer and the BZV38 reference diode will be offered for sale worldwide this fall, says Ted van Moorsel, products manager.

With the two components, receiver drift is all but eliminated. The stabilizing time for the BZV38 is about 0.8 second, and at ambient temperatures of 10° to 60°C the diode's temperature coefficient is such that its reference voltage changes by no more than 20 millivolts, or 0.3%, according to Arnold Garskamp, who designed the combination.

By contrast, in a conventional receiver the tuning tends to drift immediately after the receiver is switched on. This is due to the reference diode's long stabilizing time—maybe as much as two minutes—to ambient-temperature changes, which affect other components too.

To facilitate operation, an fm receiver should be tunable by only one control, Garskamp says. Also, the user should have a fast, simple, and reliable means for preselecting his favorite stations.

A conventional fm receiver has two controls for tuning to a station: a tuning knob and an automatic-frequency-control switch. But with the TCA750, the afc is automatically switched by a touch contact on the tuning knob.

Stays locked. Also, when an ordinary receiver is tuned to a weak signal, its afc tends to shift if a strong station is close by. With the TCA750, however, the performance of a weak station is improved because the afc can be switched by a frequency-dependent voltage from the i-f tuned circuits by electronic tuning control. This restricts the capture range of the afc and keeps it locked to the desired station.

Again, on a conventional receiver it is all but impossible to tune from a strong station to an adjacent weak one because the afc holding range is too wide. However, by combining the tuning knob's touch-contact-operated afc with electronic tuning control (as would be done in a TCA750-equipped receiver), the afc is switched off as soon as the operator begins tuning. He can therefore tune to a weak station. Then, after he has released the knob, the afc switches back on.

The TCA750 provides still other advantages. The afc voltage is superimposed on the tuning voltage *before* it is attenuated by the tuning potentiometer, so that the afc correction factor remains virtually constant over the receiver's whole tuning range. In an ordinary receiver, on the other hand, the afc voltage is superimposed on the tuning voltage *after* attenuation. As a result, the afc correction factor is high at low frequencies and decreases with increasing frequencies.

Stations preset. Elcoma's new components also improve receivers with preselected tuning, which sometimes catch the wrong station because the afc is not switched off during preselection. With the new combination, the afc becomes ineffective since the tuner is disconnected when selecting preset stations. And since the audio preamplifier stages are also switched off during selection, interstation noise is absent.

In addition to improving receivers with manual and preselected tuning, the TCA750/BZV38 combination may be part of an electronic-search tuning system. Such a system would provide continuous search-tuning over the fm band with a short automatic stop on the center frequency of each station that has a signal strength above a threshold. A nonstop tuning facility can easily be provided as an alternative.

Philips Gloeilampenfabrieken, Elcoma Division, 523 Eindhoven, The Netherlands [339]

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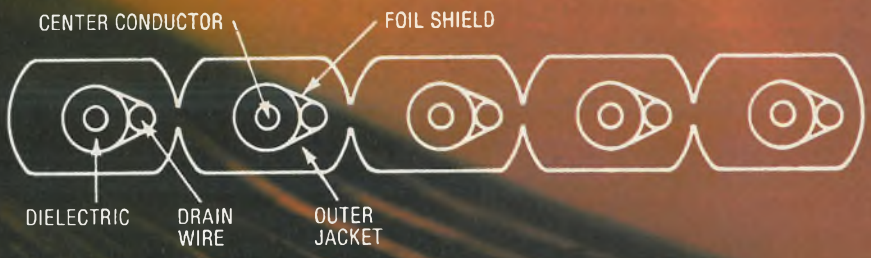

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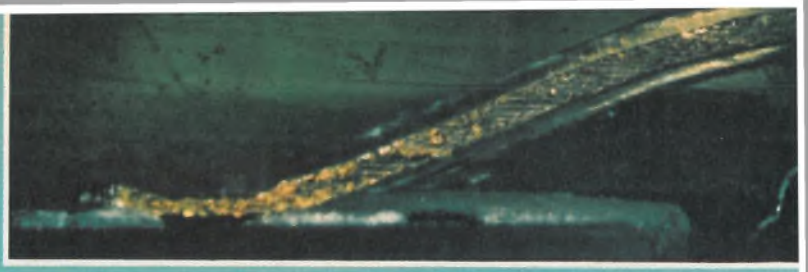
Why Parylene works where other microelectronic protection fails:



Crevice penetration in hybrids

This beam lead has a 0.3 mil parylene coating all the way to the weld. Parylene penetrates deep within small crevices, maintaining clearance while putting a coherent coating under beam leaded chips and air bridges. No area is left unprotected, preventing shorts and allowing the designer great latitude in component spacing and sizing. And parylene secures loose debris while preventing breakoff of pigtails during shock and vibration loadings.

Controlled conformality

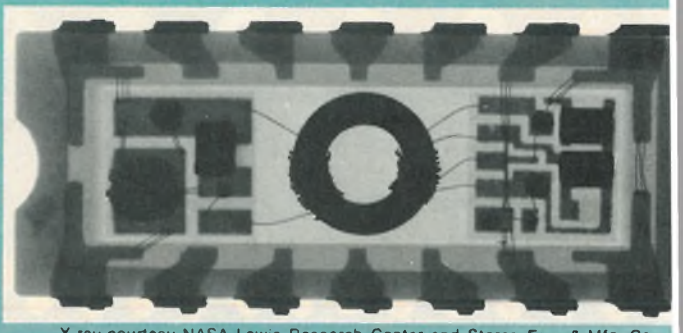
There's a uniform coating of parylene all the way around the half-mil tip of this phonograph needle. That's true conformality, and only parylene gives it, in precisely controlled thicknesses from .002 to 3 mils, in one step. Unlike spray or dip coatings, parylene won't bridge or puddle, or thin out at sharp edges, creating potential failure points. The parylene coating is completely uniform, no matter how dense or intricate the module. And because it's applied at room temperature, there's no component discomfort.

Lead Strengthening

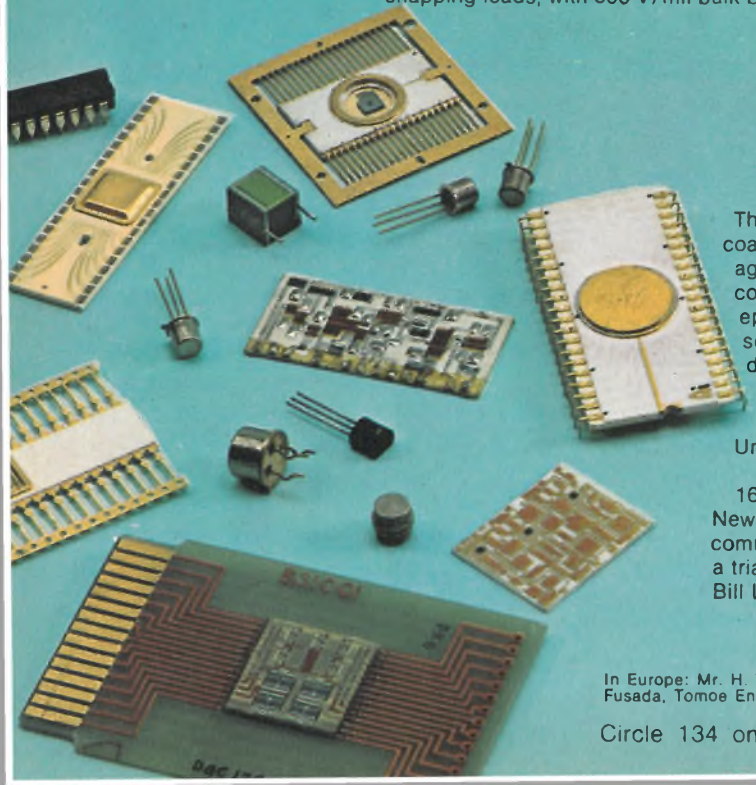
It took up to 75 grams pull to break these 1 mil wires. Bare 1 mil aluminum wires, for instance, exhibit bond strengths of 3-5.5 grams; coated with 1 mil of parylene, pull strength increases by 60-70 grams. So wire and bond are stronger, and sideward shorts and loop collapse during extreme g-loads are prevented. Parylene coatings will penetrate the less than 1 mil clearance between beam lead bonded chips and the substrate, giving such strong coating coverage that the chip cannot be lifted without destroying it.

△200 C thermal shock protection

This hybrid microelectronics relay has undergone 200 45-minute cycles from −120 to 80°C, simulating earth-orbiting conditions. This X-ray shows all leads remain intact. Parylene protection was at work, on the transformer core and then the whole assembly before packaging (TO-116). There was no appearance of corona up to 5000 V_{dc} ; leakage was reduced from 10μA to <.001μA at 1000V. RTV encapsulation suffered dimensional mismatch, straining and snapping leads, with 500 V/mil bulk breakdown.



X-ray courtesy NASA Lewis Research Center and Sterer Eng. & Mfg. Co.



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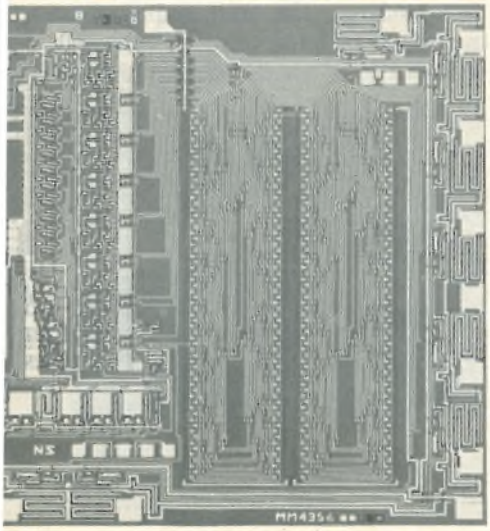
IC converter is ion-implanted

8-bit analog-to-digital device uses p-channel MOS, will sell for $7.95 in 100s

Combining an almost textbook circuit with its sophisticated high-yield ion-implanted p-channel MOS technology, National Semiconductor Corp., has built an eight-bit analog-to-digital converter that will sell for about $7.95 each in 100-up quantities. Designated the MM4356/5356, the a-d converter contains a chain of 256 identical resistors connected in series, 255 analog switches, a high-impedance input comparator, output latches, and control logic on a single 120-by-123-mil monolithic chip.

In the 4356/5356, conversion is performed using a successive-approximation technique where the unknown analog voltage is compared to the voltages at the resistor tie points by means of analog switches. A 10-volt reference applied across the series-resistor chain establishes 256 precision voltages against which the unknown input voltage is compared by the switches under logic control.



"This is the kind of circuit that is shown to a fledgling engineering student to explain in simple terms what an a-d converter is all about," says Dean Coleman, marketing manager for converter products at National. "Then the textbook is taken away and he's told that's not the way it's done in the 'real' world. Mainly, it's not done because it is extremely hard to match that many resistors, let alone get them all into a reasonably sized package."

What allows National to do this, says Coleman, is the use of ion implantation in conjunction with its LSI p-MOS technology. To form the resistors—which are in essence merely metal gates over p^- channels—ions are implanted within a very shallow layer (typically 0.1 to 0.8 micrometer deep) along the silicon surface. The result is channels with a sheet resistance roughly 20 times greater than a correspondingly doped diffused layer of 2-to-4-micrometer thickness, and with matching tolerances on the resistor channels of about ±1%. "This gives us the tight process control we need to control the matching on so many resistor channels without significantly raising the production costs or reducing the yields," Coleman says.

To the user this all translates into an 8-bit a-d converter with a linarity within half a least significant bit, an input impedance in excess of 100 megohms, and a conversion time of as little as 18 microseconds. Supply voltages are +5 V and −12 V, and power dissipation for the 18-pin epoxy B dual in-line package (4356) or the 18-pin ceramic DIP (5356) is approximately 170 milliwatts.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051 [411]

Line receivers and drivers operate at 35 megahertz

Signetics Corp. says its new set of tristate quad differential line receivers and drivers have double the industry-standard packaging density and, at 35 megahertz, double the industry-standard speed. The various operating modes of the drivers, which are designated the 8T100/101, are controlled by two lines. These lines can be manipulated to make the drivers operate in single-ended or multiplexed configurations. The tri-state capability—40-milliampere source at 1.8 volts and 40-mA sink at 0.5 V—allows disabled drivers in a multiplexed system to stay on a line without loading it. The differential feature, when used with a suitable line receiver, eliminates the troublesome ground loops and common-mode noise of single-wire transmission. The 8T101, unlike the 8T100, has clamping diodes from output to supply voltage on all drivers to suppress positive line reflections on the outputs.

The receivers, designated the 8T110/111, receive differential input signals and convert them to TTL levels. Common strobe and output-enable lines are provided for all the receivers.

Both receiver/driver pairs are driven by a single +5-V power supply; there is no need for a negative supply. All of the drivers and receivers are housed in 16-pin dual in-line packages and sell for $3.84 each in 100-up quantities. Sample units will be available in July.

Signetics Corp., 811 East Arques Ave., Sunnyvale, Calif. 94086 [413]

Data-communications circuit designed for microprocessors

The latest data-communications circuit developed by Western Digital Corp. is a third-generation LSI device especially suitable for use with microprocessors. The programable model UR1671B asynchronous/synchronous transmitter/receiver (Astro) is apparently the only such chip on the market. The n-channel silicon-gate part interfaces a serial data-communications channel with a parallel digital system. Compatible with IBM Bisync and other commonly used communications modes,

it can handle data rates as high as 1 megabaud.

The chip works on a multiplexed bus, of the kind used by microprocessors. Richard M. Perrin, manager of product design engineering at Western Digital, sees applications in all kinds of data-communications terminals, processors, and multiplexers.

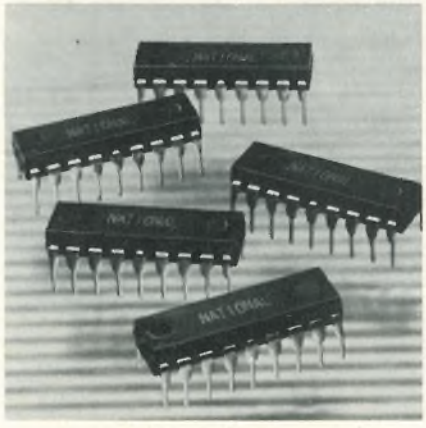
In its synchronous mode, the Astro has selectable 5- or 8-bit characters and is synchronized after only two successive sync characters. On-line diagnostic capability is provided, as are overrun and framing for transmission-error detection and parity checks.

The TTL-compatible device is packaged in a 40-pin plastic cavity package and requires ±5 volts and +12 V. The Astro is priced at $30 in quantities of 100; samples are available now.

Western Digital Corp., 3128 Red Hill Ave., P. O. Box 2180, Newport Beach, Calif. 92663 [414]

Eight-channel digit driver can sink 500 mA/channel

Designed to interface low-power MOS circuitry with large, power-consuming light-emitting-diode displays, the DS8863 LED digit driver contains eight independent Darlington circuits, each of which can sink as much as 500 milliamperes. Offered in an 18-pin plastic dual in-line package, the unit requires a maximum of 2 mA of input current, so it can interface directly with MOS



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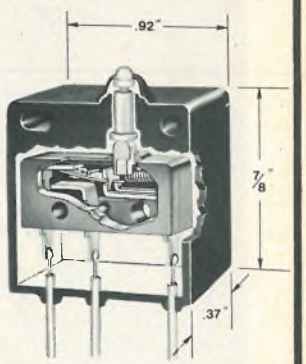

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Circle 137 on reader service card

New products

clock and calculator circuits. The driver is designed for use in display systems that employ LEDs in a common-cathode multiplexed configuration. It is priced at $2.70 in hundreds.

National Semiconductor Corp., 2900 Semiconductor Drive, Santa Clara, Calif. 95051 [416]

3½-digit dual-slope a-d converter is monolithic

Combining both analog and digital circuitry on a single silicon chip, the MN2301 is an auto-zeroing dual-slope a-d converter suitable for use in a 3½-digit panel meter. Needing only a system clock, an integrating capacitor, and two current reference supplies to generate 3½-digit binary-coded decimal outputs, the p-MOS device has an input resistance in excess of 1,000 megohms, a bias current below 100 picoamperes, and a voltage drift of only 3 microvolts per degree Celsius. Housed in a 28-pin dual in-line package, the MN2301 consumes less than 300 milliwatts from a standard ±15-V supply. The unit is priced at $24 in lots of 100 pieces; delivery time is 30 days.

Analogic, Audubon Rd., Wakefield, Mass. 01880 [415]

10:1 frequency divider operates at 200 MHz

Able to operate at rates up to 200 megahertz, a frequency divider can be programed by means of two ECL-compatible inputs to divide by either 10 or 11. The model SP8690 provides both true and inverted ECL outputs as well as a separate open-collector output for driving C-MOS or TTL circuits. Drawing only 14 milliamperes at 25°C, the device typically dissipates only 70 milliwatts and can supply 10 mA into an ECL load. The SP8690 vhf 10/11 divider is available in two versions: the SP8690A is rated over the full military temperature range from

Why you can afford the very finest in function generators.

Because Interstate's new F77 truly is a universal signal source. With F77's 0.00002 Hz to 20 MHz range, you can test with frequencies from infrasonics through video, and beyond. There are 6 output waveforms, 7 operating modes, and precision interface controls (waveform inversion and a 5/95% waveform variable symmetry vernier, for example) that can be actuated with remarkable variations. And output amplitude is specified at 15 volts p-p into 50 ohms — that's 50% more voltage swing than most 20 MHz function generators provide.

Because the F77 also incorporates a very capable, independent sweep generator offering linear and logarithmic performance, with a selection of auxiliary outputs. Sweep up or down, sweep reset control, and continuous, triggered, burst, sweep-and-hold modes, too. Interstate's special frequency dial has a direct-reading sweep limit cursor, plus two calibration scales (X1 and X2) to improve resolution and permit continuous tuning across the 20 Hz-to-20 KHz audio band.

Because this function generator is the first of its kind to deliver real pulse generator capability. The F77 produces a 15 ns rise time pulse to 20 MHz with constant width setability from 30 ns to 10 milliseconds, and full offset and mode flexibility. The generator's fully-calibrated attenuator gives you 15-volt unipolar pulses into high impedance loads, particularly useful for testing MOS, or millivolt pulses down to 1.5 mv.

Because there's also a constant duty cycle pulse (in addition to F77's standard pulse) for a variety of digital signal response applications. Circuit sensitivity to duty cycle on/off times can be tested using varying pulse rates without adjusting the width control.

Because the F77 can be used as an analog power amplifier to amplify externally applied signals as much as 600%. Even TTL pulses can be amplified to drive 50-ohm loads, and the resulting output has controlled dc offset and attenuation.

Because the F77 gives you many other high performance and human engineering features, like VCF capability for sweeping frequency-sensitive devices, and "oscilloscope-style" triggering with a variable start-stop phase control to generate haversines and havertriangles. There's even a "brown-out" switch to allow the instrument to operate at low line voltages.

Because the F77 only costs $1,095.*

*U.S. price; other 20 MHz Series 70 models available from $695.

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Circle 139 on reader service card

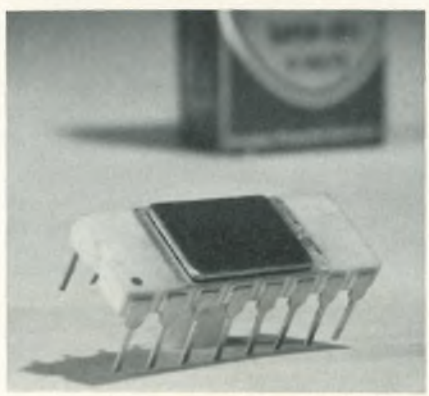
New products

–55° to 125°C and sells for $45 each in hundreds; the commercial model SP8690B is rated from 0° to 70°C and is priced at $14 in similar quantities. Both units are housed in a 16-pin ceramic dual in-line package.
Plessey Semiconductors, 1674 McGaw Ave., Santa Ana, Calif. 92705 [417]

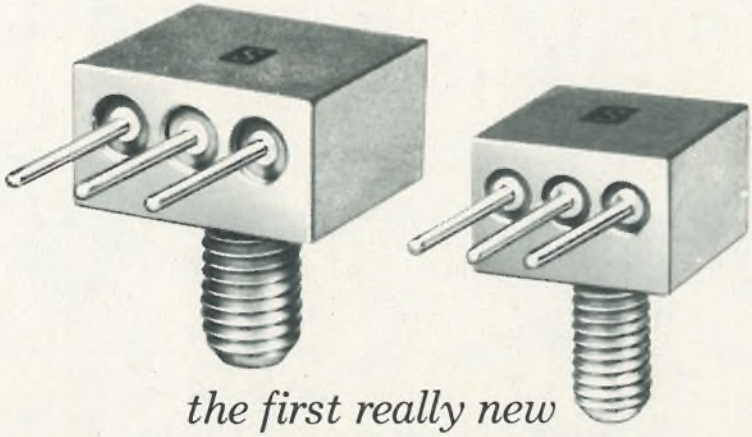
200-ns C-MOS static RAM pulls less than 50 nW/bit

A 512-bit complementary-MOS static random-access memory, the model 2222, has a typical access time of 200 nanoseconds and when operating consumes less than 50 nanowatts per bit. The device's standby power requirement is less than 4 nW/bit. Organized in a 512-by-1-bit configuration, the memory is expected to have applications in portable battery-operated equipment, military gear, and medical instrumentation—uses in which minimum power consumption is a major design consideration.

Housed in a 16-pin dual in-line package, the 2222 comes in two versions: the 2222D with a guaranteed access time of 350 ns, and the 2222AD with an access time of 450 ns. Pricing on the 2222D is $30 each in small quantities and $20 in hundreds. The 2222AD sells for $18.75 in small lots, and $12.50 for 100-up. Deliveries are from stock for small lots. Quantities of 1,000 to 5,000 pieces have a delivery time of four weeks, and 5,000 to 25,000 pieces require six to eight weeks.
Nortec Electronics Corp., 3697 Tahoe Way, Santa Clara, Calif. 95051 [418]

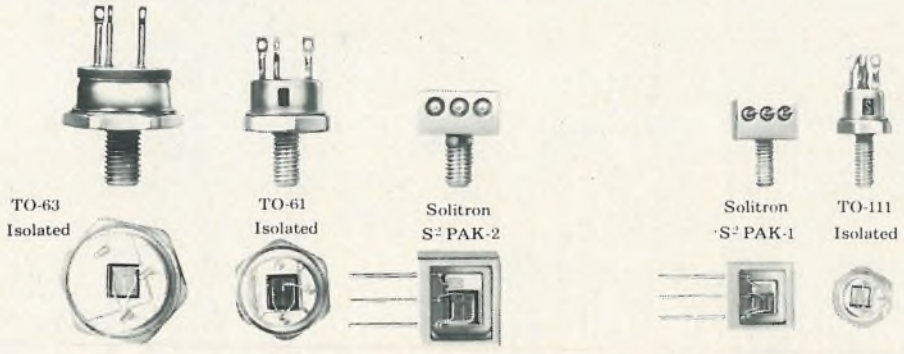


introducing the Solitron S^2 PAK



the first really new power transistor package design in years!

Solitron announces the first major breakthrough in high reliability power transistor packaging in twelve years. We named it the S^2 PAK (Square Pack)...a 3-leaded low profile, seam-welded package that offers far greater reliability and performance than conventional cases used in space, military and industrial applications. ☐ Our S^2 PAK is of all copper construction with a steel stud and features an isolated collector. It has the capability to handle up to two times more current than equivalent conventional types (typical S^2 PAK thermal resistance of 0.7° C/W as compared to 1.2° C/W for the same size chip). ☐ Now available in two sizes, the S^2 PAK-1 may be used as a replacement for the TO-111, and the S^2 PAK-2 for TO-61 and TO-63 versions.



In comparison to conventional "TO" packages, significant S^2 PAK reliability and performance characteristics are:

- Increased power dissipation (higher wattage per unit area).
- Weld splash free devices (seam-welded process).
- Low profile compact construction—higher package density.
- Elimination of all external crimp-weld.
- Copper core ceramic feed-throughs, eliminating potential failure of pin separation.
- Capability of 300°C high temperature aging.

All Solitron SDT and JEDEC 2N type devices are offered by us now in S^2 PAK designs with standard leads or custom formed. Although a new design, current pricing for S^2 PAK cases in high reliability applications is comparable to the cost of conventional packages.

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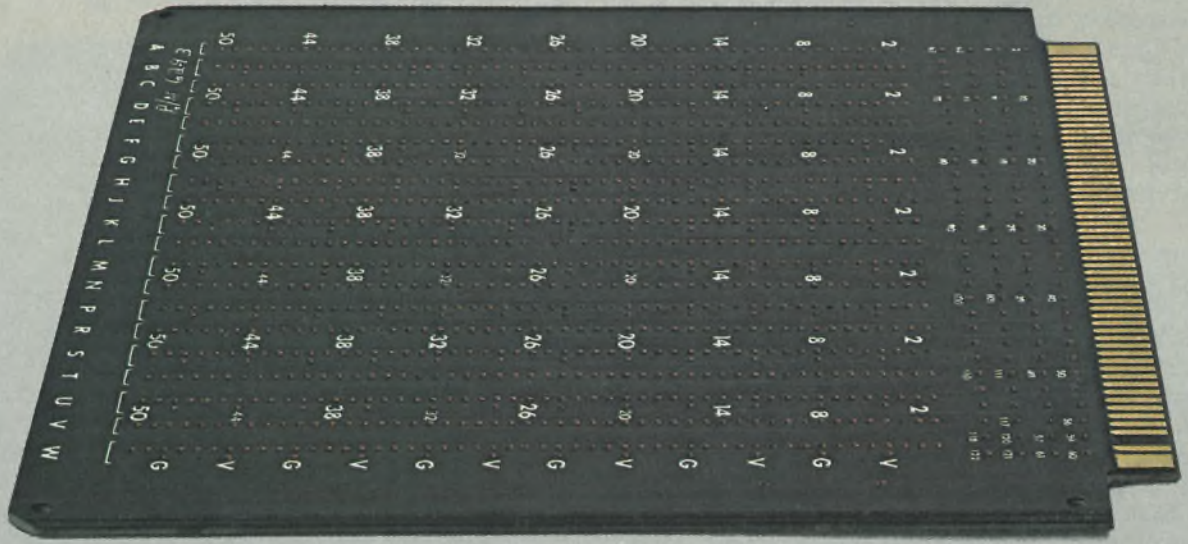
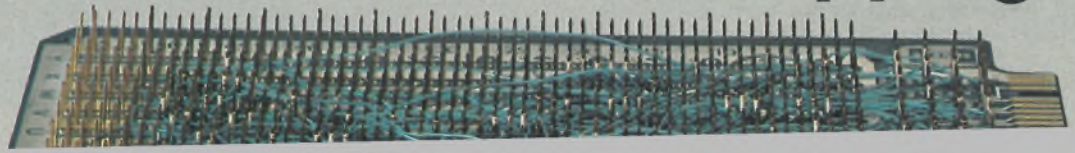
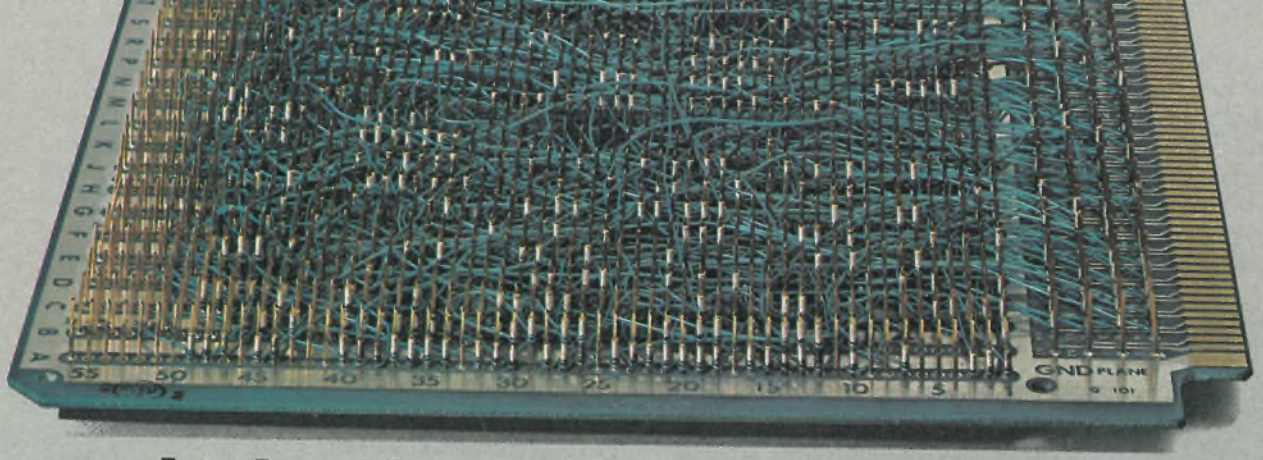
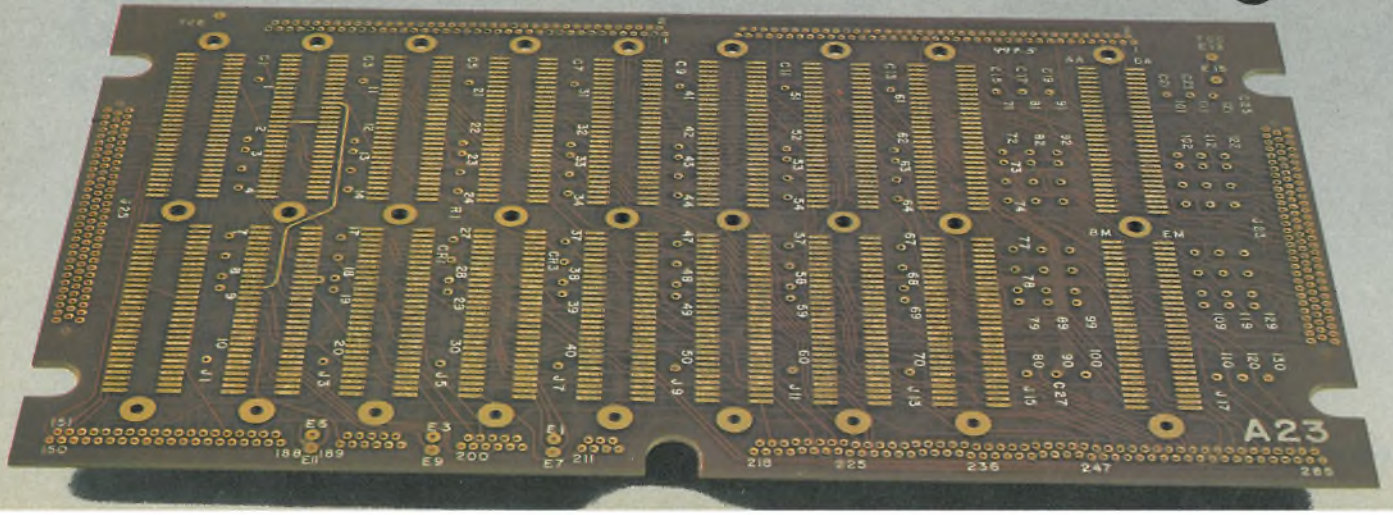


costs less than wirewrapping...



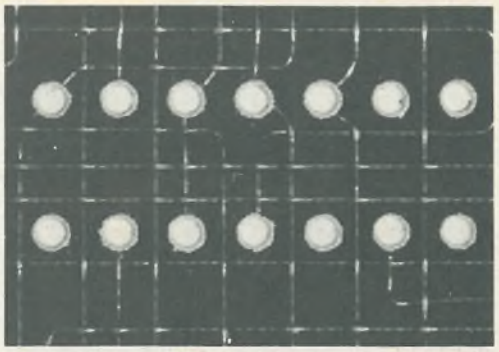


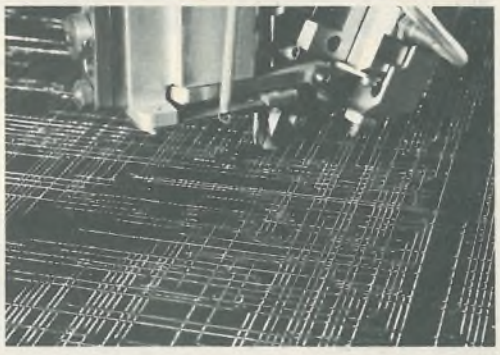
works better than multilayering.



Two major systems—wirewrapping and multilayering—have been used for complex electronic interconnection in the last 15 years. Despite improvements and refinements, each still has inherent disadvantages. That's why Multiwire was created by Photocircuits. It overcomes the disadvantages of wirewrapping and multilayering.

A Multiwire board is basically a customized pattern of insulated wires laid down on an adhesive-coated substrate by a machine operating under numerical control.





Multiwire vs. wirewrapping.

Today, interconnection costs are more important than ever. So take a long, hard look at a key advantage of Multiwire panels. They cost much less than wirewrapping in small or production quantities.

Here's an example of how much less: a Multiwire replacement of a 60 DIP wrapped-wire panel. Total tooling costs were just $750. In order quantities of 1000 pieces, the Multiwire boards at $45 each were more than $30 less than the wrapped-wire panel. (A 40% cost savings.) Multiwire prices also include a 100% continuity check.

But cost is not the only reason for the superiority of Multiwire over wirewrapping. There are also design advantages. For example, Multiwire offers two-dimensional packaging density equal to wirewrapping. But with Multiwire panels, you reduce board-to-board spacing. And Multiwire weighs much less too. So it can contribute substantially toward improving the envelope or three-dimensional package of your product.

Electrically, Multiwire is also superior. The extreme repeatability of the manufacturing process provides much higher electrical reliability as received—this is an important cost-saving factor. In addition, you get the controlled impedance characteristics required without variations.

Multiwire vs. multilayering

With Multiwire, reliability goes up and inspection cost goes down. Multiwire doesn't need extensive inspection—like multilayering does—for nicks, pinholes, hairline cracks, spacing violations and bridging. Yet Multiwire regularly yields better than 99% reliability at incoming inspection.

Compared to multilayering, designing a new Multiwire board is a far simpler operation. Component locations and a wiring list are all we need. Our computer-aided system does the rest.

Since the computer also takes care of deletions and/or additions, engineering changes are simplified. What's more, Multiwire makes it easier to find paths for interconnections, because the insulated wires can cross one another. For these reasons we can deliver finished Multiwire boards to your door in weeks rather than months.

The advantages of Multiwire over wirewrapping and multilayering vary from case to case. We'd like to help you evaluate possible time, cost, design and reliability benefits. For information and price estimates, call the Multiwire Marketing Department at 516-448-1111.

	Wrapped panels	Multi-layers	Multi-wire
Design & tooling cost	Low	Very High	Low
Design & tooling time	Short	Very Long	Short
1st piece delivery	Short to Very Short	Long	Short
Board cost in small quantities	High	High	Medium
Board cost in production quantities	High	Medium	Medium
2 dimensional packaging density	High	High	High
3 dimensional packaging density	Medium	High	High
Weight	High	Low	Low
Ease of changes	Excellent	Poor	Good
High speed electrical characteristics	Fair to Poor	Excellent	Excellent
Interchangeability with other techniques	Fair	Excellent	Excellent
Repairability	Excellent	Poor	Good
Controlled impedance	Poor	Good	Good
Electrical reliability as received	Fair	Good	Excellent

Multiwire from Photocircuits

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Subassemblies

DIP unit converts 8 bits in 1.5 μs

Hybrid analog-to-digital converter consumes maximum of 1.55 watts

Fast 8-bit analog-to-digital converters are nothing new, but the MN5100 from Micro Networks is the first to combine a maximum conversion time of 1.5 microseconds with a size allowing it to be housed in a 24-pin dual in-line package.

Further, the hybrid device can accommodate nine different voltage input ranges by means of a resistor network that is tapped at nine places and brought out to nine pins. This capability is a side benefit that comes from using a 24-pin DIP to house the converter—a move that was necessitated by the circuit layout employed to achieve the device's high speed.

The input voltage ranges are: 0 to +5 volts, 0 to +10 V, 0 to +20 V, 0 to -5 V, 0 to -10 V, 0 to -20 V, -2.5 V to +2.5 V, -5 V to +5 V, and -10 V to +10 V. This wide range of voltages means the same converter can be used in a variety of end products, thus simplifying purchasing, and cutting required inventories.

If the user is willing to sacrifice resolution for speed, the MN5100 can be connected to a simple external TTL circuit which makes it into a 6-bit converter with a 900-nanosecond conversion time, or a 5-bit converter with a 600-ns conversion time. This trick aside, the MN5100 is a completely self-contained device requiring no external trimmers or other components to achieve its performance, which includes a maximum nonlinearity of half a least significant bit (LSB) over the temperature range from 0 to 70°C. Maximum full-scale error is 1 LSB over that range, and zero error is within half a LSB at 25°C.

The MN 5100 uses a standard ±15-V power supply plus a +5-V logic supply. Maximum total power consumption is 1.55 watts, although a typical figure is 1.1 W. This is half to a third of the power consumption of competitive units.

A military version of the converter, the MN5100H, is the same as the standard unit except that it meets its specifications over the temperature range from -55 to +85°C.

The MN5100 sells for $195 in quantities of 1 to 24 pieces, while the MN5100H has a corresponding price of $295. Delivery time is two to four weeks.

Micro Networks Corp., 5 Barbara Lane, Worcester, Mass. 01604 [381]

100-A switching supply regulates to within 0.01%

"Unique" is a word rarely applicable to power supplies, but a high-frequency switched supply from Adtech Power Inc. deserves the designation. The supply employs silicon controlled rectifiers, yet it operates at a high switching rate usually associated with transistor supplies. The result is a small unit with an output of 100 amperes at 5 volts and excellent regulation of under 0.02% variation for a 0 to 100% load current change, or for the 95- to 140-V line change that occurs in brownouts, for example.

The secret to the supply is the Adtech Controfluxer tuned saturating inductor used for regulation. The Controfluxer provides inherent line regulation over the 95-to-140-V range, so only load regulation must be provided electronically. This is readily accomplished by exploiting the inductor's frequency sensitivity. The switching rate of the SCRs is constantly adjusted to keep the output on voltage. The switching itself occurs at the zero-crossing point, eliminating electromagnetic interference with both the load and input—a common problem with SCR supplies that use phase shifting to maintain regulation.

SCR supplies are considered more reliable than transistor supplies because of the smaller number of failure modes of the devices and the simpler circuitry. A single SCR can also handle higher current, and George Mousel, president of Adtech, says the same basic circuitry can be used for a 1,000-ampere supply. Multiple transistors would be required for much lower current. He also says higher voltages are easy to provide, and he expects many future high-power memory and computer systems to adopt a higher regulated voltage, such as 7 V, with on-card regulation of individual modules.

The power supply also maintains full regulation during shutdown, has automatic overvoltage protection, and folds back with overcurrent to 30% of output voltage rather than the typical 70%. Efficiency is high, as in all switching supplies, at 68% typical.

The unit operates from 120 to 180 V dc, or 95 to 140 V ac at 47 to 440 hertz. Higher voltages and three-phase operation are optional. The model CDS-5-100 is 16¼ inches long, 7⅛ in. wide, and 5-1/16 in. high. It weighs 17 pounds. Cooling is by convection, with no fan required, and operating temperature range is 0 to 40°C, derating to 30% at 70°C. The unit is priced at $595 in single quantity; a 60-ampere version is $25 less.

Adtech Power Inc., 1621 South Sinclair St., Anaheim, Calif. 92806. [390]

Plastic package cuts price of resistor nets

In its first significant move into the passive-component marketplace, National Semiconductor has started volume production of a family of thin-film plastic-packaged resistor networks selling for "much less" than 35 cents each in lots of 100,000. The 35-cent figure is significant because it is typical of the prices of thick-film resistor networks in ceramic packages. Hence, National hopes to be able to compete with thick-film networks—at least in applications for which users need net-

works in very large quantities. Ceramic-packaged thin-film networks typically sell for several dollars per device as does the recently introduced plastic-packaged thin-film network by Beckman [*Electronics*, May 29, p. 139].

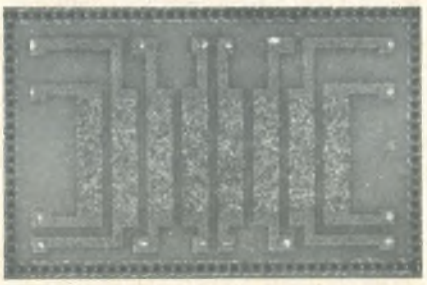
Dean Coleman, National's resistor products marketing manager, says the RA07, RA08, RA12, RA13, RA14, and RA15 family are arrays of seven to 15 equal-value resistors packaged in high-reliability epoxy-B dual in-line packages—the same ones used in the firm's MOS, linear, TTL, and transistor lines.

The six basic types in National's new line, he says, will contain 77 values in each type, or 462 values in the entire product line—from 22 ohms to 100,000 ohms. All have absolute value tolerances of ±2% or 2 ohms, whichever is larger.

Many designers are afraid to use plastic thin-film resistor networks, arguing that an hermetic ceramic package is needed to protect the thin films from moisture. Coleman admits that ceramic packages are more resistant to environmental conditions. "But," he says, "in most circuit situations, ceramic is unnecessary. Ceramic meets and exceeds by many orders of magnitude the specifications of the circuit designer—and he pays for it. Our epoxy-B molded-plastic process meets the realistic needs of the designer and at a much lower cost."

Testing the devices, in most cases, he says, is much more stringent than it is for ceramics. The devices are all put through a 1,000-hour moisture-and-temperature-resistance test at 85° C and 85% humidity. "In 1.5 million resistor-test hours, typically only two to three resistors have drifted," he says.

Resistor matching is within 0.2%, and absolute temperature coefficient is 80 ppm/°C. Maximum power dissipation is 0.25 watt per resistor and 2 W per package at 25°C. Overload resistance shift is 0.5%, maximum; rise time is 5 nanoseconds.



National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. [383]

Data-acquisition system made for IMP microcomputer

Designed to work with National Semiconductor's IMP microprocessor series, the DT1721 data-

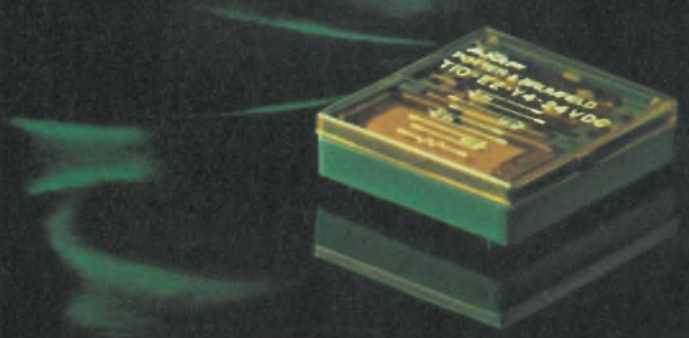
acquisition system includes a 12-bit analog-to-digital converter, a sample-and-hold amplifier, up to 64 channels of analog multiplexing, and an isolated power supply. Offered on a standard 8.5-inch-by-11-in. IMP board, the system, in its 16-channel configuration, sells for $725 in unit quantities. President Fred Molinari claims that the DT1721 is the first low-cost analog peripheral designed specifically for a major microcomputer. Delivery of the system is from stock to two weeks.

Data Translation Inc., 109 Concord St., Framingham, Mass. 01701 [384]

D-a converter contains another d-a converter

Within its modular DAC1132 digital-to-analog converter, Analog Devices Inc. has placed another one: the two-chip AD562, a converter

New from Potter & Brumfield



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Solving switching problems is what we're all about.

Circle 147 on reader service card

New products

which consists of precision current switches and a highly stable thin-film resistor network [*Electronics,* Oct. 3, 1974, p. 139]. In addition to the AD562, the DAC1132 contains a precision reference source, a fast output amplifier, and an input storage register built in standard transistor-transistor logic. A complete 12-bit converter, the DAC1132 requires only two external potentiometers for gain and offset adjustments. It is packaged in a 2-by-2-by-0.4-inch module and is priced at $159 for one to nine units.

The DAC1132 has two unipolar and three polar output ranges: 0 to +5 volts, 0 to +10 V, −2.5 to +2.5 V, −5 to +5 V, and −10 to +10 V, all at 10 milliamperes. The unit has a maximum nonlinearity of less than half a least significant bit, plus a settling time of 2 microseconds to within 0.01% of final value for a 10-V step. Monotonicity is guaranteed over the full temperature range from 0 to 70°C.

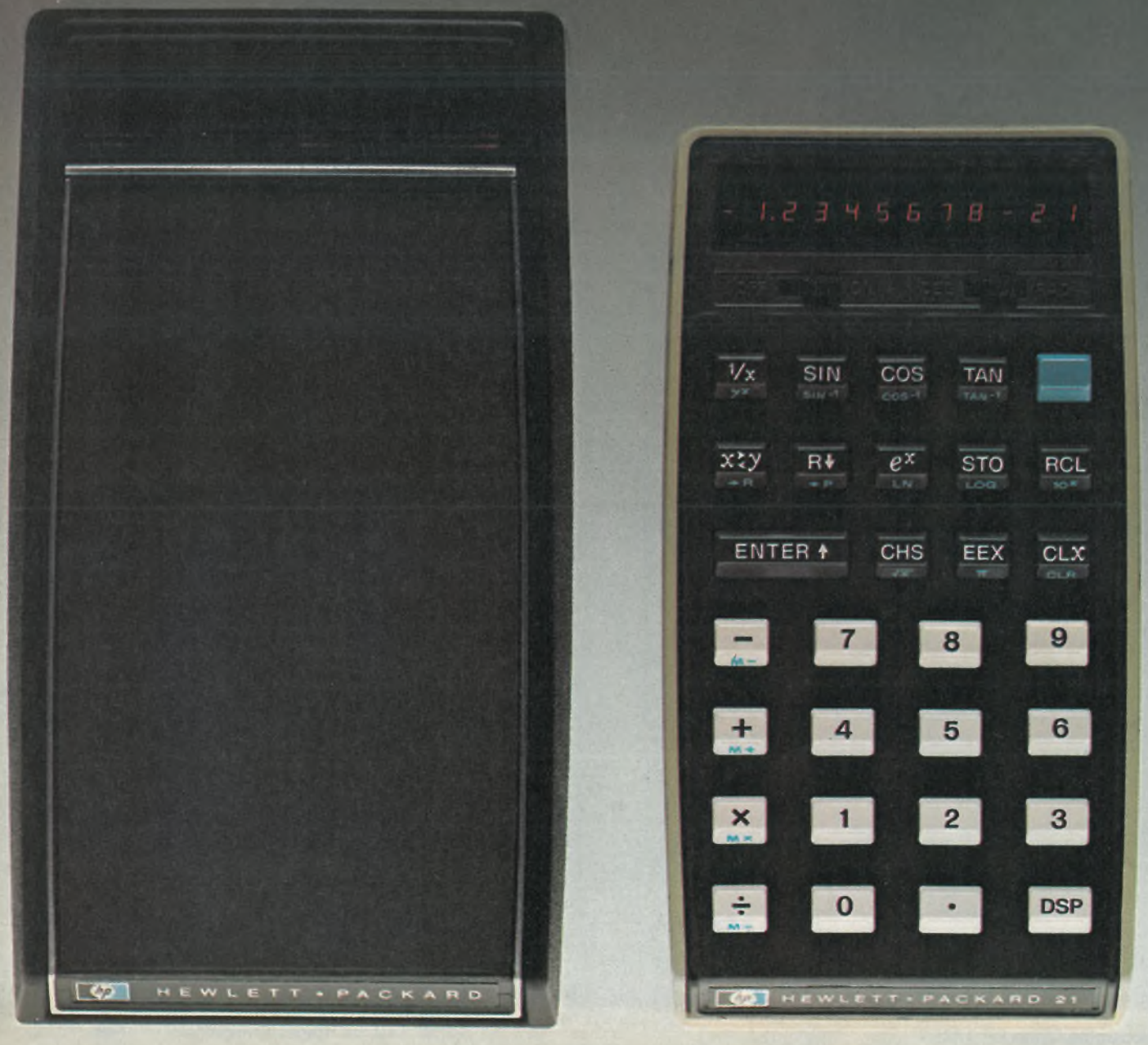
A companion a-d converter is reported to be on the way.

Analog Devices Inc., Route 1 Industrial Park, Norwood, Mass. 02062 [385]

100-kHz f-to-V converter has less than 5 mV ripple

Available in three different temperature-coefficient versions, the model 911 frequency-to-voltage converter typically has less than 5 millivolts of peak ripple on its out-

Hewlett-Packard introduces a smaller uncompromising calculator,



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- **HP's quality craftsmanship.**
- **An unbeatable price:performance ratio.**

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32 pre-programmed functions and operations. The HP-21 performs all log and trig functions, the latter in radians or degrees. It's our only calculator short of the HP-45 that lets you:

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- calculate a common antilog (10x) with a single keystroke.

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Full display formatting. The Display key (DSP) allows you to choose between fixed decimal and scientific notation and lets you control the number of places displayed. (The HP-21 always uses all 10 digits internally.)

When a number is too large or small for fixed decimal display, the HP-21 switches automatically to scientific, so you never have to worry that the calculator will confuse a smaller number with zero.

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- You solve *all* problems—no matter how complex—one step at a time. You *never* work with more than two numbers at once.
- You get continuous and immediate feedback. You see *all* intermediate answers *immediately,* because your calculator executes each function immediately after you press the function key. *You watch it happen.*
- You can easily recover from errors. You can backtrack when you err, because your calculator performs all operations sequentially.
- You can re-use numbers without re-entering them. Your calculator becomes your scratch pad.

HP quality craftsmanship. One reason Nobel Prize winners, astronauts, conquerors of Everest, America's Cup navigators and over 750,000 other professionals own HP calculators. Here are four examples of it:

- Every key on every calculator is double injection molded, so the symbol it carries won't wear off. Every function key has a positive click action, so you know for sure the function has registered when you press one.
- There's a moisture barrier under the keyboard to protect the calculator's innards from coffee, tea, milk, what-have-you.
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Circle 151 on reader service card

New products

put and is linear within 0.01% from 10 hertz to 100 kHz. Capable of supplying 20 milliamperes, the unit sells for $78 in small quantities in its 30-ppm/°C version. Higher-priced versions have tempcos of 20 ppm/°C and 10 ppm/°C. The 911 family, which is packaged in standard 2-by-2-by-0.4-inch modules, is available from stock.

Dynamic Measurements Corp., 6 Lowell Ave., Winchester, Mass. 01890 [386]

Hybrid units convert 12 bits in 10 microseconds

Two analog-to-digital converters, the ADC85C and the ADC85, are capable of making 12-bit conversions in 10 microseconds or 10-bit conversions in 6 μs. The converters have operating temperature ranges of 0 to 70°C and −25 to 85°C for the ADC85C and ADC85, respectively. Each unit is complete with an input-buffer amplifier, a reference, and a user-adjustable clock. All they need to become operational are power supplies of ±15 V and +5 V plus logic-control signals. The converters can handle five input ranges: 0 to +5 V, 0 to +10 V, and ±2.5, ±5, and ±10 V. Three parallel digital output codes are offered: complementary bipolar offset binary (COB), complementary two's complement (CTC), and complementary straight binary (CSB). The CSB and COB codes are also available in serial form.

The converters are linear to within 0.0122% ±½ LSB for the 12-bit models and within 0.05% ±½ LSB for the 10-bit units. If the user is willing to trade off a couple of bits for increased speed, the ADC85 has a short-cycle feature that allows it to convert 8 bits in only 4 μs.

Pricing on the converters, in quantities of one to 24 pieces, is $160 for the 10-bit ADC85C, $185 for the 10-bit ADC85, $195 for the 12-bit ADC85C, and $225 for the 12-bit ADC85. Small-quantity deliveries are from stock to about two weeks.

Burr-Brown, International Airport Industrial Park, Tucson, Ariz. 85734 [387]

digital or analog

Heath's new power supplies set new performance standards

- Choice of four DC outputs: 0-7.5 V, 0-15 V, 0-30 V or 0-60 V
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- Complete output protection
- Remote sensing automatically compensates for lead voltage drops
- Available factory assembled or in easy-to-build kit form

Heath's versatile new 2700-Series DC power supplies do much more than just provide the right voltage and current — they set new standards for precision and ease of operation.

Digital or analog readout. These power supplies are the first in their price range to offer a choice of readouts. The digital models have two-decade autoranging to provide high resolution for low voltage and current settings.

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Output protection. You don't have to worry about these power supplies. Short circuit operation or accidentally applied high voltages can't harm them.

All 2700-Series power supplies are available in easy-to-build kit form or completely factory assembled and calibrated. Either way you get a power supply that offers more performance per dollar than anything the competition can offer. Send for the latest Heath catalogs and get complete details.

Model	Readout	Maximum Rated Output Volts	Cur.	Price*
IP/SP-2700	Analog	60 V	1.5 A	$169.95 kit $255.00 assem.
IP/SP-2701	Digital	60 V	1.5 A	$219.95 kit $340.00 assem.
IP/SP-2710	Analog	30 V	3.0 A	$169.95 kit $255.00 assem.
IP/SP-2711	Digital	30 V	3.0 A	$219.95 kit $340.00 assem.
IP/SP-2720	Analog	15 V	5.0 A	$169.95 kit $255.00 assem.
IP/SP-2721	Digital	15 V	5.0 A	$219.95 kit $340.00 assem.
IP/SP-2730	Analog	7.5 V	10.0 A	$169.95 kit $255.00 assem.
IP/SP-2731	Digital	7.5 V	10.0 A	$219.95 kit $340.00 assem.

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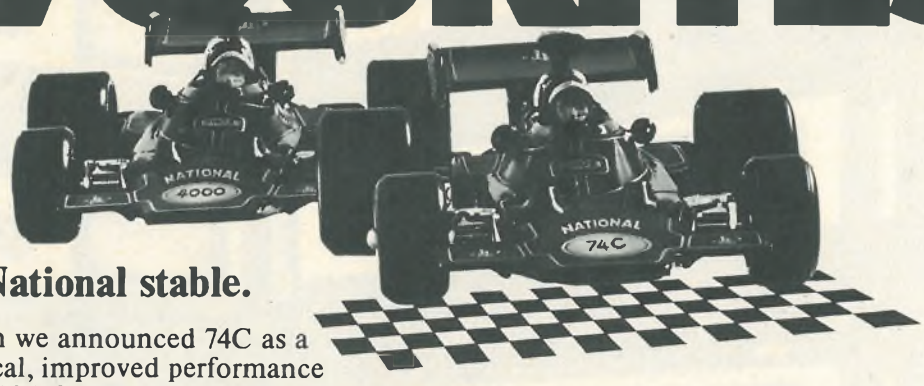
TE-323

Circle 153 on reader service card

THE CMOS FAVOURITES



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CMOS manufacturers, National included, are presently tuning up their 4000 parts (the 'B' series) aiming for the high performance of 74C.

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MM74C20	MM74C86	MM74C161	MM74C195	MM74C908	MM80C97	CD4011	CD4021	CD4035	CD4053*	
MM74C30	MM74C89	MM74C162	MM74C200	MM74C909	MM88C29*	CD4012	CD4022	CD4040	CD4066	
MM74C32	MM74C90	MM74C163	MM74C221	MM74C910*	MM88C30*	CD4013	CD4023	CD4042	CD4069B	
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* Introduction 2nd quarter '75

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Components

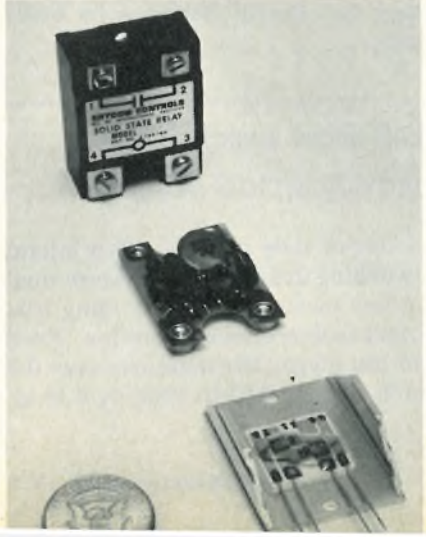
Solid-state relay works at 400 Hz

Rated at 140 or 280 V ac, the unit is offered in versions from 2.5 to 40 A

Most solid-state relays are designed to operate at normal 50- or 60-hertz line frequencies and will not perform properly on the 400-Hz power of many avionics systems and portable sources. Demand for this application has been increasing, however, says Richard W. Fox, applications manager at Crydom division of International Rectifier, and for that reason, the company has developed a standard line of high-current 400-Hz relays.

The new relays match the company's standard units in physical characteristics and most electrical specifications, but include the special filter and phase-compensation circuitry needed for operation at the higher frequency.

Fox says that the modifications required to produce the new relays were not major since Crydom already uses an anti-parallel arrangement of silicon controlled rectifiers (SCRs) instead of the more common triac for its power output stages. "Our design is more expensive," he says, "but it pays off since most triacs don't operate well at 400 Hz. They have to be severely derated, while the SCRs can operate efficiently at the higher frequency." He adds that special units can be supplied to operate up to 800 or 1,000 Hz for unusual applications.



Contact ratings for the new relay line range from 2.5 amperes to 40 A at either 100 to 140 volts ac or 200 to 280 V ac. Fox says that 480-V ac units could be supplied, but there seems to be little demand for them.

All of the relays have the same standard configuration: 2.25 inches long, by 1.75 in. wide, by 0.87 in. high. The input and output terminals are polarized, with the outputs being larger and farther apart than the inputs to help prevent accidental wrong connections.

The relay inputs are compatible with standard transistor-transistor-logic levels: they have an input impedance of 1,500 ohms.

Response time is a maximum of half a cycle of the ac power line plus 2 milliseconds. Zero-point switching is standard to prevent transient surges and radio-frequency interference. Input coupling is through an opto-isolator that provides input/output isolation in excess of 10 gigohms and 1,500 V.

The relays, whose model numbers range from 4D1202 through 4D2440, all have a minimum dv/dt rating of 100 V per microsecond and a minimum holding current of 20 milliamperes. A typical 25-A, 120-V unit (4D1225) has a 175-A rms one-cycle surge-current rating, a 40-A 1-second overload rating, a maximum contact drop of 1.6 V, and a maximum off-state leakage of 4 mA. The units are rated for operation over the temperature range from −30° to 80°C. Prices range from $15 to $42 each in quantities of 100 pieces.

Crydom Controls Div., International Rectifier Corp., 1521 Grand Ave., El Segundo, Calif. 90245 [341]

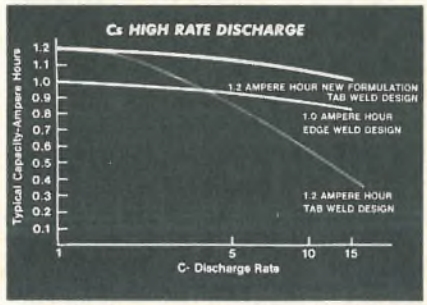
Ni-Cad cell maintains high capacity under heavy loading

A 1.2-ampere-hour tab-weld sub-C nickel-cadmium cell, the General Electric 41B001 AG 26, will deliver almost full capacity under high dis-

New products

charge rates (see curves). Instead of using the normal nickel-screened steel substrate, this new cell combines a patented stipple steel substrate with a high-density plaque material. The result gives as much as 20% improvement in deliverable capacity over 1-Ah edge-weld units at discharge rates up to 15C.

An earlier edge-weld sub-C cell with a 1-Ah capacity held up well under heavy loading, but the higher-density, 1.2-Ah, tab-weld



unit suffered severe capacity falloff under heavy discharge rates (see curves).

The new sub-C cell, which sells for about $1/Ah, can sustain a C/10 charge rate for an indefinite period. Its operating temperature range is 5° to 50°C for charge and -20° to 50°C for discharge. Storage temperature range is -40° to 50°C. The steel-encased cell weighs 1.5 ounces, has an internal impedance of 12 milliohms, and can supply up to 20 amperes continuously.

Sub-C cells measure about 0.875 inch in diameter by 1.6 inches long, and are used extensively in portable electric tools and scientific and medical instrumentation.

General Electric Co., Battery Business Dept., P. O. Box 861, Gainesville, Fla. 32602 [343]

DIP slider switches provide up to 8 positions

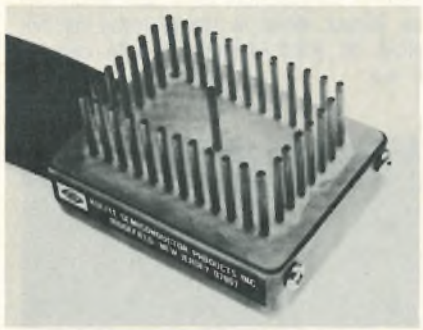
A line of slide switches offers lateral switching action in a miniature dual in-line package while retaining true break-before-make operation. Each 16-pin plastic DIP measures only 0.3 inch wide by 0.55 in. long by 0.33 in.

high, including the slider mechanism. A spring-loaded double-ball-bearing detent action ensures smooth switching and positive location of each switch position. The simplest unit in the SW40 family is a single-pole eight-position device, but switches with up to four poles and four positions are available. The contacts can switch a resistive load of 250 mA at 30 V dc. In quantity, prices range from $1 to $3.95, and delivery is from stock.

Minelco Div., General Time, 135 South Main St., Thomaston, Conn. 06787 [344]

Pressure transducer handles 25 channels

A 25-channel solid-state pressure transducer, the KPM-25, is an electrically scanned device intended for the measurement of static and quasi-static pressures. Housed in a rugged 1.5-inch by 1.5-in. by 0.5-in.



package, the unit is available in pressure ranges up to 100 psi with a mean full-scale output of 75 mV at 5-V excitation.

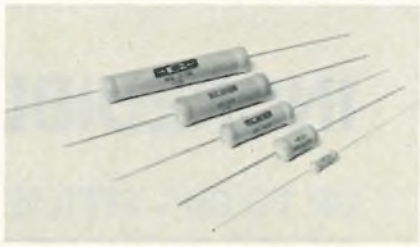
Kulite Semiconductor Products Inc., 1039 Hoyt Ave., Ridgefield, N. J. 07657 [346]

Small, high-power resistors operate to 275°C and 6,000 V

Type MS power film resistors, which have values from 10 ohms to 30 megohms, are designed for high-voltage, high-power operation at temperatures up to 275°C. The small size of the series is typified by the MS 310, which measures 1.25

158 Circle 158 on reader service card

New products



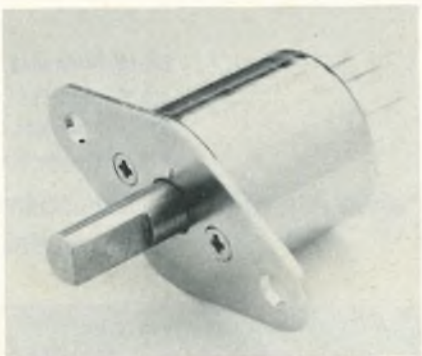
inches long by 0.375 in. in diameter and has a power rating of 10 W and a maximum voltage rating of 4,500 V. The MS 150 configuration is only 0.188 in. long and can dissipate 0.5 W, while the MS 313 is 2 in. long and can withstand 6,000 V. All MS resistors can be delivered with tolerances as tight as 0.1%, and all of them have the 0.1% per 1,000 hours stability that is characteristic of Micronox film resistors.

Caddock Electronics Inc., 3127 Chicago Ave., Riverside, Calif. 92507 [345]

Contactless potentiometer uses Hall-effect element

A contactless potentiometer incorporates a magnetoresistive element based on a Hall-effect transducer to provide a low-torque, bounceless, noiseless, and explosion-proof device. Designed for extreme environments, the LP-18S is expected to have broad applications in angle-, position-, displacement-, and tension-sensing devices as well as in motor commutation, switching, and general servomechanism use. The LP-18S is 21 mm in diameter. Sample quantities are available from stock.

DKI Div., 5430 Rosecrans Ave., Lawndale, Calif. 90260 [347]



Circle 213 on reader service card

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Introduction to Digital Filtering, ed. R.E. Bogner and A.G. Constantinides, John Wiley & Sons, 198 pp., $19.50.

Television Troubleshooting, Clyde N. Herrick, Reston Publishing, 230 pp., $14.95.

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Delta Modulation Systems, R. Steele, Halsted Press, 379 pp., $32.50.

High Rupturing Capacity Fuses, E. Jacks, Halsted Press, 280 pp., $15.75.

Electricity for Technicians, Abraham Marcus and Charles M. Thomson, Prentice-Hall, 500 pp., $13.95.

Digital Design with Standard MSI and LSI, Thomas R. Blakeslee, John Wiley & Sons, 357 pp., $19.95.

Electronic Circuit Behavior, Daniel L. Metzger, Prentice-Hall, 426 pp., $15.95.

Instrumentation in Industry, Harold E. Soisson, John Wiley & Sons, 563 pp., $24.95.

The Founders of Electrochemistry, Samuel Ruben, Dorrance & Co., 107 pp., $5.95.

Technology Mathematics Handbook, Jan J. Tuma, McGraw-Hill, 370 pp., $15.95.

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Instruments

Unit locates ac transients

Disturbance monitor senses direction of currents as well as voltage parameters

A power-line monitor that not only measures voltage transients and other line disturbances but also determines the direction of the transient current can help users pinpoint the sources of line problems. Like its

predecessor, the model 3401, the new 3402 can detect, count, and record power disturbances such as voltage dips and surges, transients, and frequency deviations for single- and three-phase voltages of 50 and 60 hertz, over a range of 100 to 480 v ac. Voltage levels can be accurately set to a resolution of 0.5 volt. When a preset level is exceeded, the disturbance is detected, categorized and counted with a printer that logs the day, hour, and minute, and identifies the event by code. Transients having rise times as fast as 0.2 microsecond can be detected. Frequency variation beyond preset limits of +½, 1, 2, and 4 hertz from base frequency can also be detected and recorded.

With the addition of a plug-in printed-circuit board containing the analog detection and digital processing circuitry, a current monitor probe, a current sensitivity switch, an added column to the printer, and a current-monitor BNC plug, the old monitor becomes the 3402, with the additional capability of determining whether the transients come from the load or the source, and identifying their polarity.

By moving this device back and forth along a line, the source of a disturbance, if it is internal, can usually be traced to a specific location.

Based on techniques invented at the U.S. Navy's Civil Engineering Laboratory, Port Hueneme, Calif., by K. T. Huang, the 3402 has a minimum voltage sensitivity of 40 volts peak, but is adjustable anywhere from 40 to 995 v with a front-panel 10-turn "low magnitude transient" potentiometer. Current sensitivity is 10 amperes minimum and is adjustable to low, medium or high with another switch on the rear panel.

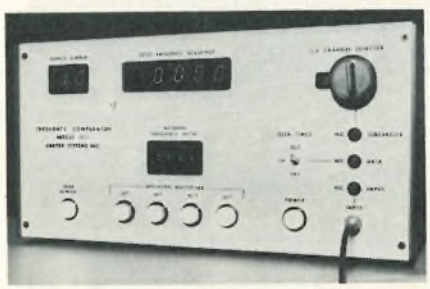
The instrument is capable of measuring transients with pulse widths ranging from 0.2 μs to 100 μs. Maximum time between voltage and current transients is 5 μs (sampling window is narrowed by the width of the transient).

Measuring 8.75 by 17 by 17.2 inches and weighing about 40 pounds, the 3402 consumes about 40 watts. Current delivery time is five to six weeks, and the price is $5,300.

Programmed Power Inc., 141 Jefferson Dr., Menlo Park, Calif. 94025 [351]

Frequency comparator offers high resolution

With a frequency comparator from Arbiter Systems, oscillators can be directly calibrated with resolutions approaching one part in 10^{11}. An internal precision reference is derived from TV network color burst signals, which use rubidium oscillators



monitored by the National Bureau of Standards, and is compared with the oscillator under test [*Electronics*, March 10, p. 107].

The $3,000 Arbiter unit provides a complete system for calibration, including TV reception. All that is needed is a TV signal, ac power, and an input from the unit under test.

The comparator regenerates 3.58-megahertz color subcarrier, then multiplies it to 100 MHz. A comparison is made with a frequency of 100 kHz, 1 MHz, 5 MHz, or 10 MHz, also multiplied to 100 MHz.

Four resolution ranges are provided from 1×10^{-8} to 1×10^{-11}. The lowest resolution-range comparison takes 1 second; the highest, 1,000 seconds. After selecting a network staion, thumbwheel switches are used to enter the network signal's offset from atomic time, as published by NBS.

An internal timer can be set to stop comparisons at the hour and half-hour station breaks, when the local stations take control, and indicators tell when input signal strength is lost or no color subcarrier is present.

Arbiter Systems Inc., 1402 Norman Firestone Rd., Goleta, Calif. 93017 [352]

Dual-beam scope added to 5000 series

When viewing simultaneous signals on an oscilloscope, reliance on the alternate mode can lead to phase errors between the displayed waveforms, while the chopped mode only allows viewing of half the waveform. One way around this dilemma is to use a true dual-beam scope, one with two electron sources, two vertical deflection systems, and two horizontal deflection systems.

The model 5444 true dual-beam oscilloscope is an addition to Tektronix' 5000 series line. A typical system would consist of a 5443 acquisition unit, a D44 display unit, a 5A44 dual time base, and two 5A45 vertical amplifiers and be priced at $4725.

With this combination, the 5444

The AILTECH 360 Frequency Synthesizer is a high performance unit whose modular design simplifies integration into specific systems and general laboratory set-ups.

Providing high-speed, direct synthesis from 10 KHz to 180 MHz, the 360 offers many outstanding features, among these:

- Spectral Purity:
  Non-harmonic spurious signals 100 dB below the output from 10 KHz to 60 MHz (94 dB from 60 to 180 MHz).
  Phase noise floor typically −138 dBc/Hz from 10 KHz to 60 MHz (−132 dBc/Hz from 60 to 180 MHz).
- High Speed Programmability:
  Frequency remotely programmable (BCD parallel) with less than 20 μsec switching time (typically 10 microseconds) with no settling time.

Modular Design Assures Ease of Application
Expensive modifications or redesign often required for systems integration are virtually eliminated with the AILTECH 360.

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AILTECH INTRODUCES
A HIGH PERFORMANCE, HIGH SPEED
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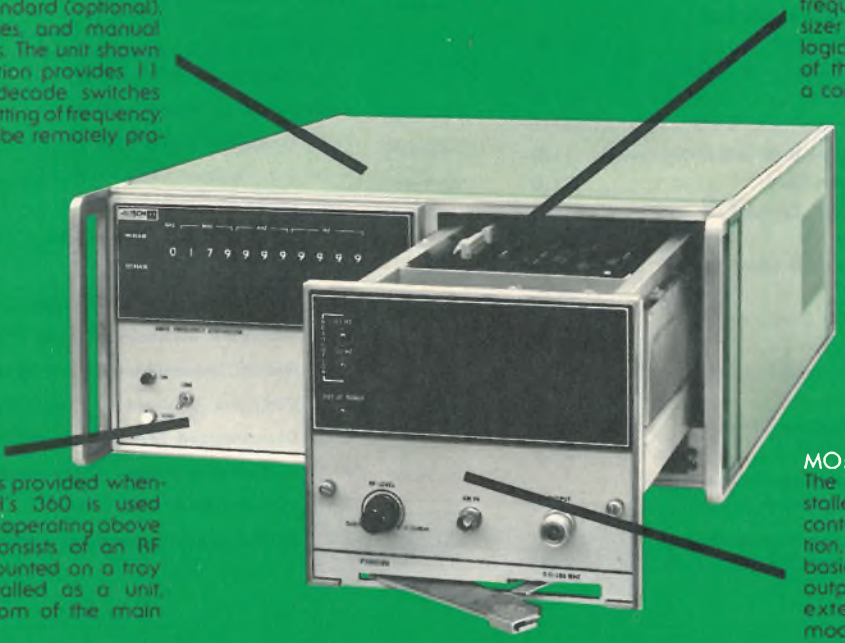
...With modular construction to simplify systems applications
...at prices comparable to indirect synthesizers.

MAIN FRAME
The main frame contains the basic synthesizer modules, frequency standard (optional), power supplies, and manual control circuits. The unit shown in the illustration provides 11 front panel decade switches for manual setting of frequency, and can also be remotely programmed.

RF PLUG-IN SECTION
The plug-in contains the RF circuitry which determines the frequency range of the synthesizer and the frequency control logic. Remote programming of the synthesizer is through a connector at the rear of the plug-in.



FREQUENCY EXTENDER
This module is provided whenever AILTECH's 360 is used with a plug-in operating above 18 MHz. It consists of an RF assembly, mounted on a tray which is installed as a unit, into the bottom of the main frame.

MODULATION MODULE
The modulation module is installed in the RF plug-in. It contains the levelling, modulation, and output circuitry. The basic unit shown offers levelled output, 13 dB attenuation, and external linear amplitude modulation.

CHARACTERISTICS ALL ITS OWN

Frequency Selection – manual pushbuttons or BCD remotely programmable; Frequency Resolution – typically 1 Hz, with 0.1 Hz available as an option; Reference Oscillator – optional internal oven stabilized, crystal controlled 10 MHz oscillator can be built-in or supply your own 5 or 10 MHz external reference.

Levelled Output – 0 to + 13 dBm, continuously variable, ± 0.5 dB flatness (1 to 180 MHz).

Seeing is Believing...the best way to appreciate our efforts is to see the 360 in operation with your application. As soon as you tell us about your requirements, we'll arrange for a no obligation demonstration.

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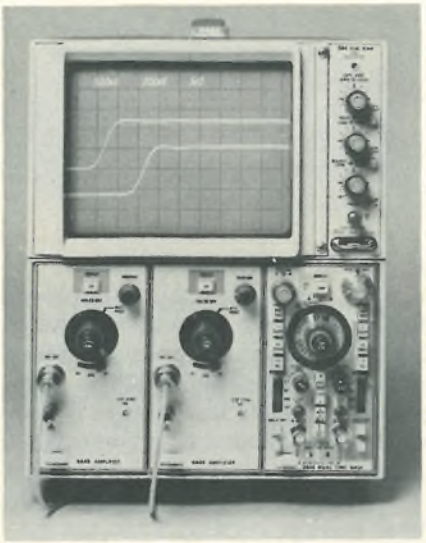

can display one signal at two sweep speeds or two signals at the same or different sweep speeds. A waveform and a delayed, magnified version of the same waveform can be viewed simultaneously.

With other plug-ins, up to four repetitive waveforms at 60 megahertz, or eight waveforms at reduced bandwidth, can be compared in the alternate or chop mode. Multiple-trace, single-shot events can be compared at sweep speeds up to 100 microseconds per division in the chop mode.

The 5B44 dual-time base has a sweep speed of 5 nanoseconds per division.

Alphanumeric readouts document the sweep speed and vertical deflection factor for each beam on the 6½-inch diagonal cathode-ray tube screen of the 5444. In addition a user-addressable readout option programs the 544 to write data, up to two 10-character words, on the screen.

Tektronix, Inc., P.O. Box 500, Beaverton, Ore. 97077 [353]

Hi-Pot tester has fully automatic test cycle

Intended for dielectric-withstand and ground-continuity tests as required by Underwriters Laboratories and similar institutions, the EPA Hi-Pot features a fully auto-

New products

matic test cycle for simplicity of operation, and automatic shutdown for high-voltage lockout at failure. The unit may be used wherever non-destructive high-voltage tests are required. Its test voltage is preset and is indicated on a front-panel meter. Two Hi-Pot models are available: the M100A meter reads only total leakage current, while the meter on the M100B reads either total leakage current or the real (resistive) part of the leakage current at the touch of a switch. The M100A is priced at $800 while the M100B sells for $850.

EPA Electronics Inc., 220 Demeter St., East Palo Alto, Calif. 94303 [354]

Universal counter is bus-compatible

Add a $350 option to the $1,300 basic price of the model 5328A universal counter and you have a flexible medium-priced instrument that can be connected into any HP Interface Bus measurement system. In its simplest form, the 5328A can measure frequencies to 100 megahertz, single-shot time intervals to a resolution of 100 nanoseconds, and repetitive events to a resolution of 10 picoseconds. Arming capability, previously available only in higher-priced instruments gives precise control over the start of a measure-

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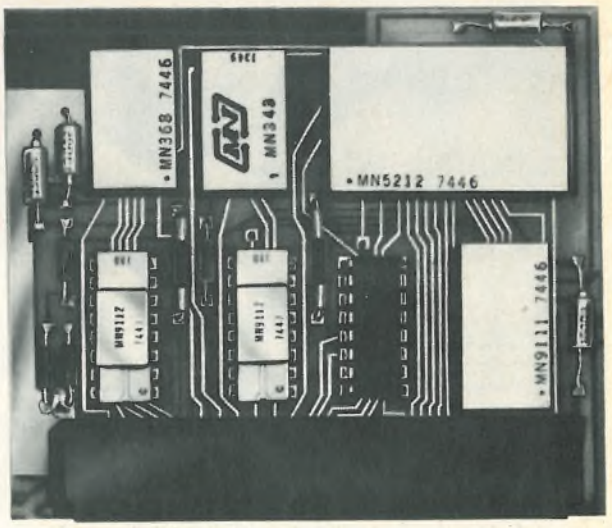

New! A miniature full MIL range adjustment-free 16-channel Data Acquisition System, Model MNA7000.

Circle 169 on reader service card

New products

ment. An eight-digit display and a non-ovenized crystal time base are standard. Extra-cost options include the interface-bus module, an ovenized oscillator, two digital-voltmeter modules, 512-MHz frequency-measuring capability, and a high-performance package which greatly expands the instrument's time-interval-measuring capability.

Inquiries Manager, Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304 [355]

Digital capacitance meter includes autoranging

The ECD model 100 is a hand-held, battery-operated, 3½-digit autoranging capacitance meter that measures capacitances from 200 picofarads full scale to 200 millifarads full scale in 10 automatically selected ranges. The meter, which has a maximum resolution of 0.1 pF, has an offset control which allows the stray capacitance of different test clips to be nulled out. The numeric readout is by means of a large (0.6-inch high) liquid crystal display, while the capacitance units are indicated by means of small light-emitting-diode lamps. The price of the meter is $289; delivery is from stock to four weeks.

ECD Corp., 232 Broadway, Cambridge, Mass. 02139 [356]

1-MHz sweep/function generator sells for $350

A low-cost sweep/function generator with a 50-ohm output impedance, the model 196A offers sine, triangle, square, pulse, and sweep waveforms over a frequency range of 0.1 hertz to 1 megahertz. Rise times of the square and pulse waveforms are less than 100 nano seconds, and a separate TTL-compatible output has a rise time of less than 25 ns. Price of the 196A is $350; the unit is stocked locally.

Exact Electronics Inc., 455 S.E. 2nd Ave., Hillsboro, Ore. 97123 [357]

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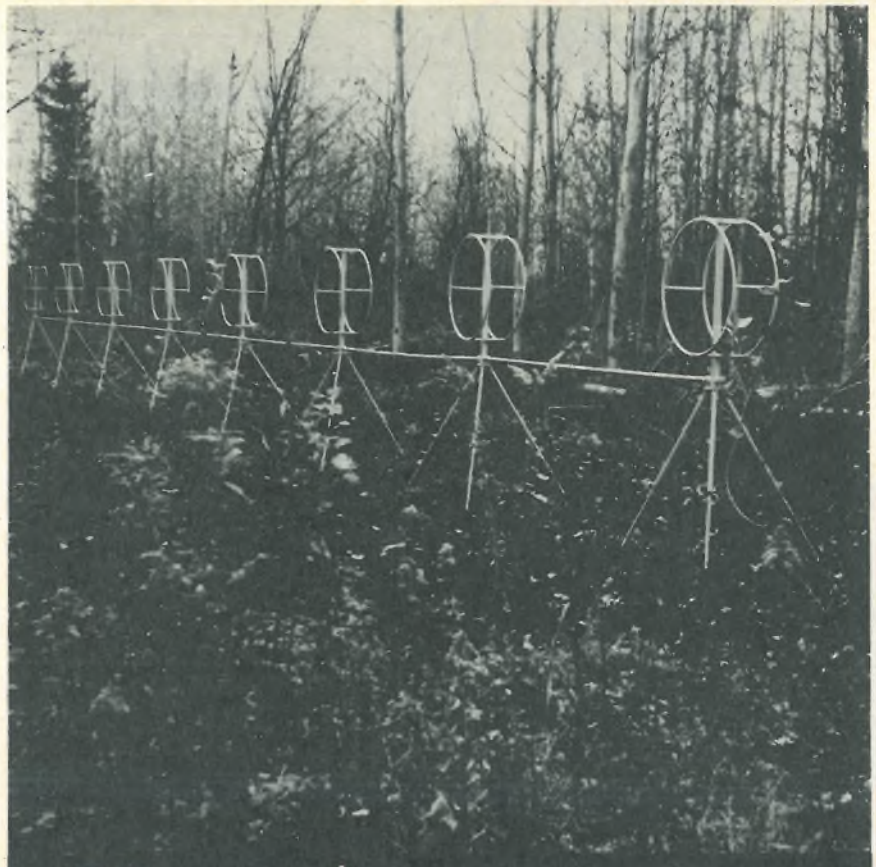

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New products

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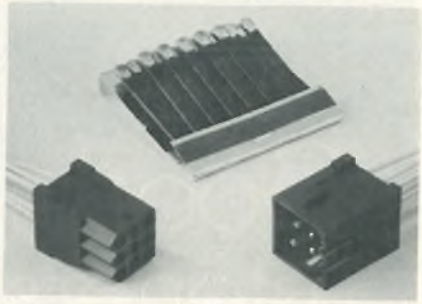
Connectors are fire-resistant

Units for consumer and industrial jobs also come in standard nylon housing

A low-cost electronic connector from Amphenol exceeds the new standard of Underwriters' Laboratories for flame-resistant plastic parts in consumer electronics gear.

Recent public and Government



concern about fires in television sets has prompted manufacturers, to take a closer look at the flammability of plastic parts. The Consumer Product Safety Commission, for example, is now developing mandatory safety standards for TV sets, and Underwriters' Laboratories will require a more flame-resistant plastic in all consumer products starting July 1, 1977.

"Connector manufacturers have been pushing for a flame-retardant material for years, but no one had been able to come up with one," explains Oscar Rothchild, product manager for what Amphenol calls the 332 Series connectors. "The major difficulty was designing the part so that it could be molded from a flame-retardant material, which is less flexible than straight nylon because of the additives."

Connectors with housings of the flame-retardant material are designated Fire-Plug; the same connector with standard nylon housing is called Econo-Plug. For applications requiring color coding, Econo-Plug connectors are available in six standard colors.

The series is completely interchangeable and matable with competitive connectors and is designed for use in appliances, computer peripherals, vending machines, transportation, and instrumentation, as well as home entertainment equipment. Mounting latches and wings on the connector lock the housing into panel cutouts with a 10-pound insertion force and, when mounted, the connector resists accidental push-out forces of 35 lb or more. The latch self-adjusts for panels from 1/32 to 3/32 inch thick.

To prevent accidental unmating, locking tabs are provided on connectors with two, three, six, and nine contacts, while contact retention force keeps the connector mated on 12- and 15-contact sizes. Both pin and socket contacts are bright tin-plated brass, and the three terminal sizes can be used with wire sizes from 14 to 30 AWG. Contact resistance is 3 milliohms maximum; current rating is 1 to 12 amperes, depending on wire size. Mating force is 24 ounces per contact maximum; unmating force, 4 oz per contact minimum.

The connectors are designed for a maximum operating voltage of 250 volts, with a dielectric-withstanding voltage of 1,800 V. A nine-contact plug and receptacle sells for 12 cents per pair in 10,000-piece quantities in the flame-retardant material; price for standard nylon versions is about 1 cent per mated pair less. Contacts loose or on reels are priced at 0.7 cent each in 100,000-piece quantities from stock.

Amphenol Industrial Division of Bunker Ramo Corp., 1830 South 54th Ave., Chicago, Ill. 60650 [391]

Bonded-overlay technique modifies circuit boards

Quick fixes or circuit modifications may force an engineer to squeeze extra wiring and components on an already frozen printed-circuit

5 reasons why the Keithley model 168 should be your number 1 digital multimeter

1. Autoranging. All you do is connect the signal to the two-terminal input and push the function you want. The 168 takes it from there to save you time.

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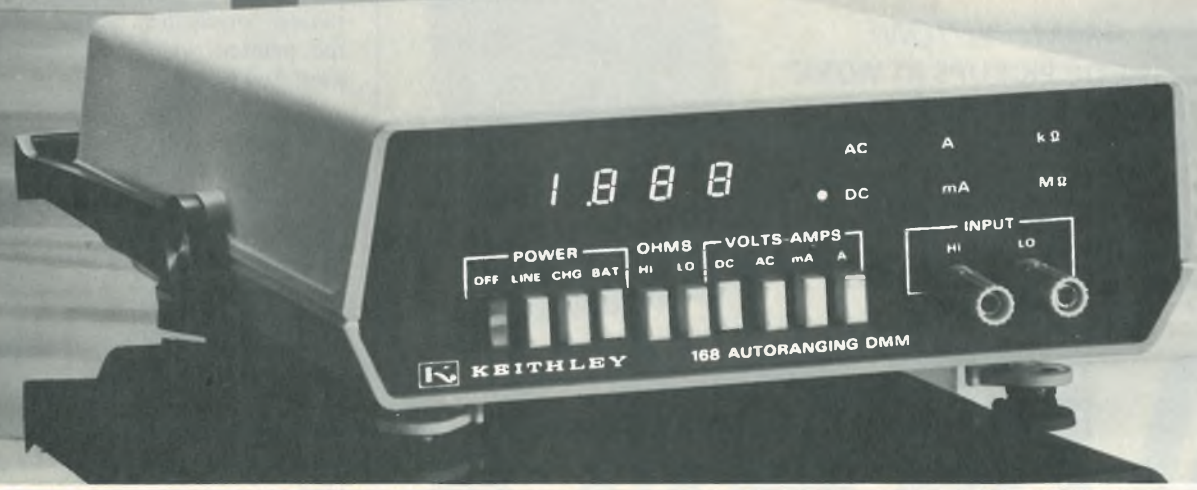
5. Low Price. Only $315 puts the Model 168 in your hands. A complete line of accessories gives the 168 even more versatility.

The Model 168 Autoranging DMM will make your job easier . . . and that should make it your number 1 choice. Send for full details or phone (216) 248-0400 for a right-away demo.



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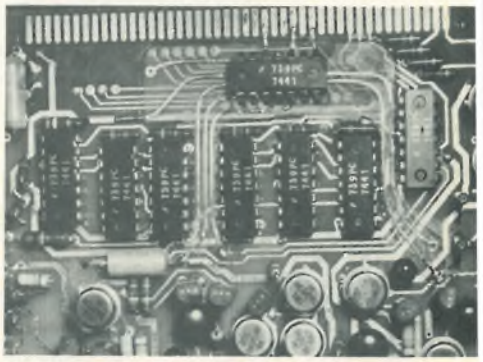
Circle 173 on reader service card 173

New products



board—and all too often the reworked board turns out to be unreliable.

A new process developed by Blakesley Electronics, an Indiana manufacturer of circuit boards, could end most modification troubles. A thin, 10-mil layer of copper-clad FR-4 epoxy glass, with the modified pattern subtractively etched on it, is bonded to an existing board by a special adhesive. The photo above shows how a 14-pin DIP plus its wiring was added to a densely packed board. A Midwest tape recorder manufacturer is currently evaluating the method by replacing a pattern for two discrete transistors with an overlay for a single-can dual transistor.

The overlay method practically eliminates the need for jumper wires and will not damage components and wiring already on the board. All a user has to do is remove any of the unnecessary printed wiring, bond on the overlay, and solder from the plated connection of the overlay to the printed wiring or lands of the modified board.

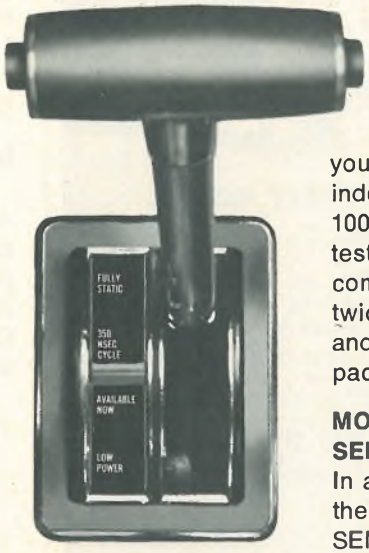
Any additional components are then soldered to the surface of the bonded overlay. This can be thought of as a limited form of the multilayering technique, and, in fact, an assembled two-sided board can be converted to a three- or four-layer board if desired.

According to Wayne Blakesley, the originator of this method, the overlays will be made on a custom basis and furnished to customers to do their own modifications on the spot.

Cost of the overlay should be slightly more than in-house repair

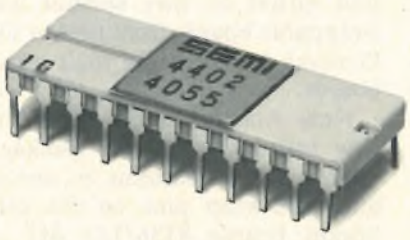
SHIFT INTO HIGH PERFORMANCE WITH A 4K STATIC RAM

FULLY STATIC: The SEMI 4402 is a fully static 4K RAM. That's important. For one thing, it means you can now design a 250 nsec MOS memory system around a 4K device without worrying about refresh or charge pump circuitry. For another, static RAMS are inherently less susceptible to soft bit error problems than comparable dynamic devices.



350 NANOSECOND CYCLE: The SEMI 4402 4K static RAM has a *complete cycle time* of just 350 nsec and 200 nsec maximum access time. That makes it the fastest 4K static RAM in production. Now you can design a truly high performance MOS memory around a static 4K device.

AVAILABLE NOW: The SEMI 4402 4K static RAM is here now. We're already delivering it to customers at the memory system level. And it is second sourced by a major supplier of MOS devices.



LOW POWER: The SEMI 4402 4K static RAM has similar power levels to comparable dynamic devices. However, power conservation is achieved by the Chip Select Input, which causes the 4402 to enter a low power standby state whenever it is unselected. Normal V_{DD} is 12 Vdc, but V_{DD} can also be reduced to 5 volts without risking loss of stored data. And the 4402's differential output results in inherently high noise immunity memory systems.

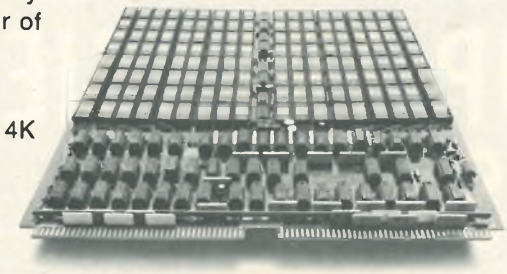
PERFORMANCE TESTED: Like all SEMI NMOS components, the 4402 4K static RAM must meet our own tough test standards, since we use it in our memory systems — for example the MICRORAM 3400N. With our reputation riding on its performance, you may be sure the acceptance standards are high indeed. In fact we 100% ac and dc test our components twice — at wafer and again in the package.

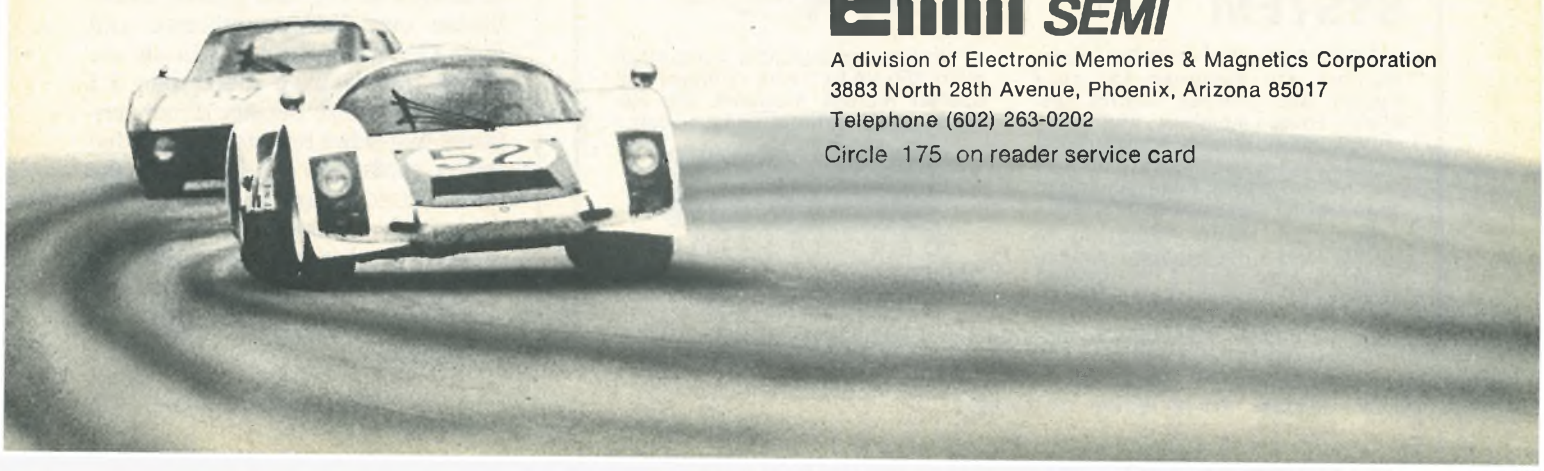
Part No.	Bit Org.	Access Time
RAMS		
SEMI-1801	1024 x 1	90 nsec.
SEMI-1802	1024 x 1	70 nsec.
SEMI RA-3-4256	256 x 4	1 usec.
SEMI RA-3-4256B	256 x 4	1 usec.
ROMS		
SEMI RO-3-4096	512 x 8	500 nsec.
SEMI RO-3-5120	512 x 10	500 nsec.
SEMI RO-3-16384	4096 x 4	1.0 usec.

More new products to come . . . additional 4K static RAMs, ROMs.

MODEL SELECTION: In addition to the 4402, EMM SEMI offers you a complete line of static NMOS RAM and ROM components to meet your design needs. Make your selection from the adjacent chart.

PROVEN TRACK RECORD: At EMM we've been making memory components and systems since 1961. Unlike memory suppliers who market components only, all EMM components are all performance proven in our own systems. When you buy from EMM, you get the benefit of the unusually high acceptance standards we impose on ourselves, as well as our years of experience in meeting the needs of the memory marketplace. If you'd like further information about any of the products featured here, or any other EMM components or systems, contact your local EMM office today.





EMM SEMI

A division of Electronic Memories & Magnetics Corporation
3883 North 28th Avenue, Phoenix, Arizona 85017
Telephone (602) 263-0202

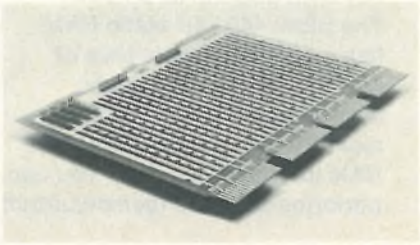
Circle 175 on reader service card

using customary procedures, the company says.

Blakesley Electronics, Box 686, Syracuse, Ind. 46567 [392]

Socket boards are designed for minicomputer interfacing

Although the minicomputers they make all have provision for extra input/output interfacing boards, neither Digital Equipment Corp. nor Data General desires to stock prewired cards for every special-purpose interfacing problem that might come along. Users therefore have had either to buy special wire-wrappable boards from DEC or Data General, or else make their own pc boards.



Now Augat has introduced two new series of interface packaging boards with IC patterns on one side and wire-wrap pins on the other. Socket boards 8136/LG 411 and LG 412 are for the DEC PDP-8, board 8136/LG 498 is for the PDP-11, and boards 8136/LG 413 and LG 414 are designed for the Data General Novas. The new boards are directly interchangeable with manufacturer-supplied boards.

The new boards, with two-ounce tin-plated-copper voltage and ground planes offer improved characteristics in V_{CC} and ground distribution over comparable DEC and Data General units. In addition, the Augat boards have more than 2.5 times the planar density of conventional two-sided boards or one-sided socket cards. For example, for the PDP-8, DEC offers a special wire-wrappable card with 40 to 50 IC sockets; the comparable Augat LG 411 has provision for 110 16-pin ICs.

Either two-level or three-level

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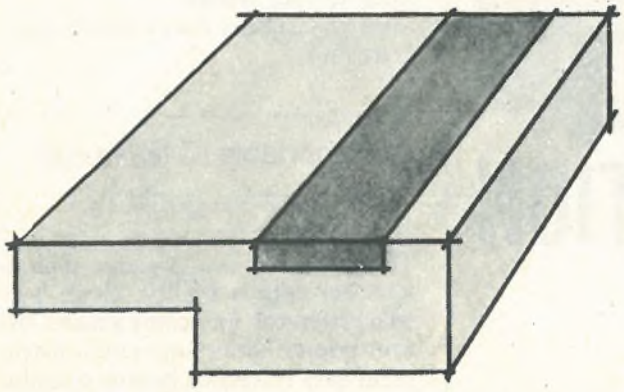

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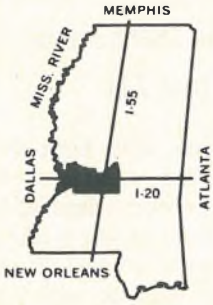

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Circle 177 on reader service card

New products

wire-wrap pins containing precision, two-piece machined contact assemblies with either tin- or gold-plated outer sleeves are available for the new boards. Approximate prices per IC pattern vary from $0.80 to $1.50 depending upon board variations and quantity. Delivery time for the interface packaging boards is from stock to four weeks.

Augat Inc., 33 Perry Ave., Attleboro, Mass. 02703 [393]

$300 portable IC tester has built-in pattern generator

The Evaluator is a portable digital-IC tester with a built-in clock, pattern generator, and comparator. The four-pound battery-operated instrument uses reference boards containing good integrated circuits for comparison testing of all transistor-transistor and diode-transistor logic,

as well as complementary-MOS and other 14- and 16-pin ICs. The unit, powered by six AA nickel-cadmium cells, can perform 10,000 1-second tests from one fully charged set. Five commonly used reference boards are supplied with the Evaluator. Price is $300.

fut-heuristic devices, P. O. Box 1117, Reseda, Calif. 91335 [394]

Ground-plane DIP boards intended for fast TTL

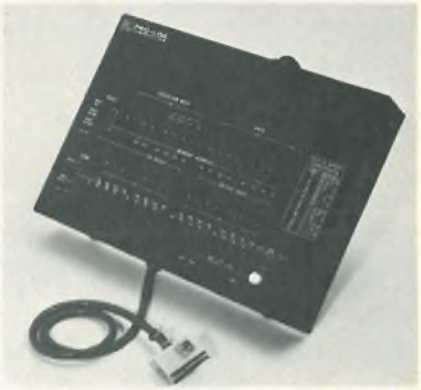
Designed to work with high-speed transistor-transistor logic, several new additions to Vero's line of circuit boards for dual in-line packages are provided with copper ground planes. The new boards, which are

New products

compatible with several of the company's existing card files, are offered with double-sided gold-plated edge contacts on either 0.156-inch or 0.1-in. centers. Like previous Vero DIP boards without ground planes, the new boards are prepunched with holes 0.040 in. in diameter on a 0.1-by-0.1-inch matrix so that they can handle any combination of DIPs. A typical price is $10.60 for a board of 4.5 in. by 6.5 in. designed to mate with a dual 40-pin edge connector.
Vero Electronics Inc., 171 Bridge Rd., Hauppauge, N. Y. 11787 [395]

Analyzer tests 8008 microprocessor chips

A portable analyzer to test the model 8008 microprocessor displays cycle data, chip status, and time-state data. Capable of working with any system containing the 8008, the M-821 analyzer allows a user to perform tests in either a single-step static mode or in a dynamic mode. In the step mode, the program is



stepped through each memory cycle. In the run mode, data is captured and displayed without interfering with the program. The analyzer interfaces with the system under test by means of an 18-pin dual in-line package connector that clips onto the 8008 package. Operating from standard 115-v ac lines, the M-821 weighs only 4.5 pounds and comes packaged in an aluminum box. Small-quantity price is $550; delivery is from stock.
Pro-Log Corp., 852 Airport Rd., Monterey, Calif. 93940 [396]

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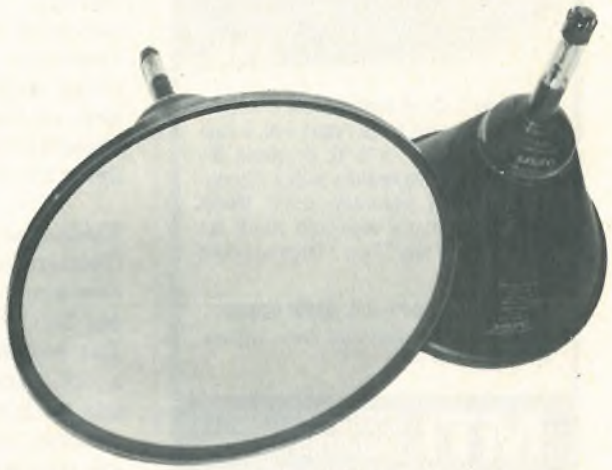

For the same price you'd pay for the all-glass type, DuMont can quickly furnish 16", 19" and 22" metal cone CRTs that offer distinct advantages both for the equipment designer and the end user. The designer will appreciate the weight he can save by eliminating EMI or personnel safety shields. (None are necessary with metal cone construction.) The user will find that the self shielding of the metal cone provides a uniform focusing field, while the high-transmission, uniformly thick faceplate is the flattest screen obtainable for any large-diameter CRT. The sum of these advantages is an extremely sharp edge-to-edge presentation with the smallest possible parallax error.

With the addition of a multi-persistence or multicolor phosphor screen these metal cone CRTs are ideal for displays that integrate low repetition video with computer generated data in radar and process control displays. Air traffic control, manufacturing process control, training simulators, interactive displays and computer terminals are some of the typical applications.

Typical tubes are briefly described below. Many other models are available.

	22 Inch Tubes		16 Inch Tubes	
	KC 3008	KC 3025	K 1222	KC 2745
Useful Screen (in.)	20.00	20.00	14.37	14.37
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For more complete information contact us at 750 Bloomfield Ave., Clifton, N.J. 07015, Tel. (201) 773-2000.

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New products/materials

A thermally conductive silicone rubber compound is usable as a stress-free encapsulant, as a repairable adhesive/sealant, and as a flexible mold compound. Castall 1200 is a two-part room-temperature-vulcanizing material that cures with very little shrinkage, and is rated for operation over the temperature range from −100° to 300°C. Available in black or white, it sells for about $69 per gallon.
Castall Inc., East Weymouth, Mass. [476]

Thick-film resistors, conductors, and dielectrics are among the two dozen new items included in catalog number 845 from Thick Film Systems. The screen-printable pastes include a 600 series resistor material that can be fired at 600°C on glass and ceramic substrates. Also included are colored dielectric formulas that retain their color after firing, and various precious-metal, precious-metal-alloy, and copper-conductor formulations. The copper paste must be fired in a nitrogen atmosphere.
Thick Film Systems Inc., 324 Palm Ave., Santa Barbara, Calif. 93101 [477]

High-temperature space cloth, Eccosorb SC-HT, is an open-weave glass-fiber cloth that has been treated with a lossy resin to make it semiconductive. The material is coated to ensure its stability at temperatures up to 300°F. Resistivity values from 100 to 1,500 ohms per square, measured at 3 GHz, are available,
Emerson & Cuming Inc., Canton, Mass. 02021 [478]

Pure copper in the form of 99.999% single crystals is available for conductivity and alloy studies in five standard diameters from 0.25 to 1.5 inch and in four standard lengths from 1 to 6 in. The crystals are normally sold in random orientation, but specific orientations within 1° of the major axis are available at extra cost. A typical crystal 0.25 in. diameter by 1 in. long costs $140.
Aremco Products Inc., P. O. Box 429, Ossining, N. Y. 10562 [479]

GE's June, 1975 miniature catalog has over 500 data changes that could affect your current design. Send for it. It's free.

(3-5169)

***NEW. June '75* Miniature Lamps:**

40 pages. 500 changes. Data covers over 500 miniature lamps ranging up to 20,000 hours rated average life. With a design voltage range of from 1.2 to 55, and candlepower range from .02 to 250. Diameter range from 11/32" to 2 1/16".

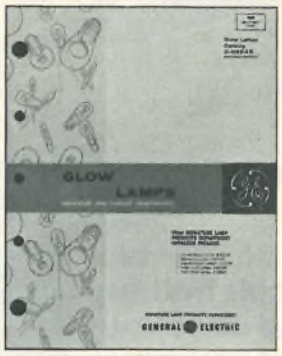
Circle Product Card # 103

(3-6252R1)

***NEW. Feb. '75* Sub-Miniature Lamps:**

24 pages. 91 changes. Data covers over 210 sub-miniature lamps. Diameters ¼" and smaller. Rated voltage 1.3 to 60. Candlepower range from .006 to 15. Rated average lamp life up to 60,000 hours.

Circle Product Card # 104



(3-6254R)

***NEW. Dec '74* Glow Lamps:**

8 pages. 50 changes. Data covers 83 Neon Glow Indicator and Circuit Component lamps. Diameters ranging from ¼" to 1¾". Wire terminal lengths ½", 5/8", ¾" and 15/16".

Circle Product Card # 105

To get the catalogs you need, free of charge, circle the product card number shown under each catalog, or write General Electric, Miniature Lamp Products Department, 3382-M, Nela Park, Cleveland, Ohio 44112.

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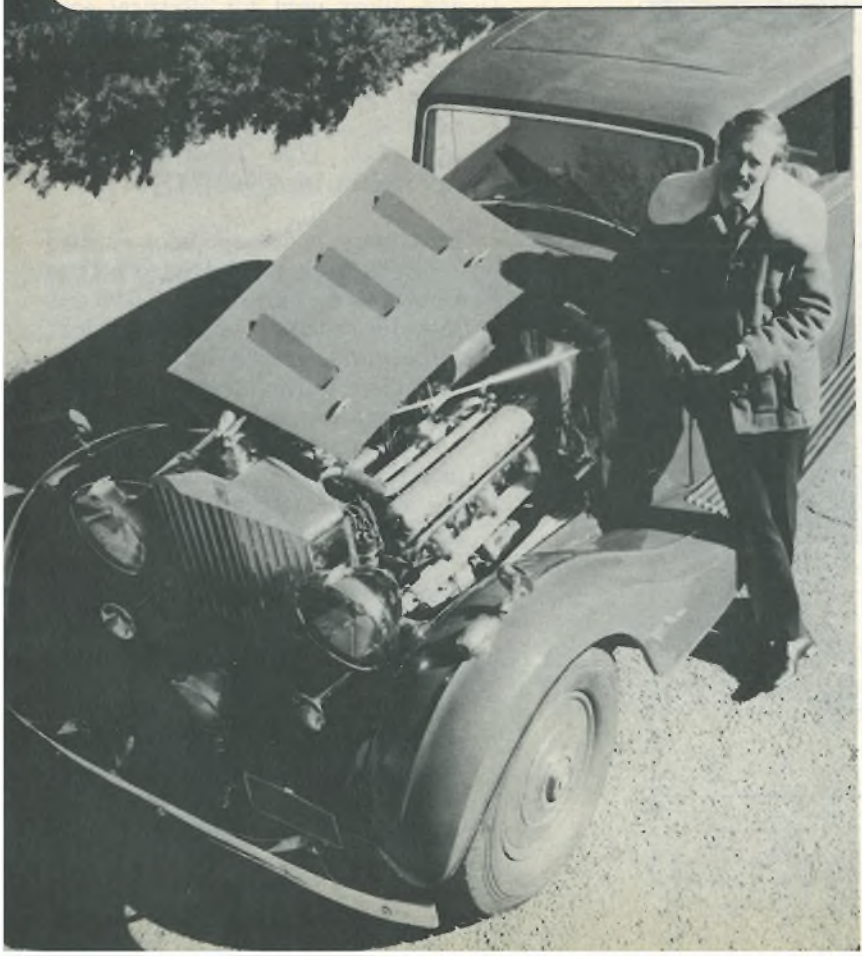

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Circle 183 on reader service card

New literature

SCRs. The specifications, ratings, and characteristics of silicon controlled rectifiers are discussed in a four-page application note put out by the Semiconductor division of International Rectifier Corp., 233 Kansas St., El Segundo, Calif. 90245. Material on forward and reverse characteristics, turn-on time, turn-on voltage drop, di/dt ratings, critical dv/dt, and turn-off time is included. Circle 421 on reader service card.

Digital switches. Digitran's 40-page general catalog includes, in addition to standard product data, such valuable reference information as digital switch theory, switching techniques, and a glossary of thumbwheel switch terms. A complete listing of current prices is bound into each catalog, which can be obtained from The Digitran Co., 855 South Arroyo Parkway, Pasadena, Calif. 91105 [422]

Electrical contacts. A four-page application note assesses the strengths and weaknesses of various metals and alloys used for electrical contacts. Entitled "Handbook on Electrical Contacts; Materials and Processes Make the Difference," the note is available from Deringer Mfg. Co., 1250 Town Line Rd., Mundelein, Ill. 60060 [423]

Data entry. A 68-page book entitled "How to Evaluate and Select a Data Entry System" is priced at $6.95 and may be ordered from Entrex Inc., Publications Dept., 168 Middlesex Turnpike, Burlington, Mass. 01803. Documented with tables, charts, and glossaries, the book guides the user through the processes of selecting equipment and implementing a data-entry system. [424]

High-voltage testing. Two booklets—"Basic Facts About High-Voltage Testing" and "Armature and Stator Testing Notebook"—published by Slaughter Co., discuss in detail the whys and hows of high-voltage and leakage testing. Slaughter Co., Moore and Hailey Streets, Ardmore, Okla. 73401 [425]

Fast Fourier transforms. The system parameters involved in defining a fast Fourier transform requirement, as well as Fourier methods, the basic Fourier transform, the discrete Fourier transform, and the fast Fourier transform, are covered in a 13-page pamphlet offered by Spectra Data Inc., Att: William Morgan, 18758 Bryant St., Northridge, Calif. 91324 [426]

Calculator programs. Two handbooks containing programs for use on the recently introduced HP-55 programable calculator [*Electronics*, Dec. 26, 1974, p. 109] sell for $10 each. "HP-55 Mathematics Programs" and "HP-55 Statistics Programs" contain general descriptions of the programs, formulas used in each program solution, numerical examples, user instructions, program listings, and register allocations. The books may be ordered from Inquiries Manager, Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304 [427]

Reference diodes. A six-panel pocket reference guide cross-indexes 270 popular temperature-compensated reference diodes by temperature coefficient, zener voltage, test current, and maximum dynamic resistance. Using the guide, engineers can quickly determine the appropriate 1N number for various devices with temperature coefficients from 0.01 to 0.0005%/°C. Also listed are static characteristics for 37 tunnel diodes and 10 backward tunnel diodes. Microsemiconductor Corp., 2830 So. Fairview St., Santa Ana, Calif. 92704 [428]

Brushless motors. An 18-page illustrated brochure describing applications and principles of electronic (brushless) dc motors using Hall-effect devices is available from Siemens Corp., Power Engineering Division, 186 Wood Avenue South, Iselin, N.J. 08830. The brochure serves as a primer for the design or applications engineer and includes sections on speed control and motor construction. [429]

New literature

Switch noise. An article called Tech Tips 2-4, available from the Semiconductor Division, Westinghouse Electric Corp., Youngwood, Pa. 15697, tells how to eliminate 120-cycle line noise and radio-frequency interference from power-controller circuits that use inexpensive bimetallic switches. [430]

Power semiconductors. A broad line of power Darlingtons, power transistors, rectifiers, zeners, and varactor diodes is described in a 28-page catalog published by TRW Semiconductors, 14520 Aviation Blvd., Lawndale, Calif. 90260. Designated Catalog No. 100, the publication includes complete electrical and operating specifications for devices that are designed for use in such applications as switching regulated power supplies, motor controls, electronic ignitions, instruments, and battery-operated equipment. [431]

English/metric converter. Particularly useful to engineers working with wire and cable, an English/metric converter in slide-rule form is being offered by Continental Wire and Cable Corp., Box 1863, York, Pa. The chart covers wire sizes from 0.5 square millimeter to 400 mm². [432]

Business abroad. A compact book called "A Basic Guide to Exporting" is available from the U. S. Department of Commerce, Domestic and International Business Administration, Washington, D.C. 20230. The 52-page, digest-sized book outlines the steps that take a businessman into the world marketplace and lists the wide range of assistance available from government and private sources. [433]

Relays and steppers. A 48-page catalog provides specifications, drawings and applications information on general-purpose relays and stepping relays available from Guardian Electric Manufacturing Co., 1550 West Carroll Ave., Chicago, Ill. 60607. The publication replaces all previous Guardian relay catalogs. [434]

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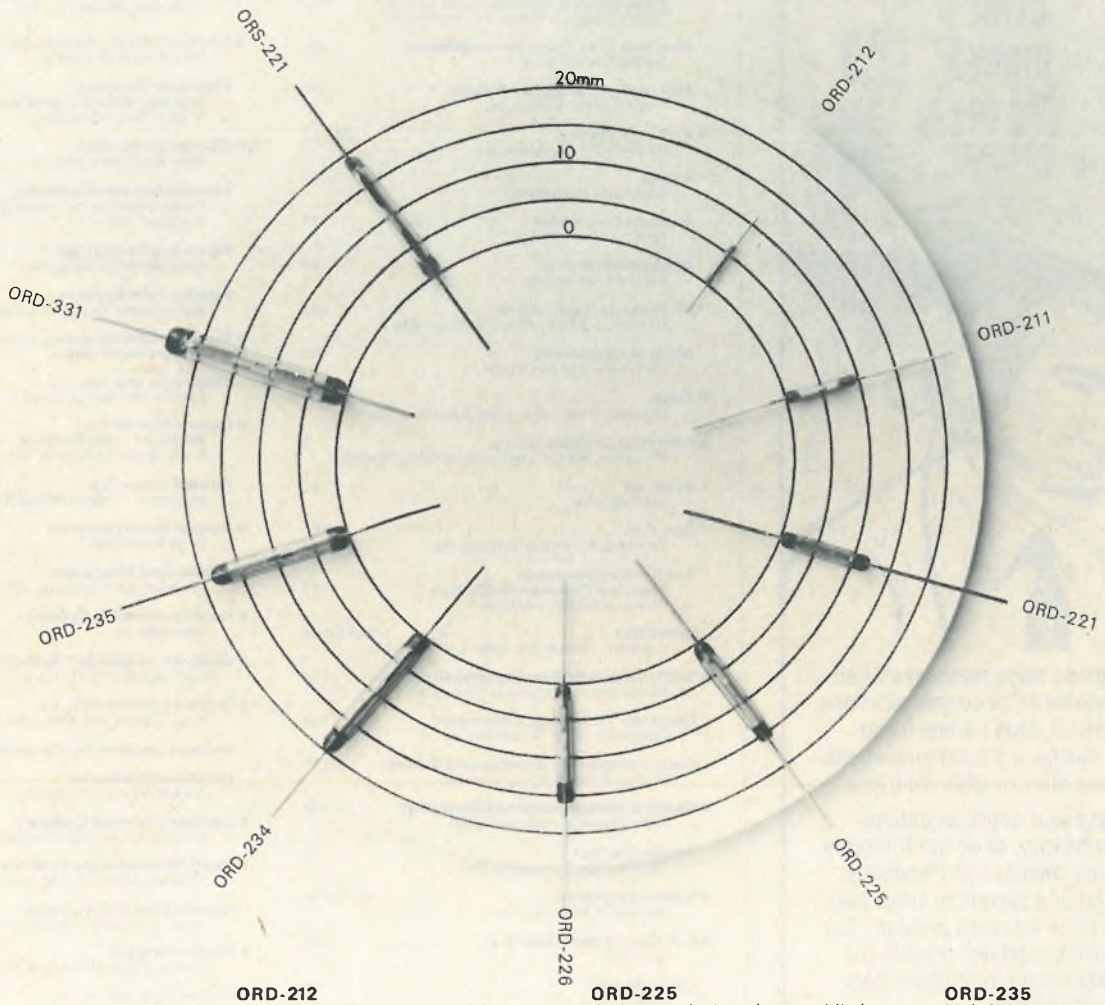

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ORD-234
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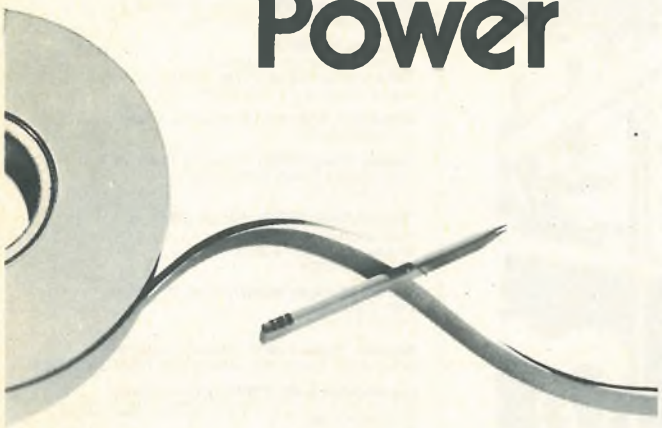
Compute Power



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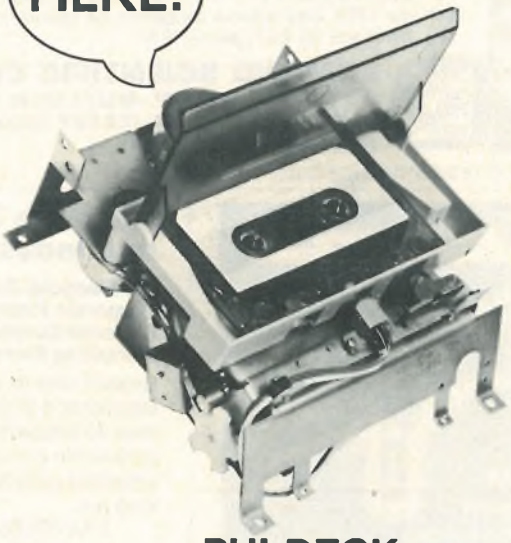

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The Phi-Deck is the first American-made tape transport with remote control capabilities and features including standard and nonstandard functions — selling for under $100 in quantities of one.

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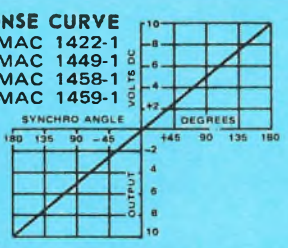
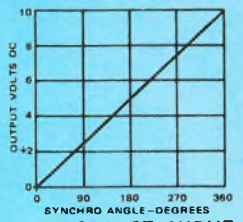
SOLID STATE 3 WIRE SYNCHRO TO LINEAR D.C. CONVERTER

RESPONSE CURVE
MAC 1422-1
MAC 1449-1
MAC 1458-1
MAC 1459-1





RESPONSE CURVE
MAC 1460-1
MAC 1461-1

FEATURES:

- Develops a DC output voltage linearly proportional to a synchro angle over a ± 180° range.
- Completely solid state with all of the inherent advantages over a mechanical system such as:
  - High reliability (since there are no moving parts)
  - Light weight–6 ozs.
  - Small size
  - All units hermetically sealed
- Wide temperature range operation
- Output short circuit protected
- Three wire inputs isolated from ground
- Package size may be altered at no extra cost
- Units can be altered to accept different line to line voltages or different operating frequencies at no extra cost
- Not affected by reference voltage or power supply variations.

UNIT	MAC 1422-1	MAC 1449-1	MAC 1458-1	MAC 1459-1	MAC 1460-1	MAC 1461-1
TRANSFER EQUATION	± IV/18°	± IV/18°	± IV/18°	± IV/18°	+IV/36°	+IV/36°
ACCURACY (+25°C)	½%	½%	½%	½%	½%	½%
ACCURACY (–25°C-+85°C)	1%	1%	1%	1%	1%	1%
L - L SYNCHRO INPUT (VRMS)	11.8	90	11.8	90	11.8	90
FREQUENCY (Hz)	400	400	60	60	400	400
FULL SCALE OUTPUT	± 10V	± 10V	± 10V	± 10V	+10V	+10V
OUTPUT IMPEDANCE	<1Ω	<1Ω	<1Ω	<1Ω	<1Ω	<1Ω
L - L INPUT IMPEDANCE	>10K	>30K	>2K	>10K	>10K	>30K
REFERENCE VOLTAGE (VRMS)	26	115	26	115	26	115
OPERATING TEMP. °C	–25 - +85	–25 - +85	–25 - +85	–25 - +85	–25 - +85	–25 - +85
D.C. SUPPLY	± 15V	± 15V	± 15V	± 15V	± 15V	± 15V
D.C. SUPPLY CURRENT	± 75MA	± 75MA	± 75MA	± 75MA	± 75MA	± 75MA
BANDWIDTH	10Hz	10Hz	OPT.	OPT.	10Hz	10Hz
WEIGHT	6 oz.	6 oz.	6 oz.	8 oz.	6 oz.	6 oz.
SIZE	3.6x2.5x0.6	3.6x2.5x0.6	3.6x3.0x0.6	3.6x3.0x1.0	3.6x2.5x0.6	3.6x2.5x0.6

A.C. LINE REGULATION

A new method has been developed which allows us to provide a low distortion highly regulated AC waveform without using tuned circuits or solid state active filters of any kind.

The result is a frequency independent AC output regulated to 0.1% for line and load with greater than 20% line variations over a wide temperature range.

FEATURES:

- 0.1% total line and load regulation
- Independent of ± 20% frequency fluctuation
- 1 watt output
- Extremely small size
- Isolation between input and output can be provided

Specifications: Model MLR 1476-1
AC Line Voltage: 26V ±20% @ 400Hz ± 20%
Output: 26V ± 1% for set point
Load: 0 to 40ma
Total Regulation: +0.1%
Distortion: 0.5% maximum rms
Temperature Range: –55° C to +125°C
Size: 2.0" x 1.8" x 0.5"

Other units are available at different power and voltage levels as well as wider temperature ranges. Information will be furnished upon request.

SOLID-STATE SINE-COSINE SYNCHRO CONVERTER - NON VARIANT

This new encapsulated circuit converts a 3 wire synchro input to a pair of dc outputs proportional to the sine and cosine of the synchro angle independent of a-c line fluctuations.

- Complete solid state construction
- Operates over a wide temperature range
- Independent of reference line fluctuations
- Conversion accuracy–6 minutes
- Reference and synchro inputs isolated from ground

Specifications Model DMD 1508-2
Accuracy: Overall conversion accuracy 6 minutes. Absolute value of sine and cosine outputs accurate to ± 30MV
Temperature Range: Operating –40°C to +85°C, Storage –55°C to +125°C
Synchro Input: 90V RMS ± 5%LL 400Hz ± 5%
DC Power: ± 15V DC ± 10% @ 50MA
Reference: 115VRMS ± 5% 400Hz ± 5%
Output: 10V DC full scale output on either channel @ 5ma load
Temperature coefficient of accuracy: ± 15 seconds/°C avg. on conversion accuracy ± 1 MV/ °C on absolute output voltages
Size: 2.0" x 1.5" x 2.5"
Units are available with wider temperature ranges and 11.8V LL, 26V reference synchro inputs. Information will be supplied upon request.

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