DECEMBER 22, 1977

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A first look at the 20th annual ISSCC/57

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Temperature Coefficient	500 PPM/°C	No Spec	No Spec	1000 PPM/°C
Contact Resistance Variation	1.0% max.	No Spec	No Spec	No Spec
Power Rating	.25 W at 70°C	.25 W at 55°C	.25 W at 55°C	.25 W at 40°C
Flammability	UL-94V-1	No Spec	No Spec	UL-94
Board Wash Capability	Yes	No Spec	No Spec	No Spec

*Source: CTS Series 201 Data Sheet, Mepco Data Sheet ME1004, Piher Data Sheet F-2002 Rev 7/73

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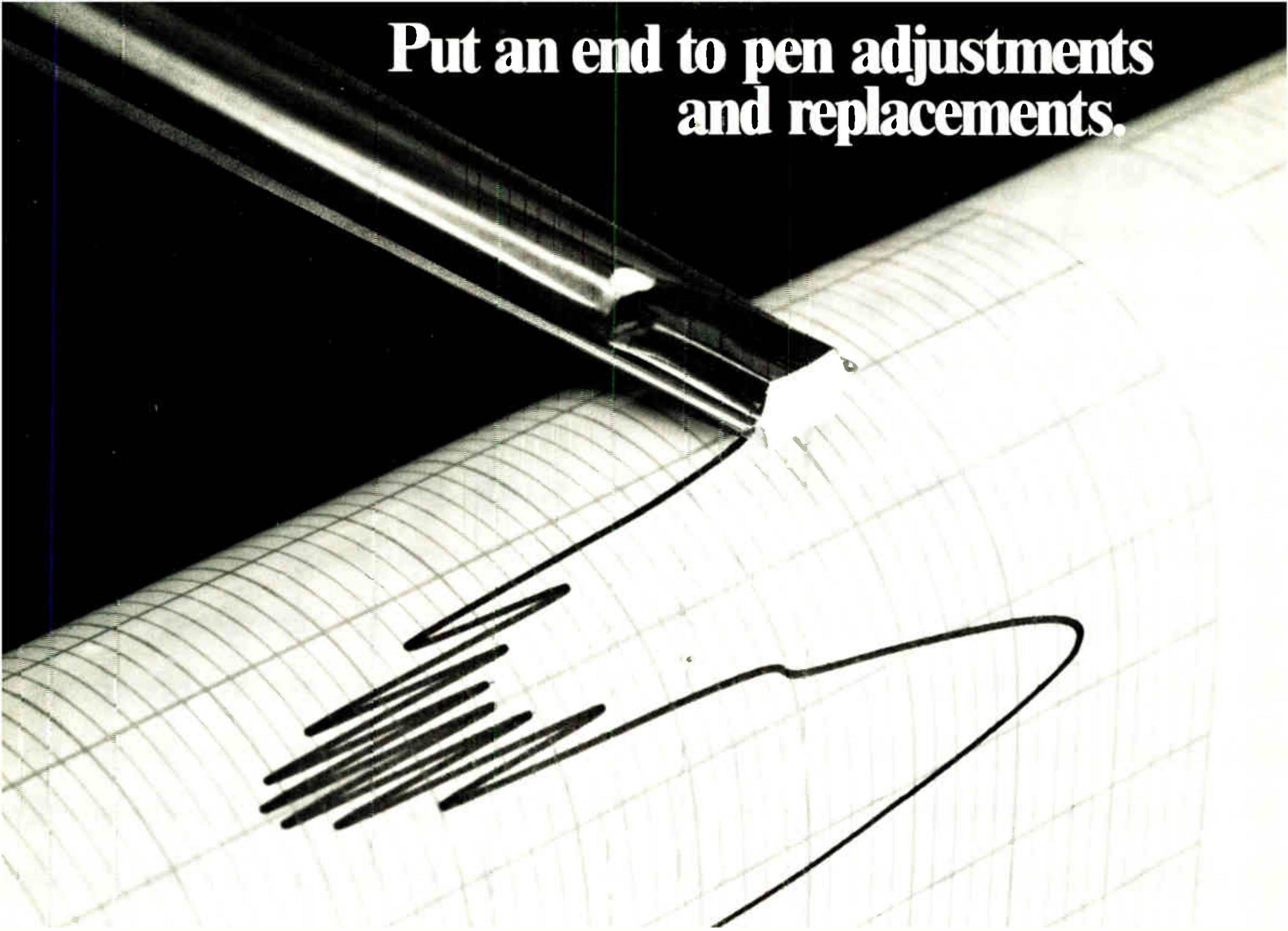

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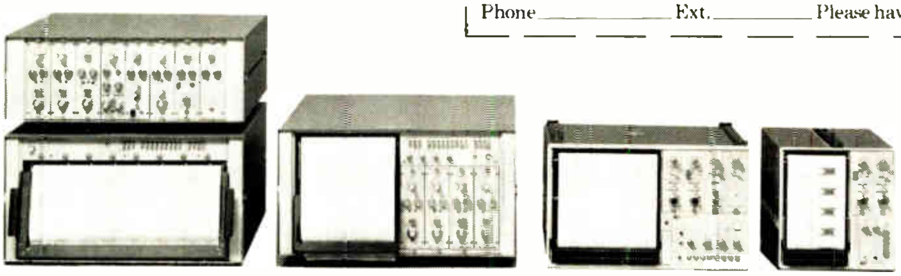

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Electronics
The International Magazine of Electronics Technology
Vol. 50, No. 26 • December 22, 1977

Highlights

Cover: Industry executives view the New Year, 81
While 1978 should be pretty much the same as 1977, top executives in electronics firms worldwide see some trouble spots. Heading the list in the U. S. are the increasing Japanese presence, the problems of capital formation, and the Carter Administration. Included in this survey is the outlook from Wall Street.

Cover photo by Joe Ruskin.

Action now, say semiconductor chiefs, 59
The time has come for the American semiconductor industry and the Government to counter the Japanese competition in U. S. markets, say leading industry chiefs. Speaking at the first annual Electronics Conference in Washington, D. C., they proposed a broad range of countermeasures.

Computers on boards boom, 65
To meet the growing demand for microcomputers on boards, many firms are turning out new products, in addition to the chip families covered in part 1 of this special report. This second and final part classifies and compares the boards.

Fast signals no problem for this scope, 73
Single-shot signals with 1-nanosecond rise times can be captured with the newest fast storage oscilloscopes. The key is a more rapid writing rate, achieved with a specially constructed cathode-ray tube.

And in the next issue . . .
The annual market survey and forecast for the U. S., Europe, and Japan . . . estimating the cost of testing integrated circuits . . . when to specify circuit breakers.

Readers' comments

Pay the price

To the Editor: Your unnamed "president of a high-technology company" [Editorial, Oct. 27, p. 24] by the omission of one word misstates his intent. Instead of saying, "the next big problem in electronics is not in technology but in human resources," he meant to say, "the next big problem in electronics is not in technology but in *cheap* human resources."

The least we can do is be honest. In "the classified pages bursting with recruitment ads," how many offer $25,000 a year to start with regular increases to $50,000 at the end of five years? As long as salaries are below these figures, it is patently obvious that there will be a shortage of available human resources.

Richard G. Devaney
Kingsport, Tenn.

Make theirs metal

To the Editor: The Nov. 10 issue of *Electronics* carried an item on our GPR 5000X general-purpose resistor [p. 134]. As the result of an error in a quote that appeared at the end of our original release, your headline and copy referred to the GPR as a carbon-film device and indicated pricing competitive with carbon-composition resistors.

The GPR 5000X is a metal-film resistor and is priced significantly below current market prices for metal-film resistors with a 2% tolerance. All of the remaining details concerning the product appeared correctly.

John E. Covey
Mepco/Electra Inc.
Morristown, N. J.

Not approved

To the Editor: The International Newsletter in the Nov. 10 issue [p. 53] leaves the impression that Intel Corp. has in some fashion approved the Cobol package developed by Micro Focus Ltd. There has been no approval given by Intel to Micro Focus for this package or for any other software product.

Mike Kane
Intel Corp.
Santa Clara, Calif.

News update

■ Conrac Corp.'s Systems-East division in West Caldwell, N. J., has won approval to continue development of the Stores Management Set for the F-18 strike fighter. Unlike earlier fighters requiring a hard-wired control system to activate and fire each type of missile, bomb, or other stores, the F-18 will have most of its weapons controlled by a single microprocessor-based system that accommodates changes primarily by means of software [*Electronics*, Dec. 23, 1976 p. 36].

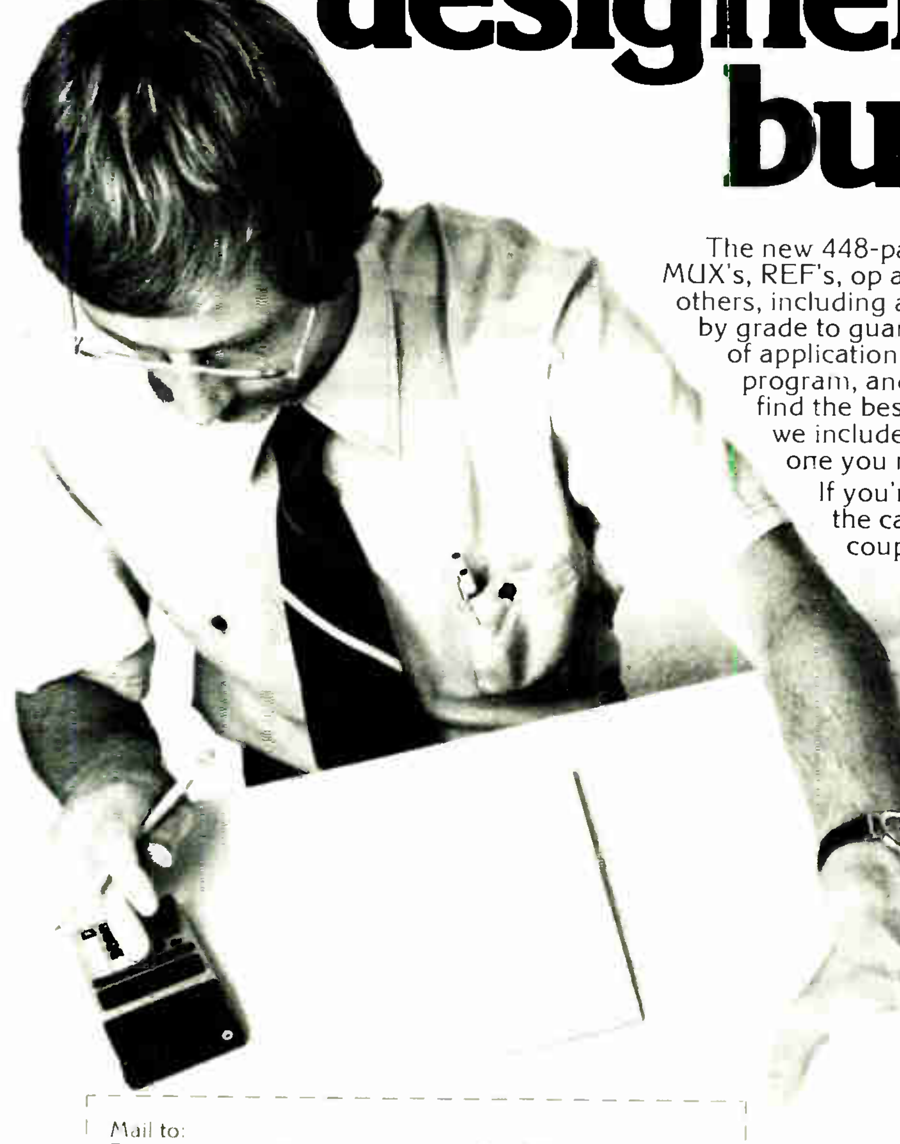
Conrac is now building a development model of the system, with which "all functions of the SMS will be demonstrated," says Louis A. Ciasulli, the division's F-18 programs director. Meanwhile, all items for the full-scale development models of the SMS, scheduled for delivery in June, have been breadboarded and tested, with actual hardware assembly slated to begin in January. "Except for one custom hybrid circuit, for the digital control function of the armaments bus controller," Ciasulli notes, "we have managed to build the SMS with off-the-shelf hybrids and discretes."

■ Using a unique method for aligning optical fibers, Hughes Aircraft Co. has developed a connector with less than a 1-decibel insertion loss across the separable interface. The work was done at the Connecting Devices division in Irvine, Calif., and is a significant step toward satisfying the low-loss connector requirements of military agencies [*Electronics*, Aug. 5, 1976, p. 81].

Axial and angular alignment are controlled by a precision bushing precisely aligned in a split sleeve, and the interface gap between two fiber ends is controlled with a 1-mil-wide metal spacer. The new connector is now available in limited quantities for evaluation. Engineering prototypes with insertion loss values of 0.5 to 1.2 dB have been tested. Moreover, notes James E. Wittmann, Hughes' product manager, "coupling loss for the system was not degraded, even after repeated mating of connectors."

Bruce LeBoss

The catalog designers can't buy.*



The new 448-page PMI catalog is packed with parts—MUX's, REF's, op amps, comparators, DAC's, and plenty of others, including a big section on chips that you can order by grade to guaranteed specs. It also provides 91 pages of application notes, an explanation of PMI's QA program, and selection guides that make it easy to find the best device for your application. For example, we include a guide for op amps that lets you find the one you need **by function.**

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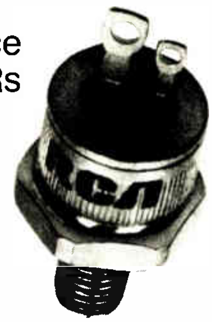

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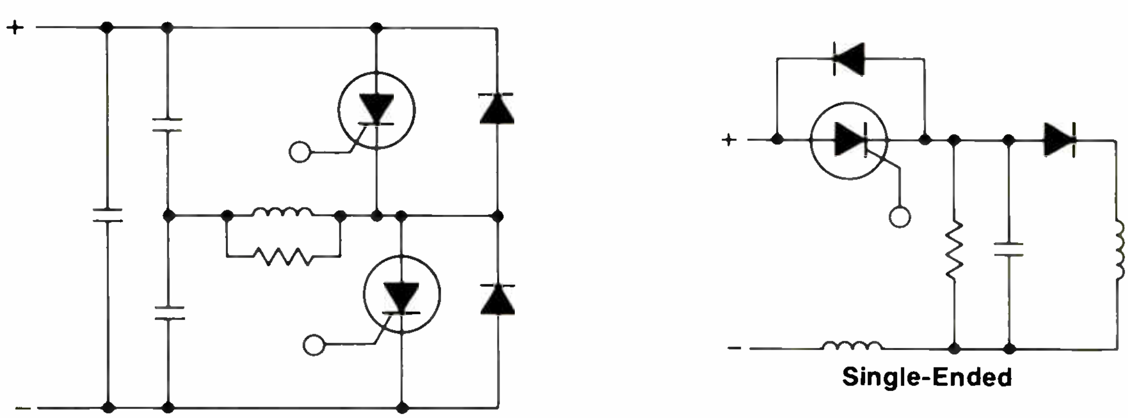

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S5800	100-600	15	25	Fast switching SCR	TO-220
C106	15-600	4.0	0.200	4-amp gen. purp. SCR	TO-202
T2320	50-400	2.5	3-40	Sensitive-gate triac	TO-202
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Circle 11 on reader service card

Editorial

IEEE's poll: a mandate at last

In the five years since the Institute of Electrical and Electronics Engineers started trying to set up a professional activities program, a constant complaint from critics has been that neither its goals nor the projects aimed at reaching those goals represent the desires of the members. Now, with the carefully prepared and circulated survey of members being analyzed this month, the institute has such a guide.

The points on which the members agree are clear enough. For one, members favor the public stands on national issues such as energy and R&D spending that the IEEE has taken in the past. A heavy majority is willing to be polled again to express their views as guidance on future positions.

For another, most members want the institute to get behind programs, such as registration, that will upgrade the status of engineers. Also, they want the IEEE to set up a legal fund to aid engineers involved in cases dealing with ethical conduct. And the majority favors various actions to curtail age discrimination as well as enhance the professional standing of engineers past 40.

Altogether, the U. S. Activities Board survey looks to have come back as an endorsement of professional activities, even though most of the members stated that they actually joined the IEEE for the technical publications. Now the question is, what will become of the results of the survey?

With a change in the leadership due next month, the fate of this survey is at present in limbo. The first step, therefore, is to get the results of the survey into general circulation—a step the institute has already taken. The more that people concerned with U. S. professional activities know about the findings, the more surely will the survey be remembered in the coming year.

The next step would be to convert the research data into a plan of action. Here is where the going will get tricky, for some of the moves approved by the survey respondents would certainly jar the corporate interests represented in IEEE. For instance, publicizing the names of companies that have consistently ignored the standards recommended by IEEE in employing engineers might arouse the resistance of members who are also company executives.

It is therefore, important for the activists to remember that the IEEE is not going to move overnight to implement the wishes indicated in the survey. By the same token, it is important for the "reluctants" in the organization to realize that the survey will not be forgotten. For it is clearly the case that any IEEE office holder who claims to serve the wishes of the working members simply must view the survey as a mandate for professional activities.

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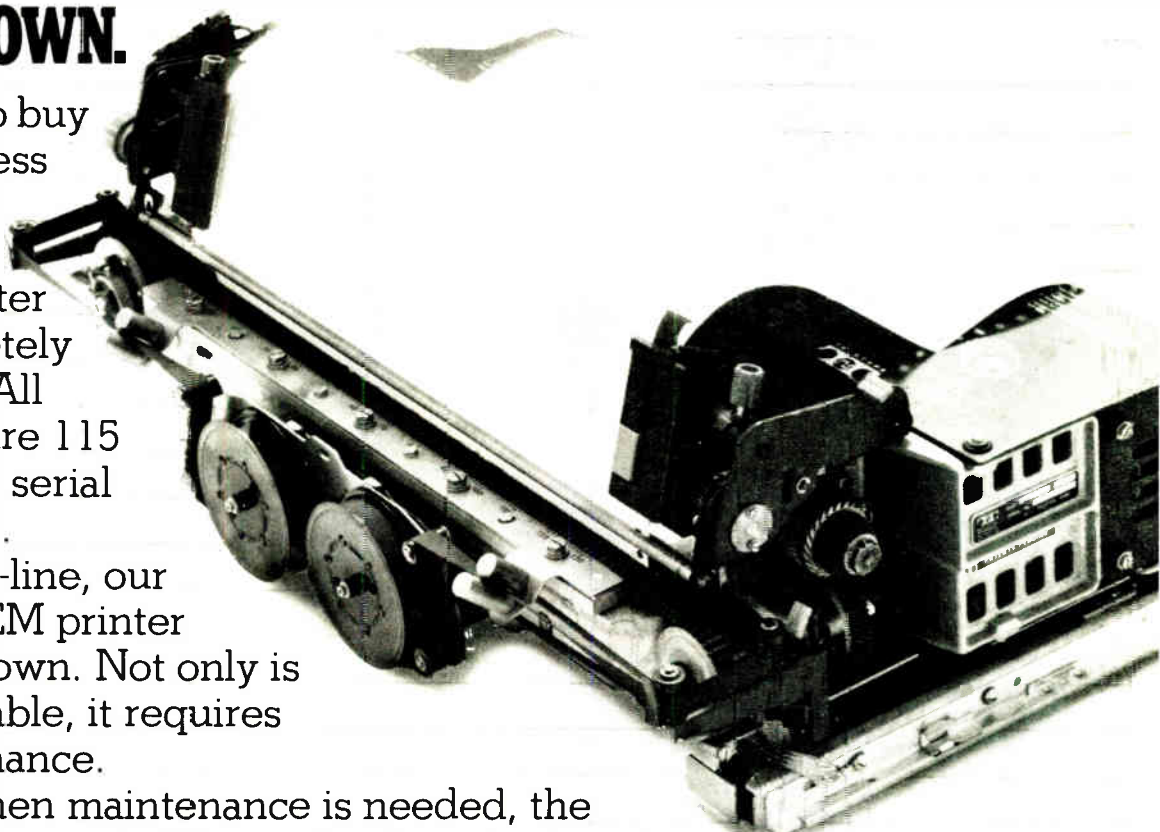

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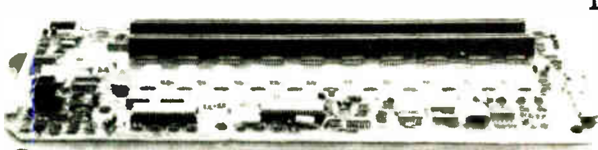

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People

Programmers fall short, says Shebanow of Shugart

When it comes to floppy-disk storage, "most software designers greatly underestimate the amount of memory they will need," asserts Michael Shebanow, recently named to the newly created post of vice president of engineering at Shugart Associates Inc., a major manufacturer of floppy disk drives. What's more, the "programmers just aren't writing efficient programs," says the 50-year-old engineer.

Floppy man. A big factor is inefficient programs, according to Michael Shebanow.

The result is that the customers for this relatively cheap mass store for microcomputer systems seem always to be asking for drives with ever-increasing data-storage capacity, he says. "That's why the single-sided floppy lost its steam after only about a year on the market—our customers demanded double-sided drives."

Big shipments. Not that Shebanow should mind the programmers' inefficiencies. Shugart is shipping more than 10,000 standard 8½-inch-diameter disk drive systems each month and more than 3,000 per month of the 5¼-in. minifloppy, which also came out in a double-sided version [*Electronics*, November 24, p. 41]. However, he makes some points worth noting. For one, users had better get used to the present floppy capacities, he says, indicating that Shugart is not likely to increase them soon. Rather than quickly asking for more capacity, they should first settle down and get to know the product.

For another, programmers should learn to optimize their software. "They tend to use as much storage as they have available," he asserts, citing the minifloppy. "Typically, when the software designer completed his operating system program, he had used 32 of the mini's 35 tracks, leaving only three tracks for data storage. So he figured he needed twice the capacity he had expected to use."

Shebanow, formerly a vice president at Pertec Computer Corp., has a background in the design of both rigid and floppy disk drives and other peripherals. He partly blames management for poor programming. "They just want programmers to get the job done—nothing clever or exciting," he says. And that, he concludes, may turn out not to be good enough.

Data Translation's Severino takes digital view of I/O

The complete engineer—logic, subsystem, and system designer, with a sprinkling of entrepreneur—that is an accurate description of Paul Severino, the prolific 31-year-old designer of analog input/output subsystems for microcomputers at Data Translation Inc. He has just been named vice president for engineering at the privately held, Natick, Mass., company, which probably has the industry's broadest line of analog I/O boards for one-board computers.

Exception. Severino does not consider himself just a designer, although he has considerable design experience stemming from stints at Digital Equipment Corp. and Prime Computer Inc. "I think we need more engineering people to get interested in entrepreneurial things," he says, having done just that himself. He owns part of Data Translation, along with Fred Molinari, the president. Most recently, he was Data Translation's director of engineering for computer products, which means that his new job is not going to

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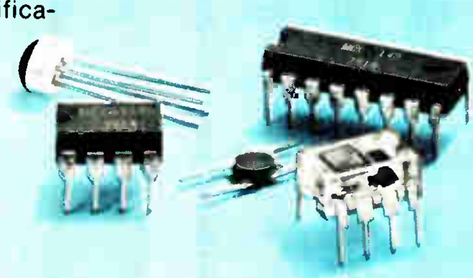

MICRO COMPONENTS CORPORATION

I/O man. A small company has less inertia to overcome, which Paul Severino likes.

change his scope all that much. But Severino is a noteworthy exception among analog I/O designers. He gained his experience at minicomputer houses, not, as is often the case, at companies primarily involved with analog products.

At DEC, Severino designed the first complete analog-to-digital subsystem for the PDP-11/20 minicomputer. "Then I was hired by Prime, along with one other engineer, to handle the design of all their data-acquisition peripherals. That was good experience, because I also participated in CPU [central processing unit] designs. I understand computer I/O structures because I designed them, and I look at data acquisition from the standpoint of the minicomputer environment, rather than from the standpoint of an analog circuit designer."

Severino's background is helping him at Data Translation by affording him a solid understanding of microcomputer architecture, which he can translate into analog I/O interface subsystem products his company can quickly make available. "We're a small company," Severino says. "We don't have a lot of inertia to overcome to get a new product out," which appeals to him. And what should also appeal is the consideration Molinari is giving to moving the four-year-old company from its base in I/O boards into full microcomputer systems. Severino's broad experience should come in more than handy then.

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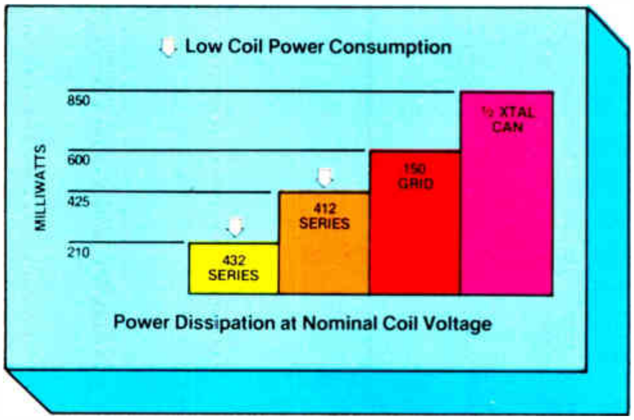

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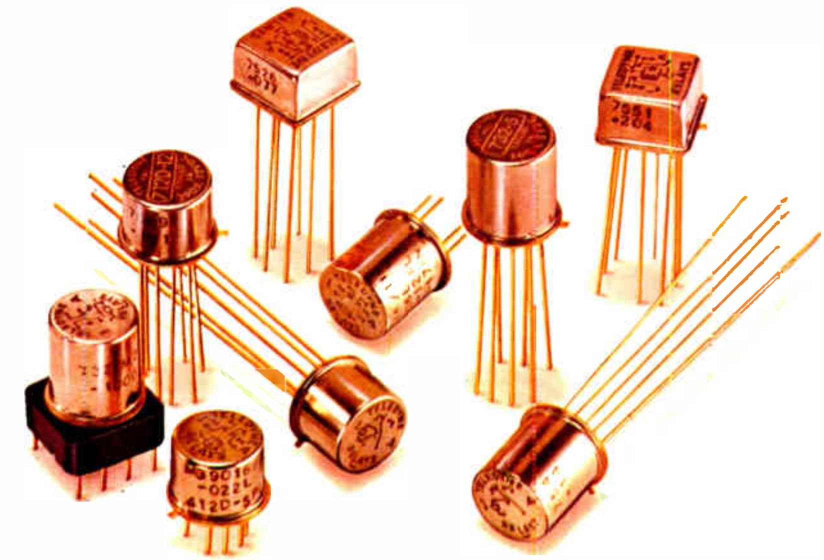

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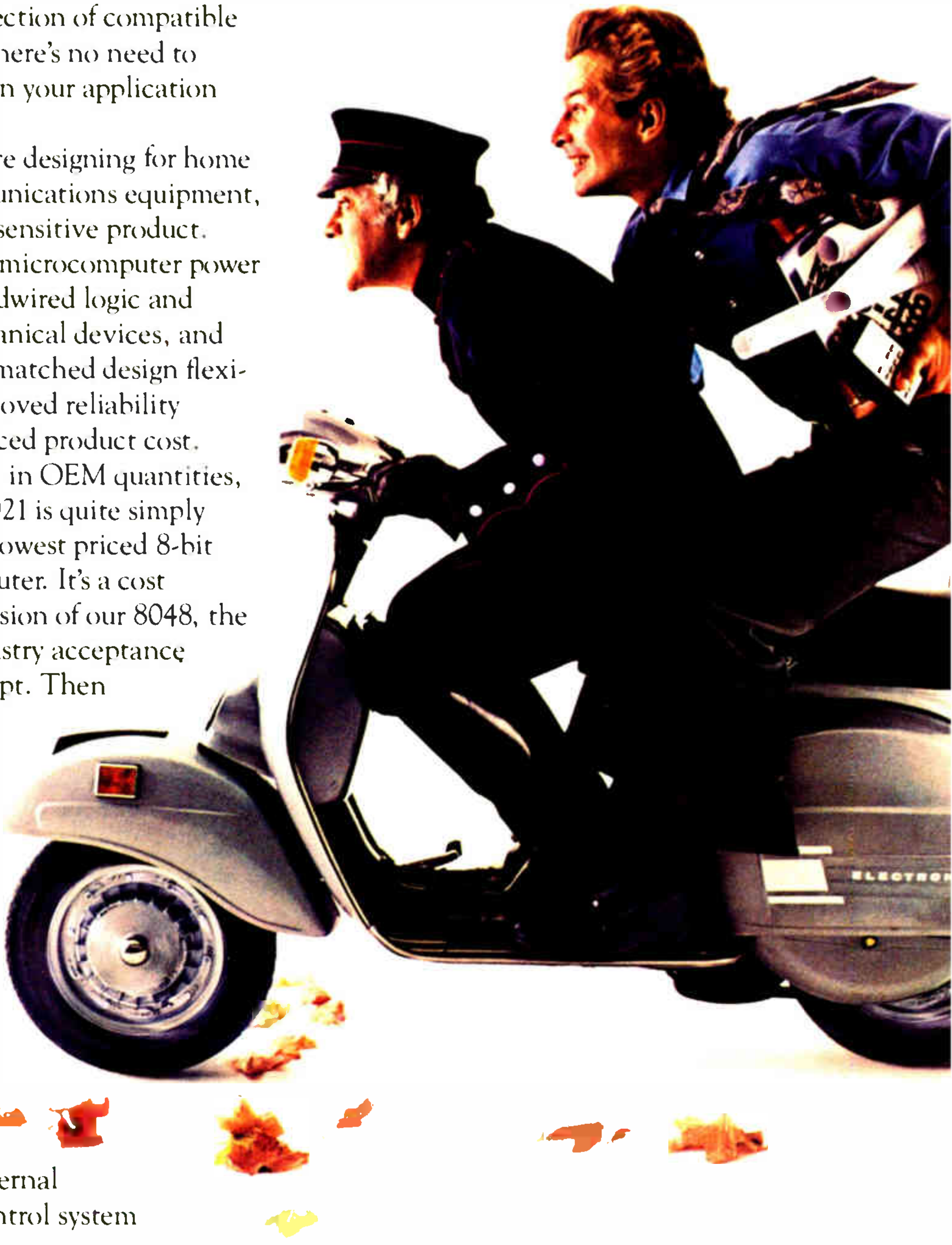

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8748*	1K Bytes EPROM	64 Bytes	27	96	40 Pin
8035*	(External)	64 Bytes	27	96	40 Pin
8049*	2K Bytes ROM	128 Bytes	27	96	40 Pin
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Meetings

Conference on Integrated and Guided Wave Optics, IEEE, Salt Lake Hilton, Salt Lake City, Utah, Jan. 16 – 18.

Reliability and Maintainability Conference, IEEE, Biltmore Hotel, Los Angeles, Jan. 24 – 26.

Internepcon/Japan and International Microelectronics Exhibition, Industrial and Scientific Conference Management Inc. (Chicago), Harumi Exhibition Center, Tokyo, Jan. 25 – 28.

Power Engineering Society Winter Meeting, IEEE, Statler Hilton Hotel, New York, Jan. 29 – Feb. 3.

Automated Testing for Electronics Manufacturing Seminar and Exhibit, Circuits Manufacturing Magazine (Boston), Los Angeles Airport Marriott Hotel, Los Angeles, Jan. 30 – Feb. 1.

CLEOS—**Conference on Laser and Electro-Optical Systems,** IEEE and OSA, Town and Country Hotel, San Diego, Feb. 7 – 9.

Wincon—Aerospace and Electronic Systems Winter Convention, IEEE, Los Angeles, Feb. 13 – 15.

International Solid State Circuits Conference, IEEE, San Francisco Hilton, San Francisco, Feb. 15 – 17.

Computer Science Conference, ACM, Detroit Plaza Hotel, Detroit, Feb. 21 – 23.

Fifth Energy Technology Conference and Exposition, U. S. Energy Research and Development Administration, Sheraton Park Hotel, Washington, D. C., Feb. 27 – March 1.

Nepcon West and Semiconductor Hybrid Microelectronic Symposium and Exhibits, Industrial and Scientific Conference Management Inc. (Chicago), Anaheim Conference Center, Anaheim, Calif., Feb. 28 – March 2.

Compcon Spring, IEEE, Jack Tar Hotel, San Francisco, Feb. 28 – March 2.

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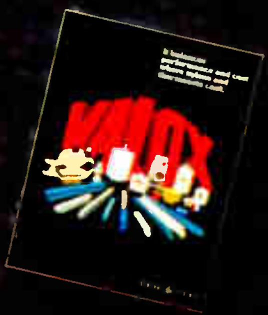

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Japanese describe 1-micrometer VLSI technique

A paper delivered at the International Electron Devices Meeting in Washington earlier this month could have long-term implications for very-large-scale integration. In it, researchers from Japan's cooperative VLSI laboratory described how to fabricate two closely spaced photoresist walls to protect the intervening region from stray ions during MOS implantation procedures. **As a result, only one photomask or one electron-beam exposure, instead of three, is needed** to build the source, drain, gate, and electrodes of very small MOS transistors.

Says Yasuo Tarui, head of the VLSI lab: "I believe this technique is one of the most important to come out of our lab so far. Combined with short-channel silicon-gate or diffused self-aligned [D-MOS] techniques, it should make it possible to build 1- to 2-micrometer VLSI in the future."

British GE out to buy U. S. companies

Watch for Britain's General Electric Co. to join the rush of European companies out to buy a slice of American technology by company acquisition. The $3.5 billion group, which has no connection with the American GE, has signed Geoffrey Cross, former managing director of International Computers Ltd., to lead the search. Cross, who joined ICL from Univac five years ago, transformed the then flagging computer company into a $720 million success story. **He has a shopping list of companies and more than $1 billion in GEC cash reserves** to draw upon. While at ICL, Cross was known to be interested in purchasing a minicomputer manufacturer; such a deal would mesh well with GEC's activities.

One-chip versions of floppy-disk formatter due

Get ready for the scramble by semiconductor manufacturers like Intel Corp. and Nippon Electric Co. to bring out a one-chip floppy-disk formatter for double-density encoding **now that IBM has released the details of its *de facto* standard.** Concurrent with first shipments of its System/34, which includes double-sided, double-density floppy-disk drives, were mailings of reference literature disclosing that IBM has settled on modified-frequency-modulation encoding for its format.

Microwave chip capacitor family coming from Vitramon

Vitramon Inc. is about to start pilot production on its first family of microwave ceramic chip capacitors for communications. The Monroe, Conn., firm is now supplying samples of engineering prototypes of the high-stability, low-loss chip capacitors **and will have initial production units available early next year,** with limited production quantities (100,000s) available by the end of the first quarter. The first devices are to be aimed at frequencies up to 1 gigahertz.

Schlumberger buying Membrain, British ATE maker

Schlumberger Ltd. of New York is expanding its already multinational measurement and control operations with yet another foreign addition—Membrain Ltd. of Wimborne, England, a $6 million producer of automatic test equipment systems. Being purchased for an undisclosed amount of cash, Membrain will continue under its present management headed by its founder and managing director, C. Anthony Davies. **The British company is planning a 1978 thrust into the U. S. market for printed-circuit-board testers** with its new MB 7700 family of systems [*Electronics*, Oct. 27, International Newsletter].

Cordless phone called key to specialty market

Although the market for traditional interconnect devices like answering machines and decorator telephones won't explode overnight, International Resource Development Inc., a Connecticut research and consulting firm, predicts that the market will grow to more than $300 million over the next decade from its present level of $50 million. But according to Stephen Caswell, IRD's director of development, the key to market growth for retailers is the cordless telephone, which now sells for more than $400. Caswell thinks **companies will mass-produce a base station that just plugs into a telephone jack** and sell it with three extension phones for $150.

ISSCC to honor Kilby and Noyce

Besides a program featuring the latest LSI digital and linear device designs (see p. 57), February's 25th Anniversary International Solid State Circuits Conference will offer two new events. **The first IEEE Cledo Brunetti award for outstanding contributions in the field of microcircuitry** will be presented jointly to Jack Kilby, formerly of Texas Instruments Inc., for his early work in ICs and to Robert Noyce, chairman of Intel Corp., for his early work in large-scale integration. Also, the first Beatrice Winner Award will be given to the engineer who writes the best paper.

Trotter leaves AMI to return to campus

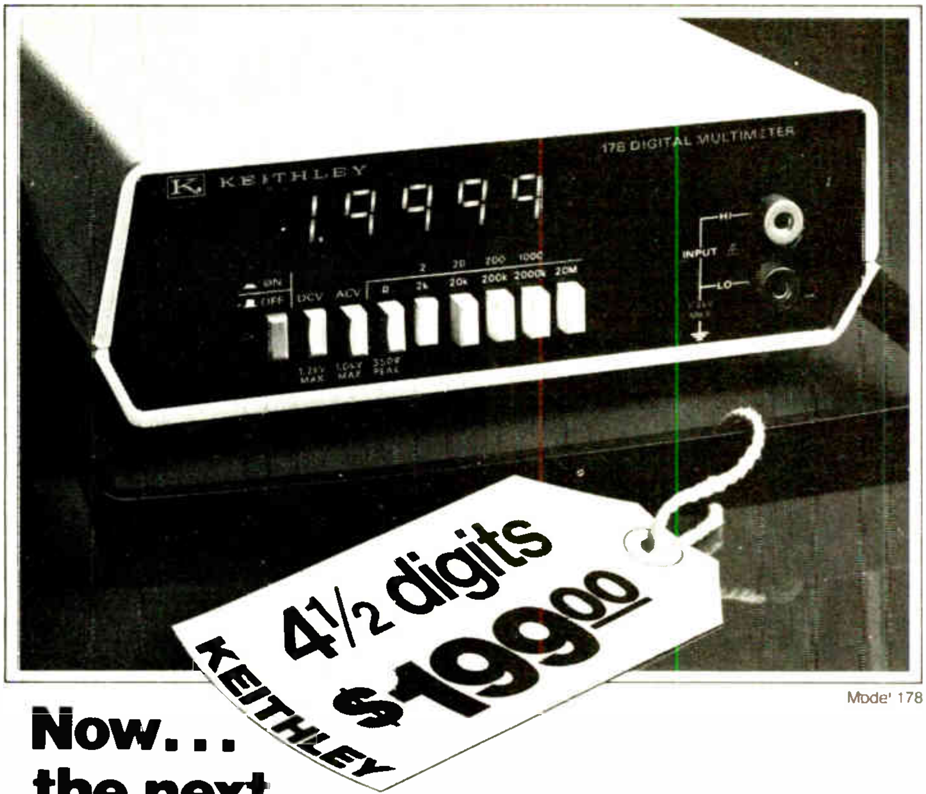
The semiconductor industry is losing one of its premier managers of research and development. Donald Trotter, vice president and director of R&D at American Microsystems Inc. for almost seven years, is going back to his old school, Mississippi State University, in Starkville, Miss. Besides teaching in the electrical engineering department, Trotter will concentrate on **attracting funded projects to a new solid-state lab there.**

Watch crystal and module work still in red at Motorola

Although Motorola Inc. says it is making progress in manufacturing its new low-cost, high-performance watch crystals and that there's much interest in its new advanced watch modules, both operations are still in the red. That is why **the demise of the unprofitable operations is predicted by at least one Wall Street analyst.** Motorola "will abandon the watch crystal business before long," says Sal F. Accardo, vice president and electronics analyst at Kidder, Peabody and Co. in New York. What's more, he continues, "the company will abandon the watch module business during the second half of 1978 because Timex, Motorola's largest customer, intends to build most of its own modules." The watch crystal operation in Franklin Park, Ill., and the watch module unit in Phoenix "are being watched closely," says a Motorola spokesman in Chicago. But, he adds, there has been "no decision" on abandoning the businesses.

Addenda

Another major manufacturer has joined the rush of Japanese TV set makers to establish a plant in the U.S. The latest, Tokyo Shibaura Electric Co. (Toshiba), will open a factory in the suburbs of Nashville, Tenn., next summer to be operated by a wholly owned subsidiary. It will be able to turn out 200,000 sets a year. The move leaves only Sharp Corp. and Victor Co. of Japan as the major Japanese set makers without U.S. plants. . . . American National Standards Institute has settled on a 35-track format for the minifloppy disk, rather than the 40-track type favored in Europe. . . . TI's Digital Systems division is introducing its model ATS-961 automated test system. It will sell for less than $50,000.



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Analyzer to rely on light waves to detect rf signals

Air Force seeking thin-film optical spectrum analyzer for dense environment of electronic warfare

Instead of translating down in frequency at the front end, a new spectrum analyzer that the Air Force wants will go up to optical frequencies, modulating a laser beam to detect broadband rf signals. The service, which will ask for bids early next year, wants the analyzer to help with the critical detection problem faced by electronic-warfare systems operating in extremely dense electromagnetic environments.

"An advanced fighter must, for example, be able to pick up signals from enemy radar in an environment of, literally, megapulses per second," explains physicist Michael C. Hamilton. He has been coordinating the analyzer project for the electro-optical techniques and applications section within the Avionics Laboratory at Wright-Patterson Air Force Base, near Dayton, Ohio.

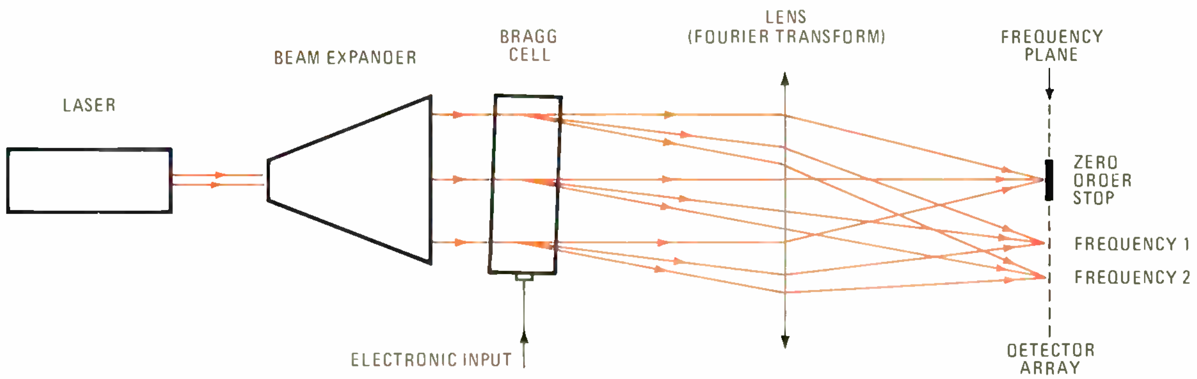
Apparently, conventional crystal video or superheterodyne radio-frequency receivers that operate by scanning over the frequency bands where enemy emissions are likely to be found are being pushed to the limits of their capabilities. Hence, the search for a solution that does not rely on the time-consuming scanning process and that offers broader bandwidths.

In the Air Force's proposed system, the rf signals to be analyzed are converted to optical equivalents by using them to modulate a laser beam in an acousto-optic Bragg cell, as shown in the drawing. The modulated beam is then focused through a lens and transformed so that individual frequency components appear at a particular point in

Basic acousto-optic spectrum analyzer

The operation of the Air Force's thin-film spectrum analyzer is made possible by a Bragg cell, an acousto-optic diffraction device often used to modulate a laser beam. The cell is generally fabricated of a crystalline material like lithium niobate, with a piezoelectric transducer bonded to one end and tuned to a specific bandwidth. Basically, the cell takes an electronic signal and converts it to a sound wave that interacts with the light wave. The modulated light beam that results is an optical analog of the radio-frequency input. Deflection angle and amplitude of the light beam depend, respectively, on the frequency and amplitude of the rf input.

Next, the light beam is passed through a transformer lens that focuses it onto a linear array of photodetectors. Which detectors receive signals depends on the rf signals that have been received and impressed on the Bragg cell. The detector signals, together with data on their amplitudes, would then go to a central processor located elsewhere in the aircraft's avionics system.



space. This is done in a spatial Fourier transformation that makes it possible to detect each frequency component of the incoming signals, as well as its amplitude, with an array of photodetectors placed in the focal plane of the lens. From this data a computer could determine what type of emitters were being aimed at the aircraft and, consequently, when danger threatened.

Very small system. But the Air Force is not just trying to solve its spectrum analysis problem with an optical system. It wants an exceptionally small one. Ideally, it would like a system contained, as are monolithic integrated circuits, in a single piece of material, such as silicon or gallium arsenide. But no one material can yet be fashioned into the light source, waveguides, lenses, and detectors that the system needs. Consequently, the analyzer will be made by butting together on a substrate individual thin-film components, each performing a different function.

While such components have been built by several research groups around the country, "this is the first ambitious integrated optical circuitry project, and we really believe it can be done," says Kenneth Hutchison, group leader of Hamilton's section. Each of the components making up the system has been proven as an individual element. "Getting them into optical alignment on a substrate is the challenge," Hamilton adds. They expect a contractor to be selected some time next spring for a June start, with the project scheduled to be finished by late 1980.

Materials choice. Moreover, just what materials will be used for what component will be left to the contractor. Gallium arsenide could, for example, be used for an injection laser, but not for a Bragg cell. For the latter, it is what Hamilton calls "a toss-up" between silicon and lithium niobate. Silicon's advantages are its good thermal properties and relatively low cost (and the fact that it could also be made into a laser); however, it falls far short of lithium niobate's acoustical properties. Whichever is chosen, the plan is to use it for the substrate also.

Hamilton hopes to obtain a system that measures 5 centimeters long and 1 cm high and operates with 10 to 100 milliwatts of rf input. "The laser will look like a grain of sand on the analyzer surface, and the 1-micrometer-thick thin-film lens will appear slightly concave," he says.

Present thinking is to tune each analyzer to a 400-megahertz bandwidth with a resolution of 4 MHz. Such a unit needs 100 detectors, one for each frequency element. "By stacking analyzers together, a much greater bandwidth could be monitored," Hamilton explains. He is hoping eventually for a cost of between $1,000 and $2,000 per unit. By contrast, all-electronic systems cost tens of thousands of dollars. Further along, improvements could result in single analyzers that cover bandwidths of up to 1 gigahertz, with frequency resolution down to 1 MHz, Hamilton says. □

Memories

V-MOS approach aimed at 65-k RAMs

Even as memory-chip makers struggle for volume production in 16,384-bit dynamic random-access devices, strong programs in 65,536-bit RAMs—the next density level—show indications of paying off. Samples of the big new 65-k parts could be available by the end of next year, in line with the industry's "rule" that memory densities double each year—the 16-k RAMs reached sample production in 1976.

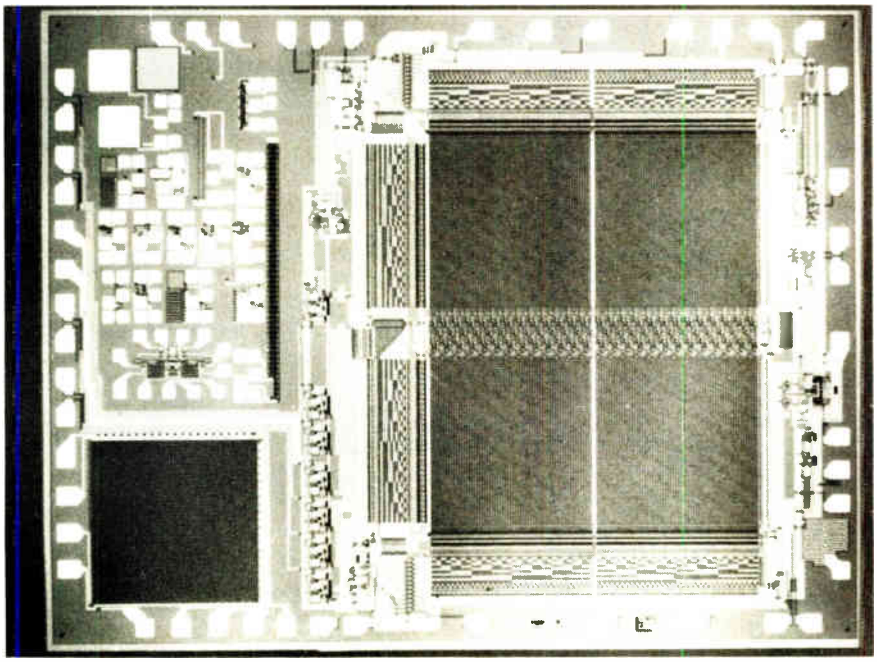
But who will build the 65-k devices and with what technology? Today's 16-k suppliers (Mostek, Intel, Fujitsu, Nippon Electric, Texas Instruments) are interested in extending their planar silicon-gate technology with some process and design-rule modifications. But a relatively new approach, using a buried-source, V-groove metal-oxide-semiconductor process, could result in the first marketable devices, judging from recent disclosures by American Microsystems Inc. of Santa Clara, Calif., and Siemens AG of Munich, West Germany. In papers delivered earlier this month at the International Electron Devices Meeting in Washington, D. C., both companies made public advanced designs of V-MOS dynamic memories.

In V-MOS, the transistors are built in a V-shaped groove and isotropically etched into the silicon. The resulting three-dimensional structure can be made very small, without relying on advanced and harder-to-build scaled-down geometries.

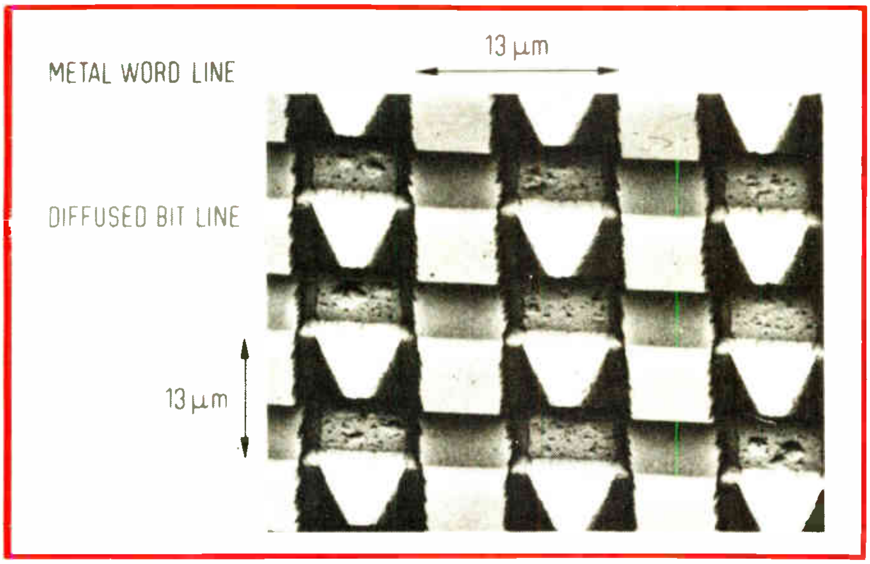
Definite feasibility. Fred Jenne, who heads American Microsystems' V-MOS RAM project, says: "We have definitely shown the feasibility of building 65-k dynamic RAMs with V-MOS technology. We have built 16-k feasibility chips with cell sizes under 170 square micrometers, using very relaxed 5-μm rules. This is more than enough margin to reach the 65-k level."

Indeed, Jenne is already looking ahead to the pinouts on the 65-k device. If the parts are to remain in the 16-pin multiplexed configuration of today's 16-ks, then a pin must be found to address the additional blocks of bits. "Our objective is to free a power-supply pin by eliminating one of the three supply voltages needed on 16-k devices," says Jenne. "We're shooting for a single +5-volt supply voltage, with a −2-V substrate bias supply" to reduce the effects of increased substrate doping. The die would have to fit the long and narrow 16-pin package, dictating a very narrow chip that could be subject to breakage in handling.

The 16-k V-MOS chip is AMI's second test vehicle. The first was used to test the application of the buried-source V-MOS configuration to dynamic RAMS [*Electronics*, August 18, p. 100]. AMI has already applied its V-MOS structure to commercial 65-kilobit read-only memories and 1,024- and 4,096-bit static RAMs. By successfully building V-MOS dynamic RAMs, AMI will prove that the process is a main-line memory technology and not simply a



Demonstrator. American Microsystems' 16-kilobit V-MOS test chip demonstrates the feasibility of applying the V-groove technique to 65-k RAMs. The complete RAM with its peripheral devices is at the right, with the chip's test pads and a sample array at the left.



Big one. Details of the V-groove structure show up sharply in this photograph of the 65-k V-MOS RAM test chip built by Siemens. Cell dimensions of 13 micrometers on a side make the basic memory cell half the size of today's 16-k random-access memories.

specialty technique.

Large outputs. With its 16-k test chip, AMI has demonstrated an important figure of merit for V-MOS. "We've shown that the ratio of the cell's storage capacity to equivalent bit-line capacity is two to three times larger than in [conventional] n-MOS designs," says Jenne. "That says that our outputs at the end of the bit line will be larger and easier to detect, giving us more design flexibility and better reliability."

Underscoring Jenne's optimism is the work of Siemens, which has never been an important MOS memory supplier. "We see V-MOS technology putting us into the forefront of memory design," says Hugo Ruchardt, who directs Siemens's advanced component efforts. "We began a V-MOS program just one and a half years ago, and now we have a 65-k RAM in sight." A commerical version is a year away, he says.

Siemens is working with several approaches, as is AMI, including an all V-MOS chip, a chip with V-MOS arrays and planar peripheral, self-aligned, or non-self-aligned cells. "We feel we are zeroing in on the best approach," Ruchardt says. "We will have a complete 65-k chip to talk about in February," he says. Siemens's project is being sponsored by the West German government. ☐

Photovoltaics

Multilayer cells have high efficiency

Spurred by the recent spate of Government funding, solar cells are surging forward. One example is the high-efficiency cells used with solar concentrators unveiled by two firms earlier this month at the International Electron Devices Meeting in Washington, D. C.

Researchers at RCA Laboratories in Princeton, N. J., and Sandia Laboratories in Albuquerque, N. M., have built silicon solar cells designed to be efficient at high concentration levels. RCA reports 15.5% with sunlight concentrated to the equivalent of 280 suns, and Sandia expects about 20% at 50 suns.

Cost-effective. These results are in line with "the 18% efficiency now accepted as the threshold for cost-effective power generation by concentrator photovoltaic systems and represent an appreciable improvement over the 13% efficiency of present commercially available concentrator cells," says James Hutchby, an aerospace technologist with the Physical and Optical Electronics group at NASA's Langley Research Center in Hampton, Va.

Concentrator cells, which are optimized to operate at high sunlight levels, require an external lens system to intensify the light that shines on them. Unlike ordinary cells, which have two semiconductor layers, concentrator cells are three- or four-layer structures in which the top region (emitter) or the bottom region (base) or both are heavily doped to create a deep junction, thus lowering the series resistance of the device for increased current flow.

Three layers. For its concentrator cell, RCA is fabricating p^+-n-n^+ structures from bulk-grown n-type silicon wafers. It diffuses phosphorus (an n-type impurity) into the n region to create a 25-micrometer-thick back-contact layer. Then follows a 100-μm-thick base layer forming the n region and a 0.5-μm-thick boron-implanted top surface layer for the p^+ region.

The thick base layer gives the cell high quantum efficiency in the infrared region, while the thin p^+ layer provides high quantum efficiency in the ultraviolet region, says G. A. Swartz, one of the cell's developers. "To achieve a long minority-carrier lifetime, we use a high-resistivity silicon in the base layer, so that the carrier diffusion length is greater than the base layer thickness." At high illumination, the series resistance of the base layer is practically eliminated because of the conductivity modulation of the base by light-generated carriers, he notes.

Additionally, RCA deposits chrome-gold metalization on the back-contact layer and a metal grid structure on the top surface designed to provide low series resistance. The grid is made up of a thin layer of vacuum-deposited chrome-gold over which is placed 5 μm of gold. The exposed top silicon surface is then covered with a two-layer antireflection coating that transmits 96% of light with wavelengths of 4,000 to 11,000 angstroms. This coating consists of 600 angstroms of titanium oxide over which is deposited 800 angstroms of silicon oxide.

Tailored emitter. At Sandia, work on improved concentrator silicon cells is taking the form of a proposed structure having a high-low junction in the emitter region, instead of the heavily doped back-contact layer of the RCA device. This gives rise to an n^+-n-p configuration. According to J. G. Fossum, one of the experimenters, the new structure will reduce the leakage current in the emitter region, thereby increasing the cell's open-circuit voltage, one of the key properties for a photovoltaic device.

"This reduction in emitter recombination current occurs when high-level-injection conditions in the low-doped emitter region impose constraints on the hole and electron transport in the emitter," he points out. The proposed structure is now undergoing intensive experimental evaluation. The results thus far indicate that the configuration should be "a highly superior cell at high concentration levels," he says.

Working with Fossum on the cell are F. A. Lindholm of the University of Florida in Gainesville and C. T. Sah of the University of Illinois in Urbana. Both RCA and Sandia are also working at building the concentrator cells repeatably, and improving efficiency still more. □

Communications

Bell eyes digital spot-beam system

The Bell System, which was not saying much while Satellite Business Systems Inc. got a lot of publicity for its all-digital satellite communications network, seems finally to have something to talk about. Researchers at Bell Laboratories earlier this month described a new communications concept that would greatly increase the capacity of communications satellites and make a variety of business services more widely available. These services include all those that Satellite Business Systems, a joint venture of IBM Corp., the Communications Satellite Corp., and Aetna Life & Casualty, has been talking about—facsimile, high-speed data, voice, video, and teleconferencing.

Fixed plus scanning. In a paper delivered at the National Telecommunications Conference in Los Angeles by Douglas O. Reudink, head of the satellite systems research department in Crawford Hill, N. J., Bell proposes to divide the satellite's transmitter power into spot beams, instead of relying on present approaches that use a single fixed beam to cover a wide area of the country. Bell is considering use of a dozen fixed spot beams to handle the cities with the heaviest telecommunications traffic, plus a pair of additional beams that would scan across the country, polling ground stations to determine their transmission needs. These stations would operate on demand with the satellite, using a time-division, multiple-access technique similar to the one that SBS, which plans to be operational in 1981, will use.

The scanning beams, directed by phased-array antennas, could sweep over the continental 48 states in 1/100 of a second. Each ground station, identified by a unique address, would be allotted a transmitting or receiving time that would be stored in a controller at a master ground station. The controller would relay this information to the control system aboard the satellite, which would then form and direct the scanning beams to the ground.

The beams would operate at the same 11- and 14-gigahertz frequency bands that SBS proposes to use, but the Bell approach would more efficiently use the 500-megahertz bandwidth available at these frequencies. Because the antenna beams would cover only 1% of the nation's area at any one time, channel frequencies could be reused more often, and thus channel capacity in the satellites could be increased from 15,000 telephone conversations to more than 50,000, according to Bell. Moreover, the system would save 20 decibels effective isotropic radiated power, compared with a single-beam system.

More services. Like the SBS network, Bell's concept would permit more widespread services because the system could use small, less expensive 10-foot-diameter earth-station antennas. For the same reason, the cost of multipoint video and high-speed data transmission

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At present, Bell Laboratories is building a prototype of the system, including a full-scale 100-element antenna array and a 16-element transmitting and receiving system. Some parts are already being tested, according to a spokesman, who is cautious about predicting the outcome. "No one quite knows what the economics are going to be," he says of the system, which is described as "still in the theoretical stage and not yet committed to development." □

Industrial

Microprocessor does machine-tool chores

Now creeping into the unsophisticated end of the machine-tool business, microprocessors are bringing automatic control to tools that could never afford it before. One of the first such microprocessor-based controls will accompany a new $46,900 press brake that Dreis & Krump Manufacturing Co. plans to ship early next year.

Press brakes are massive yet conceptually simple machines that put bends in sheet and plate steel along the two axes of a plane. They are used extensively in the manufacture of metal furniture, cabinets, and door frames. An operator loads the press brake by inserting a sheet of metal horizontally, and a gage at the machine's rear moves forward to position the sheet precisely over a fixed die. Then a vertical ram comes down, forcing the metal into the long, narrow die with tons of pressure to form the bend.

Unlike contouring operations, where the position and speed of one axis must match that of another to follow a profile, the press brake's two axes get to their positions independently. That eases the control's computational burden enough so that Dreis & Krump handles the job with an MC6800 microprocessor from Motorola Semiconductor, says Eddie Farazandeh, manager of new product development at the Chicago-based subsidiary of Nu Trek Inc. The application—110 tons of pressure are exerted by a ram anywhere from 10 to 14 feet long—demonstrates that other simple point-to-point operations could also be easily brought under microcomputer control.

Like the microcomputers used on more complex tools, this one decodes the machine's keyboard and runs the 40-character alphanumeric display. The keyboard unit is used for entering and storing piece-part programs that specify advance and return speeds and stops for the ram and gage and the forming speed of the ram. But it differs from other controls because the microprocessor is also responsible for closing the servo loop that positions the tool.

Servo in software. "With the exception of a minimum amount of hardware—digital-to-analog converters and pulsed encoder logic—we do all of the servo control in software," Farazandeh says. "The microprocessor monitors the ram and gage positions and, knowing the distance to go, computes acceleration and deceleration to create a velocity profile. It tabulates those motions as it's executing them, while it's monitoring everything else." In contrast, most machine-tool processors simply supply a destination and a command to move, and then hard-wired servo translator logic takes over, reporting back to the computer when the motion is finished.

Until now, most press brakes have had mechanical back gages, though automatic gages made by several manufacturers can be retrofitted. But there has been no hard-wired numerically controlled ram marketed successfully in this country.

Dreis & Krump has also taken advantage of the microprocessor to add extras to the machine. The 6800 keeps the ram level based on inputs from rotary encoders. The encoders replace both a steel leveling tape formerly used to sense whether one end was moving faster than the other

Entry point. Most of the press brake's setup and control is handled through this microprocessor-based control console.

and a series of switches tripped by a cam that sensed the ram's vertical position. This new approach brought an eightfold increase in accuracy and repeatability in ram positioning, to ±0.001 inch.

The firm's new control is nothing more than three standard Motorola boards—a 6800-based central processor card with input/output and memory expansion boards—and a pair of interface cards for the ram and gage. The interface cards convert signals from the processor to the analog outputs that run the machine and accept bidirectional square-wave inputs from the rotary encoders and odometers on the ram and gage. □

Television

GE, Hitachi merge U. S. TV operations

With U.S. government restrictions on television exports by Japan to the United States in effect, Hitachi Ltd. has joined forces with an American TV producer, General Electric Co. The two have formed General Television of America Inc., with headquarters in Portsmouth, Va. The new

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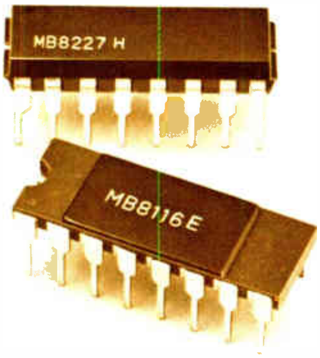

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Circle 35 on reader service card

Corp. to move significant parts of its color TV assembly to low-wage countries [*Electronics*, Oct. 13, p. 69] did not precipitate GE's move. Rather, "our plan was underway before the Zenith announcement was made," says Gault, who described the joint venture arrangement as a "long-term insurance policy against the same type of thing happening to us." Fred R. Wellner, currently general manager of GE's Television Business department, will be president and chief executive of the new firm. □

IEEE

Members support career activities

Early returns from a survey of members of the Institute of Electrical and Electronics Engineers reveal that the majority does not want any easing up on professional activities. Such easing has been anticipated after the new officers, including Bruno Weinschel, the vice president for professional activities [*Electronics*, Dec. 8, p. 42], take over in January.

If anything, the respondents want more action on economic matters, such as pensions and patent rights, and on public policy matters, such as IEEE position papers that take stands on national issues affecting engineers. They also want both closer surveillance over entry into the profession and IEEE efforts to stop age discrimination. In addition, a majority favors mandatory state licensing of practitioners who are responsible for designing products.

The tabulation of the survey, which will be completed by the end of this month, represents the opinions of well over 4,000 members. They responded to a four-page questionnaire designed and circulated by the activities board. So far, the results contain several surprises, according to John Guarrera, 1977's vice president for professional activities.

Although most of those surveyed say they join the institute primarily for the technical publications, the IEEE's traditionally strong suit, they are in favor of most professional activities—and that includes the power engineers, who have been considered the least enthusiastic about them.

Another surprise, Guarrera points out, was that almost 51% favor having the IEEE publicize the names

News briefs

SIA forms trade committee

The Semiconductor Industry Association, based in Cupertino, Calif., has formed a trade policy committee under Intel Corp. chairman Robert Noyce. It will develop a program aimed at combating the Japanese challenge to the U. S. semiconductor marketplace (see p. 59). The committee, which starts twice-monthly meetings in January, will "take a sounding of Washington attitudes" and canvas its own members for their feelings before developing a plan, says SIA's executive director, Thomas D. Hinkelman. One of the committee's tasks will be to alert member companies to the as-yet potential threat of increasing Japanese penetration of U. S. markets, although the SIA's four-year forecast [*Electronics*, Dec. 8, p. 25] predicts practically no increase in penetration of Japan's domestic market by U. S. semiconductor companies.

Phone company buys fiber-optic system

The first fiber-optic communications system purchased commercially by a U. S. telephone company that had no role in the development of the components is now on line in Las Vegas, Nev. It links the MGM Grand Hotel to Central Telephone Co.'s main switching office, 4.2 kilometers away. The system, including the optoelectronic interface, was developed and manufactured jointly by Valtec Corp. in West Boylston, Mass., and Comm/Scope Co. of Catawba, N. C., a privately owned cable supplier for cable TV systems that Valtec now is acquiring.

Under Valtec's supervision, Central Telephone used standard installation techniques to lay the cable. Commercial connectors from Thomas & Betts Corp., Elizabeth, N. J., were used to join each of the six graded-index fibers in the 0.6-in.-diameter cables in manhole and central-office locations. Average attenuation of the cable is 5 decibels per kilometer and connector loss is less than 1 dB. Similar installations connecting central offices are planned by Central Telephone for early 1978. (See p. 43 for a related story.)

Northern Telecom sets Sycor acquisition.

Canada's largest telecommunications equipment manufacturer, Northern Telecom Ltd. of Montreal, plans to acquire Sycor Inc. of Ann Arbor, Mich., a producer of intelligent terminals and distributed data-processing systems. The acquisition will be done through an exchange of stock valued at more than $66 million. The agreement comes on the heels of Northern Telecom's purchase for $15 million of a 12% interest in Data Corp., a Minneapolis CRT manufacturer. Meanwhile, the Canadian firm's U. S. subsidiary, Northern Telecom Inc., Nashville, Tenn., is negotiating to acquire Danray Inc., a Dallas maker of electronic PBXs and tandem switching gear.

IBM introduces data-encryption products

International Business Machines Corp. has introduced three new data-security products based on the cryptographic formula, or algorithm, developed by IBM and adopted for Government equipment by the National Bureau of Standards [*Electronics*, March 3, p. 74]. IBM's new 3845 (table-top) and 3846 (rack-mounted) encryption devices, priced from $2,125 to $3,600, are designed to protect point-to-point transmissions—between a computer and inquiry terminal, for example. A third device, the IBM cryptographic subsystem, will encrypt data stored in magnetic-tape or disk files and is designed for IBM System/370 computers and data-processing networks. First shipments to customers are scheduled for the second and third quarters of 1978.

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New microprocessor-based games doing well

The high prices of the new nonvideo electronic games that are built around microprocessors are apparently not discouraging Christmas shoppers, according to the three makers of toys and games who were the first companies to introduce them [*Electronics*, August 18, p. 71]. "We're selling all we can make," says James Houlihan, director of research and development at Milton Bradley Co., Springfield, Mass., of his company's Comp IV number-guessing game and its Battleship attack game. The games, which hit retailers' shelves in August, sell for between $20 and $30.

Also selling successfully are the three pocket-calculator-sized games from Mattel Inc., Hawthorne, Calif., and the most expensive game, Code Name: Sector, the submarine-chase game from Parker Brothers Inc., Salem, Mass. The Parker Brothers game retails in some outlets for as much as $50. The success of the games has sent the toy makers back to their drawing boards, and each says it will design new ones for 1978. In addition, semiconductor makers such as Texas Instruments and Rockwell International, eager for this new market for microprocessors, will be coming up with different ways to use light-emitting diodes and sound-producing integrated-circuit chips that make the games flashier and more exciting. No one is talking specific numbers but next year the volume of games could reach into the hundred thousands.

of employers who consistently ignore the Guidelines to Professional Employment for Engineers and Scientists, a set of goals for employer practices endorsed by the institute a few years ago. Some 64% want the IEEE to "engage in constructive persuasion" to encourage companies to comply with the guidelines, and almost 67% say employers observing the recommendations should receive favorable mention by IEEE. Publicizing the "bad guys" as well as the "good guys" had been thought of as a no-no among institute leaders, who have been leery of putting corporate noses out of joint while the IEEE depends for financial cooperation from industry.

A third surprise was the large number, 85%, who favor the IEEE's taking positions on technical policy questions as it has in the past regarding communications, research-and-development spending, and U. S. energy policy. "Almost the same percentage want to be polled regularly on current engineering issues to provide continuing guidance for the formulation of position statements," Guarrera adds. There is little enthusiasm, though, for collective bargaining by engineers. Two thirds of the respondents would neither join a non-IEEE collective bargaining unit nor have IEEE form one.

Now that the institute has a survey of members' opinions, what happens? "If ever we had any input from our members about what they are thinking, we have it now,"

IEEE members on age discrimination

Here are preliminary tabulations of IEEE members' answers to questions concerning age discrimination in the U. S. Activities Board's survey:

1. Would you favor IEEE/USAB efforts in support of legislation or an Executive Order for Affirmative Action for engineers over 40?
   Yes: 55.6%; **No**: 27.6%; **Not sure**: 16.8%
2. Should the IEEE suggest to employers that they establish a policy of rotating assignments as a means of offering engineers who are expert in older technologies the opportunity to be assigned to projects requiring the latest technologies?
   Yes: 59.3%; **no**: 26%; **not sure**: 14.6%
3. Should the IEEE suggest to employers that younger engineers be assigned to projects in older technologies to provide them with broader experience?
   Yes: 56.8%; **no**: 28.7%; **not sure**: 14.6%

Electronics review

comments Carlton Bayless, the outgoing IEEE executive vice president. "I hope the Board of Directors, when they see all the results, will be responsive. I have seen an increasing willingness on behalf of the board to follow what the members want."

Herbert H. Heller, chairman of the USAB task force that conducted the survey and senior staff engineer for Bird Electronics Corp., reports that the in-coming vice president in charge of the board, Bruno Weinschel, has already assured him that results of the survey will be "considered a mandate" during 1978. □

Education

Heath to package technical courses

Heathkit builders rarely think of the company this way, but Heath Co. has been in the education business a long time. For example, the 410-page set of instruction manuals for its top-of-the-line TV kit is almost a primer on color television principles.

But now, the 51-year-old Benton Harbor, Mich., kit maker has decided to go aggressively after continuing education as a market in its own right. It has been sprinkling basic electronics home-study courses throughout its mail-order catalog for about two years now and last month started shipping its most ambitious one—a microprocessor course with hands-on breadboard trainer that is tagged at $269.95.

High-growth market. "We see continuing education as a high-growth market, and I expect that educational products will be a $40 million to $50 million business for us within five to eight years," says William E. Johnson, marketing vice president. That is a hefty chunk of new business for the Schlumberger Ltd. subsidiary, which is estimated to have sales of $100 million.

Heath will expand its home-study business primarily by tying courses to the products it sells. Accordingly, Johnson envisions offering self-study packages in audio, television, automobile tune-up and repair, and automotive and marine electronics. "But we see an opportunity for many, many more," he adds, listing such diverse topics as welding, photography, and mathematics.

Heath tested such a tie-in to its massive amateur radio business this summer when it offered an inexpensive course that promised to help budding hams pass the Federal Communications Commission's amateur radio novice examination. At $29.95, the firm sold almost 8,000 copies of the text-and-tape-cassette course in less than six months. For $9.95 more, Heath throws in a code-practice oscillator kit for learning Morse code.

The microprocessor course is also configured to hit the purchaser twice: once, at $89.95, for the programmed text, tape cassettes, printed visual materials, and a generous handful of 62 microprocessor-oriented components to be used in the course's experiments; and a second time for the $189.95 digital trainer, a miniature computer built around Motorola's MC6800 microprocessor, with built-in monitor program, six-digit display, and hexadecimal keyboard. "We took it to the New York Personal Computing Show, and we got more interest in our microprocessor trainer than in our personal computers," comments Louis E. Frenzel, director of computer and educational market development.

Business boon. Heath's personal computers will be a boon to its educational business, he adds, as Heath readies courses in programming and using computers. It has already developed a home-study course in Basic programming and is preparing courses in assembly language programming for Intel Corp.'s 8080 microprocessor and Digital Equipment Corp.'s LSI-11 microcomputer—the processors behind Heath's two hobby computer systems. In the works are courses for programming in high-level languages like Fortran.

Further, Heath is eager to apply the computer as an instruction aid. "But CAI [computer-aided instruction] takes a lot of memory," Frenzel says, "and we're waiting for our floppy disk," a product that Heath will introduce early next year. "We'll start with CAI on courses that teach how to use the computer effectively," he says. "We've even toyed with the idea of a stand-alone computer that's designed for people to take our courses on." □

Fiber optics

Bell's Chicago system goes like gang busters

After eight months of field operation, the exploratory fiber-optic telecommunications system in Chicago is yielding excellent performance, say officials of Bell Laboratories. Still, they say their prototype needs some improvement in the operating lifetime of the injection-laser light sources before it goes to volume production, now planned for the early 1980s.

"We had only four instances of trouble, but by automatic switching to backup channels, we never dropped a call," says Ira Jacobs, director of Bell Laboratories' wideband transmission laboratories, Holmdel, N. J. There were three electronic circuit malfunctions and one laser failure after 60,000 operating hours, he says. One reason the overall system performed so well, he admits, "is that each channel has a one-to-one fiber backup whereas in a production system, one would back up many."

Better lasers. "While results give us confidence that lasers are reasonably reliable, our biggest problem is laser devices that fail early," adds Stewart D. Personick, supervisor of Bell Labs' fiberguide repeater group. The injection lasers used in the Chicago trial are fabricated of gallium aluminum arsenide and have a mean statistical lifetime of 1 million operating hours. But the laboratory's objective is a 10-million-hour lifetime, and to get this kind of improvement, Bell is "considering changes in fabrication and

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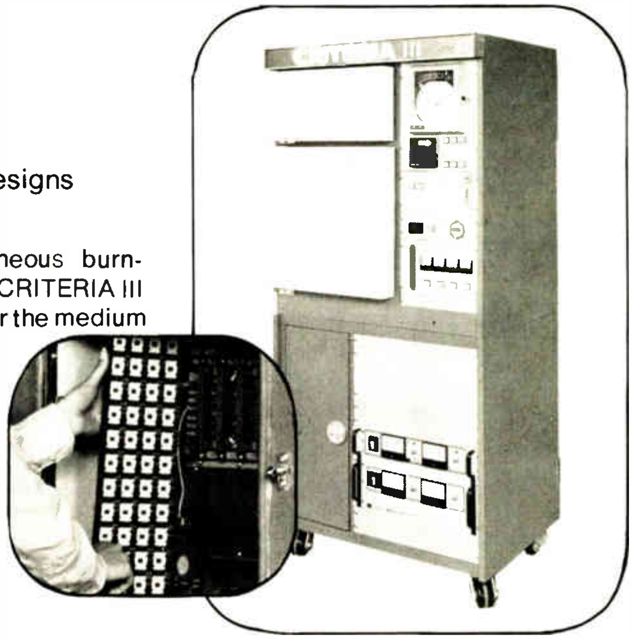

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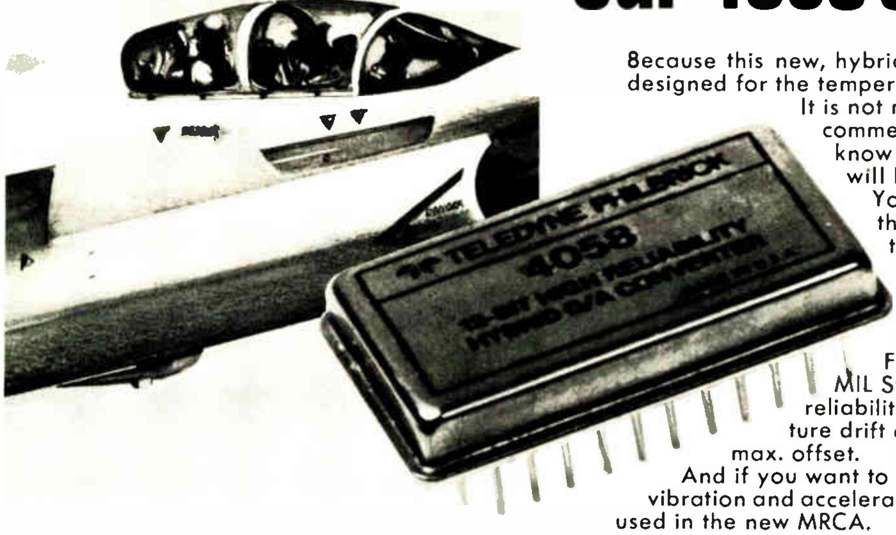

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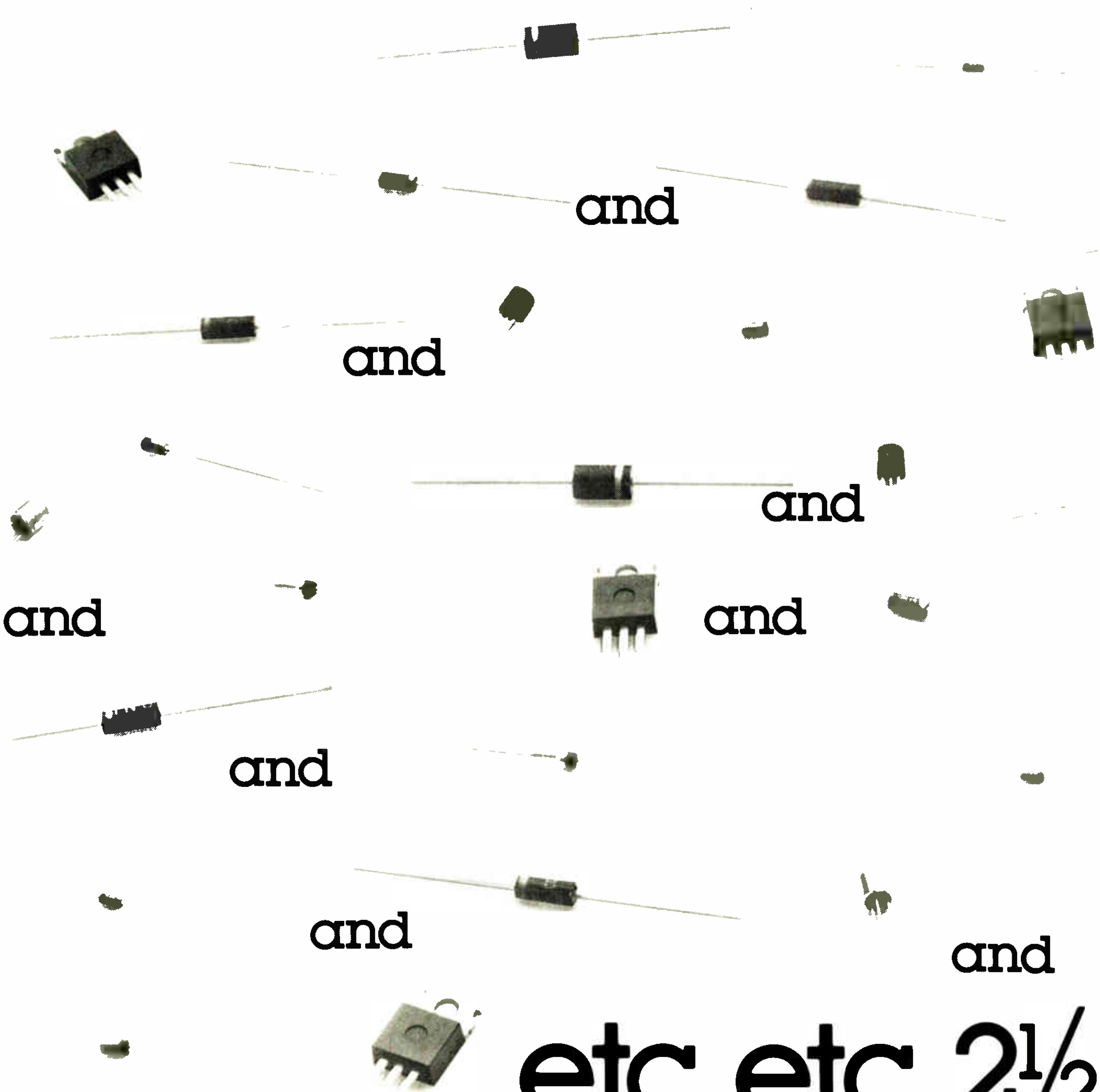
culling out devices in testing," he says.

Jacobs, Personick, and others described results of Bell's fiber-optic system, operating since May 12, to a session at the National Telecommunications Conference, which met earlier this month in Los Angeles. An all-digital system, operating at a 44.7-megabit-per-second data rate, it has 1.5 miles of 24-fiber cable, serving as trunk lines between two downtown telephone company exchanges and as a customer loop to an office building [*Electronics*, Feb. 3, p. 48]. The layout carries voice traffic for all three, in addition to data and video service between one telephone exchange and the customer's building.

Mass splicing. An important goal of the Chicago trial is to test Bell's mass fiber-splicing technique, with workmen laying the cable in manholes and striving for alignment accuracy of 1/10,000 inch. "With a total of 12 splices joining no less than 144 fibers, there was an average loss of only 0.5 decibel per fiber splice, a gratifying result," Personick says. Furthermore, Bell researchers gained data on how far the fiber cables could be pulled through underground ducts without splicing. "We're confident that between a ½- and 1-kilometer length is the tradeoff [to make] between the minimum number of splices and the cable size, strength, and pulling length," he says.

Overall, the spliced cables are averaging a loss of 8.5 dB/km, compared with 5.0 dB/km unspliced, according to Bell calculations. No cables broke when pulled through the crowded underground ducts, some dating back to the 1890s.

As fiber-optic technology proves itself, Bell officials see economic realities calling the turn on when telephone companies adopt them. "What concerns me is how rapidly costs of the fiber and optical devices come down," says Jacobs. "Users are not going to junk perfectly good wire or microwave trunks and loops for light-wave systems, and it's no secret we're in a period of slow growth of new facilities." □



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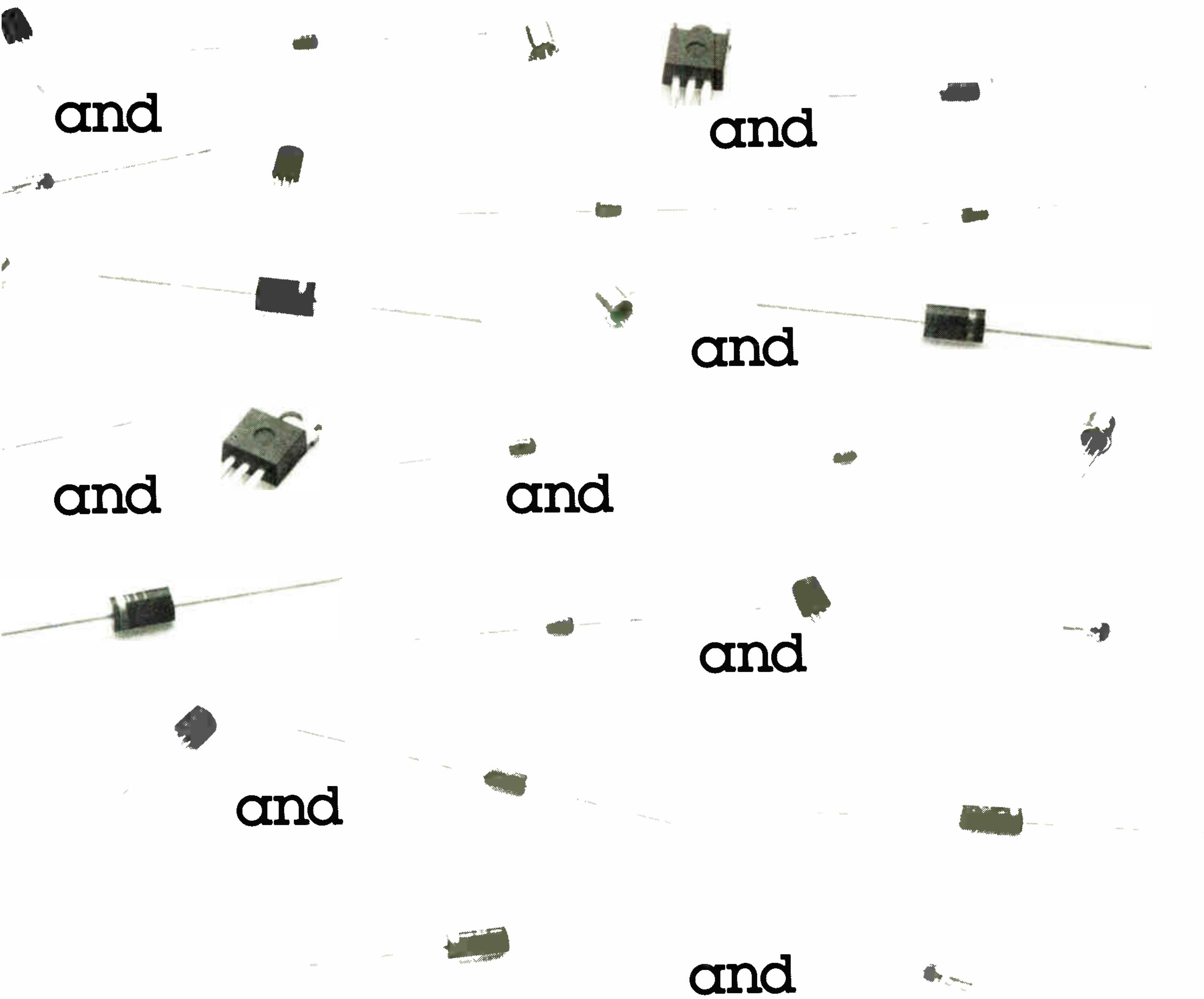

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Circle 48 on reader service card

Washington newsletter

Army replacing Electronics Command with 3 others . . .

Reacting to top Defense Department and congressional concern with its costs and performance, **the Army is abolishing its Electronics Command at Fort Monmouth, N. J.,** and setting up three new ones—Electronics Research and Development (Eradcom), Communications Research and Development (Coradcom), and Communications and Electronics Materiel Readiness (Cercom). Projected reorganization costs over three years are $13.4 million, but the Army figures it will save $4 million annually in operating costs thereafter. Civilian staff cutbacks will total 345, while another 314 civilians and 38 military personnel will be transferred to other facilities.

. . . new Eradcom headquarters to be in Maryland

Eradcom headquarters will be set up at Adelphi, Md., near Washington, at the site of Army's Harry Diamond Laboratories. **Fort Monmouth will keep the Electronics Warfare Lab** as an Eradcom unit, as well as the Electronics Devices and Technology Laboratory and portions of the Combat Surveillance and Target Acquisition Laboratory not involved with lasers. Laser work now at Adelphi and Fort Monmouth will be consolidated at Fort Belvoir, Va., under Eradcom.

Headquarters for Coradcom and Cercom will be at Fort Monmouth, and will be composed of the remaining Electronics Command units. Coradcom will take over tactical computer-software responsibilities from the Army Computer Systems Command at Fort Belvoir, while Cercom will direct all logistics functions of the Electronics Command at Fort Monmouth, Fort Huachuca, Ariz., and Sacramento Army Depot, Calif.

Ferris reshuffling top FCC staff; Spence to leave

The Federal Communications Commission's new chairman, Charles Ferris, is reportedly shaking up the organization by replacing chief engineer Raymond Spence and Charles Higginbotham, chief of safety and special radio services who oversees citizens' band radio regulations—along with at least two other long-time staffmembers holding appointive positions. Higginbotham, with the FCC since 1948, will be replaced by Carlos Roberts, present chief of policy and planning. **A successor to Spence has not been selected,** sources say. Also on the list of top executives to be replaced by Ferris is Howard Kitzmiller, an 18-year FCC veteran and chief of the legislative division.

Fossum to head DARPA; Heilmeier joins TI

The Defense Advanced Research Projects Agency got a new chief in mid-December with the appointment of Robert Ross Fossum to succeed George H. Heilmeier, who resigned to join Texas Instruments Inc. in Dallas. Fossum was vice president and general manager of ESL Inc., Sunnyvale, Calif., specializing in strategic reconnaissance. Earlier, he was dean of both research and science and engineering at the Naval Postgraduate School, Monterrey, Calif.

At TI, Heilmeier becomes vice president and director of a new System Technology Laboratory, which the company says will emphasize coupling semiconductor technology with its business thrusts in equipment and services.

Washington commentary

Will you take your Japanese wet or dry?

U. S. trade negotiators and electronics companies, frustrated by the slow pace of trade talks with Japan, are getting angry. Unfortunately, that bodes well for new protectionist measures that are certain to be introduced in Congress next year. Those could seriously impair the ability of American multinationals in the computer and semiconductor industries to maintain their preeminent position in other world markets, much less develop new ones.

George Meany's AFL-CIO and a host of small American electronics companies under pressure to save domestic markets and jobs reject this view. To them, only leading multinationals like Texas Instruments Inc. and IBM Corp. can afford such an egalitarian approach. The little guy almost invariably sees himself as just one more walnut about to be crushed in a nutcracker made up of an IBM or a TI on one side and Japan Inc. on the other. That perception is generating increasing hostility toward Japan and injecting a mean spirit into trade negotiations that the U. S. cannot afford if it is to avoid protectionism and instead get Japan to open its markets to competition from America—the Carter Administration's stated goal.

The dry American

To achieve that goal, American negotiators and businessmen need to learn much more about Japanese thinking than they know at present. Rockwell International's Terry Wong, for one, suggests there is more to doing business in Japan than putting a new piece of technology or a bankroll on the table. Crucial to success there, says Wong, business development chief for microelectronics, is the development of "a 'wet' relationship." That concept, as President Carter should be made to understand, has nothing to do with the number of martinis an American businessman can consume at lunch.

"The quality of being 'wet,' as applied to an individual," Wong explains, "implies that you are very likable, very amiable, a nice guy—and you can be accommodating, understanding, empathetic—all those good things one would learn about in transactional analysis. The opposite type—the 'dry' personality—is one who usually gets to the point right away and doesn't beat around the bush like most Japanese. The dry person is interested in doing something quick and forces you to do something that's uncomfortable."

Americans and other industrialists from the West, though, are seen as dry in Japan in view of their often impersonal, profit-oriented approach. "In fact, in the U. S., you are expected to be dry—'get to the point or get out of here,'" says Wong. "But in Japan you've got to understand the guy, and he has to understand you. He has to know your motivations and what you're really up to. He has to become convinced that you're not out to get him—or dominate him. Once he feels comfortable with you, he wants to do business." Interested Americans, he adds, can take a major step toward a wet relationship by learning to speak some Japanese.

Americans should also know that there is no way of becoming wet overnight. It is, instead, a long, slow, and often frustrating process for non-Japanese. The Rockwell manager, who speaks from experience, almost sighs when he notes that "things always seem to go very, very slowly. It takes an unmercifully long time to get anything started, and a whole hell of a lot of patience to see it through to the end. What you can accomplish here in one or two meetings will typically take five or six over there."

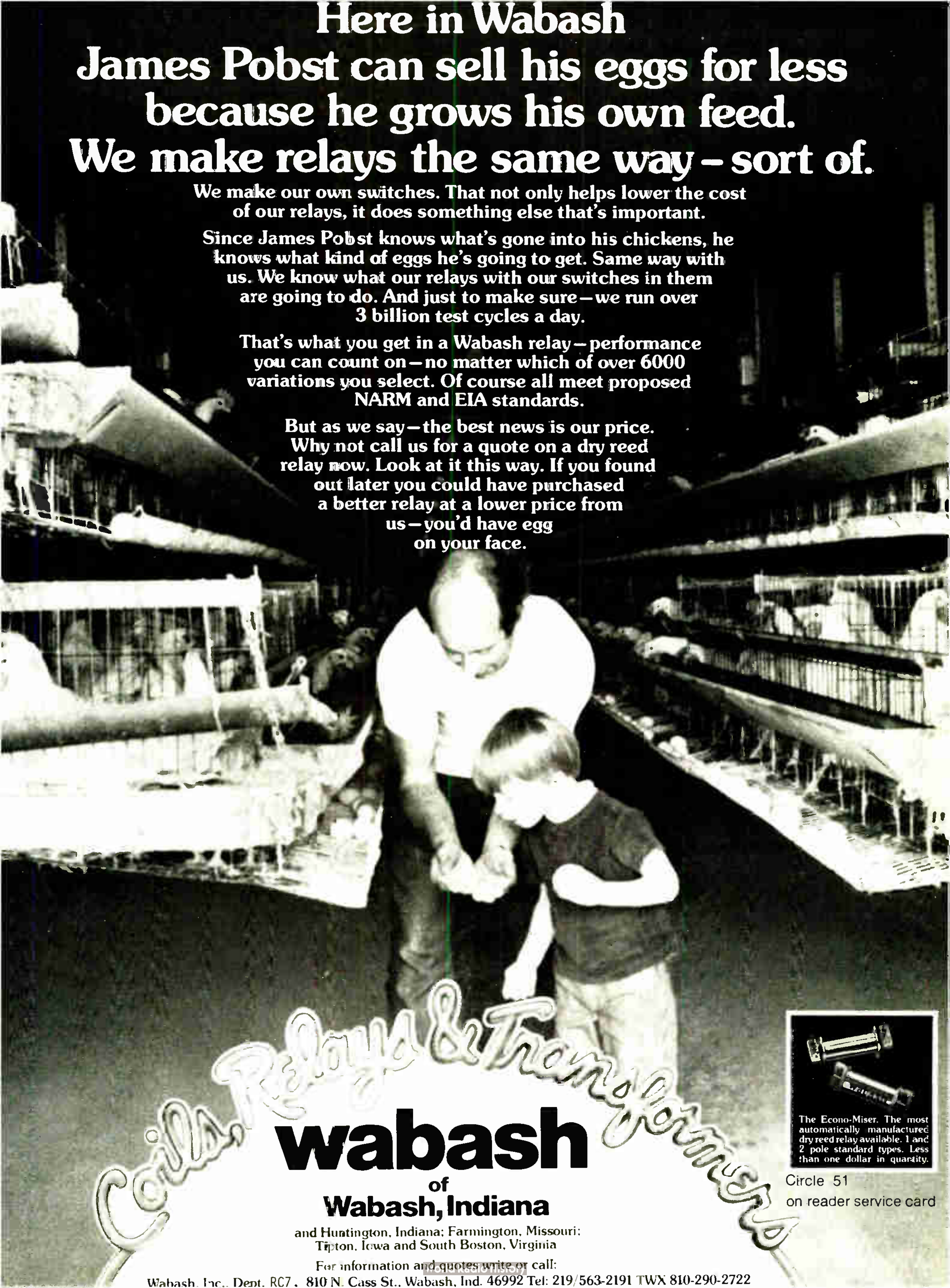
The long wet road

The concept of the wet relationship advanced by Wong is supported by Japanese businessmen in Washington. "It tracks perfectly," says one. Moreover, it contributes a great deal to understanding Japanese corporate philosophy. Wong explains that, too. "Whereas in the West, companies are interested in the fast buck—'get in, grab the money, and get out'—Japanese companies, especially large corporations, are looking for long-term advantages."

An amazing number of the large Japanese companies coming here to the U. S. are less concerned about making a profit in the first few years than in "flying the company flag and establishing a long-term position," Wong says. "The Japanese feel that if you're in anything for that stretch of time, you will make out, and that it's important for the two of you to be good buddies." Though good wet relationships are no guarantee of success, Wong cautions, they are "a necessary first step."

Insights like those provided by Terry Wong should help American executives—and White House negotiators—develop a better appreciation of Japan's approach to world markets, as well as a useful base for their own approaches to Japan. Nevertheless, the option of taking a loss over several years in order to establish a long-term position in a market is one that is open only to the largest American corporations. Indeed, even they could have difficulty translating that philosophy for the dry, dividend-hungry stockholders to whom they must ultimately answer.

Ray Connolly



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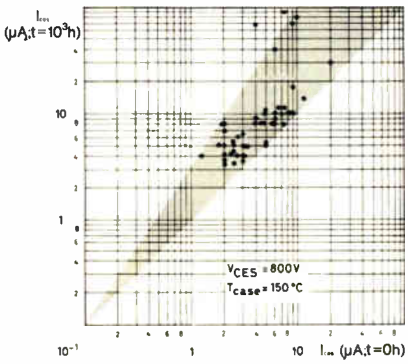
If existing technologies can't cope, we use our resources to improve them: and Biplanar® technology is an SGS-ATES first. Technological research has made SGS-ATES the first to produce 800 V transistors in Planar structure and therefore stable in high voltage and high temperature conditions. Typical of the range - the BUW 26, NPN transistor



Stability of Biplanar® devices

with V_{CBO} = 800 V, V_{CEO} = 450 V, I_C = 10 A, P_{tot} = 125 W, TO-3 metal case. The diagram demonstrates the stability of Biplanar® devices, with I_{CES} remaining constant before and after the 1000-hour life test at high voltage and high temperature.

The BU 406/409 family

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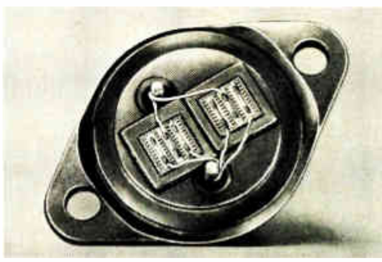

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International newsletter

Line width drops to 0.5 μm in bubble memory

Optical contact printing is defining lines only 1.5 μm wide, separated by 0.25-μm gaps, on a permalloy substrate in bubble-memory experiments under way at Hitachi Ltd.'s central research laboratory. To obtain this high resolution, deep ultraviolet in the 2,000-to-2,600-angstrom range (200 to 260 nanometers) from a xenon-mercury discharge lamp is used as the light source. **Engineers from the Japanese firm say they selected a photoresist sensitive only to these short wavelengths** so that no filter need be used to eliminate other wavelengths. The resist is equivalent to poly methyl isopropenyl ketone, but the firm says the resist it actually uses is a poly methyl 3 butene 1. Chrome masks are fabricated by electron-beam exposure and plasma etch, and ion milling etches away unwanted material. Although resolution is high, alignment is limited to that attainable with conventional techniques, so these fine lines are limited to self-aligning patterns, or single-layer ones such as the bubble memories.

I^2L memory chip from Siemens has 6-MHz clock rate

West Germany's Siemens AG is coming out with first samples of an integrated-injection-logic device incorporating eight shift registers on a 12-mm² chip and featuring a clock rate of 6 MHz. **The inputs and outputs of all eight registers are compatible with low-power-Schottky-TTL components** and can be put in series so that configurations with lengths of 64 bits can be obtained. The new device, designated S355, can be used in digital delay lines, as a serial data memory, and as a buffer memory for data-bus systems for microprocessors.

L M Ericsson consortium wins Saudi Arabian telecommunications pact

The Saudi Arabian government says it will sign a $3 billion contract for a telecommunications network this week with a consortium led by Sweden's L M Ericsson and including the Dutch multinational Philips and Bell Canada. **The consortium won out over ITT and AT&T's Western Electric** with its Ericsson AXE computer-controlled switching system. In late summer, Ericsson beat out ITT for a $500 million contract from Australia for a similar system of computerized telephone exchanges.

4-μm rules show up in 4-k RAM from Matsushita . . .

Coming in the spring from Matsushita Electronic Corp. is an n-channel random-access memory featuring 4-μm aluminum and polysilicon line widths and source-to-drain spacing. **Similar geometry will appear in the 16-bit 8080 due from Intel Corp.** (p. 57). The 1-k-by-4-bit device with 26,500 transistors will fit onto a chip only 3.7 by 3.1 mm. The TTL-compatible device operates from a 5-V power supply with power consumption of 300 to 400 mW. Access and cycle times are each less than 450 ns, with many of the devices showing times around 200 ns. The new chip is pin-compatible with the Intel 2114.

. . . and in microprocessors due from NEC

The upcoming complementary-MOS versions of Nippon Electric Co.'s μCOM-43 will have aluminum lines with minimum widths and spacing of 4 μm, while source-to-drain spacing will be 6 μm for n-channel transistors, 6.5 μm for p-channel transistors. Chip size will be 6.2 by 6.2 mm, compared to 5.66 by 6.37 mm for the present p-channel models. The TTL-compatible devices will have the same instruction cycle time of 10 μs as the earlier models, but they will operate from a 5-V supply, instead of a 10-V one and will have a maximum power drain of 5 mW instead of 500 mW.

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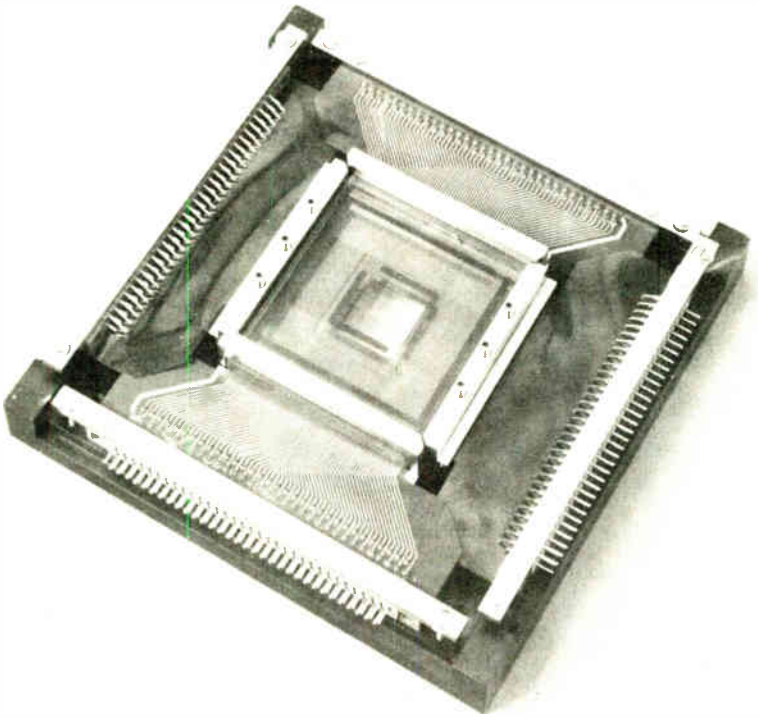
French lab produces tiny LCD for videophone applications



Showoff. With this LCD, in the center of the matrix, and a projection lens and lamp, the French post office hopes to cut the bandwidth for picture transmission in videophones.

Bucking the trend to ever larger liquid-crystal displays, the French Laboratoire d'Electronique et de Technologie de l'Informatique has developed a 128-by-128-element LCD on a 6.4-millimeter-square matrix. The tiny display has a very practical purpose—minimizing the bandwidth necessary for picture transmission in videophones.

In developing its video display, LETI joins Japan's Hitachi Ltd., which is working on a miniature television set [*Electronics*, May 26, p. 41], and Hughes Aircraft Co., which is working on aircraft video displays for the U.S. Air Force [*Electronics*, Feb. 19, 1976, p. 29]. However, the French LCD has nearly double the number of elements of the Hitachi 120-by-90-mm display—16,384, compared to 8,938. The basic Hughes display size is about midway between the other two at 44 mm by 44 mm, and its element array is 175 by 175. But the center-to-center distance between elements is 0.25 mm, while LETI has whittled it down to 0.05 mm.

Complex images. Because the French display must provide fairly complex pictures of faces and the like, it needs a gray scale as well as the many elements. Hence LETI, which is the electronics laboratory of the French atomic agency, has worked eight shades of gray into its new unit and is developing a 20-by-20-mm version that will have a 256-by-256 matrix.

The work is being carried out for the Centre National d'Etudes des Télécommunications, the research arm of the French post office. CNET has already reduced videophone bandwidth requirements down to 2 megahertz, about a fifth the usual video requirement. Since LCDs produce many fewer images per second than the faster-scanned cathode-ray tubes, they will cut the bandwidth even further. Moreover, they occupy less space and use less power than CRTs, and they have no image distortion, since the points are geometrically defined, CNET says.

Originally, LETI tried to develop a 7-by-7-centimeter display, but encountered difficulties getting a uniform thickness of glass. Thus the 41-mm^2 matrix is enlarged by a 150-watt projection lamp and lens to a larger display. The image produced is fine for static scenes, but any moving subjects cause a noticeable blur.

To drive the display, 50 volts are applied to the 128 rows sequentially, and signals of about 6 V are applied to the 128 columns simultaneously. If the current to the rows and columns is in phase, the display is black; if out of phase, then it is white. Phase variations between these extremes give the gray levels.

While scanning is at a rate of 25 frames a second, the LCD's 100-to-200-millisecond response time means the image changes between 5 and 10 times a second. In a CRT videophone, the image changes 25 times a second, so with the LCD the transmission bandwidth should be cut by a factor of 2½.

The liquid crystal. The liquid-crystal material is a mixture of metoxybenzylidene butyl and etoxybenzylidene butyl. To produce the image, LETI uses the technique called deformation of aligned phases. Jacques Robert, head of the lab's liquid-crystal team, says it investigated the twisted-nematic process which also is a member of the field-effect family of techniques. But the method chosen allows easier multiplexing and greater complexity—at least 256 by 256 elements, he says. The contrast ratio has not been measured, but it is better than 50:1. So far, the display is based on discrete components, but Robert says LETI's development and manufacturing counterpart, Société pour l'Etude et la Fabrication de Circuits Integrés Spéciaux, may develop an integrated circuit for the device. The key will be sufficient potential in other applications. □

Japan

Analog facsimile unit gets digital processor

With only two master chips, Tokyo Shibaura Electric Co. has devised a digital processing system for analog facsimile equipment. Incorporation of read-only memories on the modulator/demodulator and filter chips makes it simple to tailor them to the desired modulation scheme and filter characteristics, Toshiba engineers say.

Easing implementation of the digital scheme is the input signal from the analog transmitter's document scanner—it is essentially a 0/1 signal since it is reproducing a black-and-white document. The scanner's shift register and the interface circuitry are synchronized at the sampling frequency of the digital integrated circuits. The transmitter's modem converts the baseband signal into the digital equivalent of a modulated carrier.

In the receiver, a modem converts the carrier signal back to the baseband signal, and the output interface circuit looks at the signal's 5 most significant bits, slicing them at a preset value to give a 0/1 analog signal for the writing head. To use standard analog transmission lines, d-a and a-d conversion is needed.

Advantages. However, Toshiba engineers say the digital design is desirable not only because it cuts costs and contributes to miniaturization. They point out that it should improve long-term performance, since the ICs will not degrade with age as do analog circuits. Also, it greatly simplifies manufacturing and quality control, because complex adjustments and the resultant tests are not needed.

The sampling frequency in the digital circuits is a function of the frequency of the external clock and the number of sections used in the filters. Each filter requires a clock rate that is 32n times the sampling rate, where n is the number of filter sections used—in this application, five of the eight sections give a 10th-order filter, adequate for facsimile. For the sampling frequency of 15.552 kHz used in Toshiba's initial system, the clock frequency is 15.552 times 32 times 5, or 2.48832 megahertz. Maximum clock rate is 3 MHz, and the carrier frequency is derived from the clock by pin-connection programming of the modem.

The block diagram shows a system designed for full-duplex amplitude-modulation–phase-modulation vestigial-sideband operation. With a carrier frequency of 2.1 kilohertz, it has nine of the master chips—two identical modems and seven filters of five different types. For half-duplex operation, one low-pass filter, one modem and one attenuation equalizer can be used for both transmitting and receiving, cutting the number of ICs to six.

N-channel. Both the T3545 digital filter and the T3546 modem use standard n-channel metal-oxide-semiconductor technology. Both operate from single +5-volt power supplies and are compatible with transistor-transistor logic. The filter has 5,300 active elements on a 4.1-by-4.9-millimeter chip, and the modem has 6,100 active elements on a 4.8-by-4.8-mm chip. Toshiba will sell the chips, as well as use them in its own facsimile equipment. Initial prices are about $10.40 for the filter and $14.60 for the modem. □

Around the world

Interim Viewdata module combines Teletext decoder with 2650

Mullard Ltd. is teaming its Teletext module with a microprocessor in order to have an easily modifiable Viewdata module ready for next summer's trials of the electronic information service planned by the British Post Office. Thus the firm is joining Texas Instruments Ltd. in adapting a Teletext module to Viewdata with a microprocessor [*Electronics*, Oct. 13, p. 53]. Unlike Mullard, TI is considering a single-chip processor for the final design.

The Mullard Viewdata module occupies two printed-circuit boards measuring 165 by 305 millimeters and 150 by 230 mm. Some 65 ICs are packed onto the boards, but they will shrink to three or four large-scale integrated circuits in the final design. The microprocessor is the 2650 from fellow Philips' subsidiary Signetics. While partitioning of the logic has not been set, there are basically two functional blocks. The first, the line-coupling unit, has a modem. The second logic block acts as an interface between the first and the decoder. It transfers the data from the computer to the Teletext display circuitry and transmits the users' information requests, entered via a remote control unit, to the computer.

Vehicle-guidance system uses radio signals

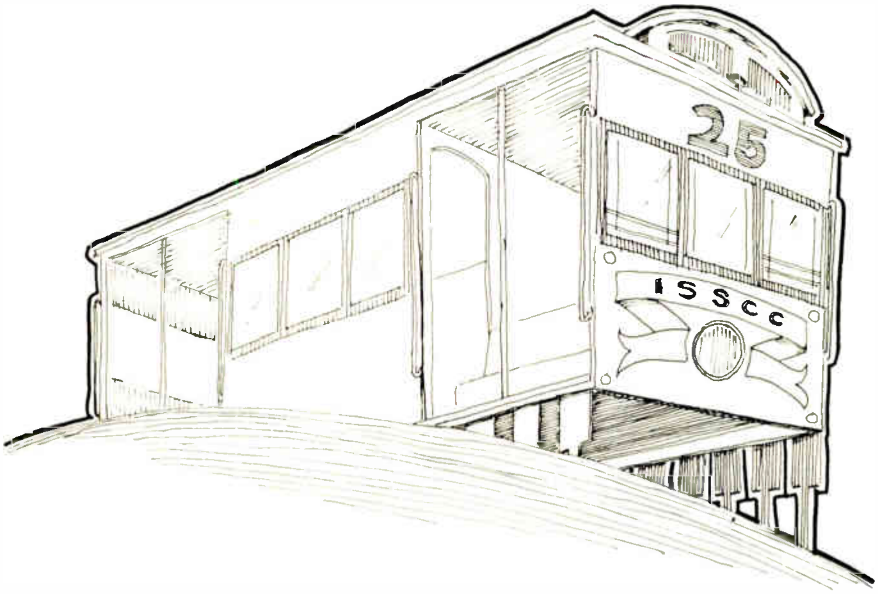
The West German ITT affiliate, Standard Electrik Lorenz AG, is drawing on know-how gained in making aircraft navigation equipment to come up with a vehicle-guidance system based on radio signal-measuring principles. The system consists of a vehicle-mounted transceiver and a tripod-mounted transponder that is the reference point. An amplitude-modulated carrier in the 1-gigahertz range travels from the transceiver to the transponder that may be more than 500 meters away. There it is converted to another frequency and fed to the transponder's two radiating elements—the line along which these signals' phases are equal is the guidance line.

By timing the signal trip between transceiver and transponder, the distance can be determined. Any difference in phase between the two elements' signals yields the deviation from the course. From the angle and distance measurements, the processing unit determines lateral deviation from the guidance line. Accuracy is within 1.5 m.

New stars to shine at ISSCC

65-k RAMs, 4-k and 8-k statics, I²L converters, 1-chip codecs, sub-100-ns 65-k ROMs, and 1-volt linears to head February program

by Laurence Altman, Senior Editor



A dazzling program has been prepared for the 1978 International Solid State Circuits Conference. Now being mailed to members of the Institute of Electrical and Electronics Engineers' Solid-State section, it is studded with papers on those next-generation digital and linear integrated circuits about which users have been hearing hints and stories but precious few details.

In new memory devices alone, those in San Francisco on Feb. 15, 16, and 17 for the silver-anniversary meeting will learn about:

- Nippon Telegraph and Telephone Public Corp.'s 65,536-bit dynamic random-access memory. Not to be confused with an earlier device reported by Nippon [*Electronics*, June 9, 1977, p. 116], this production-ready highly manufacturable part is built with one-transistor silicon-gate processing. It delivers a bit in 200 nanoseconds at a 150-milliwatt chip dissipation. Prototypes of commercial versions are currently under development at Nippon and Fujitsu Corp.
- Two V-channel metal-oxide-semiconductor 65-k dynamic RAMS, one from Siemens AG and the other from American Microsystems Inc. About one year away from prototype, the two are the first to apply the V-MOS technique to high-density dynamic memories, the kind that achieve 150-ns access times and 300-mw power dissipation off a chip 30,000 to 35,000 square mils in area. V-MOS is being closely watched as a strong alternative to silicon-gate planar technology at the 65-k level.
- Two bipolar static 4,096-bit RAMS, both from Japan. Hitachi Ltd. is reporting on a 25-ns, 330-mw part, and Nippon Electric Co. on a 40-ns, 50-mw part. The unprecedentedly low power dissipation of these transistor-transistor-logic devices will intensify the battle between bipolar and n-MOS statistics for the $60 million cache-memory market.
- Meanwhile, from Fairchild Semiconductor, a 16,384-bit dynamic memory design built with integrated injection logic and attaining 130-ns access time off one 5-volt power supply. If Fairchild can get its II parts out in volume in 1978, they will challenge n-MOX dynamic memories.
- Also from Fairchild, a 65-k charge-coupled-device memory. Operating at 1 to 5 megahertz in a 16-pin, 300-mil-wide package, it is the type of device that puts CCDs in contention for serial storage jobs.
- A spectacular big read-only memory from Mostek Corp. A less-than-100-ns, 65-k dynamic design that sets a speed record for MOS ROMS, it is as fast as many bipolar parts with a quarter its capacity. The memory's 8-kiloword-by-8-bit layout makes it perfect for microcomputer or minicomputer program storage.
- Finally, in static RAMS, another first, an 8,096-bit part from EMM/Semi Inc. Organized in a 1,024 8-bit word microcomputer configuration, it is the densest static MOS memory yet to appear. Mostek is close to a similar device.

Microprocessors. Also important on the digital agenda are two new microprocessors, both 16-bit chips that underline the trend to better-performing minicomputer applications. Intel Corp.'s eagerly awaited 8086 will be described for the first time. With 10 times the performance of the old 8080s, it can handle 16-bit-wide words, as well as stay roughly software-compatible with 8-bit 8080/8085 designs. It represents the first Intel central processing unit built with the 4-micrometer geometry of H-MOS silicon-gate processing. The other eye-opener is

Nippon's 16-bit CPU, which combines n-channel MOS and complementary-MOS for a 600-ns instruction-execution time.

Analog and special LSI. Complementing this digital activity is a program loaded with outstanding analog designs, as well as an impressive array of chips that handle both analog and digital functions for data-converter and communication applications. In straight analog, for example, there is a microwave biphase modulator from Hughes Aircraft Co. that can operate in the 4- to 16-gigahertz region, thanks to improved, integrated, gallium-arsenide field-effect-transistor operation. Also included is a 32-point CCD filter for chirp radar applications from Texas Instruments Inc.

In data converters, monolithic devices are moving up the scale in complexity, speed, and precision. For example, using I^2L, Analog Devices Inc. is building a fully self-contained 10-bit successive-approximation analog-to-digital converter that is microprocessor-compatible.

Similarly, in a high-speed 8-bit d-a converter, Advanced Micro Devices Inc. has a bipolar chip that includes all registers and logic for an 8-bit microprocessor and bit-slice interface. And Japan's Tokyo Shibaura Electric Co. has put an 8-channel multiplexer and a 10-to-12-bit a-d converter on the same chip—all in C-MOS. And the device operates from a single 5-v supply.

Specials. A new IC showing up more frequently at ISSCC is the dedicated system or subsystem chip, which mixes dense digital LSI circuits with high-performing analog functions. For example, researchers at Sprague Electric Co. will describe an integrated motion-detector chip, containing an on-chip photodiode that operates over three ambient-light decades. The diode's output, which corresponds to motion-triggered light changes, is processed by I^2L linear and digital circuits. National Semiconductor Corp., which has been working with optolinear IC combinations for two years, will present the details of its work using the photodiode/linear/digital technology as a building block for light-activated ICs.

Finally, Motorola designers will describe their I^2L automobile speed-control system. It contains integrated op amps, comparators, counters, a 9-bit d-a and a 4-bit a-d converter, and all the control logic.

A major opportunity emerging for IC penetration is the dedicated communications chip. The ISSCC program has no fewer than six large-scale integrated coder/decoders on one or two chips for pulse-code-modulated telecommunications over private-branch exchanges and public voice and data lines. Intel Corp. will disclose its one chip n-MOS approach, which includes a-d and d-a functions and multiplexer time-slot assignments under microprocessor control, while National and Siliconix Inc. will disclose two-chip systems offering sample-and-hold, precision references, and fast PCM buffers.

Two telephone system manufacturers also will describe their codec designs. Bell Northern uses an n-MOS approach that also has a CCD transversal filter built right on the chip, and Bell Laboratories has a bipolar design. □

Some gems from ISSCC 1978

Session 1.4: Bipolar ICs for industrial fiber-optic data links (HP Labs)
Session 3.1: A fully integrated motion detector (Sprague Electric Co.)
Session 3.2: A controller with high-speed I^2L and high-voltage analog circuits (Hitachi Central Research Laboratories)
Session 3.3: A monolithic speed-control system for automotive applications (Motorola)
Session 6.1: Model for a 15-ns, 16-k RAM with Josephson junctions (IBM)
Session 6.2: Sub-100-ps Josephson interferometer logic (IBM)
Session 6.5: Low-power GaAs digital ICs using Schottky FET logic (Rockwell)
Session 7.1: A monolithic integrated 4-GHz amplifier (HP)
Session 7.2: A uhf monolithic operational amplifier (Bell Labs)
Session 7.3: Gigabit-rate GaAs FET rf phase modulators (Hughes)
Session 8.4: A fully integrated, 32-point chirp Z-transform IC (TI)
Session 8.5: An integrated dual-tone multifrequency decoder (Mostek)
Session 9.1: A high-speed, low-power, 4,096-by-1-bit bipolar RAM (Hitachi)
Session 9.2: A 4-k static bipolar TTL RAM (NEC)
Session 9.3: A four-device bipolar memory cell (Signetics)
Session 9.4: A 1-k-by-8-bit, 5-V-only static RAM (EMM-SEMI Inc.)
Session 9.5: A 4k C-MOS erasable PROM (Intersil)
Session 11.1: A microprocessor-compatible high-speed 8-bit d-a converter (AMD)
Session 11.2: A single-chip C^2MOS a-d converter for microprocessors (Toshiba)
Session 11.4: A 10-bit monolithic tracking a-d converter (Ferranti)
Session 11.5: A monolithic tracking a-d converter using I^2L and thin-film resistors (Analog Devices)
Session 12.1: Magnetic bubbles—status and future (IBM)
Session 12.2: A 65-k MOS RAM (NTT)
Session 12.3: A 65-k CCD memory (Fairchild)
Session 12.4: A 100-ns, 150-mW 65-k ROM (Mostek)
Session 12.5: A 16-k-by-1-bit I^3L dynamic RAM (Fairchild)
Session 12.6: A V-MOS dynamic RAM (Siemens)
Session 14.1: A two-chip PCM codec for per-channel applications (National)
Session 14.2: A single-chip n-MOS PCM codec for voice (Intel)
Session 14.3: A two-chip C-MOS codec (Siliconix)
Session 14.4: A PCM voice codec with on-chip filters (Bell Northern Research)
Session 14.5: An integrated PCM encoder using interpolation (Bell Labs)
Session 14.6: A companding d-a converter for a dual-channel codec (Siemens)
Session 15.1: An E^2-PROM-based TV synthesizer (SGS-ATES)
Session 15.6: A high-speed n-MOS/C-MOS single-chip 16-bit microprocessor (NEC)
Session 15.7: A 16-bit H-MOS microprocessor (8086) (Intel)

Trade

Answer Japanese now, U. S. warned

Fairchild, Mostek want Government-built barriers plus R&D aid, but TI would rather have free access to Japan's markets

by Ray Connolly, Washington bureau manager

How much of a threat to America's world dominance in semiconductors is Japan's very-large-scale integration program? To several U. S. manufacturers it looms as critical, with American markets of the 1980s as the target.

For example, Fairchild Camera and Instrument Corp. and Mostek Corp. have just issued calls for the Government to adopt strong protectionist measures, including a one-for-one reciprocal quota on semiconductor trade with Japan, as well as increased direct Federal support for basic technology. On the other hand, America's leading producer, Texas Instruments Inc., opposes greater direct Federal support and quotas, calling them short-sighted approaches.

They could cost U. S. companies their free access to world markets that have grown 11% annually in the past decade to generate a favorable American trade balance reaching $765 million this year, says TI president J. Fred Bucy. Instead he wants the Government to push for free access to markets in Japan by equalization of tariff barriers and the elimination of nontariff trade barriers.

Meeting. Bucy, his counterpart from Fairchild, Wilfred J. Corrigan, and Mostek chairman L. J. Sevin, spelled out their differences and concerns in Washington earlier this month during the first annual Electronics Conference. The two-day meeting, titled "Threats and Opportunities: How to Face Today's Challenges," was sponsored by *Electronics* magazine.

Japan's four-year VLSI effort, now almost two years old, is a joint government-industry program to leapfrog existing digital electronics technology and establish Japan as a major force in the world's data-processing markets by advancing the state of the semiconductor art in five areas (see p. 63). Program costs are estimated at upwards of $250 million—Bucy pegs them at $300 million—to be split 60/40 between industry and government. Goals include developing logic chips with 50,000 gates and memories with 1 million bits.

Where Corrigan and Sevin view VLSI as the coming battleground in what they believe is a U. S.-Japanese economic war that already embraces television, automobiles, and steel, Bucy cautions against overreaction and panic by the U. S. "If the response of the semiconductor industry is to call for the lawyers, we will be making a serious mistake," he says.

Using his $300 million estimate—half going for equipment and installations—Bucy says "the numbers are not overwhelming" when viewed in relation to U. S. efforts. Exclusive of International Business Machines Corp. and Bell Laboratories, he notes, all other American semiconductor research and development will surpass $200 million in 1977 alone, with much of that devoted to VSLI. Other industry sources place IBM's investment in VLSI over the next three years near $1 billion.

The TI executive sees possible Japanese restrictions on licensing VLSI patents as a much more serious problem than the investment. Unlike the U. S., where a jointly held patent may be licensed by any one of its owners—including the Govern-

Telecommunications: make it locally

Americans may have an advantage over Japan in competing for developing world telecommunications markets if they respond to a country's desire for local manufacturing of products. That is the estimate of International Telephone and Telegraph Corp. senior vice president Frank P. Barnes, who says Japan is not only reluctant to provide local integration in offshore plants, but also has had relatively little experience in technology transfer.

He warns that continued growth of U. S. telecommunications exports to the expanding world market depends as much on a supplier's ability to cope with political and financial considerations in the buying nation, as on superior technology and a low bid. The reason is that the potential customer is usually the government. Ability to tie financing into bid packages may also be critical, Barnes says, especially in developing nations that have a small industrial base and insufficient resources to build up enough foreign exchange to support lump-sum financing of expansion.

Americans can expect tough competition for world markets from Japan's telecommunications monopoly, Nippon Telephone and Telecommunications Co., which supports a telecommunications network second only in size to America's. The firm's "very close working relationship with manufacturers on development of standard products causes some people to refer to the competition as coming from Japan Inc.," Barnes says.

ment—any party of a Japanese patent may veto its licensing. Bucy says Japan has not replied to inquiries on VLSI licenses, but he is not optimistic. TI suspects "the decision has been made and that the answer is 'No,'" he says. Denial of access to such patents for the U.S. and European competitors, he points out, would seriously impair their ability to compete and, at the same time, turn patent exchange into a one-way street.

Transfers. While Bucy offers no immediate solution to the patent-exchange threat, he does believe American semiconductor producers and equipment makers can limit the threat in the marketplace. They must guard against "transferring our latest technological know-how to competitors who use it to beat us." He defines know-how as "the detailed knowledge of how to design or manufacture, as well as the equipment that contains this detailed knowledge." It is a definition advanced to the Defense Department in February 1976 in an extensive report by a Bucy-led task force that studied ways to prevent foreign military usage of American leading-edge technology.

U.S. makers of semiconductors and test equipment have already racked up sales of between $50 million and $60 million to the Japanese VLSI program, about half the projected capital equipment outlay, he contends. "It's ironic to me that a few of our industry members who are now so publicly concerned about Japanese competition are the very firms that transferred key technologies to them."

Questioned later, he added, "I wouldn't sell my advanced machinery to Fairchild or Intel any more than I could walk on air. The same applies to anyone, regardless of nationality." However, individual companies "should be hardheaded enough to negotiate market participation as a price for transferring U.S. technology to Japan," he believes.

Mostek's Sevin also cautions semiconductor makers "to watch more closely our technology flow and thoroughly evaluate the long-term consequences of licensing and cross-licensing arrangements" with foreign companies. Citing U.S. Department of Commerce figures, he notes that Japanese royalties and fees paid for foreign technology soared from $62 million in 1961 to $299 million in 1971, then again jumped considerably, to a figure of $428 million just two years later.

The specter that American semiconductor makers may export more R&D to offshore facilities was raised by Bucy when discussing the long-term impact of Federal R&D policies. The beginning of the decline in university high-technology exploration came when control over funds for such programs was transferred to the National Science Foundation from the Pentagon, he says. Economic slumps in 1970 and 1974 compounded the problem by slowing industrial R&D spending, he adds, noting that Federal rules on profits also slowed private R&D investment generally at a time when foreign competition was limited.

A third element aggravating the slowdown, Bucy points out, was a U.S. Treasury ruling disallowing corporate credits for R&D performed overseas. Although he believes that it is not possible to measure the impact of Government actions alone, he sees the result producing either a period of declining U.S. development or of greater transfers of R&D offshore to decrease the cost of company facilities.

Agreement. While the three semiconductor company chiefs divided on the issues of import quotas and direct Federal R&D support, they were in substantial agreement on questions of increasing U.S. productivity, better Federal tax incentives for R&D and capital formation, equalization of tariffs and elimination of nontariff barriers to permit free access to Japan.

Productivity of both labor and management in the U.S. "is generally lousy," Bucy contends. "They are not trained in school or by industry as to the importance of productivity or how to improve it." Productivity of Japanese workers at TI's facilities there, on the other

Spotlight to shift to Congress

Evidence in Washington is increasing that those U.S. industries that feel threatened by Japan's economic invasion will next year turn away from the White House and to the Congress for protection. Bolstered by the December commitment of George Meany's AFL-CIO to put its muscle behind the drive, businesses seeking protection are increasingly optimistic.

Meanwhile White House trade negotiators are coming under strong pressure not to lose control of the delicate trade situation. Those pressures intensified when Robert S. Strauss, the President's special trade representative, rejected as insufficient the initial proposals by Japan to reduce its surplus trade balance with the U.S., which will reach $8.5 billion this year.

Factoring the interests of U.S. electronics industries into the trade talks is particularly difficult, says Richard Heimlich, special assistant to Strauss. The negotiators are aware that the electronics industries now account for nearly 10% of the Gross National Product and employment and still held a $900 million positive trade balance in 1976 from $8 billion in exports. But, Heimlich notes, "national trade interests with respect to electronics are not easily identified. The multinationals have a substantially different perspective from domestically oriented firms and labor unions. Firms concentrating in consumer electronics see the world in a harsher light than those who sell computers and many other types of equipment."

Heimlich says the U.S. is pushing for more liberal access to Japan's domestic market, "especially in manufactured products, which now represent 20% of her total imports compared with 40% to 60% in other major developed countries." The U.S., he says, insists that the Japanese "do more than acknowledge that problems exist" in such areas as relative currency values, high tariffs, credit restrictions and other nontariff barriers, distribution inefficiencies, and "the close interrelationship among the producing, banking, and trading elements of the Japanese economy." How much Japan will reduce those trade barriers is still unknown, Heimlich concedes, cautioning that there will be no quick resolution.

Probing the news

hand, "is 20% to 40% better than in the U. S."

He believes the key to increasing productivity includes both work simplification and personal involvement by management. Mostek's Sevin suggests "awareness programs for employees" to alert them to "the full impact upon losing the challenge from foreign producers—namely, their jobs." U. S. workers, he says, "are our best resource," but must be encouraged "to work harder and smarter."

He also wants a technology or R&D tax credit to cover product development as well as basic-process R&D, based on a percentage of sales. "In this way," he explains, "we could expand from the present 7% level for R&D to more near the 12% Japanese levels" for semiconductor work.

The Mostek chairman and Fairchild's Corrigan were also in agreement with TI's Bucy in calling for what Corrigan listed as "additional tax credits for investment in advanced equipment" used for production. To become stronger international competitors, Bucy argues, "we need the catalysts that the U. S. government can provide" in the area of tax incentives, rather than more costly direct Federal funding.

Fairchild's Corrigan nevertheless supports "more Government support of basic technology" in the U. S., including "increased military funding for R&D." He also proposes "relaxing antitrust legislation to enable closer cooperation without fear of reprisal between companies operating outside the U. S." To preclude Japanese and European semiconductor acquisitions or buildups within the U. S., he calls for "restriction of foreign ownership of American companies in critical technology areas."

Japanese view. Differences were clearly reflected in the views of Corrigan and those of H. William Tanaka, Washington attorney who spoke for the Electronic Industries Association of Japan. "Japanese suppliers last year had only 1.6% of the U. S. semiconductor market," Corrigan observes, "but this is up sharply from previous years." Imports of Japanese integrated circuits "climbed from $2.4 million to $18.7 million" in the last three years, he says, and are up 86% from 1976 levels in the first half of 1977. Japan, he warns, has cut the American technology lead on 4,096-bit memories to "between one and two years. The U. S. will have no more than a one-year lead on the 16-k memory," he says.

While Tanaka acknowledges the rise of Japanese IC exports, he contrasts the minute share of the U. S. market with America's 30% share of the Japanese IC market. 18% is imported directly from the U. S., while an additional 9.6% imported from third countries is produced by local U. S. subsidiaries, he says. "Thus, U. S.-based multinationals account for 90% of all ICs imported by Japan."

Barriers. All three semiconductor executives urged elimination of the semiconductor import tariff differential—about 12% in Japan vs 6% in the U. S. But Tanaka challenged the importance of that difference. Despite Common Market duty rates of about 17%, he said, American manufacturers have still managed to capture an estimated 80% of the European semiconductor market.

More critical, the three agreed, is the need to eliminate Japanese nontariff trade barriers that discourage imports. High on the list was the Ministry of International Trade and Industry's policy that effectively pressures Japanese buyers to limit imports to a percentage of total purchases.

Computers are but one example, Bucy observes. There, "MITI's administrative guidance suggests that computer imports not exceed 50% of total computer purchases." Another nontariff barrier, notes Fairchild's Corrigan, is Japan's unwieldy distribution system "with three or four layers between producer and consumer" that results in significant price increases on imported goods for the end user.

On a broader front, Bucy wants American industry and the Government to pressure Japan to stop exporting unemployment as a means of countering its own internal economic problems. Japanese corporations are used by the government to implement its full-employment plan, he contends. Resultant excess production is exported at the expense of jobs in other nations. "Some of the largest Japanese firms are maintaining full employment at the cost of running their debt-to-equity ratios as high as 20:1 and higher," he says. "I'm convinced that Japan will have to pay dearly for this free lunch of full employment sometime in the future."

Moreover, he sees a need for the U. S. to encourage Japan to continue liberalizing its foreign investment policy. "It's time the Japanese recognize they have a well-developed economy, and that they no longer need to engage in the sort of invest-

Goals of Japan's VLSI program

If the Japanese very-large-scale integration program meets its goals, says Texas Instruments president J. Fred Bucy, it would affect American makers of medium to large computers. But more important, Bucy says that such devices—subnanosecond logic arrays of 1,000 gates—would also "significantly advance the state of the art of such military equipment as radar array processors and satellite communications systems."

The overall goal is to develop VLSI technology by 1980. Bucy lists specific objectives as:

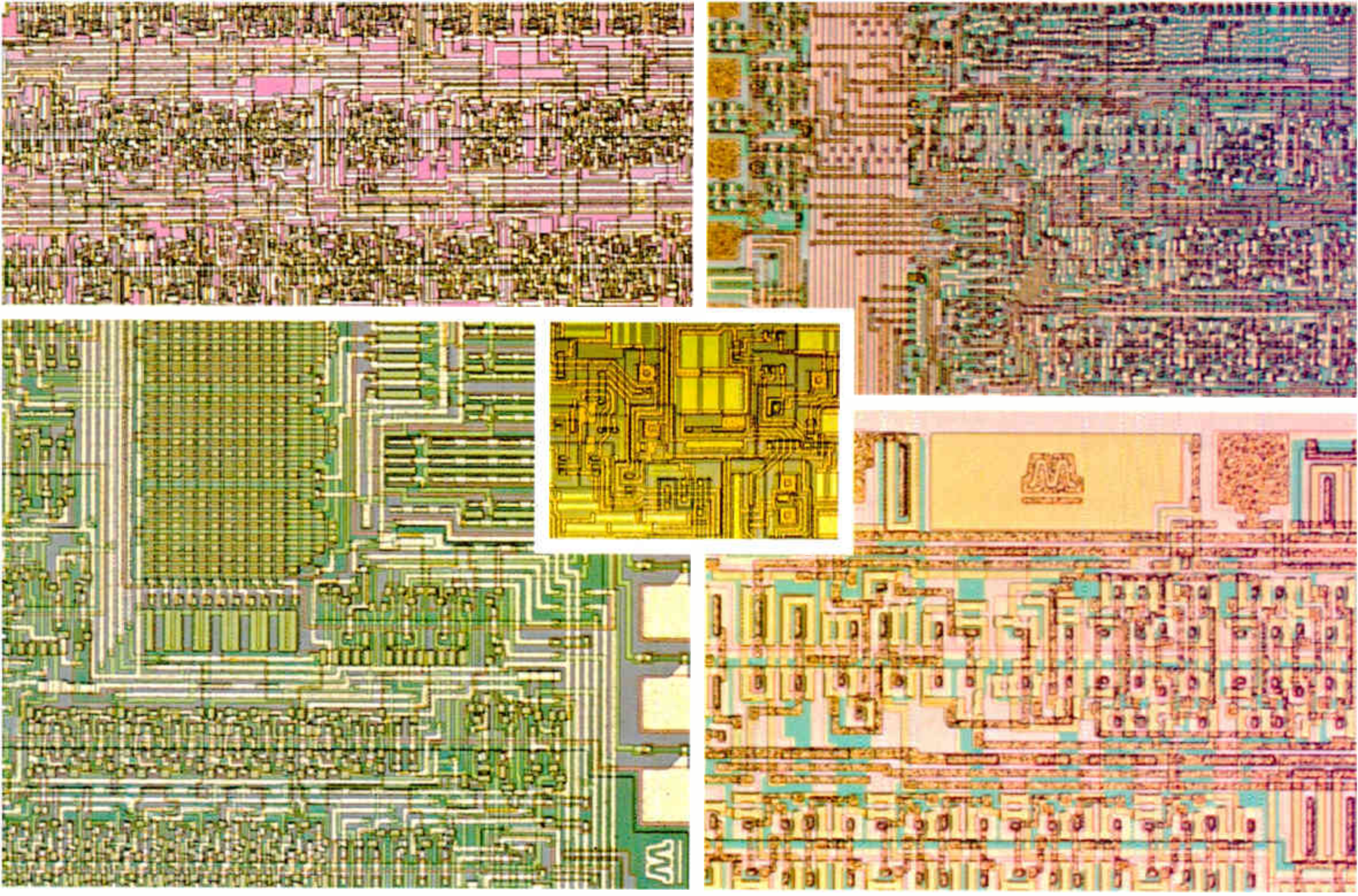
- In logic, to reduce the current 1-nanosecond delay per gate for complexities of 100 gates to 0.5-ns delays for 1,500 to 2,000 gates.
- In memory, to increase chip complexities from 4,096 bits with 200-ns access time to 1 megabit with 500-ns access.
- In geometry, to reduce minimum line width to 0.5 micrometer from the current 5 μm.
- In crystal perfection, to reduce the number of flows in single epitaxial crystals to 10 per square centimeter from the current 300/cm^2.
- In wafer diameter, to increase size to 6 or 8 inches from the current 4 in.

The VLSI program [*Electronics*, June 9, p. 99], started early in 1976, involves five companies and the Ministry of International Trade and Industry. The group's Computer Development Laboratory comprises Fujitsu Ltd., Hitachi Ltd., and Mitsubishi Electric Corp. The NEC-Toshiba Information Systems Inc. unit includes Nippon Electric Co. and Tokyo Shibaura Electric Co. Nippon Telephone and Telegraph Public Co. is not a member of the program, but funds its own VLSI effort. Its connection to the main program is, in effect, a consulting arrangement. It appears that the first group will develop IBM-compatible computers, the second noncompatible ones, Bucy says.

ment-restriction practices typical of less developed countries," the TI president says.

"Japan has liberalized its policy twice. In 1966, they permitted 50% foreign investment in selected electronic product industries. Then in 1969, they permitted 100% investments in the production of certain consumer equipment. This is a trend we should encourage, because it can give U. S. manufacturers fair access to Japanese markets just as we have given them access to ours."

To counter the threat of Japanese allocation of export markets, price fixing, or other trade constraints, Bucy also urges American producers to "insist that the U. S. government apply antitrust legislation evenhandedly" to all competitors for American markets. While certain sectors of Japan's electronics industries are exempt from the anticartel provisions of the Japanese monopoly law, violation of U. S. antitrust rules in U. S. markets should be subject to sanctions, he says. □



Microcomputer families expand, part 2: the new boards

by Raymond P. Capece, *Computers Editor*

☐ Chip makers, minicomputer manufacturers, analog-device houses, and all those hopeful independent suppliers—everyone with the slightest claim to a related expertise is scrambling to meet a growing demand for computers-on-boards. Each has a different angle.

Exploiting their newest microcomputer families to add to their boards' functions are semiconductor firms like Intel, Motorola, and Zilog. Busy scaling down minicomputer hardware and software to the board level are Digital Equipment and Data General, while plug-compatible analog input/output boards are pouring forth from Analog Devices, Adac, Data Translation, and others. And springing up like crocuses are a host of independent makers, offering boards that are plug-compatible with other manufacturers' products but that provide all sorts of additional functions.

As with the chip families discussed in Part 1 of this special report on microcomputers, by far the most popular computers-on-boards are the mid-performance-range 8-bit types, built around the one-board machines that started it all. Above them, the high-end 16-bit microcomputer boards are reaching the capabilities and performance of minicomputers; below, the low-end 8- and 16-bit versions seem certain to propel the boards into new control applications. Less easily classifiable is the wide array of specialty boards for dedicated applications, which the user can slip into his equipment with a minimum of hookup hassles.

Hassle-free design—that is what boards aim to offer, and many come close. From the engineer's viewpoint, it is certainly more expedient to build intelligent equipment around a microcomputer board or boards rather than around chips, since boards exact much less attention to particulars like signal timing, power-supply levels, and circuit layout.

Perhaps even more important, the board approach cuts the software problem down to manageable size. Several manufacturers in the field can supply their customers with low-cost, on-board software development aids such as monitors, editors, and even compilers for high-level languages. Some even have prototyping packages available that make the job of kicking off a microcomputer design about as simple as it can be.

As a result, no other approach beats a board implementation for getting a microcomputer-based product to market fast, with a minimum of engineering time and expense. In high-production volumes, of course, it may well cost more than a strictly chip approach—but for one-time-only designs, or for any product that does not warrant large development costs, it is unexcelled.

ONE-BOARD COMPUTERS

Since its introduction nearly two years ago, the one-board microcomputer has seen much play as a relatively easy-to-use controller. Loaded with processor, program memory, read/write memory, and input/output ports, by now it far outstrips hardwired logic control in popularity. Related families of special-purpose microcomputer adjunct boards are growing, too, but the number of strictly one-board solutions is greater than ever, especially since advancements in large-scale integration are rapidly multiplying the number of functions that a board is capable of carrying.

The next generation is expanding both upwards and downwards. The one trend is toward powerful, high-performance systems with additional functionality but at much the same cost as their predecessors. The other is to a universal controller that is easy to use both electrically and physically—a small board needing only one power supply and equipped with lots of I/O, all for a dramatically small price.

This low-end product market is now being supplied by several manufacturers, most notably Intel Corp. with its 8-bit models and Texas Instruments Inc. with its 16-bit machines.

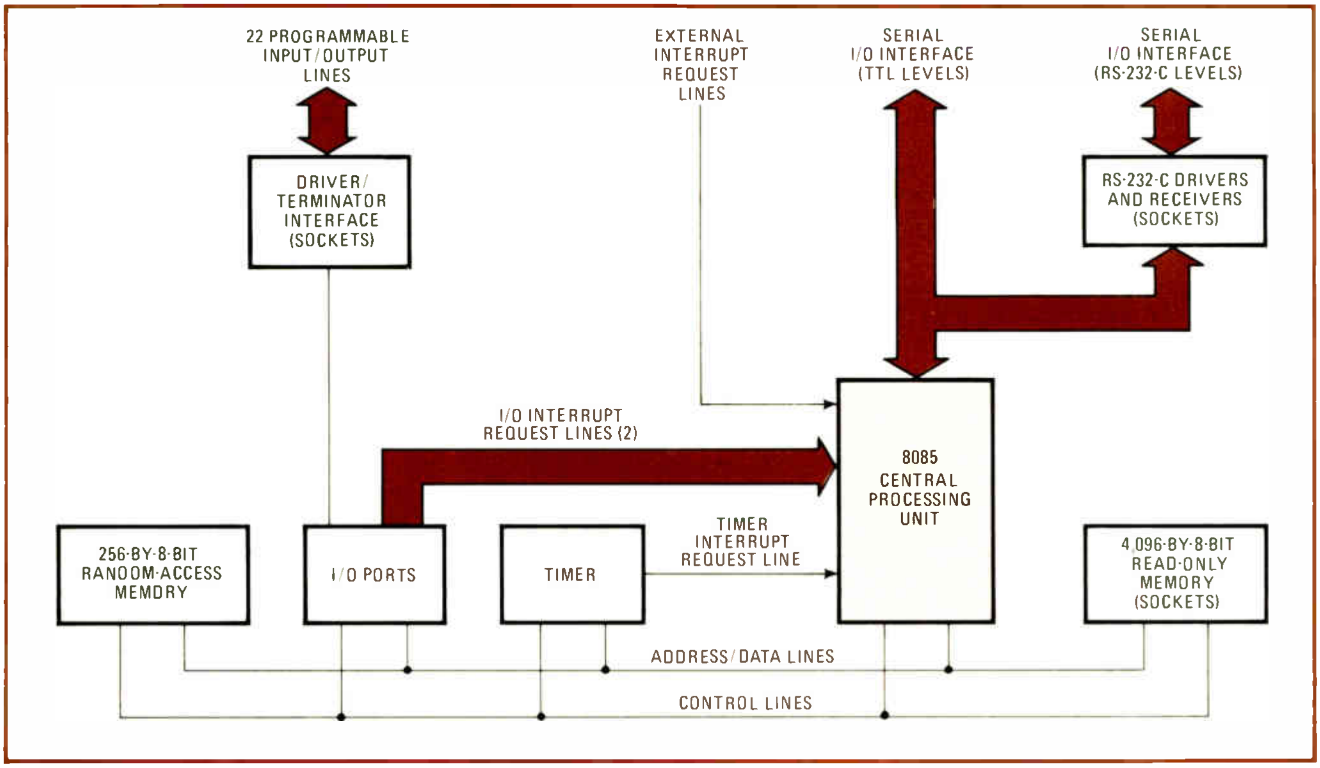
Intel's SBC 80/04, introduced this year, underlines the price decline. It has a single-unit price of $195, which drops to under $100 for original-equipment manufacturers buying in quantity. Yet it in no way falls off in functionality. Shown in Fig. 1, the 80/04 is built around the second-generation 8085 microprocessor (comprising processor, clock, system controller, and serial I/O port) and the 8155 256-byte random-access memory (with I/O port and timing functions), and it needs only a single 5-volt supply. Its board measures 6.75 by 7.85 inches.

One of the economies in the design of the 80/04 is the omission of any bus interfacing. This restricts its use generally to stand-alone applications, although its serial port and 22 programmable I/O lines can be used for modest communication.

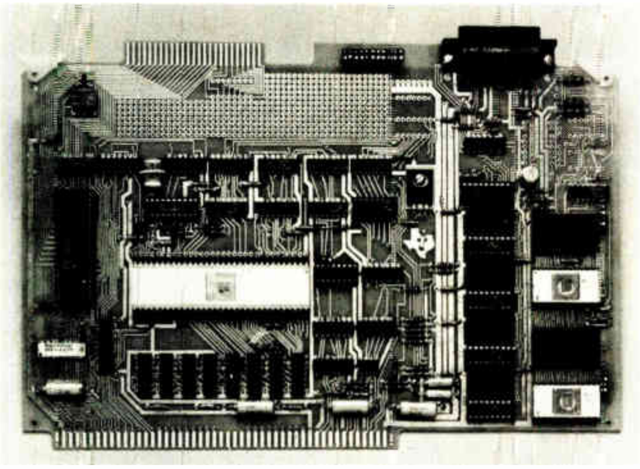
The low-end trend for 16-bit microcomputers was set by TI with its TM990/100M (Fig. 2), which sells in unit quantities for $450. Built around the 9900 microprocessor, the board includes 256 16-bit words of RAM, a serial I/O port, 16 lines of parallel I/O, and 1,024 16-bit words of erasable programmable ROM. Extra sockets on board allow RAM to go to 512 words and ROM to 4,096 words.

Several features set the TM990/100M apart from other board products. For instance, it has an area in its foil pattern intended for breadboarding of special interfaces or additional custom designing. Also, an erasable PROM can be shipped with a software monitor called TIBUG, a debugging aid that can be erased by the user once his program is up and running. OEM kits containing a four-slot chassis, connectors, and cabling are available, and other accessories include a calculator-like hand-held terminal for data entry.

Upward trends in performance of one-board microcomputers stem partly from increased on-board memory



1. Controlling costs. A one-board microcomputer from Intel marks a downward trend in the size and cost of 8-bit controller boards. Built around the company's 8085 microprocessor, the SBC 80/04 has the same instruction set as the 8080, fits all its functions onto a 6.75-by-7.85-inch board, and in quantity is priced below $100. Intended for stand-alone use, the board has no bus interface.



2. Pressure from above. A $450 16-bit microcomputer competing with the mid-range 8-bit types is Texas Instruments' 990/100M. Mounted on its 7½-by-11-inch board are TI's 9900 microprocessor plus memory, parallel I/O, serial port, and programmable timers.

capacity for both read/write and program storage and partly from faster and more powerful processors with more interrupts and more interrupt levels. Perhaps even more significant is the growing variety of interface capabilities. It seems that eventually such conveniences as high-speed direct-memory-access ports, analog voltage and current-loop inputs and outputs, and optically isolated ports—all under firmware control—will cease being spread among multiple-board families and will be consolidated into one-board products as LSI circuit density rises and hardware costs drop.

Such an upward evolution in one-board microcomputers can be seen, for example, in Intel's SBC-80 line (Table 1). From the 80/10 to 80/20, memory sizes doubled with increased chip integration, but more importantly both levels and sources of interrupts increased greatly in number. From a systems standpoint, a major advancement in the 80/20 was its bus's ability to interconnect several processors and give them direct memory access. Power consumption was also reduced. Next, the 80/20-4 doubled the amount of RAM on the 80/20 and added two on-board timers. Most recently, the 80/10-A enhancement of the first SBC one-board model doubled the erasable-PROM capacity by replacing the 2078 device with the newer 2758.

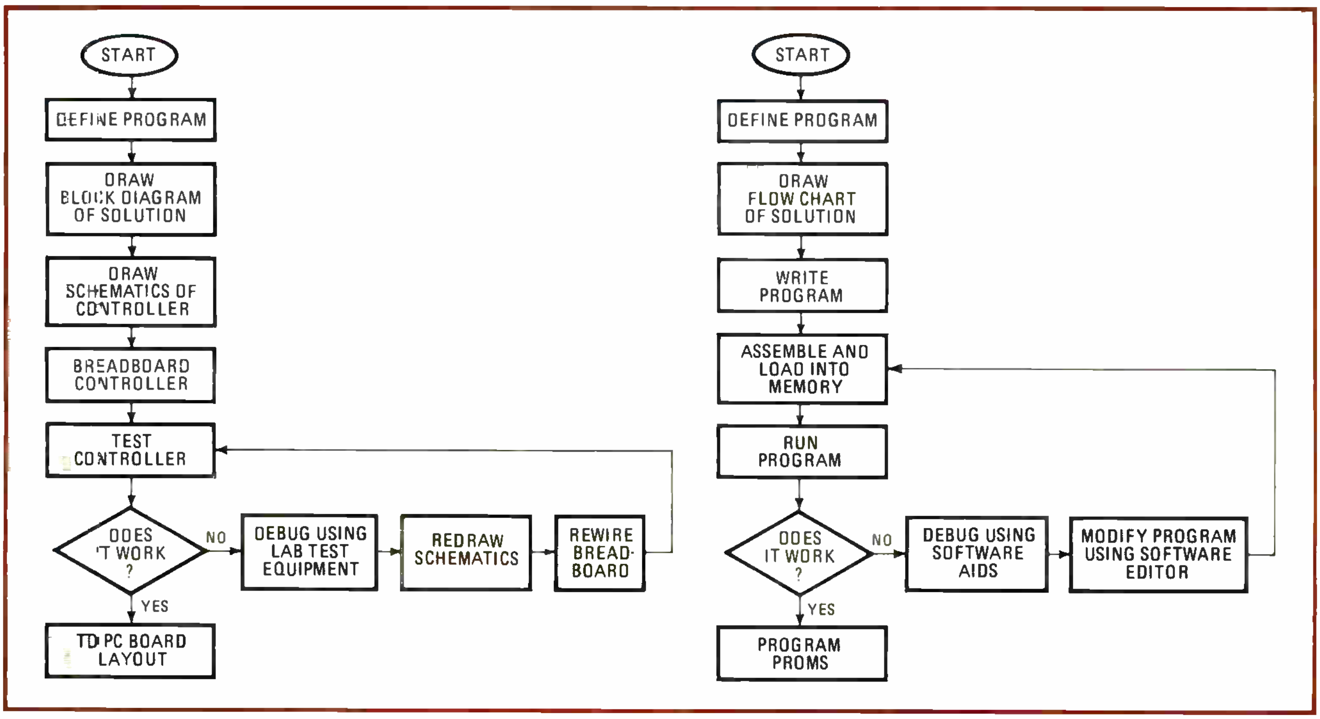
Some competitors

Comparable one-board microcomputer capabilities are available in Zilog Corp.'s Z80-MCB. Since its instructions are a superset of the 8080A microprocessor's, the Z80 is more powerful while still able to run 8080 programs.

The size of the microcomputer boards has come in for a lot of attention lately, and the 7½-inch-square-or-so Zilog board will undoubtedly have its advantages in some applications over the 6¾-by-12-in. Intel board. However, the I/O lines number only 16 versus Intel's 48.

Mostek Corp.'s SDB-80 single-board computer (called the OEM-80 if supplied without firmware) is also built around the Z80 microprocessor. Over and above the Z80-MCB's assets, the Mostek board is equipped with a separate scratch-pad RAM for the operating system (so as to free user main memory), four 8-bit parallel ports with handshaking capability, and three user-programmable timer/counter channels. All of which takes up quite a bit more board space—8½ by 12 in.

(Incidentally, National Semiconductor Corp. manufactures a plug-compatible version of Intel's SBC-80/10, called the BLC-80/10, for a bit lower price, though



3. Help available. Tinted areas show where designing a controller is time-consuming and vulnerable to error—unavoidably so in the case of hard-wired logic (left), whereas development aids can help a microcomputer implementation (right) past its programming problems.

On-board microcomputer development aids

For the one-time or occasional design, on-board development aids can save many manhours of programming and debugging time, at little extra cost beyond that of the microcomputer itself. During the prototype stage, a monitor program resident in microcomputer firmware is almost indispensable. Many suppliers therefore offer preprogrammed read-only memories or erasable programmable ROMs with a few kilobytes of monitor software.

Zilog, for example, ships most of its one-board Z80-MCBs with at least a 500-byte monitor system and offers more extensive monitors. Basically, the monitor allows a terminal connected via an RS-232-C or teletypewriter hookup to display memory and register contents in hexadecimal notation and to command the loading and execution of programs. Zilog's 3-kilobyte monitor adds several commands and a disk controller that, when used with the MDC memory/disk controller board in Zilog's family, allows for disk-based software development.

Intel makes its system monitor available as part of prototyping packages that, in addition to a one-board computer, include a card-cage and backplane and teletypewriter adapter. Resident in an erasable PROM, the monitor occupies 4,192 bytes on either two or four chips.

But far and away the most on-board firmware-resident development aids are offered by Mostek's one-board microcomputer. An operating system in a 2,096-bit ROM chip serves both as controller and monitor and can be purchased together with a listing of source code mnemonics and manual for $75. A more extensive system consisting of a four-chip set adds a text editor with full random access to character strings, an assembler that accepts the Z80 mnemonics and generates machine code, and a linking loader that allows programs to be written in blocks that can be relocated into memory for execution in proper order. The whole package is well worth $300 when compared with the cost of disk-based outboard development systems or software that must be cross-assembled on a host computer.

For its TM 990 family of 16-bit microcomputers, Texas Instruments sells a $100 erasable PROM preprogrammed with an interactive debugging monitor that it calls TIBUG. An additional $100 buys an erasable PROM containing a line-by-line assembler that lets the user write his programs in the mnemonics of the 9900 microprocessor.

nearly all the features of the BLC and SBC family lines are identical.)

Motorola's Microsystems division in Phoenix has been producing its 6800-microprocessor-based board for over a year. The original design, designated the M68MM01, includes 1,024 bytes of RAM, sockets for up to 8,192 bits of ROM, and three peripheral-interface adapters that provide a total of 60 input or output lines. Making up the 60 are: 24 programmable I/O lines; six interrupt inputs, three peripheral-control outputs, and three other lines that can be either; 12 buffered parallel-data output lines; and 12 buffered paralled-data I/O lines.

Motorola's other one-board, the M68MM01A, sacrifices one of the programmable interface adapters to add an asynchronous communications interface adapter, which allows exchange of data serially, for instance, in the RS-232-C protocol. The number of parallel I/O lines is therefore reduced to 40—the A version's only inferiority to the M68MM01.

It is worth noting that, apart from Intel's 80/04, all these one-board microcomputer have bus interface capabilities that allow them to be expanded into systems. Although each manufacturer has designed his bus to his own specifications, each bus has become a standard in its own right and is in effect a solid basis for development of a microcomputer systems approach.

MULTIBOARD COMPUTERS

While single-board computers are gaining low-end design sockets, the multiboard microcomputers take many minicomputer applications in their stride. Since ROM capacities have risen to 8,192 bytes on the processor board and lots more on extension boards, programs of several hundred lines are not uncommon. Today, sophisticated control applications, such as automatic testing or process control, can be realized with just a few boards from most of the common 8-bit microcomputer families. Whereas a complicated controller designed with hard-wired logic would lie for an extended period of time in the prototyping and wiring phases, a multiboard microcomputer solution can be ready almost as soon as its program is written. Figure 3 shows the snags in both such approaches. Unquestionably, large development systems, with their diskette-based software, editing and

TABLE 1: SINGLE-BOARD COMPUTERS

Manufacturer	Product	Microprocessor	Bits
Intel Corp.	SBC 80/04	8085	8
	SBC 80/05	8085	8
	SBC 80/10	8080A	8
	SBC 80/10A	8080A	8
	SBC 80/20	8080A	8
	SBC 80/20-4	8080A	8
National Semiconductor Corp.	ISP-8C/100N	SC/MP	8
	BLC 80/10	8080A	8
	IMP-16C/400	IMP-16	16
Motorola Inc.	M68MM01	6800	8
	M68MM01A	6800	8
Zilog Corp.	Z80-MCB	Z80	8
Mostek Corp.	SDB-80	Z80	8
Texas Instruments Inc.	990/100M	9900	16
	990/4	9900	16
Computer Automation Inc.	LSI 4/10	custom 2-chip set	16

monitoring capabilities, and emulation, can speed programming; but for starters, simple tools can make a big difference (see "On-board microcomputer development aids" on opposite page).

As for the 16-bit families, being essentially barest-bones minicomputers, they have found their way into dedicated high-performance applications. For now, the price and performance gap between 8- and 16-bit microcomputers permits separate discussion of the two. But the expected announcement of 16-bit microprocessors by the 8-bit makers will undoubtedly blur the distinction within the next year or so.

The various board products for both 8- and 16-bit families are summarized in Table 2, and from the long list of board components in several of the families, it can be concluded that lack of hardware is unlikely to be a problem in choosing a microcomputer system. Rather, identifying the family with the right attributes for a given job is more likely to be the difficulty. For instance, familiarity with the 8080 could sway customers to Intel's products, but the Z80 microprocessor, with 80 instructions in addition to those the 8080 set—and a faster cycle time, to boot—makes a good case for the Zilog and Mostek microcomputers.

The immediate family in all 8-bit board products that are built around single-board computers includes extensions for both program and main memory and for I/O. Several manufacturers offer combinations of RAM and ROM in different mixes and sometimes with additional I/O expansions. Intel even equips its SBC line with a 4,096-byte RAM extension having on-board battery backup: it can retain data for 96 hours when the system is powered down. Zilog has a combination board that puts 12 kilobytes of RAM at the disposal of a floppy-disk controller. This arrangement allows for flexible memory management, since the RAM can be used to buffer data between microcomputer and floppies, up to eight of which can be accommodated.

TABLE 2: MULTIBOARD FAMILY LINES

	Intel's SBC	Motorola's MM	National Semiconductor's BLC	Zilog's MCB
Single-board microcomputer with RAM, ROM, and I/O				
Processor-only board				
ROM board				
RAM board				
RAM board with battery backup				
RAM/ROM board				
Memory and I/O board				
General-purpose parallel-I/O board				
Programmable parallel-I/O board				
Optically isolated I/O board				
Combined parallel/serial – I/O board				
Serial - I/O board				
Communications board				
Direct-memory-access controller board				
Analog input board				
Analog output board				
Combined analog - I/O board				
Memory/disk controller board				
PROM/erasable-PROM programmer board				
Video display board				
Fast math board				
Blank prototyping board				

Source: Electronics

Many versions of digital I/O expansion exist, both for serial and parallel data. Some are general-purpose, but the programmable I/O boards made by most of the manufacturers are far more flexible. They have vectored interrupts and also afford handshaking capabilities that permit one port to control the communication between an adjacent port and a remote one. The best serial I/O boards have four or more independently programmable ports, which can be tailored to any of the common protocols. The widest variety of peripheral equipment is accommodated by those that provide different parity-bit formats and independent baud rates in each of the ports,

Instructions	Random-access memory capacity (bytes)	Read-only memory capacity (bytes)	Serial I/O ports	Parallel I/O lines	Interrupts		Timers	Power requirements (A)				Size (in.)
					Levels	Sources		+5 V	+12 V	−5 V	−12 V	
78	256	4,096	RS-232-C	22	4	4	1	0.6	–	–	–	6.75 x 7.85
78	512	4,096	RS-232-C	22	4	12	1	1.8	–	–	–	6.75 x 12
78	1,024	8,192	RS-232-C or TTY	48	1	6	0	2.9	0.14	0.002	0.175	6.75 x 12
78	2,048	8,192	RS-232-C or TTY	48	1	6	0	2.9	0.14	0.002	0.175	6.75 x 12
78	2,098	8,192	RS-232-C	48	8	26	2	4.7	0.1	0.001	0.025	6.75 x 12
78	4,096	8,192	RS-232-C	48	8	26	2	4.7	0.1	0.001	0.025	6.75 x 12
46	256	512	TTY	8	1	1	0	0.75	–	–	–	4.375 x 4.862
78	1,024	8,192	RS-232-C or TTY	48	1	6	0	2.9	0.15	0.002	0.150	6.75 x 12
43	1,024 words	1,024 words	–	16	1	1	0	2.25	–	–	0.5	8.5 x 11
72	1,024	2,048	–	60 max	–	9 max	1	1.1	0.26	–	0.18	5.975 x 9.75
72	1,024	8,192	RS-232-C	40 max	–	8 max	1	1.3	0.26	–	0.18	5.975 x 9.75
158	4,096	4,096	RS-232-C or TTY	16	–	8	3	2.0	–	–	–	7.7 x 7.5
158	16,384	20,960	RS-232-C or TTY	32 max	–	10	3	1.5	0.175	–	0.100	8.5 x 12
69	512 words	4,096 words	RS-232-C or TTY	16	15	17	2	1.2	0.2	–	0.1	7.5 x 11
69	4,096 words	1,024 words	–	16	8	8	0	1.12	0.64	–	–	11 x 14.5
85	4,096 words	3,072	4 channels for distributed I/O		6	6	1	5.4	–	–	–	7.5 x 17

as well as for either synchronous or asynchronous data.

Even optically isolated digital I/O expansion puts in an appearance, as an option for Intel's SBC 556 board. With 24 fixed input lines (16 fixed output lines, and 8 programmable either way), the board is especially useful in industrial environments. It circumvents ground-loop problems, accepts inputs of up to 48 V, and has both current and voltage outputs.

A few board manufacturers also offer a high-speed direct-memory-access controller, which, though, is needed less with 8-bit microcomputers than in the high-performance 16-bit area. With transfer rates to or from RAM as high as a million bytes per second, DMA boards give the most use in systems with large data bases and thus greatly expanded memory, best handled by such 16-bit machines.

HIGH-PERFORMANCE 16-BIT MACHINES

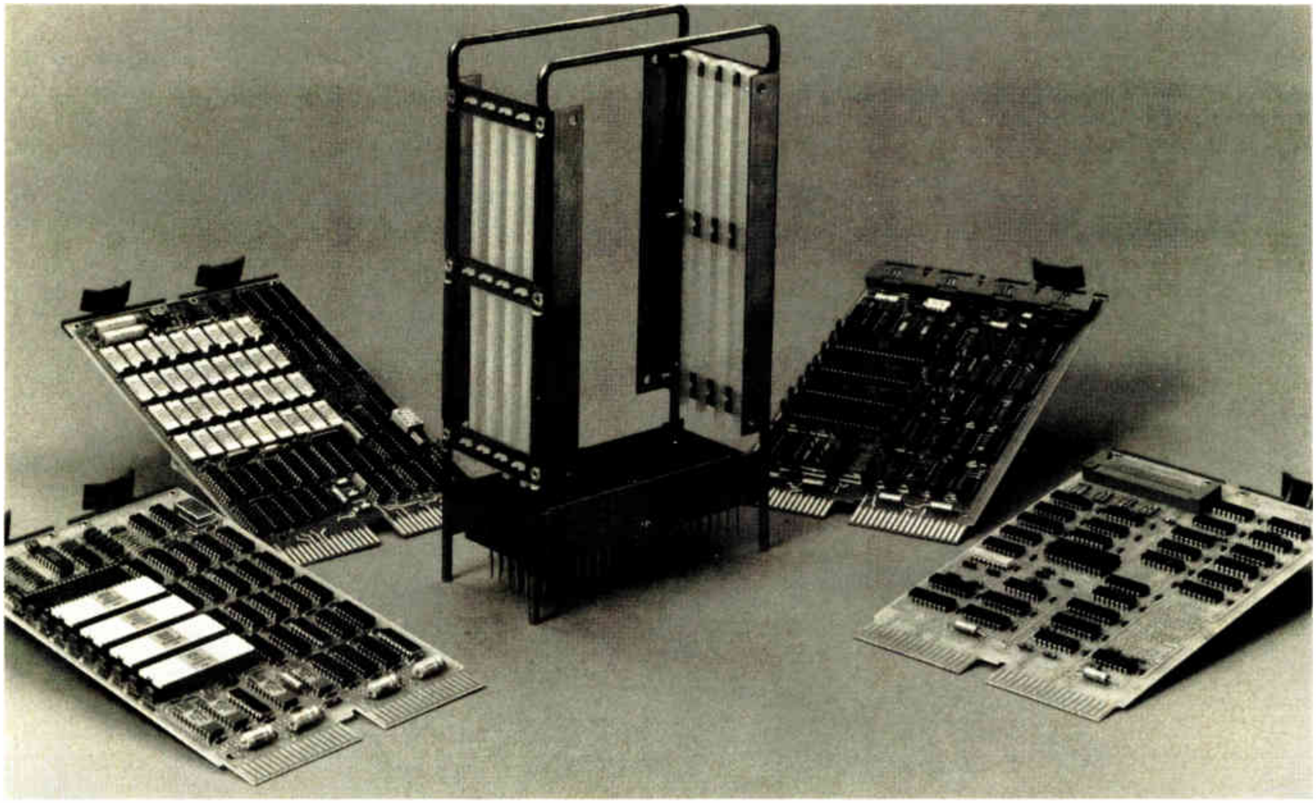
Being descended from minicomputer technology, as almost all 16-bit multiboard computers are, they generally require more powerful software development tools than 8-bit machines, often needing a minicomputer with disk-based software for their design. They are, after all, capable of high-speed calculations, large data-base manipulations, and fast throughput I/O, for which on-board development aids would be less than adequate.

But descendants are sometimes also heirs, and certainly those 16-bit models from minicomputer manufacturers inherit a handsome quantity of mature applications software that has been thoroughly field-tested on the larger equipment. Thus board microcomputers from Digital Equipment Corp. and Data General Corp., for instance, almost guarantee long-term serviceability—and can talk to minicomputers besides.

DEC's LSI-11, having found its way into tens of thousands of systems, is now being retired in favor of its recently announced successor, the LSI-11/2. Not only does the LSI-11/2 halve the board size exactly and add to the features of the LSI-11, it even undercuts the older model in price.

DEC sees the reduction in board size, or form factor, as a definite trend brought on by falling hardware costs and rising circuit density. The tiny card-cage of the LSI-11/2 (Fig. 4) has slots for up to four cards—which is not the restriction it seems, since the four can contain the functions of up to 16 of the larger LSI-11 boards. The smaller boards can do it because of their multilayered printed-circuit construction. In addition, they have been reconfigured: whereas the processor board of the LSI-11 included up to 4 kilobytes of RAM, the 11/2 CPU board contains no memory at all. DEC explains that most users prefer their own memory configurations, and the company therefore elected to pack all the 11/2 RAM on a board that uses 16,384-bit chips to hold up to 32,768 16-bit words.

A major goal of the LSI-11/2 design is to give the user



4. Form factor slashed. DEC's second-generation microcomputer board family, the LSI-11/2 is exactly half the size of the LSI-11, yet offers more functions for less money. Shown are the line's first boards: processor, memory, serial-line interface, and IEEE-488 interface.

more flexibility. In an about-face, DEC is now encouraging purchases of the processor board only. There are even extra holes on the board near the edge connector that will facilitate wiring the boards in the Eurocard vertical-stacking format widely used in Europe.

Other boards in the 11/2 family thus far are a serial line unit and an interface board. The first of these contains four completely independent programmable interfaces for synchronous or asynchronous operation and offers fully programmable baud rates and parities. The interface card is for the IEEE-488 standard instrumentation bus.

DEC will follow up with more boards for its smaller microcomputer as it begins phasing out the LSI-11. Those adjunct boards that are critical to many LSI/11 applications, like the analog I/O board, can be expected out early next year.

Data General's microNova line, just over a year old, has acquired both hardware and software enhancements over the past few months. An analog I/O board has been added to its family, as well as several interface boards for various communications protocols and for interfacing to peripherals like paper-tape readers. Most important, though, are the software packages being passed down from the company's minicomputer line that now extend the microNova's applicability into industrial, communications, and small-business applications.

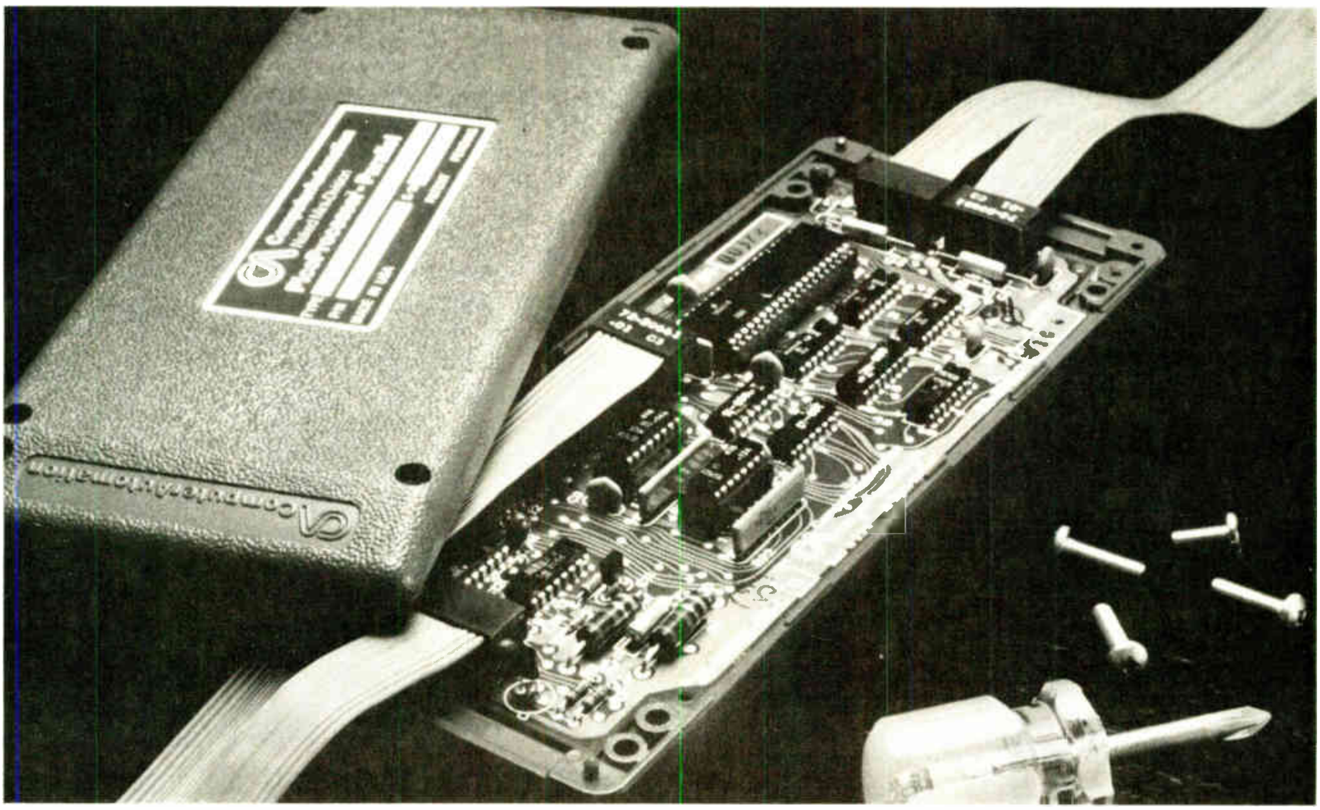
Data General's sensor-access manager, for example, is a program of device handlers and subroutines for control of I/O transfers between user programs and analog and digital sensors. Tested extensively in minicomputer systems, it can do the same sorts of jobs for the microcomputers. When used with the new analog I/O board in Data General's data-acquisition and control chassis subsystem, the manager program can shorten the time it takes to design interfaces for process-control systems.

Communications interface boards for the microNova include a synchronous line controller, an asynchronous multiplexer, and a cyclic-redundancy-checking (CRC) board. These can be used with diskette-based software that supports several protocols and provides compatibility with IBM's remote-job entry systems, including RJE80 and HASP II.

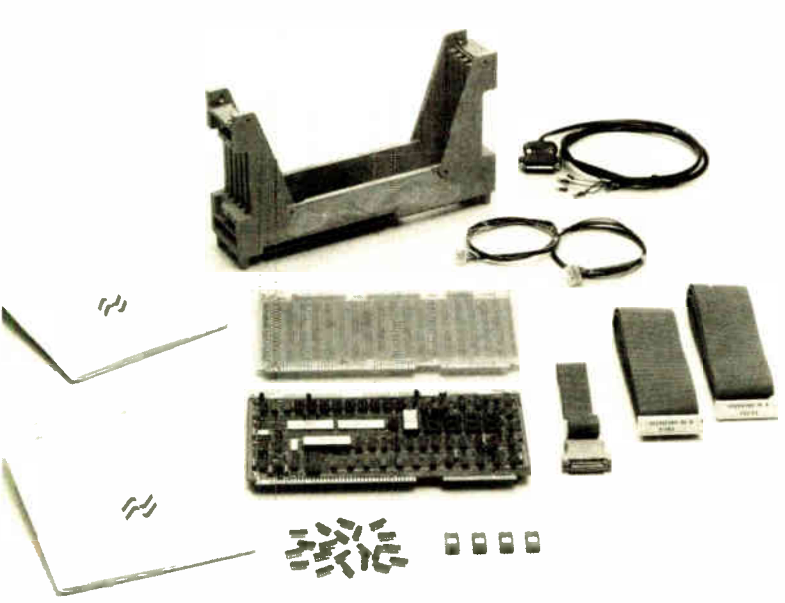
Finally, a diskette-based Business Basic compiler allows the microNova to be used in small business and other commercial systems.

Two more 16-bit types

Like the microcomputers from DEC and Data General, TI's 990/4 is a board version of a minicomputer, TI's 990/10. The 990/4, however, can function also as a one-board microcomputer, since it has room for up to 4,096 16-bit words of RAM and up to 1,024 words of RAM and/or PROM for program storage. An extended system can be built in a three-slot chassis, with an additional memory board, expandable to 32 kilowords, and a communications register board for interfacing with various protocols. Unique to the 990 processors (all built around the 9900 chip) are 16 extended-operation instructions, which allow special hardware execution of complex arithmetic and logical operations that are less well suited to software implementation. This extension is



5. Distributed I/O. Computer Automation's solution to the interfacing problem is unique: intelligent cables having small boxes mounted on them. Hardware in a box can hook each I/O port on the firm's LSI 4/10 16-bit microcomputer to up to eight assorted peripherals.



6. Starter kit. This prototyping package for National Semiconductor's BLC 80 family provides everything a user needs to design a fully functioning microcomputer at the board-level: one-board computer with memory chips, prototyping board, card-cage, cabling, and system monitor software in programmable read-only memories.

especially useful in high-speed signal-processing operations, such as fast Fourier transforms.

Computer Automation Inc., Irvine, Calif., came out this year with microcomputer boards that are a low-end version of its Naked Mini series and use a two-chip custom microprocessor set. Like the firm's minicomputer boards, the microcomputers offer what Computer Automation calls distributed I/O, which allows each of four ports on the board to interface to up to eight peripherals of a wide mix.

The same firm is the only one to make intelligent cables—an interconnecting ribbon cable that has a small box called a Picoprocessor mounted on its middle to house ROMs, universal asynchronous receiver/transmitters, or even microprocessors (Fig. 5). Among the various intelligent cable types are interfaces that connect Computer Automation machines to printers, disk drives, teletypewriters, and even other computers. Why bother with intelligent cables? Well, they free the central processor of all interfacing chores, and in reconfiguring systems, only the cable need be changed to match up the equipment on either of its ends—the microcomputer's operating system remains intact.

SPECIAL-PURPOSE BOARDS

In almost all microcomputer families the variety of boards is mushrooming, as one special-purpose board after another is developed to increase the functionality of the line. These adjuncts began first as extensions, then as I/O enhancements, including direct memory access and digital and analog I/O, and finally have branched into more dedicated interfaces and miscellaneous functions.

The most welcome of all additions are probably the analog I/O boards, which at last allow the microcomputers to talk to the real world (or at any rate the electrical world). Of the microcomputer manufacturers themselves, Intel, Zilog, Mostek, DEC, Data General, in fact nearly all of them make an analog board or have one on the way. Those that do not are most likely covered by a small-systems manufacturer or by the analog-components manufacturers, such as Burr-Brown Research Corp., Adac Corp., Data Translation Inc., Datel Systems Inc., Analog Devices Inc., and Analogic Corp.

The availability from the analog houses of analog I/O boards compatible with a particular microcomputer line is a good indication of the line's success. Nearly half a dozen such products can be had for Intel's SBC family; Burr-Brown supplies the board for Motorola's MM6800 products; and Analog Devices has recently announced its version for Texas Instruments' TM 990 family.

The analog boards, which may be input only, output only, or combinations of both, hold a-d and d-a converters, multiplexers, and some memory and are completely programmable by the host microcomputer. A particular analog I/O board must be checked carefully to ensure that it suits the specific application—some input boards, for example, offer no low-level inputs (±10 millivolts nominally) of the kind that allow direct hookup of sensors and thermocouples. Others are restricted in their limits of common-mode voltage rejection for balanced inputs. Most will offer voltage inputs (usually ±10 v nominally) with current-loop input capability available from optional input resistors since signals are carried over current loops. The number of single-ended lines, as well as the capability for paralleling two lines for balanced inputs, may be critical in some applications.

Other special-purpose boards include a group for interfacing, like those from Mostek and Zilog that hook the microcomputer to a cathode-ray tube for display, to a floppy disk for storage, and to other peripherals such as printers and terminals. Several of the higher-performance microcomputers offer high-speed DMA interfacing and I/O for achieving throughputs of a million words or more per second.

Another special-purpose board handles fast mathematics. In crunching through high-speed single- and double-precision additions and multiplications in hardware, these boards unburden the host microprocessor of the software arithmetic that in any case it performs less than admirably. Signal processing often requires hardware multiplications of at most a few microseconds—a speed unrealizable by the microprocessor alone.

Where to begin? At the beginning, with a prototype package, which is offered by most manufacturers. These kits, like the one in Fig. 6, start with the basic one-board computer, card-cage, ROM monitor, cabling, and an interface to a teletypewriter for keying in the program. ☐

Reprints of the two-part article on microcomputer chips and boards cost $4.00 from Electronics Reprint Dept., P. O. Box 699, Hightstown, N. J. 08520. The first part covering chips appeared in the Dec. 8 issue. Copyright 1977, Electronics, a McGraw-Hill publication.

Rapid writing rate lets storage oscilloscope grab 1-nanosecond single-shot signals

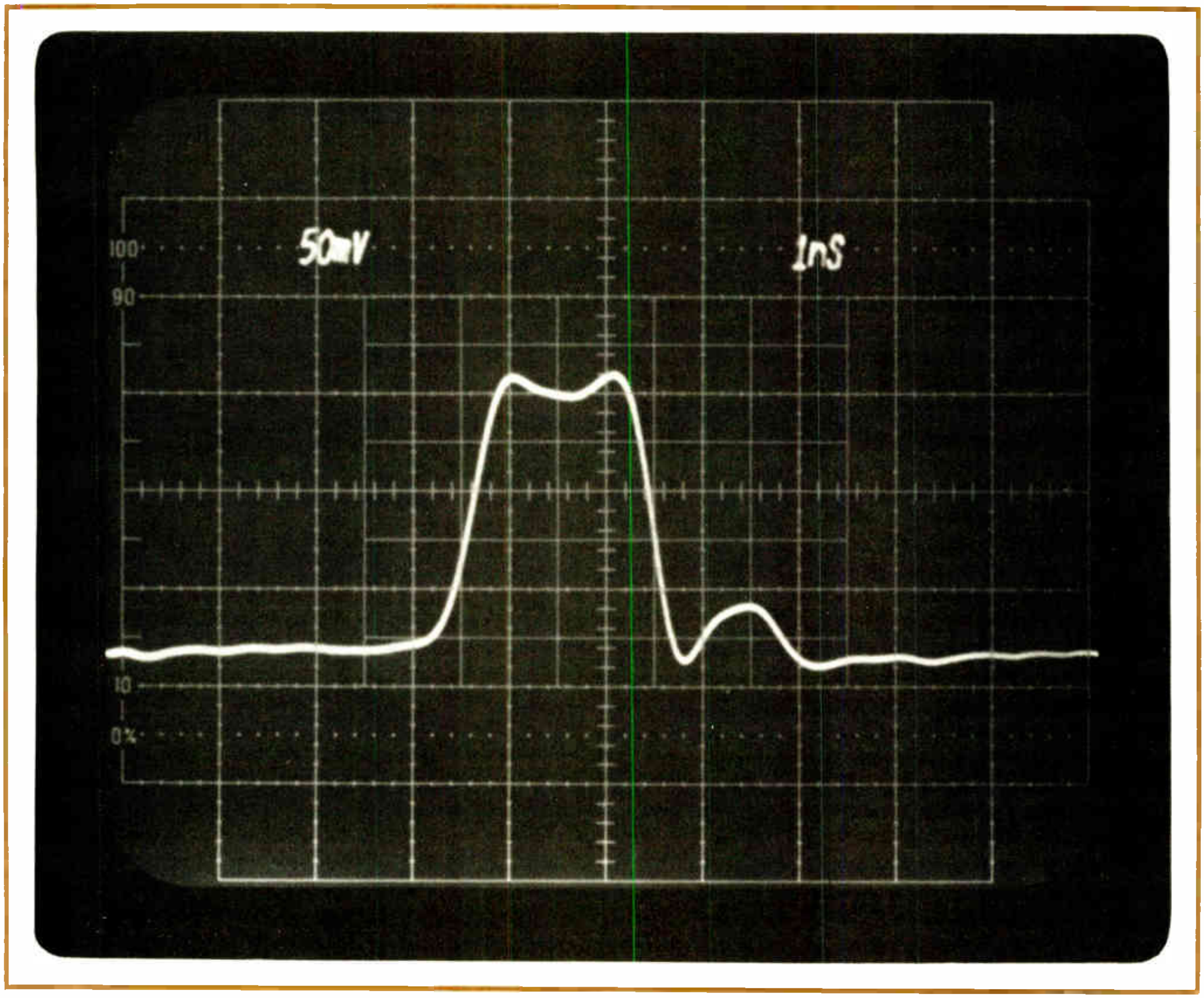
by Ken Hawken, Keith Taylor, and Hale Farley, *Tektronix Inc., Beaverton, Ore.*

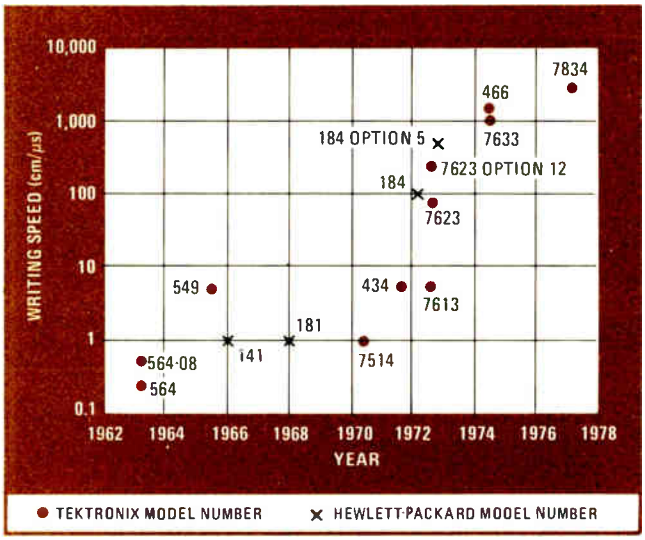
☐ There's no better way to catch fast single-shot signals and those with very low repetition rates than an oscilloscope with a storage cathode-ray tube. Still, such scopes must combine a storage time long enough to allow meaningful measurement with a writing rate fast enough to catch the signals.

Advances in direct-view storage cathode-ray tubes have met this challenge. Now, recent improvements in the electron-gun structure and focusing system of such CRTS have pushed the storage writing rate up to 2,500 centimeters per microsecond. Such a fast speed means that single-shot signals with 1-nanosecond rise times can be displayed clearly (Fig. 1).

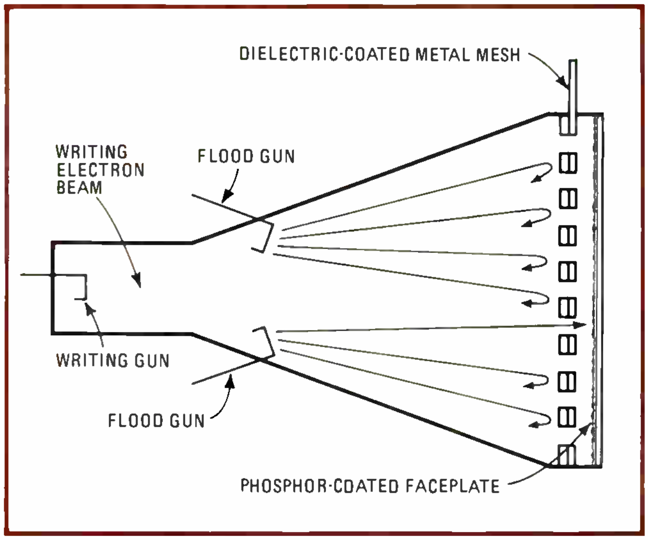
The writing speed of the newest direct-view storage

1. Fast grabber. With a 2,500-cm/μs writing speed, storage scope can display pulses with rise times that are less than 1 nanosecond.





2. Speed improvements. Latest direct-view storage cathode-ray tubes are about 150% faster than previous models. Furthermore, the stored traces can be viewed for longer time periods, so they can be easily photographed with an oscilloscope camera.



3. Basic storage. The storage cathode-ray tube uses a wire mesh near the faceplate. When writing-gun electrons strike the mesh, they dislodge electrons, leaving a net positive charge at those sites. Flood-gun electrons then pass through screen and strike the phosphor

scope is about 2½ times that of earlier models (Fig. 2). The stored rates are viewable for tens of seconds in the variable-persistence mode and for tens of minutes in the bistable mode. Thus, they are easy to photograph, even with an inexpensive oscilloscope camera.

The 2,500-cm/μs speed compares with the fastest photographic writing speed available in nonstorage scopes. However, the photographic approach is often time-consuming and inconvenient, and if the event is missed, there may not be a second chance. An alternative approach is digitizing techniques, but they tend to be expensive at high speeds.

Faster stored writing rates

The key to capturing fast signals is the writing rate (see "Obtaining the stored writing rate," opposite). The fastest storage scopes use a transmission CRT in which the image is captured by a storage mesh grid, rather than being stored directly on the bistable faceplate phosphor (Fig. 3). The mesh has a dielectric coating on the side facing the stream of electrons coming from the writing gun and flood guns. It is biased negative with respect to the flood-gun cathodes, so they are usually repelled by the mesh.

Writing-gun electrons land on the dielectric surface and, by secondary emission, dislodge electrons, which are drawn away. This activity leaves a net positive charge at the image locations traced by the writing gun, so mesh apertures along this waveform trace are open to electron flow. Flood-gun electrons pass through these open apertures to produce a trace on the CRT screen.

The decay time of the stored pattern on the transmission grid is determined by the dielectric coating material and the mesh bias. However, there is an inherent tradeoff between writing rate and stored viewing time: the faster the writing rate of the dielectric chosen, the faster the stored image will decay.

To minimize the tradeoff, another mesh grid is added, producing a transfer-storage tube. Now the writing beam first strikes a grid coated with a dielectric chosen for a fast writing rate. Before the image can decay, bias-control pulses are applied to the grids to allow the flood guns to transfer the image to the second grid, which has a dielectric selected for long image retention. This second grid can be biased to produce either bistable or variable-persistence storage.

Better guns and focusing

As well as a 2,500-cm/μs stored writing speed in the variable-persistence mode, the recent scope refinements achieve 350 cm/μs in the bistable mode. At the same time, they result in improved vertical- and horizontal-deflection sensitivities required to extend bandwidth to 400 megahertz.

An improved gun structure delivers greater charge density to the high-speed storage mesh. Increased writing-gun voltage improves secondary-emission yield and reduces space-charge spreading of the writing beam. Independent X and Y focusing systems, together with a vertical-only scan-expansion lens, obtain the required vertical-deflection sensitivity. The improved gun structure and focusing system result in narrower trace width for the same beam current.

Additional gain in stored writing speed comes by improving the uniformity of the display's background. A more uniform background is achieved by computer design of the flood-gun system to improve collimation of the flood electrons at the storage meshes.

High-speed digital applications

The capacities of the fast direct-view storage scopes will be particularly useful in the growing number of applications of emitter-coupled logic and Schottky transistor-transistor logic. In such applications, there are several situations in which it was quite impossible to view signals before.

One problem area is asynchronous systems involving fast pulses that may not repeat or that will have a repetition rate measured in seconds. Another is sequences of fast data pulses or fast control pulses that do not repeat.

Glitches pose problems too. Fast sporadic glitches can result from sliver pulses caused by race conditions. Other glitches can result from noise caused by current transients on power supplies, fast transients coupling between closely spaced signal lines, and ringing or other distortions on improperly terminated signal lines.

Another situation is pulses resulting from automatic testing of fast digital components. Because hundreds of tests may be performed at high speeds, the test sequence is usually not repeated for a given component. During component development or characterization, however, it may be necessary to observe in detail a particular failure mode. A final problem area is any sporadic failure in high-speed digital circuitry that precludes looping on the failure sequence to produce a repetitive signal.

Even when the signal is repetitive, fast storage often proves useful. When conventional oscilloscopes are set for sweep rates of 10 ns per division or faster, the trace can become progressively dimmer as sweep rate increases. With storage, a clearly visible trace can be produced by adjusting the persistence control to produce an easily viewed display. A particularly common case is the missing vertical segment of the trace on fast-switching digital waveforms. At the proper persistence setting, the rise and fall times are visible. Also, storage makes it possible to compare signals that occur at different times.

Take the case of a signal line switching from a fast clock to a slow clock (Fig. 4a). Two counters in different parts of the system but both driven by the clock must maintain equal counts. One counter is near the clock driver, and the other is at the end of a transmission line. At times the counters can get out of step after switching from the fast clock to the slow clock. The switching commands are not in synchronization with the fast and slow clock oscillators, and the oscillators are not in sync with each other. So there is no way to view the signals as a repetitive phenomena.

Fast storage to the rescue

By synchronizing a fast storage oscilloscope on the switching command, however, it is possible to display the transition period from fast to slow clocks. What's more, the display can be retained for long enough to study it.

If both clocks are high at transition time, a small negative-going glitch appears on the clock line (Fig. 4b). This glitch, caused by the fast clock turning off slightly faster than the slow clock turns on, is detected by the counter near the clock driver. Distortions caused by the transmission line, however, prevent the glitch from going far enough negative to be detected by the second counter, which would give a count difference.

This glitch could probably be detected using a fast-writing nonstorage oscilloscope and a viewing hood. At best, however, that technique is an excellent way to produce severe eyestrain — blink and the sweep is missed. Moreover, it is hard to be sure just what was seen during the sweep's brief duration. With storage, the image is retained in its entirety.

Another broadly useful glitch-catching application of fast storage occurs when it is used with a logic analyzer. With the word recognizer of a logic analyzer set to trigger on a known erroneous parallel word, one cause of error would be a glitch on one or more of the signal lines at a time preceding the detected error. Setting the logic analyzer to the pretrigger mode permits study of a block of data for the time before the error. Logic analyzers are available for viewing more than 1,000 clock cycles preceding the error. If the error-causing glitch is very

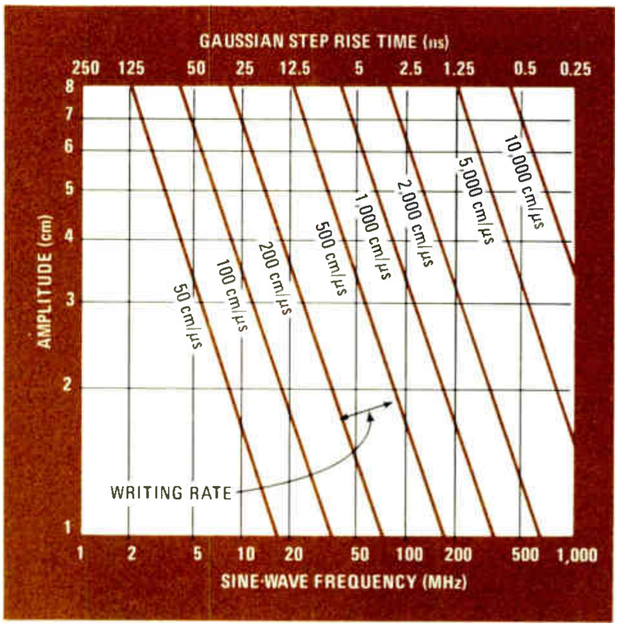
Obtaining the stored writing rate

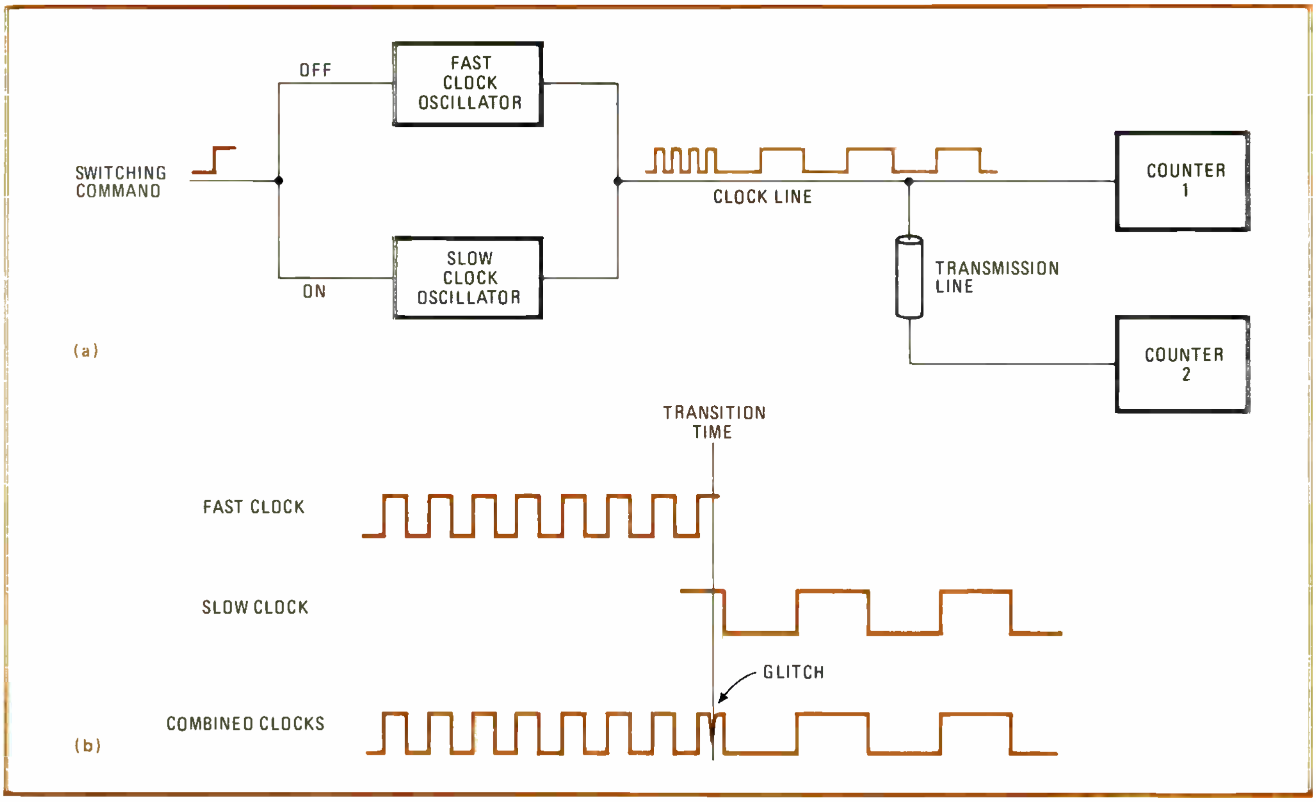
The stored writing rate of a storage oscilloscope is simply the highest rate of spot movement that will leave behind a stored image on the face of the cathode-ray tube. Faster spot movement will not leave an image, as in step-response displays with no vertical edges or sine-wave displays with the zero-crossing edges missing.

Two equations provide a measure of the stored writing rate required to properly record a single-shot signal. For a sine wave where the sweep rate is much slower than the beam's writing rate, then the stored writing rate (cm/μs) = π f A, where f is the frequency in megahertz and A is the peak-to-peak amplitude in centimeters.

For pulse or step responses, the stored writing rate (cm/μs) = kA/t_r, where t_r is the 10% to 90% rise time in microseconds. Here, k is a constant ranging from a value of 0.8 for a linear ramp to 2.2 for a single-pole RC response. A value of k = 1 applies to the case of a Gaussian (typical step) response.

The required stored writing rate can be obtained from the equations or from a graph such as the one shown. For example, a Gaussian step response with a 1-nanosecond rise-time and a 2.5-cm amplitude requires a 2,500-cm/μs stored writing rate.





4. Glitch catcher. In this application, two clocks drive a system, and two counters, one local and one remote, monitor the counts. The counters can get out of step if glitches occur during switching. A high-speed storage scope can display such glitches and retain them.

narrow (on the order of 1 to 2 ns), it is not likely to be captured by the logic analyzer.

With a fast storage CRT, the user can examine the data captured by the logic analyzer to determine where it first departed from the correct sequence. Then he selects an event just before that point as a trigger for the scope. The logic analyzer's word recognizer serves as a convenient source for the needed trigger.

If examination of the logic-analyzer display does not clearly disclose where the data sequence first went wrong, trigger points can be chosen earlier and earlier until the glitch is captured. If the scope can simultaneously house the logic analyzer and real-time plug-ins, then logic data and real-time waveforms can be displayed simultaneously on the same CRT.

Other applications

In laser work, some of the primary tests are verifying the presence and determining the characteristics of mode-lock pulse trains, measuring flash intensity and

Maximizing the usefulness of fast storage

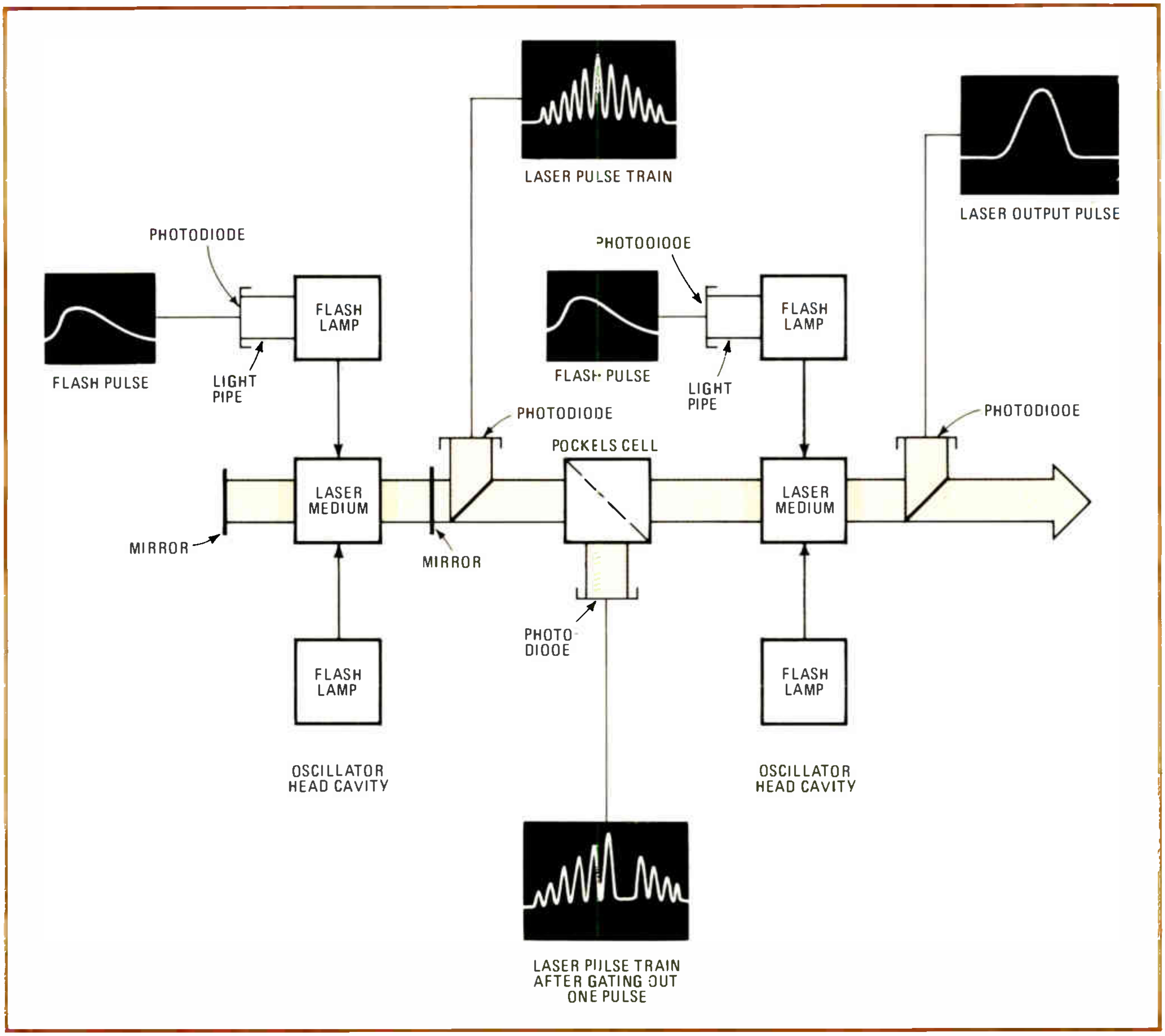
The usefulness of rapid direct-view storage oscilloscopes is illustrated by the Tektronix 7834. In the bistable mode, a long storage time permits detailed analysis of hard-to-repeat, single-shot signals written at 350 centimeters per microsecond. The variable-persistence mode provides easy viewing of slow-moving traces, while fast variable persistence, written at 2,500 cm/μs, extends views of single-shot rise times to the 1-nanosecond range. When operated in the nonstore mode, the instrument performs all the functions of a conventional oscilloscope with a 400-megahertz bandwidth.

Some 7834 features maximize the usefulness of fast storage. One of these is a multitrace delay control used to vary the display time between successive sweeps when the scope is used in a repetitive-sweep mode. Suppose the user wants to study a periodic waveform that occurs in a longer sequence of events. The scope's multitrace delay control can be adjusted to blank out unwanted events and allow triggering only on the desired periodic waveform.

In calibration adjustments, the operator can set the multitrace delay equal to the time required to make an adjustment. The new result is then displayed along with the old, freeing the operator from manually resetting the time base for each trace.

An external input for the transfer-control pulse permits control of the transfer time of the stored image from the fast mesh to the long-retention-time mesh. Thus transfer can be delayed until several closely spaced events have been recorded on the fast mesh. The events then appear together on the same display for measurement. This allows the operator to view the events as they occur in relation to one another.

Remote control of storage functions such as erase, reset, and save gives the operator the ability to control the scope from a distance in such situations as experiments in hazardous environments. Also, these storage functions can be controlled by other equipment when used in an automatic test setup.



5. Laser setup. High-speed, direct-view storage oscilloscopes are useful in many parts of a laser system that operates at low repetition rates. Here, typical waveforms are shown for such measurements as flash intensity, fluorescence delay, and width of the output pulse.

fluorescence decay, measuring the gated output pulse, and aligning the laser and tuning the cavity. All these operations involve displaying high-speed pulses at very low repetition rates. Signal rise times from the light detectors range from milliseconds for the flash lamp down to nanoseconds or even picoseconds for the laser pulse train. Figure 5 shows several of the places in a pulsed laser setup where a fast, direct-view storage oscilloscope could be employed. Typical observed waveforms are shown at each point.

A typical mode-lock laser may have a repetition rate ranging from a few pulses per second for relatively low-power units to one pulse every 30 minutes for lasers used in fusion research. Effectively, these are single-shot signals to the oscilloscope.

For lasers with repetition rates ranging from a few pulses per second to one pulse every few seconds, fast direct-view storage is valuable in tuning. The variable-persistence decay time can be adjusted so that one pulse has not been lost before the next is written. Thus the operator can track signal variations as he tunes the cavity. For faster repetition rates, it may be desirable to use the multitrace delay control for blanking some of the pulses to reduce on-screen clutter.

Other uses for the fast storage scopes include electromagnetic-pulse work and destructive testing. Electromagnetic-pulse measurements are not restricted to nuclear explosions. Other typical sources include lightning strikes, rocket engines, large motor-generators, automotive engines, and miscellaneous electromechanical components such as solenoids.

For example, the operation of logic modules in an automotive system can be disrupted by very short, radiated, high-energy pulses. In one case, a Fourier analysis traced the source of such random pulses, only 5 ns wide, to a solenoid in the differential system. Once located, the pulses were suppressed successfully at the source. □

C-MOS twin oscillator forms micropower metal detector

by Mark E. Anglin
Novar Electronics, Barberton, Ohio

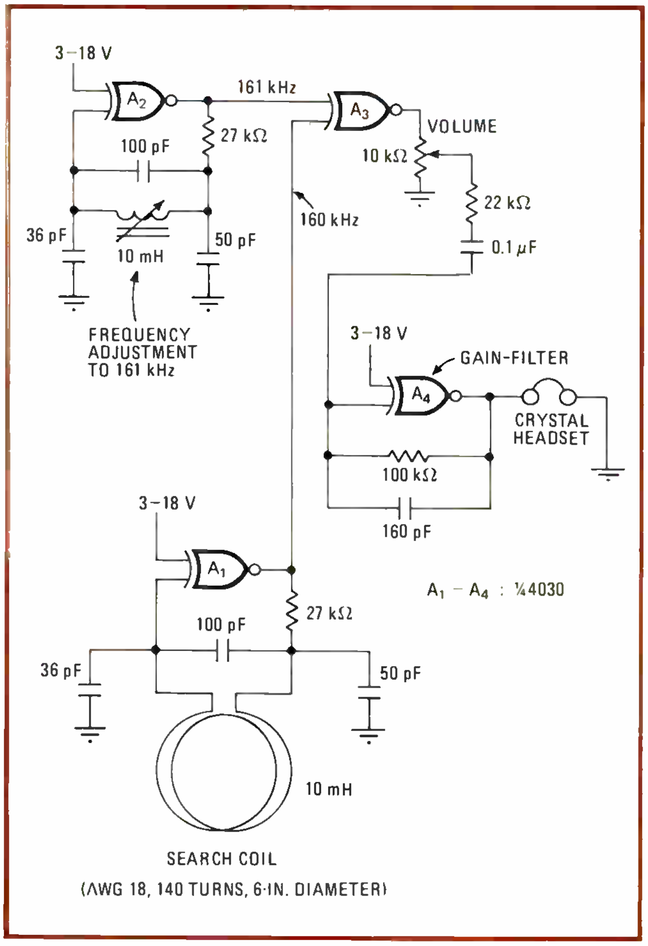
A battery-powered metal detector can be built with the four exclusive-OR gates contained in the 4030 complementary-metal-oxide-semiconductor integrated circuit. The gates are wired as a twin-oscillator circuit, and a search coil serves as the inductance element in one of the oscillators. When the coil is brought near metal, the resultant change in its effective inductance changes the oscillator's frequency.

Gates A_1 and A_2 in the figure are the active elements in the two simple oscillators, which are tuned to the fundamental frequencies of 160 and 161 kilohertz, respectively. A_1 serves as a variable oscillator containing the search coil, and A_2 oscillates at a constant frequency.

The pulses produced by each oscillator are mixed in A_3, and its output contains sum and difference frequencies at 1 and 321 kHz. The 321-kHz signal is filtered out easily by the 10-kHz low-pass filter at A_4, leaving the 1-kHz signal to be amplified for the crystal headset connected at the output. The headset has a high impedance (2,000 ohms) and therefore will not impose a big load on A_4.

A change in the output frequency indicates a frequency change in the variable oscillator due to the mutual-coupling effect between a metal and the search coil. The device's sensitivity, determined largely by the dimensions of the search coil, is sufficient to detect coin-sized objects a foot away.

This device's effectiveness derives from the twin-oscillator approach, because it is not feasible to directly vary a single oscillator operating at 1 kHz. An oscillator operating in this range requires high values of L and C, and these elements would load down the gate and consequently reduce circuit sensitivity. In addition, the cost of high-value inductors and capacitors is great. □



Metal detector. Two oscillators and a search coil form a simple metal detector. Objects near search coil change A_1's frequency of oscillation and the 1-kHz output note produced by the mixing of oscillators A_1 and A_2. A_4 amplifies and filters audio signal.

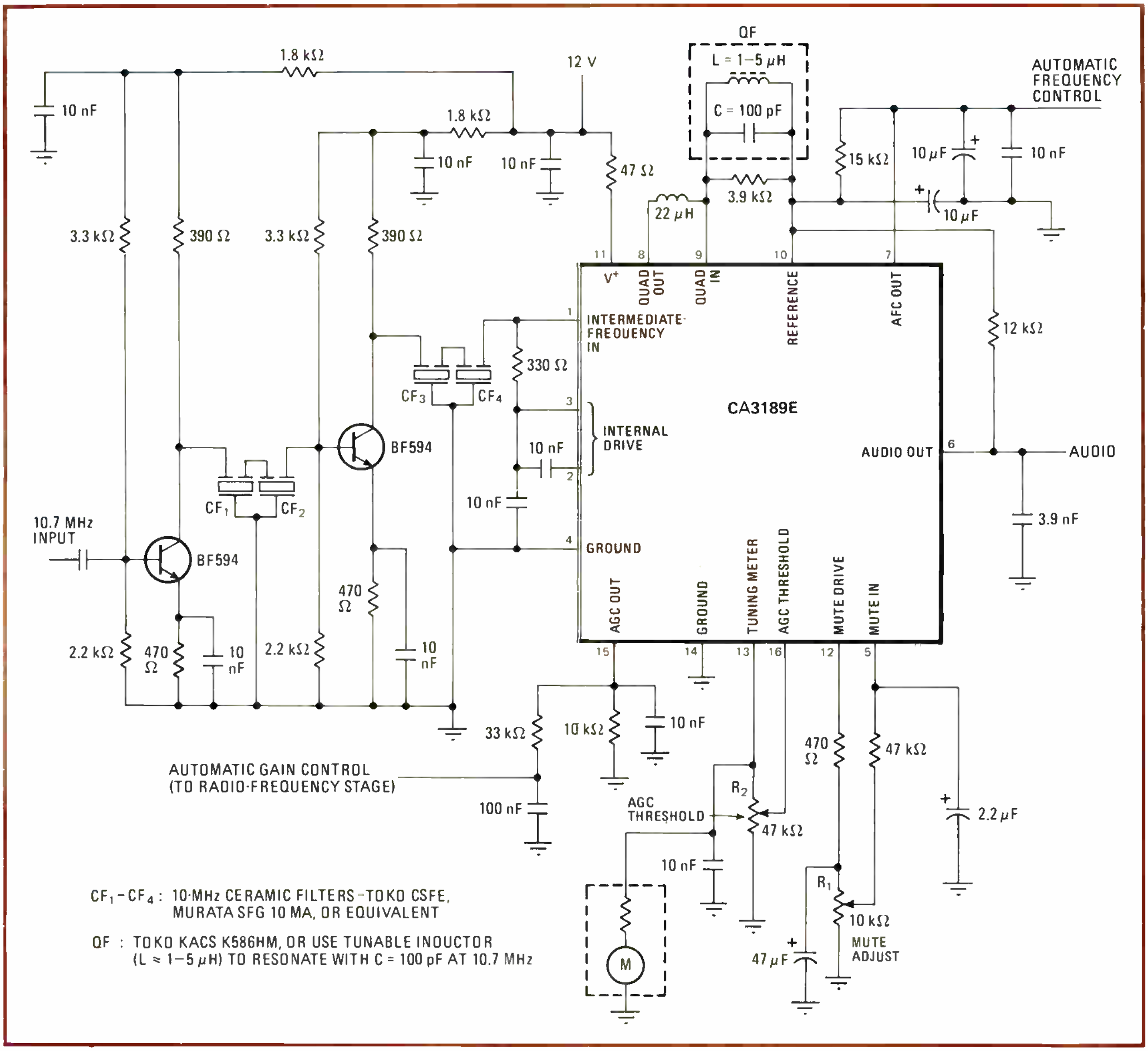
One-chip fm demodulator has improved response

by J. Brian Dance
North Worcestershire College, Worcs., England

Coupling a preamplifier that has good selectivity with the new RCA CA3189E demodulator chip builds a frequency-modulation detector that outperforms the well-known CA3089 fm/i-f system. The circuit described here provides greater rejection of input-signal noise and high amplitude-modulation signals than its predecessor, while ensuring better audio-channel muting. Also the automatic-gain-control threshold can vary.

Although the 3089 and the 3189 are similar, the external circuit shown in the figure differs considerably from the standard detector circuit used with the 3089. An input signal encounters four 10.7-megahertz ceramic filters ($CF_1 - CF_4$) and two transistors in the preamp, which provide the needed selectivity and gain to optimize the signal-to-noise ratio, even before the 3189 operates on the signal.

The bandwidth of the intermediate-frequency amplifiers in the 3189 is limited to 15 MHz, as opposed to 25 MHz in the 3089; but the narrower bandwidth



1. Improved fm detector. A good preamplifier and the CA3189 fm/i-f system provide optimum response. The circuit has greater noise immunity and better protection from a-m signal overload than detectors now used, and the agc threshold is selectable.

improves circuit stability and, if printed-circuit boards are used, makes layout less critical. More important, since the overall bandwidth is only slightly greater than the input frequency, less noise is produced in the frequency band of interest from intermodulation products caused by signals outside the band. Also, a specially constructed zener diode is employed in the regulator circuit of the 3189 to minimize noise.

Two muting circuits are used. For noise between stations, part of the voltage change appearing at the mute-drive port at pin 12 (which is driven by the noise from previous input stages) is fed to the mute-control input at pin 5 through a voltage divider that includes potentiometer R_1. The muting threshold can thus be selected.

Although this arrangement is satisfactory for inter-station noise, additional components are needed to combat noise produced by tuning through a signal; otherwise, a sudden change in the output dc level will produce the familiar, low-frequency "thump" noise. An integrating circuit is formed by adding the 47- and 2.2-microfarad capacitors between pins 5 and 12 to reduce this noise, but even this step does not eliminate it if the integrating-circuit time constant is too small for fast tuning. However, the deviation-muting circuit formed by placing a resistor between pins 7 and 10 ensures the noise will be eliminated, provided the deviation is less than ±40 kilohertz. (The deviation is controlled by selecting a resistor of 15 kΩ.) Thus any voltage change caused by noise is reduced at the output, pin 6.

The agc threshold is determined by R_2, which sets the voltage fed to pin 16 from pin 13. The threshold point can be selected from 0.2 to over 200 millivolts. A 40-decibel agc range can be easily obtained if the very-high-frequency tuner driving the 3189 uses dual-gate metal-oxide-semiconductor field-effect-transistor stages or similar stages having wide dynamic range.

The signal-to-noise ratio is 50 dB for a 3-microvolt input signal. If the first transistor stage in the preamp is omitted, a s/n value of 20 dB can be obtained for the same input level using only two ceramic filters. For a deviation of ±75 kHz, the a-m signal rejection is 60 dB for input signal amplitudes greater than 500 μV, and the limiting sensitivity of the 3189 is typically 12 μV at 3 dB. The tuning meter has an approximately logarithmic response over an input signal range of 10 μV to 100 mV.

The quadrature tuned circuit between pins 9 and 10 determines the percentage of audio harmonic distortion—typically 0.3%. This figure can be reduced to 0.1% if the network is a double-tuned circuit.

The 12-kilohm load resistor sets the audio output level. The 3.9-nanofarad capacitor provides the 50-microsecond de-emphasis required for reception in Region 1 (Europe), and a 5.6-nF capacitor is suitable for the 75-μs de-emphasis required in Region 2 (U. S.). This capacitor should be omitted when the signal is fed to a stereo decoder circuit. □

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.

Keyboard programs the gain of an operational amplifier

by P. A. Benedetti
LAFBIC-CNR, Pisa, Italy

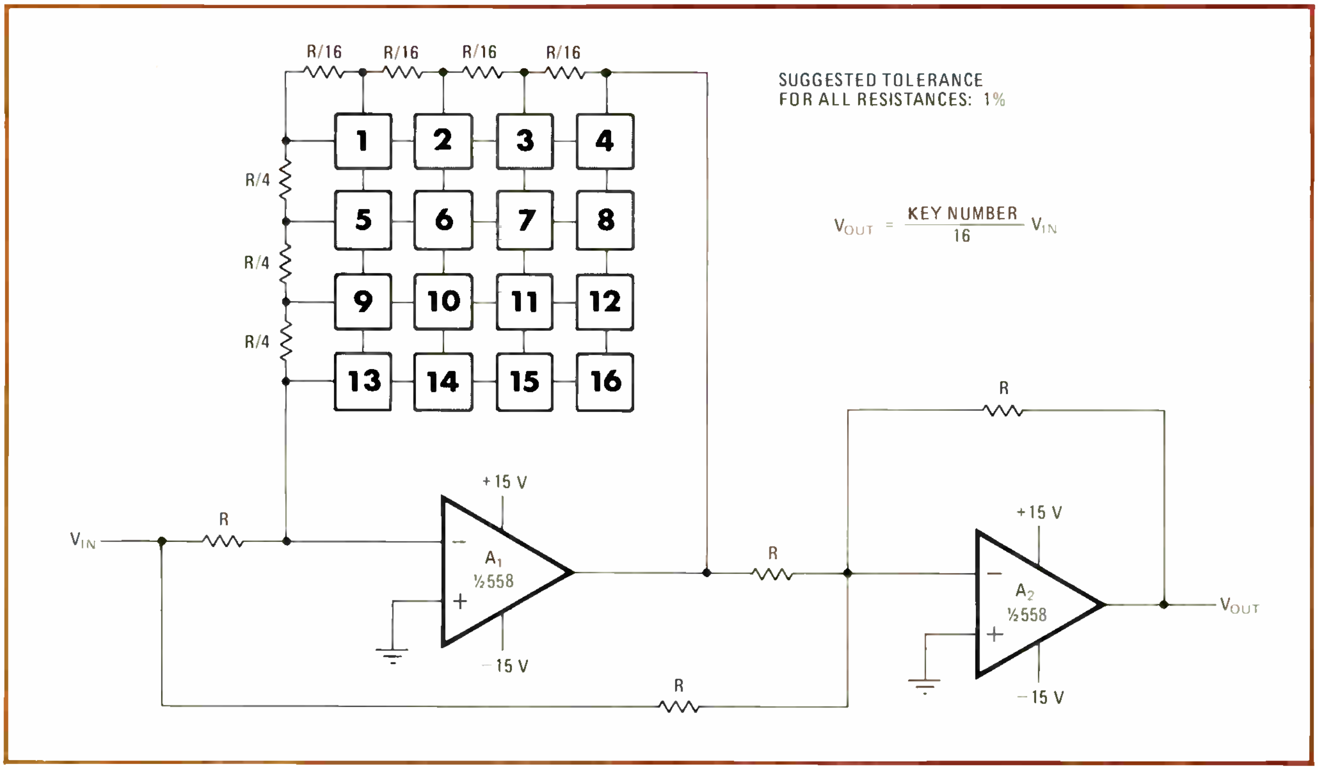
Placing a standard keyboard and a few precision resistors in the feedback loop of an operational amplifier produces a handy gain-programmable amp, useful for generating any one of several equally spaced voltages at the push of a button. Applications vary from testing components to controlling a computer program that employs an analog-input channel.

As the figure indicates, depressing 1 of 16 keys on the normally open contacts of the keyboard selects the value of the feedback resistor placed across the 558 operational amplifier A_1, to which a fixed input voltage V_{in} has been applied. A_1's gain varies with feedback resistance, of course, and so the output voltage also varies and assumes 1 of 17 equally spaced values (including 0), depending on which button has been depressed. The resistance values in the feedback loop have been selected so that the output voltage at A_2 is:

$$V_{out} = \left[\frac{\text{Key number depressed}}{16}\right] V_{in}$$

As might be expected, the programmable-gain principle applies to a keyboard of any size. Resistor precision must vary accordingly, however, becoming greater as the number of keys increase.

Key-bounce effects are not a problem except in some computer-based applications. A solution is to include double-testing of contact points in the software. □



Digital control A standard keyboard and a few precision resistors in op amp's feedback circuit generate an output voltage proportional to the number on the key depressed. Circuit applications vary from component testing to analog-voltage control of computer systems.

Executives' concerns: JAPANESE COMPETITION, GOVERNMENT POLICIES

Look for steady growth in 1978, say top executives participating in *Electronics'* annual survey. But they temper their optimism with growing alarm over the Carter Administration for what they term inattention to unfair competition from Japan and for an antibusiness attitude. Meanwhile, European executives worry about inflation as well as Japanese aggressiveness, and the Japanese fear a backlash

RAY STATA
chairman and president, Analog Devices Inc.

Here's Stata's good news: the electronics industries have applied the lessons of the 1974–75 slump about overcapacity and swollen inventory and are in a good position to prevent an early repetition. In fact, "it looks like the electronics industries, particularly semiconductors and computers, continue to be in for good times in 1978," Stata says, particularly since executives seem to have learned a lesson from the recession of 1974–75. The result, says Stata, is that top managements are being more prudent when planning expansion and hiring.

Now for the bad news: while he is projecting a 25% annual revenue increase for the Norwood, Mass., firm through 1982, he fears the lack of qualified engineers and technicians could endanger that progress. The human resource problem is the chief brake on the firm's growth. "We have a large list of openings now, many of them for critical job functions in both the semiconductor and data-acquisition systems areas." Many of them have been open for months, and he is not optimistic about filling them soon.

Other clouds on the company's horizon are generated by the continuing lack of private investment capital and the high cost of doing business in Massachusetts. After repeated unsuccessful attempts to get a stock offering on the market, the company accepted a $5 million equity investment from Standard Oil Co. (Indiana).

While state and local taxes are a problem, Stata says it would be too costly and disruptive to move outside the state. So the firm will expand within the state and combat the problem through such groups as the newly organized Massachusetts High Technology Council [*Electronics*, Nov. 24, p. 35].

Continued

FEDERICO FAGGIN
president, Zilog Inc.

With 1978 promising to be a very good year for microcomputers and the semiconductor industry in general, the major long-term worry is Japanese competition, Faggin asserts. It will not "really materialize in 1978 or 1979, but the trend is definitely there. The signs are that we will have to cope with the Japanese to keep ahead.

"One reason is the way the Japanese economy works with respect to ours. They have strong government participation in industry for export. This makes it easier for them to compete against U. S. companies." But that is only part of the problem, he says. "The Japanese culture and people are primed to do a very good job in this area. We have to compete by keeping ahead, by reducing costs, and so on."

While he is not pessimistic, he says that "it will take a strong effort by everybody to keep their edge sharp. The name of the game here is really technological superiority."

How much of a threat to the fast-growing microcomputer maker is Japan's project to produce very-large-scale integrated circuits? "More important for us is the threat of other major competitors in the U. S.," he says. "In the near term, there's no threat to us. Our goal always has been to be the technological leaders in microcomputers, and that includes Japan as well as the domestic market."

Faggin is not too worried about the high cost of domestic production, including labor and materials, because "we're all in the same boat." However, the cost of doing business in California is another matter for the Cupertino company. Consequently, and for other reasons as well, the company plans to set up a new plant elsewhere in the U. S.

One other reason is the availability of people: he admits to some difficulty in hiring enough qualified engineers because "the area here is saturated. We have to work harder, which also means we have to offer higher pay."

A second is the high cost of living, including taxes and housing prices. Still another is that with a single plant in Silicon Valley, "we have all our eggs in one basket. One earthquake can put you out of business," or drought can affect the supply of energy.

RICHARD E. HORNER
president, E. F. Johnson Co.

The sorry state of the citizens' band radio business worries Horner, but not nearly as much as the Government's economic policy. "How long can consumer spending carry the economy with no help from the capital-investment sector?" he asks.

"Typically, capital spending should have followed consumer spending by six months to a year, but that hasn't happened because of the last two changes in the tax laws. Carter was saying all the right things before the election. But the honeymoon is over, and the Administration has lost its opportunity to encourage capital accumulation."

After taking a bath in the CB business from price wars and fat inventories, his Waseca, Minn., firm is looking to commercial customers for salvation. "We are becoming increasingly engaged with the capital-goods market because our consumer business is devastated," he says.

His goal is to reverse Johnson's sales mix next year from a peak of 70% CB to 70% land-mobile, where the firm's business has been growing by 40% annually the last five years. "We'll have a small CB line that will sell at normal margins, but we're not going to lose any more money on it." Horner plans to absorb most CB losses this year; in the first three quarters, that added up to $8.4 million on sales of $42.5 million.

Even with no new investment, 1978 will be recessionless. "There's an election in November, and the politicians will strive to keep the economy on an uptick, even at the expense of 1979 inflation."

GEORGE J. HART
vice president and general manager, TRW Electronic Components divisions

Most U. S. component makers see a Japanese cloud over their markets, but Hart sees a chunk of blue sky ahead. "We have a growing feeling that some of our biggest customers know in the long run that they can't depend upon Japan for components." If U. S. firms go out of business, "it could be like OPEC and oil—and our customers are starting to come around to realizing it."

The Government has to understand the competitive disadvantages in trading with the Japanese and devise remedies, he says. Thus the Los Angeles–based firm plans a major effort directed at educating Government officials about the political concerns that affect American business's ability to grow and to provide jobs. Besides trade policy with Japan, other pressing issues are weak incentives for investment and high taxes, Hart says.

Although top company officials have long been leading spokesmen on business's political concerns, the new effort will involve middle managers. "In 1978, we want our people to be more active in their political environment."

Next year, the firm expects inflation of 5% to 6%, which will be difficult to pass along as price hikes in such product areas as home entertainment. A downturn in the economy seems unlikely, "but if it happens, it would come late in 1978 or after." All in all, the components business looks pretty rosy: "When it's good, it's very good; and when it's bad, it's still pretty good."

STANLEY J. KUKAWKA
vice president, Allen-Bradley Co.

It has been a banner year for the country's largest resistor maker. Sales are up 20% and will grow 15% next year, Kukawka says. Yet the Milwaukee-based company has a problem that it plans to solve by shifting its manufacturing to Texas to take advantage of lower labor costs.

"Manufacturing costs continue to be our biggest problem. We've tried, through mechanization and productivity improvements, to stay competitive in a high-cost area like Milwaukee. But in the past several months, we concluded it couldn't be done. Look at where our competitors manufacture; one might conclude we're a little late."

Wisconsin residents are heavily taxed, with personal income taxes ranging from 6% to 11%, he points out. Companies operating there are obliged to make up their employees' loss of disposable income.

Also, wages in Milwaukee, a heavy-industry town, are high because "heavy industry has a history of passing labor and material cost increases on to the ultimate consumer. We're caught in the middle, because price increases generally aren't accepted in our industry."

Kukawka thinks it is time for the Government to drop the capital-gains tax. "The U. S., Canada, the United Kingdom, and Sweden are the only countries with capital-gains taxes, and all four are in deep trouble with industrial expansion and unemployment. And we wonder why we can't compete."

Drawing from statistics developed by the Government, he points out that small companies raised $1.1 billion in equity capital in 1969, but only $16 million in 1974. Furthermore, in 1975 there were 10.2 million fewer people investing in the stock market than in 1969, when portfolios averaged $10,100 per investor. "Multiplying that out tells me that there's about $103 billion now out of the stock market, some portion of which would have been available as equity capital for new ventures or new stock issues."

Continued

J. C. AKERMAN
managing director, Mullard Ltd.

Worries about Japanese technology and marketing acumen are not limited to American semiconductor and component manufacturers. Though Akerman says, "I am very, very optimistic for the immediate prospects of the United Kingdom consumer market," he sees a Japanese threat there, as well as in other areas, despite Hitachi's decision to kill plans for a TV-assembly plant in Britain. His subsidiary of Netherlands-based Philips Gloeilampenfabrieken expects to do reasonably well next year, but not well enough to generate the money necessary to invest in people and plant for the 1980s. "If I look beyond 1978 and the Japanese competition we can expect then, it's going to take a hell of a lot of money to compete." While buoyed by the resurgence in the company's integrated-circuit business since Philips purchased the U. S. firm Signetics, he is worried by the Japanese advances in technology.

The Americans have their heads in the sand and believe that the world will continue the same, with U. S. technology leading the way, Akerman says. But the Japanese already have 2% of the American IC market and are coming on with bigger, cheaper, and more efficient products.

To match the thrust from the Far East, the European countries must work together, although Common Market attempts to hammer out such a policy have been fruitless. However, one good area of cooperation would be a common approach to IC technology.

DAVID T. KIMBALL
president, Leeds and Northrup Co.

The exceptionally strong growth enjoyed by the process-controls industry in 1977 may not be repeated next year, yet the new year still looks very good to Kimball. "I don't see any recession in 1978, rather a flat economy continuing through the year and into 1979."

Perhaps the major reason for a lack of significant growth in the industry is that its primary market, the chemical-petroleum industry, will be spending less. "It seems that there'll be some softening.

However, the electric utility market continues to be strong for both instruments and systems, and, he says, "we don't see any easing of that through the early part of 1978." Despite some negative comments about the steel industry, "our business in the primary-metals segment, surprisingly, is very strong."

Kimball does not see any short-term harm to process-control markets caused by the Carter Administration's lack of direction on energy, "but this could become a problem in about five years." He is more concerned with hiring enough experienced systems engineers and qualified programmers to handle the growth of his North Wales, Pa., company, and is troubled about increasing taxes. For example, the planned corporate tax increase in Pennsylvania "makes companies like L&N have to consider expanding in other locations, rather than continuing to accept being penalized by states that look to business to carry an increasingly large share of the states' operating expenses."

DONALD R. BEALL
president, Rockwell International Corp., Electronics Operations

Next year presents more opportunities than problems for steady expansion of Rockwell's electronics markets, believes Dallas-based Beall. Sales of its fastest moving line, equipment for digital transmission and switching, show no signs of slowing down. New common carriers and established firms, both in the U. S. and abroad, are further stepping up competition, he says, which helps equipment suppliers.

Surprisingly, he singles out for an upswing one area that has been slow recently. "Air transport and general-aviation avionics markets here and abroad appear strong for 1978," he says. Specifically, he expects airlines to start long-delayed purchases of replacement aircraft.

Like his counterparts in other U. S. executive suites, Beall seems most worried about political considerations and their effect on business. "I hope the U. S. government, in an effort to improve the ability of our firms to compete abroad, will reach decisions soon." Most needed, he believes, are clear-cut policies on technology transfer, taxes, export controls, and aid to U. S. firms that are seeing "greater impediments" in the form of foreign competitors' getting government help for product development and exporting.

His units' operations reached sales of $1.1 billion in 1977, 49% to Government customers. He foresees defense markets remaining strong in 1978, especially command, control, communications, and intelligence segments.

ANDREW S. GROVE
executive vice president, Intel Corp.

Next year the semiconductor industry will do something that it's not accustomed to doing: grow only 15% to 18%, predicts Grove. This, for an industry more used to increases in the 25% range, should be a cause for concern, right? Wrong. Certain parts of the market are really very strong, he says, "from the standpoint that we are beginning to move into realization—a case in point is data-handling equipment." By realization, he means the point at which concepts are turning into commercial products.

Those markets include distributive processing, terminals, and minicomputers. Likewise "microcomputers, which have been at the design and beginning production stages in a whole range of industrial equipment, are shifting into full production. So we have these phenomena superimposed on generally ho-hum overall economic growth, and it gives an extra boost."

Such growth has its problems, particularly at his firm, "which is outpacing the industry as a whole." Ideas abound, and "every day we find a major design event that took place many years ago popping into manufacturing."Thus, "we are operating under a capacity restriction—we just can't do everything we see."

He also believes that the most difficult obstacles to overcome will be generated by what he calls the cross-currents of technological changes. "The industry, for instance, is again in a major change from the 4-k to the 16-k level. Whenever that happens, there are very strange eddies—delivery problems and seeming shortages of capacity and availability for other products."

The Japanese semiconductor effort "doesn't represent a qualitative change for our industry, but a quantitative change. We've had a lot of competition before, and what this says is that we are going to have significantly more competition in terms of price, technology, and new products. The truth is that we have to run faster and more scared. But I don't think combating the Japanese requires different acts than combating TI does."

However, one action that the Japanese thrust has in very-large-scale integration triggered at Intel is to "try to run stronger in Japan," Grove says. "We're doing things there that aren't dramatic but that, perhaps, we wouldn't have done before, just to create a second front and not have all the fighting done on our shores." Some of those things are a stronger sales force, applications centers, and the "establishment of a testing laboratory in Japan with on-site technical expertise imported from the States and staffed there." Overall, he continues, "we're making more of a capital investment there to supply the Japanese market." Additionally, "we'll be aggressive in price, but we're not going to dump in Japan."

Since new markets for semiconductors continue to open, Grove predicts that 1978 will be the largest year of capital investment in his firm's history, above previous highs of $30 million to $40 million. He does not expect the possible curtailment of tax credit to affect those plans, because, he says, "our expenditure plans are determined by our operational needs."

The growing size of Intel presents another problem: finding qualified people in production, marketing, and engineering. One thing he hopes will attract potential recruits is the company's geographical diversification, triggered in part by California's tax structure. Many of Intel's facilities have moved out of the crowded and expensive Santa Clara area to the Portland, Ore., vicinity. And Intel is looking for a third site.

JAMES V. BITNER
senior vice president, Lear Siegler Aerospace and Electronics Group

Political uncertainties are what keep the military/aerospace industry in business, but right now one political uncertainty is also Bitner's chief concern. He vigorously opposes the Carter Administration's attempt to cut offshore sales of U. S. military equipment. Such a move would not only threaten one fourth of his group's $266 million annual revenues, but also the industry's $10 billion plus contribution to the U. S. trade balance, he notes.

To counter the Administration's proposals, aerospace officials organized the American League of International Security Assistance a year ago. "It tries to tell Government officials our story," says Bitner, an active member. "So far the restraint of foreign military sales hasn't happened," but he is not claiming the credit for Alisa. "Perhaps we've somewhat ameliorated it."

A longer-term concern for the Santa Monica, Calif.-based group is the direction of research-and-development spending—"a muddy thing right now." While some defense projects are well funded, on others "the military has thrown the ball back to industry" for broader company-funded research efforts.

However, 1978 should show "continued steadiness in business," with no recession in sight. Surprisingly, the aerospace job market, so often hit by layoffs recently, is tight. "We need a new wave of EE students to replace those who have moved on." Moreover, veteran engineers are once more in demand, he says.

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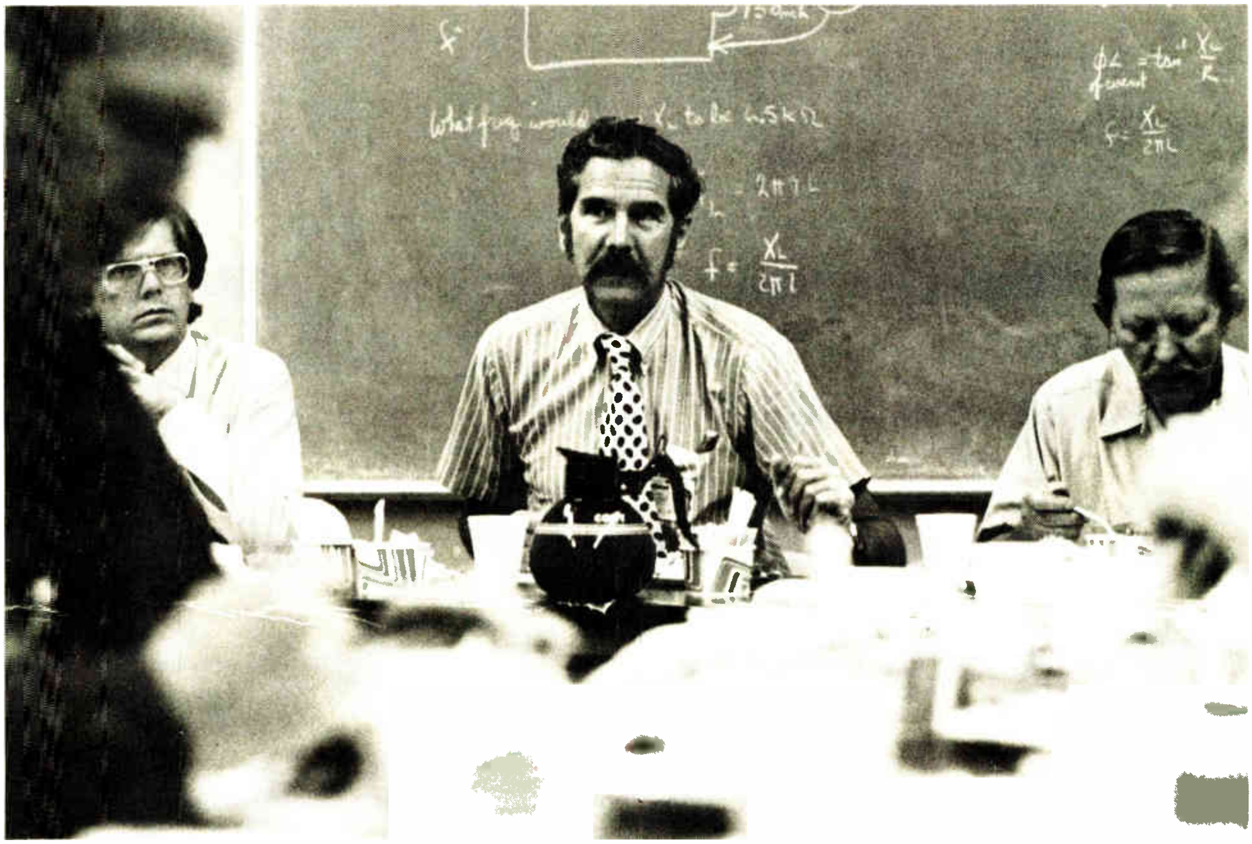


CHARLES E. SPORCK
president, National Semiconductor Corp.

The time has come to spur the Government to action on the Japanese challenge, Sporck holds. "The semiconductor industry—in fact, all U. S. companies have a real problem," he says, noting the Japanese penetration of the steel and television-set markets in particular. "Our problem is that we have a competitor that operates by a different system. We cannot continue to allow our market to be open when the competitor plays by a different set of rules.

"The Government somehow, sometime, somewhere, must face up to the problem. The final solution lies in its hands. It must make the fundamental decision whether it wants U. S. industry to be eliminated." If Japan is allowed to continue playing by different rules, the outcome will be "a situation where we buy manufactured goods from Japan and sell them raw products and materials. I view that as an absolute disaster."

Sporck's solution: on an industry-by-industry basis, "the Japanese should be told that if you have 20% of our TV business, for example, then we get 20% of yours." He would not tolerate Japanese protests that U. S. companies cannot sell in Japan because they do not understand the market. He thinks that is utter nonsense.

The "first giant step" is to make electronics companies aware of the problem, since recognition "is not universal yet. We're trying to put out to the electronics industries the dangers in buying Japanese products. Any electronics company that buys Japanese components, subassemblies, or finished products" where competitive U. S. products are available "is driving nails into the coffin."

Yet for U. S. firms, the electronics business, especially the semiconductor business, will be good in 1978." Some things cloud the outlook, however. A key example is the issue of a national energy policy, which he doubts will be formulated in a way that "will get us to increase the supply of energy. Instead, I see a continuous move away from the marketplace."

He believes that nuclear energy is the only short-term means of meeting the demand for energy. "The problem cannot be solved by exotic things [like solar or wind power] or conservation." His conclusion is that "we're in a shambles on energy. It won't hit us this year or the next but [lack of policy] will do us long-term harm."

High California taxes also are a cause of concern and are one reason the Santa Clara–based firm established manufacturing facilities outside the state, he says. Moreover, the short supply of labor means that any further manufacturing expansion will also be outside the state. Still, the company intends to expand its California development shop. Since there is "clearly a shortage of engineers, especially EEs, we're in the process of recruiting a lot of people across the country."

ALFRED PROMMER
vice president, Siemens AG Electronics Components Group

"Rather temperate" is Prommer's summation of the 1978 outlook for Europe's components industry. Moreover, as president of the European Components Manufacturers' Association, he speaks for a market that accounts for about 25% of the world total.

He links the not-so-rosy prospects for components next year to the Continent's general economic progress in 1978. "The growth of Europe's economies has slowed considerably this year, and the outlook for 1978 isn't any better. Inflation is likely to increase again as governments embark on new programs to combat unemployment; the unemployment rate will still be at a high level; and the revaluation pressure on the strong European currencies will continue unabated." The upshot: declining prices coupled with rising production costs will put a squeeze on profit margins for European component makers.

"Another problem facing European component producers is that world competition is not always under equal terms," Prommer maintains. "Therefore we strongly advocate that national governments and the Common Market authorities use all their power in international trade negotiations to equalize these terms." As long as that is not achieved, the components industry should urge the authorities to hold onto the badly needed tariff protection in the current GATT (General Agreement on Trade and Tariffs) negotiations, Prommer believes.

KENNETH G. FISHER
president, Prime Computer Inc.

In what could be titled "A Lament for the Bay State," Fisher joins chief executives of other companies based in Massachusetts in singing the praises of somewhere else. The reason is that he knows his firm could be more profitable if it were based elsewhere.

State and local taxes, plus labor and energy costs, are restricting profits. "We did a survey in 1976 that showed that our after-tax profits were double what they would have been if we had been in a state like Texas."

While the firm will expand in 1978, doubling today's 170,000 square feet of manufacturing space and employment of about 1,000, "it's not a lead-pipe cinch that we'll expand in Massachusetts." Like others, he finds skilled technical people difficult to attract to Massachusetts. "All my friends are looking for the same kinds of people, and that's when we cease to be friends."

Another worry is the Carter Administration's capital-gains tax-credit stance. Fisher says that he is in the fortunate position of being able to expand almost despite what the Administration does on capital gains. But elimination of that credit "would raise the cost of expansion, and I'm not happy about having to fight Carter at the same time I'm fighting my competitors."

He does not expect strong Japanese competition in computers in the near term, but considers it a concern for the U. S. electronics industries. "They have good technology and are state-subsidized. Any time I see a competitor with that kind of command of technology and pocketbook, I have to think he'll come after me sometime."

On the brighter side, his firm has doubled its revenues each year for the past three—to $50 million in calendar 1977—and while he isn't forecasting another doubling, he sees a strong market and economy for the next five years. "I don't expect a recession next year—I'm bullish about both the general economy and the computer industry."

In his view, demand for computers will be up at least 25% over the next five years. Supplies are short, costs are coming down, and prices are stabilizing or going up for the larger systems he sells. The average price of the Framingham, Mass., company's systems is about $100,000 and going up. Accounting in part for the company's recent growth are the average prices of two systems: $140,000 for the Prime 400 and $200,000 for the 500.

Continued

TARO KUNINOBU
president, Matsushita Electronic Components Ltd.

Just as overseas competitors must deal with Japanese encroachment on their domestic markets, the Japanese must prepare to cope with the backlash that is building in the U. S. and Western Europe.

That is the major concern facing Kuninobu, even as he wrestles with lesser problems: excess inventories because of limitations on exports of television sets and the dead market for citizens' band radios, and overnight shifts in government policy that scramble business plans.

To breach the rising wall of protectionist sentiment around the world, the obvious means would be more direct overseas investment, he says. But even such a solution might breed a new problem: the company that builds plants in the U. S. or Europe must be sure to maintain enough domestic business to keep jobs filled and unions happy. The best way to accomplish that is to take a leaf from the American electronics industries' book: develop even more advanced technology to cover the loss.

The Japanese have the money to spend for electronics-laden products, he says, but they cannot make up their minds about what to buy. They need a reason, much as the 1964 Olympics in Tokyo became the reason to buy color TV sets.

JOHN A. YOUNG
president, Hewlett-Packard Co.

Unlike his semiconductor neighbors, Young is not yet alarmed by Japan's powerful push into advanced large-scale integration. "For the long run, it's hard to draw a conclusion at this moment," he says. "The Japanese have proven to be very effective competitors." With their big investment in new technology, they bear watching, but "we haven't seen the outcome yet.

"If they do play by a different set of rules, and if they damage U. S. semiconductor companies, then that would have a negative effect." Still, he sees a bright side. "Looked at from one point of view, it's not a threat but an opportunity," in that it opens up more suppliers.

However, his firm is hardly waiting around for the Japanese to catch up technologically. "We are just getting on-stream with liquid-crystal and integrated-circuit processing facilities." Moreover, the company's diversified product lines are matched by its wide ranging markets—nearly half of its $1.1 billion sales are outside the U. S., and the major European economies, for example, bottomed out in 1977 and are climbing. "We expect that upward trend to continue next year."

As an older, larger, and more diversified company than its Silicon Valley neighbors, the company does not share all of the same problems—such as finding qualified professionals. Except for field engineers with computer-related experience, Young says, an aggressive recruiting drive on college campuses provides the firm with a well-qualified supply. Half of the professionals hired each year come without previous work experience.

Since the firm is well spread out across the western world, it is not too troubled by high California taxes and living costs. In fact, renewing its commitment to Palo Alto, the company plans to build a headquarters building on a 30-acre site below its present headquarters. The new building, to total 40,000 to 50,000 square feet, is scheduled to be completed in about 1980. The firm's philosophy has always been that it does not want to be the dominant employer in any locality.

J. FRED BUCY
president, Texas Instruments Inc.

"The biggest problem we have in business is the fact that the present Administration doesn't show any confidence in business, and therefore business is not showing any confidence in the Administration," says the Dallas firm's chief operating officer. Though it sounds like the old chicken-or-egg question, Bucy puts the blame squarely in the Government's lap.

"It can't make up its mind about what it wants to do about tax bills, about investment credits, about encouraging exports, about protecting high technology. Our customers are very cautious: they're keeping purchases to a minimum, they're delaying capital investment, they're controlling inventories very tightly. They're preparing for the worst. Sure, our economy is very strong—the strongest in the world—but it's not moving forward because of the Administration's uncertainty."

In instances where the Government has established a position, its signals are generally read as antibusiness, says Bucy. For example, it has made concessions to consumer activists that have resulted in increased regulation. "The consumerists are doing a great injustice to the country by increasing the cost of doing business in the U. S."

The Government simply is not supporting industry in the same way that other governments do. "I'm not saying I want the U. S. government tied as tightly to business as the Japanese government is, through MITI [the Ministry of International Trade and Industry]. But I do think it could avoid being antagonistic." For example, "our antitrust people are trying to break up the auto industry, they're trying to break up IBM, and they're trying to break up AT&T."

REGINALD H. JONES
chairman, General Electric Co.

Although the U. S. recovery should continue into 1978, "the economy is stuttering, giving off mixed signals," says Jones. His chief concern is that "business investment is lagging behind the pattern of previous recoveries" and beyond what most economists agree is necessary to satisfy national needs for energy, productivity, job formation, and control of inflation. The reasons "are both economic and political."

"There has been a long-term decline in the real return" that investors can expect, Jones says. "Because of inflation, underdepreciation and phantom inventory profits have sharply reduced industry's real return on investment, after taxes." Also, with profitability declining and depreciation falling short of replacement costs, "industry has had to turn increasingly to outside sources for its capital funds," and "after several credit crunches and liquidity crises, they are hesitant about going further into debt."

The political factors that deter capital investment are summed up by the Stamford, Conn.-based Jones in one word: "uncertainty." In that category he places energy, tax laws, tight credit, inflation, and Government attacks on business structure.

Until the Administration and the Congress come up with a coherent long-term economic game plan, Jones says, "we can expect a continued shortfall in business investment." However, he adds, "there are hopeful signs that a game plan is emerging, at least for taxes."

Continued

EDSON S. deCASTRO
president, Data General Corp.

A rational man, deCastro expects reasonable expansion in 1978. "I'm reasonably encouraged about the last six to nine months. There's been a reasonable rate of growth in the economy, and that makes for more confidence than there would be if a lot of excesses had been built in." Possible excesses include idle plant capacity and high inflation and interest rates, but he sees no problems with them.

He looks for the computer industry to grow in the 30%-per-year range "for some time, and I don't see 1978 departing from that." And while he stresses that he's not an economist, deCastro doesn't expect a recession next year. "I foresee a sustained market without a lot of worry about ups and downs," he says, basing that feeling on an absence of those excesses that make for recessions. But he describes himself as "very personally frustrated" about the Government's involvement in the energy issue. "We have a free enterprise system that's totally capable of taking care of the energy problem. The Government should repeal all laws regarding energy and get out of the business."

While he thinks elimination or reduction of capital-gains tax credits would not affect his Westboro, Mass., firm, deCastro says small companies could be badly hurt. "We're big enough to succeed in the financial markets even if those tax credits were eliminated." Like Analog Devices' Ray Stata, he has been quite vocal about the difficulty of attracting qualified managerial and technical people to work in Massachusetts. Thus the company has new facilities under construction in North Carolina and Maine, with expansion planned at home also.

Another facility will be started at an unspecified location outside of Massachusetts in 1978, "because it's not as attractive to live here for many people as it is elsewhere, where the tax burden may be 30% less." Nor does he expect any substantial changes soon. "The attitude in the administration here seems to be to get the unemployed person a check, not a job, whereas the reverse is true in the other states where we have facilities."

The plant that will be started outside the state probably will be a 130,000-square-foot manufacturing module to which more production space can be added later. That's been the pattern for Data General in other states, except that the facility under construction in the Raleigh-Durham area in North Carolina will be devoted initially to advanced research and development [*Electronics*, Oct. 28, 1976, p. 36].

Competition from the Japanese is not significant in the computer industry, in his opinion. Still, he recognizes a strong "buy Japanese" ethic in Japan and points to extensive cooperation companies there get from their government as the reverse of the practice here.

In addition, he continues, "the U. S. government has been very remiss in not forcing elimination of barriers to trade in the computer industry. Brazil, for example, has tremendous barriers, and the Government hasn't done anything about it. I'm afraid the Brazilian example could become a model for other countries."

GEORGES PEBEREAU
director–general manager, CIT Alcatel

The shadow looming over many French electronics firms is the parliamentary election next March. A victory of the Left will almost certainly mean a slowing of investment and even the nationalization of some firms, such as CIT, a billion-dollar member of the mighty CGE group. But there is precious little any of them can do about the prospect, points out Pébereau. Management has little choice but to continue to run the company as if the specter were not threatening.

Nevertheless, he is hoping for a substantial increase in business next year. Though more than 50% of its business lies outside its traditional telecommunications activities—in areas like computer peripherals, data-processing services, and automation—his company is pinning many of its hopes on its successful range of digital telephone exchanges, the E10 series.

The export success of the E10 illustrates one solution to a major concern for CIT: slower growth in French telecommunications. The French carrier, the PTT, has a bigger telecommunications budget in 1978 than ever before, some $5.2 billion. Though this means a big rise in deliveries, the growth rate is lower—less than 24% compared with almost 35% in 1977.

"One of the biggest unknowns in 1978 will be exchange rates," says Pébereau. Though the franc has not been the strongest of currencies, the falling dollar could make competition tougher.

L. J. SEVIN
chairman, Mostek Corp.

Everything grows big in Texas, and that includes growth problems. Like other electronics executives, Sevin is concerned about raising money for future growth, and he does not like the possibility that the Congress will enact less attractive capital-gains tax laws.

But he's quick to point out that the Government is not the only obstacle to capital formation these days. "The investment community has a bad case of the jitters, along with the rest of the country. And even though we're performing better than ever, the semiconductor industry is not really recognized as a high flyer anymore."

"However, we can still raise money in the capital market, even though we have to give up more of our company than we'd like, since stock prices are lower." Another avenue is borrowing from the banks for short-term financing, a common practice but something to which semiconductor firms are unaccustomed.

"We can always borrow, but equity is, and will always be, the No. 1 solution for capital formation, especially for a growth industry like ours," says the top executive of the Carrollton-based firm.

Besides being harder to get, today's money does not go as far. "The return on invested capital isn't as good as it once was. Photoresist equipment that went for $12,000 a few years back is now in the neighborhood of $40,000, and we never used to spend $4 million to $5 million a year on test equipment for sophisticated devices. And not only is new equipment depreciated on the books in three years, it is often obsolete in three years. Nevertheless, to process competitively, we've got to spend the money, and therefore we've got to make an effort to find the money to spend.

"So in addition to screaming to Washington for relief—for reversal of the capital-gains situation, for higher foreign-tax credits, for increased depreciation allowances—we should start looking harder for the capital that's available. The Government's done what it's done, and we must get on with doing business in that new environment."

A year ago, Sevin was alarmed about unequal trade barriers in the Japanese and U. S. markets. "The inequity of the situation still irritates the hell out of me, but enough people have taken up the banner so that Washington is at least aware of our position. Now it's out of our hands; if nothing is done about it, we'll just have to live with it."

Continued

RICHARD B. TULLIS
chairman, Harris Corp.

Nowhere is business as consistently good as in communications and data-handling, and this year is not likely to be a disappointment, despite political and economic problems. That is the view from Cleveland, where Tullis expects sales of his $800 million firm—and of the industry—to grow at least another 15% next year.

He does see problems, but they do not seem to be affecting his business. "There are more changes and crosscurrents running through the markets and countries we serve than any time I can remember," he says. "I'm not naive, but we're surmounting all my political and economic worries—business is booming.

"No one is coming up with viable solutions to high Federal budget deficits; persistent worldwide inflation seems unanswerable; several countries' internal tensions or problems with their neighbors would seem to pose a threat to American business. But people are coming up with the money to buy the equipment." In addition, Tullis is not worried about Japanese inroads into his computer and communications businesses.

How do analysts see 1978? Look at 1977

Experience is the best teacher for financial analysis, and the seers who follow the electronics industries have learned from 1977 that next year will be a good year. For nearly all market segments, they think 1978 will be a carbon copy of trends established this year.

By and large 1977 has come in as predicted, says Hans C. Severiens, vice president and senior technology analyst at Merrill Lynch, Pierce, Fenner and Smith. "It has been a good year, with good demand and little excessive inventory at all levels: work in progress, finished goods, and user and distributor inventory." What's more, capital spending for all industries increased about 14%, but more for the electronics industries.

He expects 1978 "will be a continued strong year, with particular strength in communications companies and minicomputer and distributed data-processing businesses." Volume gains in these areas should be similar to those of 1977—"about 20% for communications and 30% to 35% for those in minicomputers, peripherals, and distributed data processing."

However, Severiens does expect "the second half to show some diminution of growth rates across the board, but not by a large factor." At the moment, "I expect no sharp discontinuities in the evolution of business during 1978." He believes the semiconductor industry "will grow no more than 14% in 1977," based on Semiconductor Industry Association projections. Therefore, "it would seem total industry growth in 1978 will be more than 10% but won't exceed 15%, with the integrated-circuit portion growing up to 20%." Should growth be as low as 10%, "it would still be a good year, because it would represent the third consecutive year of double-digit growth."

Other Wall Street analysts have estimates in the same ball park. Sal F. Accardo, vice president at Kidder, Peabody and Co., believes "dollar shipments of semiconductors will expand by 15% in 1978," assuming no recession. A key positive indicator is "continuing strength in important end-user markets such as computers, instrumentation, and communications."

Furthermore, "generally lean inventories exist at all levels, as implied by short lead times, because of available capacity and customer desire to maintain low stocks." Other plus factors for next year are "high quoting activity, strong distributor business, a recovery in the commodity semiconductor market, and continuing expansion of demand for advanced integrated circuits."

As for other industry segments, Accardo foresees "continuing strong demand in the consumer electronics market for watches, programmable TV games, and microwave ovens," among other products. Also, "color TV production of U. S. manufacturers could conceivably increase, especially with the curtailment of imports from Japan," he says.

"The probability of a recession in 1978 is very low," says Kent A. Logan, vice president of research at Goldman, Sachs and Co. He predicts an increase of about 12% to 13% in worldwide sales of semiconductors in 1978, and a 17% increase in sales for test and measuring instruments. Should the unexpected occur, he doubts the degree of earnings contraction will equal the severity of the 1975 decline especially for semiconductor manufacturers.

Behind this belief are two factors. First, "there has been no accumulation of semiconductor inventories in 1977, in stark contrast to the huge oversupply that developed in 1974. Consequently, shipment trends in 1978 should parallel actual usage trends without an inventory liquidation problem." Secondly, "semiconductor managements appear to be much more cautious with respect to the 1978 business outlook and consequently seem to have a much tighter grip on expenses." In contrast, "a sense of euphoria gripped the industry in 1975," which resulted in unrestrained increases in employment and in discretionary expenditures.

Logan believes the Carter Administration's lack of direction on energy might erode business confidence, which, in turn, "could restrict the capital-spending environment." Another concern, adds Severiens, "is going to be the role that the Japanese will play in the mass-produced memory-components market." Yet, because of the revaluation of the yen, the tendency toward U. S. government action, and the "tendency of semiconductor users in the U. S. to diminish their dependency on Japanese suppliers," he believes that "Japanese penetration will not significantly grow in 1978." However, "I wish U. S. semiconductor manufacturers would stop their shoddy practices and do more thorough testing so as to meet the Japanese head on in reliability. That's where we've been deficient." □

Extending the range of the linear-scale ohmmeter

by Edward H. Armanino
Montevideo, Uruguay

The linear-scale ohmmeter described by V. Ramprakash [*Electronics*, Nov 11, 1976, p. 115] can be adapted for the measurement of both small and large resistances. The current through both the resistance to be measured, R_X, and the standard R_C is objectionable in the original circuit when R_X is below 100 ohms or so. A comparator stage has therefore been added that multiplies any small value of resistance R_{X1} measured by up to 1,000 before it is presented to the ohmmeter proper. Moreover, the instrument's upper measuring limit may easily be extended to 500 megohms by replacing the 741 operational amplifier in the original circuit with a high-impedance input amplifier.

The complete ohmmeter circuit is shown in the figure. The multiplier uses two 741 op amps—A_1 for performing the actual resistance transformation, and A_2 for aiding the transformation by generating a needed reference voltage that is compared with A_1's output.

To ensure proper multiplication, the quiescent output level of A_1 must always be at one half the supply voltage (V/2), independent of the resistor values connected to its input. Op amp A_2 is a unity-gain buffer whose noninverting input is always biased at V/2, as shown; its output is therefore at the same value. Two light-emitting diodes indicate the voltage difference between the outputs of A_1 and A_2, and this difference is minimized when measurements are performed.

When the output of A_1 equals V/2, the voltage at its inverting and noninverting inputs is approximately equal. Thus:

$$\frac{V_1}{V_2} \approx 1 = \frac{R_{C1}I_1}{1\,k\Omega I_1} = \frac{R_{X1}I_2}{R_P I_2} \qquad (1)$$

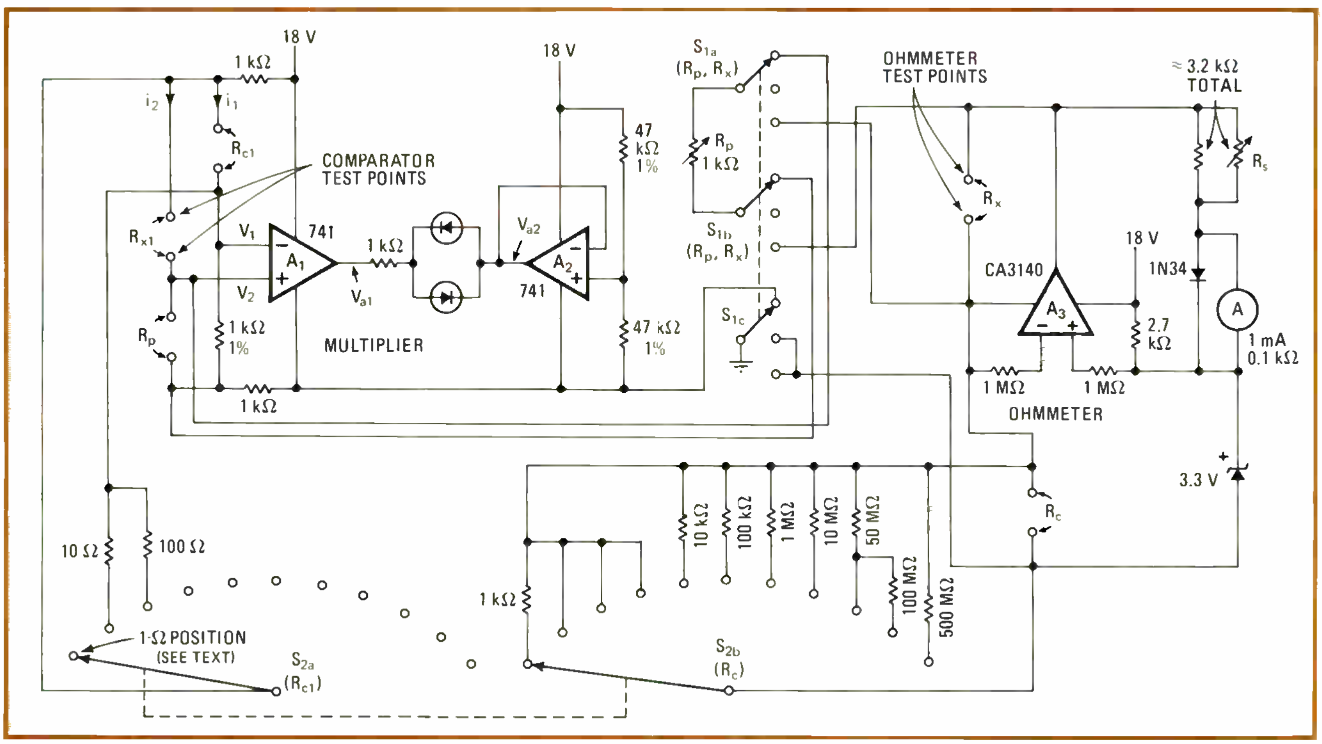
which reduces to:

$$R_P = R_{X1}(1\,k\Omega) \qquad (2)$$

if $R_{C1} = 1\ \Omega$.

Potentiometer R_P is adjusted with the aid of the LEDs in order to satisfy Eq. 2 for any R_{X1} tested. R_P is varied until both LEDs either are extinguished or alternately light as the pot position is rocked (wobbled) through a particular threshold point.

The milliammeter in the original ohmmeter circuit reads the ratio R_{X1}/R_{C1}, and such is the case here. Thus, to measure R_{X1} (which has been converted to R_P), it is only necessary to switch potentiometer R_P across the R_X terminals in order to compare it with the standard R_C



Improved. Linear-scale ohmmeter measures resistance over 500-MΩ range, an extension of the range offered by a previous design. Lower limits have been extended by adding a resistance multiplier, which reduces the current drain during low-value resistance measurements. Upper range has been increased by adding high-impedance operational amplifier to reduce variable offset currents.

value (1 kilohm). R_C R_{C1}, R_P, and R_X are switched to the various circuit points with the aid of two ganged switches, S_1 and S_2.

In measuring very small values (R_{X1}), the resistances of the internal wiring and the test leads (connected to R_{X1}) must be subtracted from the final reading. The value of the small resistance may be found simply by shorting the test leads, rocking R_P to find the comparator threshold as before, then switching to the ohmmeter to read the milliammeter. Also, it is recommended that direct screw-mounting terminals be added on the front panel of the instrument and used to connect R_{C1} into the circuit when its value is below 10 Ω. This should be done because the resistance of the selector switch contacts are variable and on the order of magnitude of the standard value of R_{C1}.

Resistances above 1 MΩ cannot be reliably measured in the original ohmmeter circuit because of variable offset currents caused by the comparatively low-input impedance of the 741 op amp. This difficulty is overcome by using a CA3140 op amp, as shown. It has an input impedance of about 1.5 teraohm, and when 1-MΩ resistors are placed in series with each lead, reliable resistance measurements up to 500 MΩ can be performed.

Of course, the circuit is no longer self-calibrating, because range switches have been added. Potentiometer R_S sets the meter for full-scale deflection when measuring a resistor with a value equal to a standard R_C. Once this has been done at any one range, the setting holds for all ranges, and the milliammeter will always read the ratio R_{X1}/R_{C1}, or R_X/R_C. □

7-segment generator displays PROM contents on a scope

by Gérald Garon
Quebec, Canada

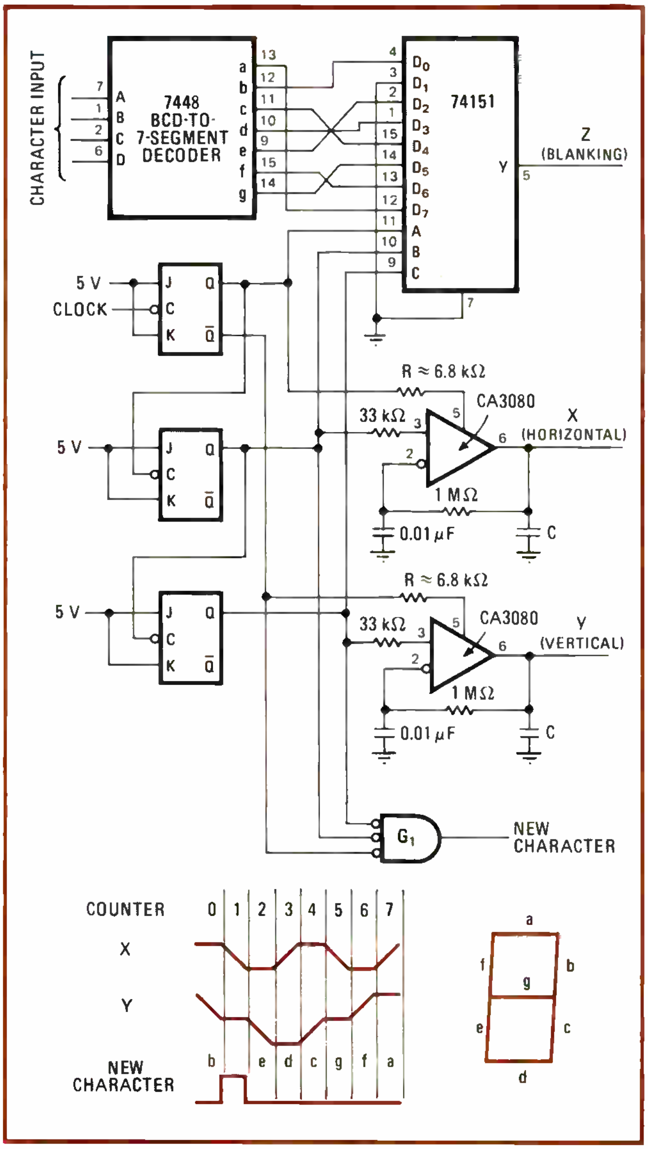
By generating the necessary horizontal and vertical deflection signals, this circuit enables an oscilloscope to display seven-segment characters. Such a generator-scope combination is particularly useful for displaying the contents of programmable read-only memories in the familiar hexadecimal form.

A 3-bit counter, two operational transconductance amplifiers, a binary-coded-decimal-to-seven-segment decoder, and an eight-line multiplexer make up the simple character generator that is the circuit's main building block (Fig. 1). Each character to be displayed is introduced into the 74151 multiplexer through the 7448 decoder. Meanwhile, the 3-bit counter formed by three 7473 J-K flip-flops begins to step through a 0 through 7 count at a rate determined by the system clock.

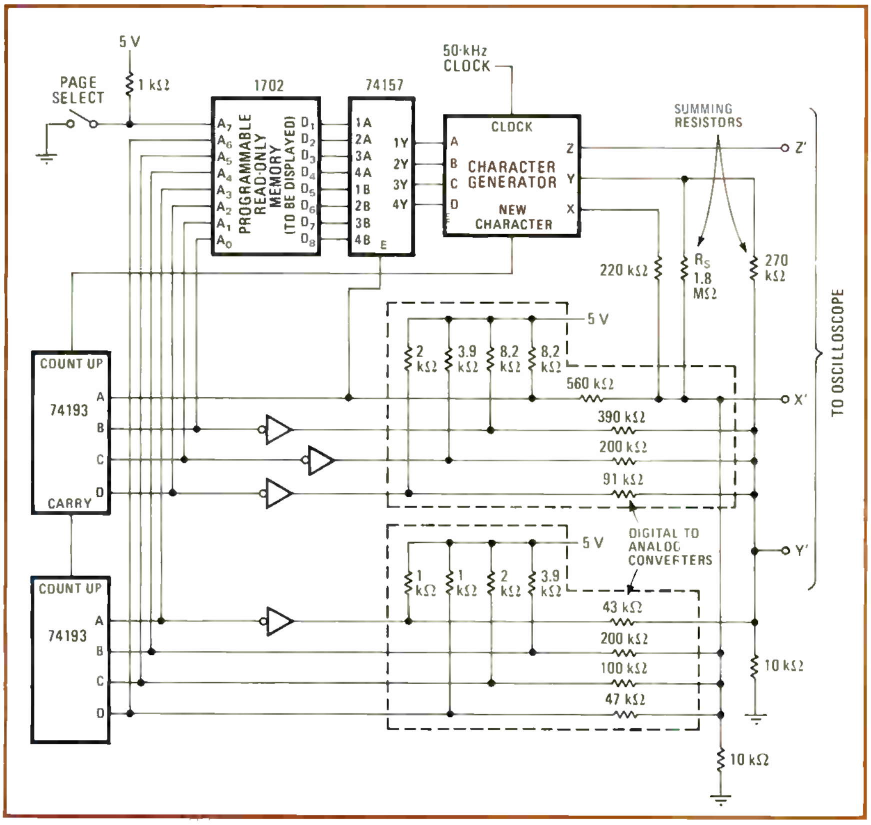
The least significant bit of the counter alternately generates a ramp voltage at the X and Y outputs with the aid of the CA3080 operational transconductance amplifiers and their corresponding integrating capacitors. The second and third bits of the counter determine whether the ramp voltages are positive- or negative-going. The counter also drives the 74151, which in turn blanks the scope trace for all but the desired segments.

The appropriate segments are displayed one by one as the counter steps rapidly from 0 to 7. Thus one character is generated each time the counter cycles through all of the eight states. A new-character strobe signal is then generated at G_1.

The segment voltage is given by $S = 2.5fCR$ volts, where f is the clock frequency (typically above 10 kilohertz), while C is the capacitance and R is the resistance of the components in the network surrounding the CA3080 op amps. The clock rate depends on the number of characters to be displayed and should be at least 25



1. Character generator. Standard logic gates and op amps generate deflection signals required for digits 0–9 and letters A–F on scope. The 7448 BCD-to-7-segment decoder is replaced by 8233 or 74188 device for display of hexadecimal characters.



2. Application. Character generator must be combined with n-bit counter, d-a converters, and summing network in order to position trace on CRT. Programmable ROM and 74157 multiplexer provide character input and BCD-to-7-segment conversion. Resistor nets assume the d-a converter and summing functions.

cycles per second, which is the approximate minimum flicker rate detectable by eye. The segment voltage should be less than 0.5 v for the best viewing results.

Instead of the CA3080 amplifiers, exclusive-OR gates, transmission gates, or three-state buffers may be used. The circuit should be designed so that the waveforms produced at X and Y will be identical in any case.

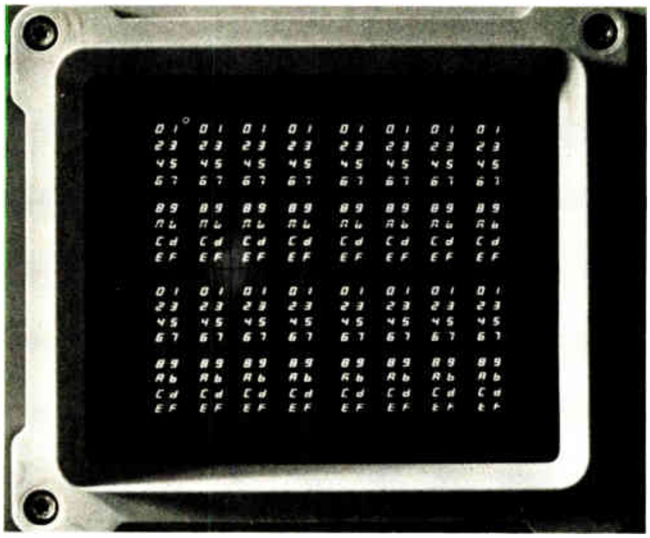
By itself, this character generator can position only one character on the cathode-ray tube. More circuitry must be added in order to position the trace at a multitude of points on the scope face, as shown in Fig. 2. Also note that to display hexadecimal characters, the 7448 must be replaced by the 8223 or 74188 open-collector PROM, and programmed as suggested by Withrow [*Electronics*, July 8, 1976, p. 106].

The complete circuit requires an additional counter, two digital-to-analog converters, and two summing networks. In this typical application, the contents of a PROM are displayed.

To position the trace at each of a possible 256 points, the X and Y outputs of the character generator must be combined with the output of the d-a converters by means of the summing networks. The n-bit counter, driven by G_1 in the character generator, strobes the converters and also determines the address of the PROM to be displayed.

Note the PROM and its associate multiplexer will provide a 4-bit input and that hexadecimal characters can be displayed. In this case, relatively few characters are displayed, and so the simple d-a converters formed by the resistor network shown are used. These converters yield a visually acceptable linearity over 16 lines.

By under- or overweighting some bits, the display may be formatted. For example, increasing the resistance



3. Output. Paired, partitioned, and slanted digits are displayed on the oscilloscope. Formatted display results from overweighting individual bits in d-a converter by adjusting its resistor networks.

corresponding to the least significant bit (390 to 560 kilohms) will position the digits in pairs. Decreasing the resistance that corresponds to the most significant bit (47 kΩ to 57 kΩ) will partition the display vertically. The degree of slant in the digits is accomplished by summing a small part of the Y′ output with the X′ output by means of resistor R_s. The paired, partitioned and slanted digits appear on the scope as shown in Fig 3. □

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

Use DIP sockets to 'rewire' pc boards

Changing any of the wiring on a printed-circuit board usually involves cutting traces on the board and adding jumpers—a troublesome and unreliable process, as Will Schweber, an electrical engineer at Instron Corp. in Canton, Mass., points out. So he suggests building **a simple adapter that requires fewer jumpers and no trace cutting at all.**

Take a socket for a dual in-line package—one with wirewrap pins—and insert it into the board, soldering the ends of the pins flush with the board so that the socket stands above the board. Clip a quarter inch off those pins associated with the correction, and then solder jumpers between the clipped pins to make the correction.

In addition, you can use the adapter to substitute an available IC for a temporarily unavailable one. Since the board is left intact, you can remove the adapter and plug in the proper part as soon as it arrives.

Modifying CROM programs for the TI-58/59

The TI-58 and -59 programmable calculators from Texas Instruments can interface with user-replaceable CROM (for constant read-only memory) program modules—you use specified key routines to call subroutines within a program by label. If you want to modify the CROM programs, though, you have to copy them into the user-program random-access memory, where they occupy a lot of your valuable read-write memory.

But Richard C. Vanderburgh of Dayton, Ohio, has found a shortcut—a way to specify any entry point, not just those steps that are labeled, for CROM execution. So, **even though you cannot change any of the CROM instructions, you can change the way they are executed** and determine precisely where execution should begin at each subroutine call. The sequence of *Pgm mm SBR nnn will cause the CROM code in program mm to start executing at step nnn. Similarly, the sequence of *Pgm mm SBR*Ind nn will cause the CROM code in program mm to start executing at the step specified by the contents of register nn. In either case, CROM code execution ends with the next INVSBR (return) instruction.

Learn about frequency standards and clocks

Are you hazy about the design, performance, and limitations of quartz-crystal oscillators and atomic (cesium, hydrogen, rubidium) clocks? A 64-page technical note from the National Bureau of Standards, "Frequency Standards and Clocks: a Tutorial Introduction," can go a long way towards explaining the operating principles and design features of these devices.

The booklet gives **a thorough but nonmathematical explanation of the various standards and clocks, besides introducing and defining the concepts of time, frequency, frequency stability, and accuracy.** To order a copy of the $1.30 booklet, write to: Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402 for SD Cat. No. C13. 46:616 (2nd rev.).

How everyone else's career is doing

The latest publications and bulletins from the Engineers Joint Council deal with **salary surveys, manpower guesstimates,** and other engineering career information. For a catalog listing them all, write to: Engineers Joint Council, 345 East 47th St., New York, N. Y. 10017. **Lucinda Mattera**

L108

Lambda MPU-1 & MPU-2 Microprocessor System Power Supplies

EFFECTIVE NOVEMBER 1, 1977

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MPU-1	~~$125~~ 100	~~$106~~ 80
MPU-2	~~$195~~ 135	~~$165~~ 108

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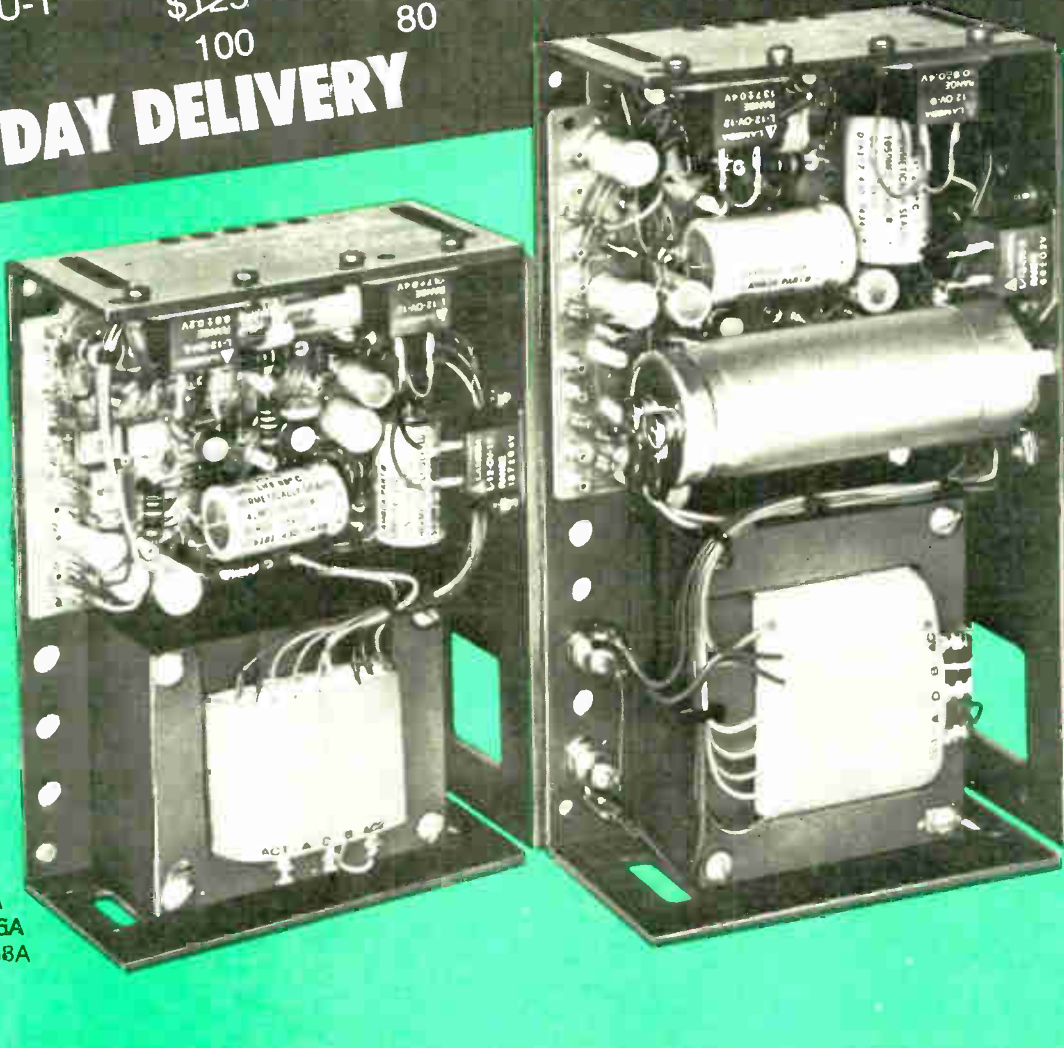

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12V @ 0.6A
9-12V @ 0.6A
or 5V @ 0.38A

MPU-2
5V @ 7.0A
12V @ 1.0A
9V @ 1.2A
or 5V @ 0.75A

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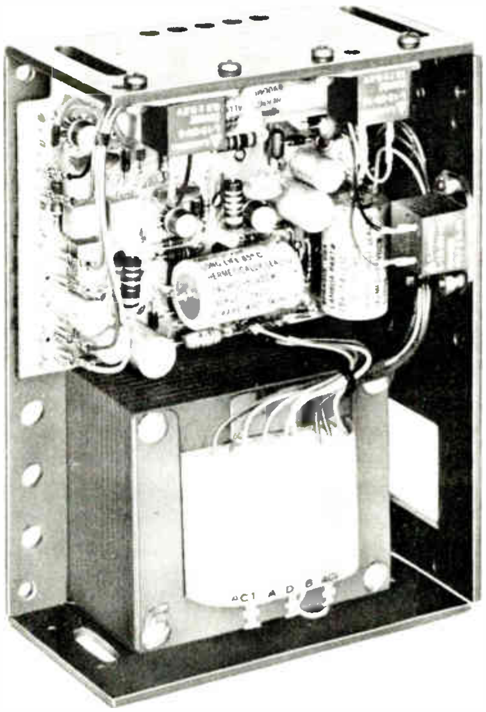
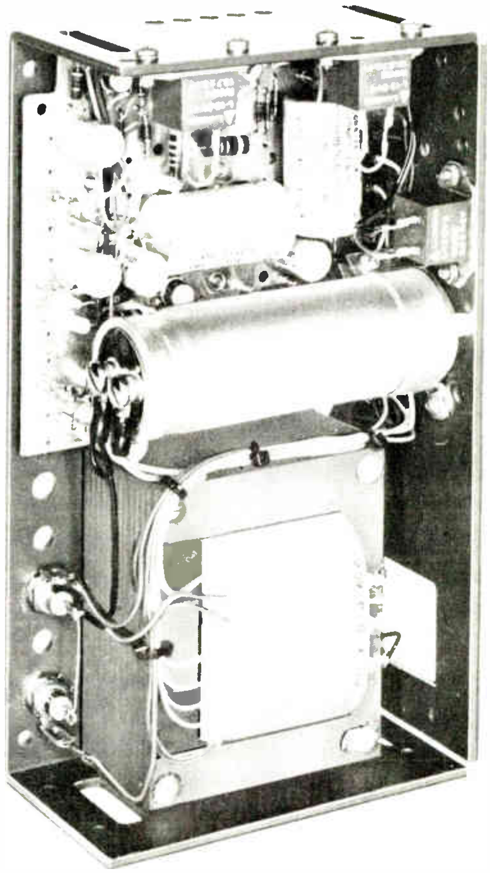
MICROPROCESSOR POWER SUPPLIES

△ Lambda's triple output MPU-1 and MPU-2 are compatible to power any microprocessor and its associated clock, ROM's, FPROM's, RAM's, PROM's, memories and I/O chips.



MPU-1



MPU-2

FEATURES

MPU-1 and MPU-2 are designed to be used for laboratory, breadboard, engineering prototype and pilot production as well as production systems.

1. All MPU power supplies contain three Lambda hybrid overvoltage protectors, the only true overvoltage protector that can maintain, tripvoltage tolerance over 71°C temperature range to protect microprocessors; clocks, memories, RAMs, ROMs, PROMs, FPROMs and I/O chips from destruction.
2. Dual input voltage for domestic and overseas use in both MPU supplies: 105-125 or 210-250 VAC.
3. Sprague electrolytic capacitors used exclusively for improved reliability.
4. All hermetically sealed Lambda IC regulator LAS-723 used exclusively.
5. Modern design Darlington silicon power transistors.
6. All hermetically sealed semi-conauctors.
7. No overshoot under conditions of power turn-off or power failure.
8. Lambda long-life vacuum impregnated magnetics.

SPECIFICATIONS OF MPU-1 AND MPU-2 POWER SUPPLIES

Voltage and Current Ratings For Triple Output MPU-1 and MPU-2 Power Supplies

Model	VDC	Max Current (Amps) at			Price	
		40°C	50°C	60°C	Qty 1	Qty 100
MPU-1	5 ± 5% Adj.	3.0	2.5	2.0	$100	$ 80
	12 ± 5% Adj.	0.6	0.5	0.4		
	9-12V Adj.	0.6	0.5	0.4		
	or 5V*	0.38	0.38	0.38		
MPU-2	5 ± 5% Adj.	7.0	6.0	5.0	$135	$108
	12 ± 5% Adj.	1.0	0.9	0.8		
	9V	1.2	1.1	1.0		
	or 5V*	0.75	0.65	0.55		

(*)Customer selectable

DC output
voltage ranges shown in table above

Regulated voltage
regulation, line . . . . 0.15% for input variations from 105-125, 125-105, 210-250 or 250-210 VAC

regulation, load . . . . 0.15% for load variations from no load to full load or full load to no load.

ripple and noise . . . . 1.5mV rms, 5 mV pk-pk

temperature coefficient . . . . 0.03% per °C

remote programming resistance (5V output only) . . . . . 200 ohms/volt, nominal.

remote programming voltage (5V output only) . . . . . volt per volt.

AC input
line . . . . 105-125 VAC/210-250 VAC at 47-440 Hz (derate 10% at 50 Hz). Units are factory prewired for 105-125 VAC. Consult factory for operation at frequencies other than 47 to 63 Hz.

input power . . . . MPU-1 75 watts, MPU 2 145 watts.

line current . . . . MPU-1 1.0A, MPU-2 1.7A.

Overshoot
no overshoot on turn-on, turn-off or power failure

Ambient operating range
continuous duty from 0° to 60°C

Storage temperature range
-20°C to +85°C

Overload protection
automatic electronic current limiting circuit, limits output current to a safe value, protecting load and power supply when overload and direct shorts occur.

Overvoltage protection
all outputs include fixed built-in overvoltage protection circuits which prevent damage to the load caused by excessive power supply output voltage. Overvoltage protection firing range—see table below:

Output	Overvoltage Trip range (volts)
5V	6.6 ± .2
12V	13.7 ± .4
9-12V or 5V (MPU-1)	13.7 ± .4
9V or 5V (MPU-2)	10.5 ± .4

Cooling
convection cooled, no heat sinks or forced air required

Controls
DC output control.
Simple screwdriver voltage adjustment over voltage range.

Remote sensing
Provision is made for remote sensing, on 5V output only, to minimize the effect of power output lead resistance on DC regulation.

Input and Output Connections
AC input and Ground—thru terminals on transformer
DC output and Sensing—thru turret terminal on P-C boards

Finish
Gray, Fed. Std. 595 No. 26081

Mounting
Three surfaces, each with clearance mounting holes, can be utilized for mounting this unit.

Physical Data

Model	Weight Lbs net	Weight Lbs ship,	Size (inches)
MPU-1	5 1/2	6	7 x 4 7/8 x 2 3/4
MPU-2	7 3/4	8 1/2	9 x 4 7/8 x 2 3/4

Guaranteed
60 day guarantee includes labor as well as parts. Guarantee applies to operation at full published pecifications at end of 60 days.

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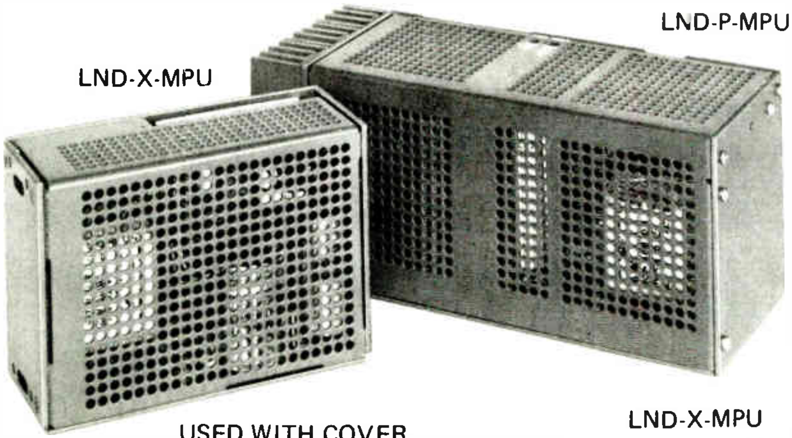
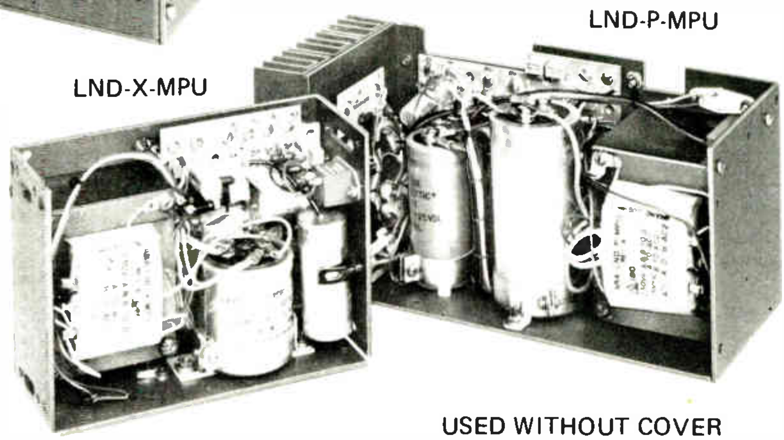


USED WITH COVER



USED WITHOUT COVER

FEATURES

New Monolithic and Hybrid OV
overvoltage protection standard on 5V models — available as an option on other models

Designed to Meet VDE Specs.

Isolation Resistance
10 Megohms

Regulation
line or load — 0.1%

Ripple and Noise
1.5 mV rms, 5mV pk-pk

Isolation Voltage
input to output — 4000V

Thermally Engineered Ventilation Holes

Convection Cooled
no external heatsinks or blowers necessary

Dual Input
105-127 VAC, 47-440 Hz
210-254 VAC, 47-440 Hz

Mounting
3 positions; 3 surfaces

Fungus Proof
No fungus nutrient material used

Shipped Complete with Cover
can be used with and without cover, depending on your application

Listed in UL Recognized Component Index

CSA certified

DUAL OUTPUT

5 VOLTS ± 5% ADJ, 9V-12V ADJ

MODEL	REGULATION (line or load)	RIPPLE (RMS)	VOLT. VDC.	(1) MAX CURRENT AMPS AT 40°C	50°C	60°C	71°C	PKG SIZE	DIMENSIONS (2) (inches)	PRICE
LND-X-MPU (3)	0.1%	1.5	5±5%	7.0 (5.95)	6.0 (5.11)	4.7 (4.0)	3.2 (2.72)	X	7 x 4 7/8 x 2 7/8	$172
			9–12	1.2 (1.02)	1.1 (0.94)	1.0 (0.85)	0.8 (0.68)			
LND-P-MPU (3)	0.1%	1.5	5±5%	14.0 (13.3)	12.2 (11.59)	10.0 (9.5)	7.5 (7.13)	P	11 x 4-7/8 x 4-13/32	245
			9–12	2.5 (2.38)	2.2 (2.09)	1.8 (1.71)	1.35 (1.28)			

NOTES: 1. Rating in Parenthesis for LN Series when cover is used
2. Dimensions include cover
3. Includes OV protection on both outputs (5V OV trip point is 6.6 ± .2V fixed; 9–12V OV trip points is 13.7 ± .4V fixed)

SPECIFICATIONS OF LN SERIES

DC Output

Voltage range shown in tables

Regulated Voltage

regulation, line . . . . . 0.1% (0.15% for LN-Z)
regulation, load . . . . . 0.1% (0.15% for LN-Z)
ripple and noise . . . . . 1.5mv RMS, 5mV pk-pk with either positive or negative terminal grounded.
temperature coefficient . . . . 0.03%/°C
remote programming resistance . . . . 200 ohms per volt nominal
remote programming voltage . . . . volt per volt

AC Input

line . . . . 105-127 VAC, 210-254 VAC (by transformer tap change) 47-440 Hz. Consult factory for operation at frequencies other than 57-63 Hz.
Efficiency (Typical) . . LND-MPU 34%.

Ambient Operating Temperature Range

Continuous duty from 0° to + 71°C with corresponding load current ratings for all modes of operation.

Storage Temperature Range

–55°C to 85°C

Overload Protection

Electrical

External overload protection, automatic electronic current limiting circuit limits the output current to a preset value, thereby providing protection for the load as well as the power supply.

Thermal

Thermostat — automatically reset when over temperature condition is eliminated.

Overshoot

No overshoot on turn-on, turn-off or power failure.

Overvoltage Protection

Overvoltage protection module crowbars output when trip level is exceeded — standard both outputs of models LND-X-MPU and LND-P-MPU.

Input and Output Connections

Heavy-duty screw terminals on printed circuit board.

DC Output Controls

Simple screwdriver adjustment over the entire voltage range.

Remote Sensing

Provision is made for remote sensing to eliminate effect of power output lead resistance on DC regulation.

Mounting

Three mounting surfaces, three mounting position. One mounting position for LN-P models.

Convection Cooled

No external heat sinking or forced air required.

Transformer

MIL-T-27C, Grade 6; Electrostatic shield; 4000 VAC input/output isolation.

Isolation Rating

Minimum 10 Megohm isolation from DC to ground at ground at 1000 VDC.

Fungus Proof

No fungi nutrient material used.

Military Specifications

The LN series has passed the following tests in accordance with MIL-STD-810C:

1) Low Pressure — Method 500.1, Procedure I.
2) High Temperature — Method 501.1, Procedure I & II.
3) Low Temperature — Method 502.1, Procedure I.
4) Temperature Shock — Method 503.0, Procedure I.
5) Temperature — Altitude — Method 504.1, Procedure I. Class 2 (0°C operating)
6) Humidity — Method 507.1, Procedures I & II.
7) Fungus — Method 508.1, Procedure I.
8) Vibration — Method 514.2, Procedures X & XI.
9) Shock — Method 516.2, Procedures I & III.

MIL-I-6181D — Conducted and radiated EMI with one output terminal grounded.

Physical Data

Package Model	Weight Lbs. Net	Weight Lbs. Ship	Size Inches
LND-X	7-3/4	8-1/4	7 x 4-7/8 x 2-7/8 (w/cover) 7 x 4-7/8 x 2-3/4 (w/o cover)
LND-P	15-1/2	17	11 x 4-7/8 x 4-13/32 (w & w/o cover)

Finish

Gray, Fed. Std. 595 No. 26081.

UL/VDE/CSA

Listed in UL Recognized Components Index.
Designed for listing in VDE Index.
CSA certified

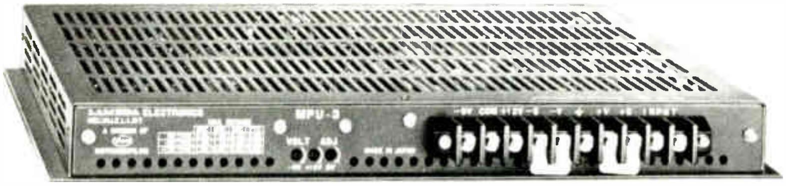
Accessories

Overvoltage protectors standard on models LND-X-MPU and LND-P-MPU .

Guaranteed for 5 Years

5-year guarantee includes labor as well as parts. Guarantee applies to operation at full published specifications at end of 5 years.

Lambda's new MPU-3 microprocessor system switching power supply for expanded 8080 microprocessors



Features include:

- Greater than 60% operating efficiency with switching circuitry on all 3 outputs
- Full 5 year guarantee on parts and labor
- Compatibility with any 8080 microprocessor system
- Switching Circuitry on all 3 outputs

VOLTAGE AND CURRENT RATINGS—MPU-3

MODEL	OUTPUT VOLTAGE	MAX. AMPS AT AMBIENT OF 40°C	50°C	60°C	71°C	PRICE
MPU-3	5V ± 10%	9.0	7.2	5.4	4.5	$325.00
	–9V ± 10%	1.3	1.1	0.8	0.6	
	+12V ± 10%	1.0	0.8	0.6	0.5	

SPECIFICATIONS—MPU-3

DC output

voltage range: refer to table

Regulated Voltage

regulation, line: 0.4% for line variations from 105-132VAC
regulation, load: 0.4% for load variations from 0 to full load
remote programming resistance: 1000 ohms/volt (5VDC output only)
remote programming voltage: volt/volt (5VDC output only)
ripple and noise: 10mV rms, 50mV p-p for 5V output. 15mV rms, 100mV p-p for -9V and +12V outputs
temperature coefficient: 0.03%/°C
power failure: All outputs will remain within regulation for 16 msec after power failure

AC input

line: 105-132 VAC 47-440 Hz; hold up time: 16 msec min at low line and full load, and Vo max

DC input

145 VDC ± 10%

Overshoot

No overshoot on turn-on, turn-off, or power failure

Ambient operating temperature range

Continuous duty from 0°C to 71°C with load current ratings as shown in table

Storage temperature range

-55°C to 85°C

Overload protection

Electrical—external overload protection: automatic factory preset electronic current limiting circuit limits the output current to 110% of max. rating, thereby providing protection for the load as well as the power supply.

Efficiency

Greater than 60% with advanced 20 KHz switching circuitry

Input and output connections

Heavy duty terminal block on chassis

Cooling

convection-cooled

Controls

DC output controls
Three voltage adjustment controls, one for each output

Remote sensing

Provision is made for remote sensing on 5VDC output only to eliminate effect of power output lead resistance on DC regulation

Overvoltage protection

Built-in fixed overvoltage protection for all outputs standard on all units. When a preset-voltage is exceeded, the overvoltage protector crowbars the output and removes the inverter drive.

Mounting

One mounting surface, two mounting positions

Physical data

Package Model: MPU-3
Weight (lbs.) Net: 5.5
Size (inch): 12 51/64W. x 1 3/8H. x 7 3/32D.
Finish: Gray, Fed. Std. 595 No. 26081

Guaranteed for 5 years

5 years guarantee includes labor as well as parts. Guarantee applies to operation at full published specifications at end of 5 years.

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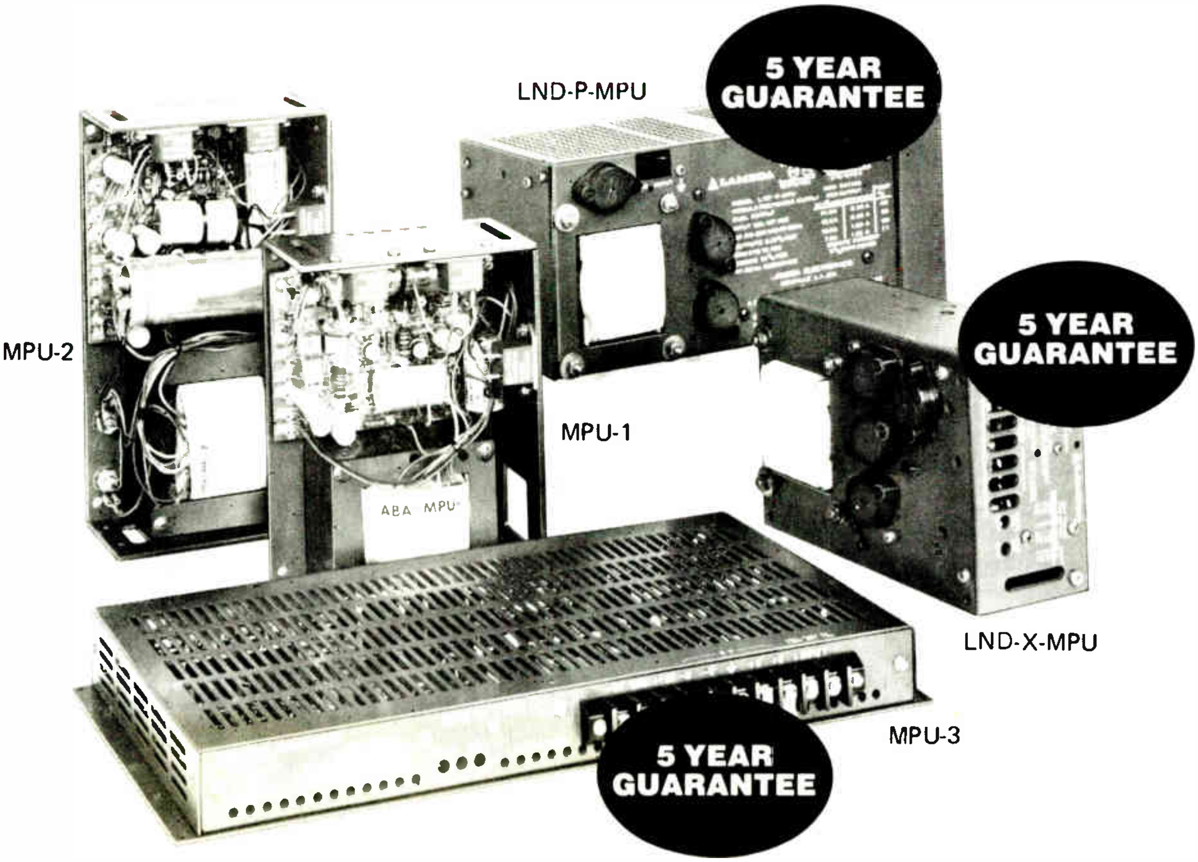

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LND-P-MPU & LND-X-MPU

First triple output

SWITCHING POWER SUPPLY FOR μP SYSTEMS-MPU-3

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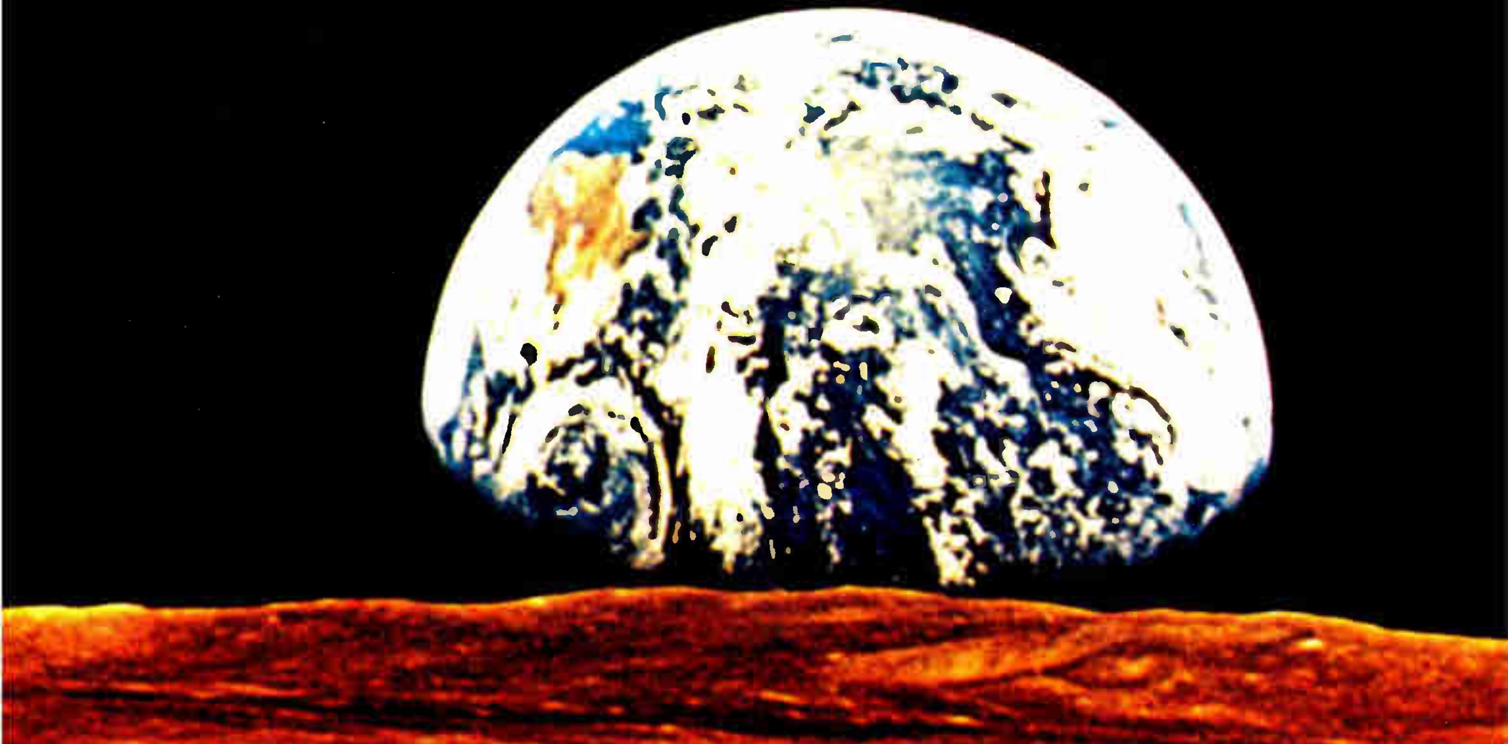

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For people who need to know

Modem filters minimize crosstalk

Family of more than 100 fixed-frequency units offers wide range of baud rates and frequencies for communications, control applications

by Lawrence Curran, Boston bureau manager

A family of more than 100 fixed-frequency filters for modems is described by Frequency Devices Inc. as offering the broadest range of baud rates and frequencies available to date. Useful in applications ranging from control, telemetry, and computer data transmission to high- and low-speed telegraph systems, the 534 series includes models for the standard CCITT baud rates of 60, 75, 110, 150, 300, and 600. The filters require no external adjustment.

Steven M. Ruscio, vice president for marketing and sales at the Haverhill, Mass., company, maintains that the high-frequency members of the family, especially, will answer a growing need for communications and control applications. "These are precisely defined band-pass filters based on computer-optimized state-variable design techniques," he says.

At their center frequency, about which the frequency response is symmetrical, all models have an inverting midband gain of ±0.5 dB. Relative to the midband gain, the filters attenuate the in-channel space and mark frequencies—the triggering frequencies—by no more than 1.5 dB. At the same time, they attenuate the space and mark frequencies in adjacent channels by a minimum of 28 dB. "This inhibits crosstalk between channels while attenuating the signal of interest only moderately," Ruscio notes.

The filters are implemented mainly with discrete components, but Ruscio points out that monolithic operational amplifiers that combine bipolar and field-effect transistors are used to achieve good slew rates and gain-bandwidth products. "Beyond that," he says, "the designs are essentially a computerization of classical state-variable design techniques." The reason the company can offer so many different models is that the operator specifies the center frequency and shape (roll-off) the customer wants, and the computer program then outputs the poles and zeros of the desired filter.

"Once we have these," Ruscio says, "and to maintain the characteristics of the device, we do a computerized sensitivity analysis of all the components of the device," resulting in a computer printout giving the resistance and Q values required for the specific model.

Thirty-five 60-baud models offer a choice of fixed center frequencies in 100-Hz increments between the ranges of 365 to 965, 1,075 to 1,875, and 2,000 to 3,600 Hz. The mark frequency is defined as 25 Hz above the selected center frequency, the space frequency as 25 Hz below. Twenty-eight 75-baud models offer center frequencies between 420 and 3,660 Hz in 120-Hz increments. The mark frequency is 30 Hz above the selected center frequency, with the space frequency 30 Hz below.

Twenty 110-baud models provide center frequencies between 425 and

3,655 Hz in 170-Hz increments, with the space and mark frequencies 42.5 Hz above and below the selected center frequency respectively. Fourteen 150-baud models have center frequencies between 480 and 3,600 Hz in 240-Hz increments, with space and mark frequencies 60 Hz above and below the selected center frequency.

There are nine 300-baud models offering center frequencies between 215 and 3,315 Hz in 300-Hz increments, with the space and mark frequencies 75 Hz above and below the specified center frequency. A single 600-baud model with a center frequency of 1,815 Hz passes space and mark frequencies 150 Hz above and below the center frequency. Ruscio adds that users can specify center frequencies other than these in their baud ranges, and the company can still handle the parts as standard.

Models in the 534 series operate from a single-ended power supply that may range from 10 to 30 V dc, depending on the application.

As an option, all models in the series can be supplied for operation from dual supplies that range from ±12 to ±18 V dc. The short-circuit-protected output-current capability of the devices is 2 mA, with an output noise level of 50 μV rms in a bandwith from dc to 50 kHz. All models in the series have an input impedance of 20 kΩ and an output impedance that is specified by the company as 1 Ω typical.

The operating temperature range of the 534 series filters is 0°C to +70°C and the storage temperature range is −30°C to +85°C.

The filters are encapsulated in low-profile modules that are 2 by 2 by 0.4 inches. They are pinned out for mounting on printed-circuit boards with 0.04-in.-diameter pins on 0.1-in. centers.

Prices start at $42 each in quantities of one to nine, dropping to $19 each for quantities of more than 1,000, and delivery time is two to four weeks.

Frequency Devices Inc., 25 Locust St., Haverhill, Mass. 01830. Phone W. Morse at (617) 374-0761 [338]


La
Gd
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rare earths
rhône-poulenc
all grades
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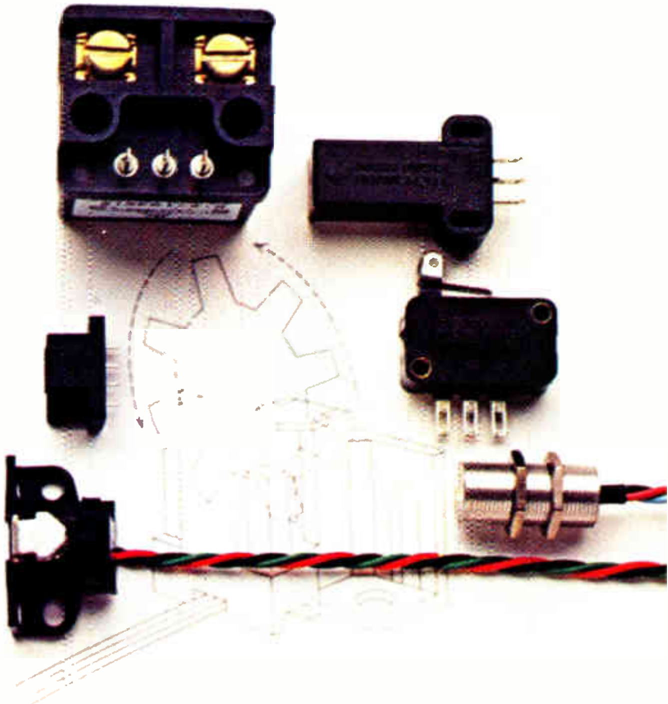
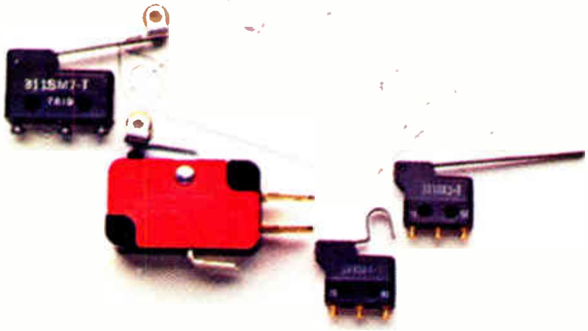
99,9999% purity

Some of these components will probably never
The others will just come close.

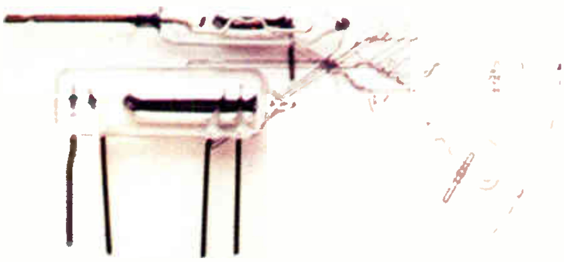
The SR, XL, XK and AV are solid state position sensors featuring almost infinite life. All offer zero speed operation with some up to 100 Khz. ES current sensor utilizes Hall-effect IC and protects against damage from short circuits or overcurrent conditions.





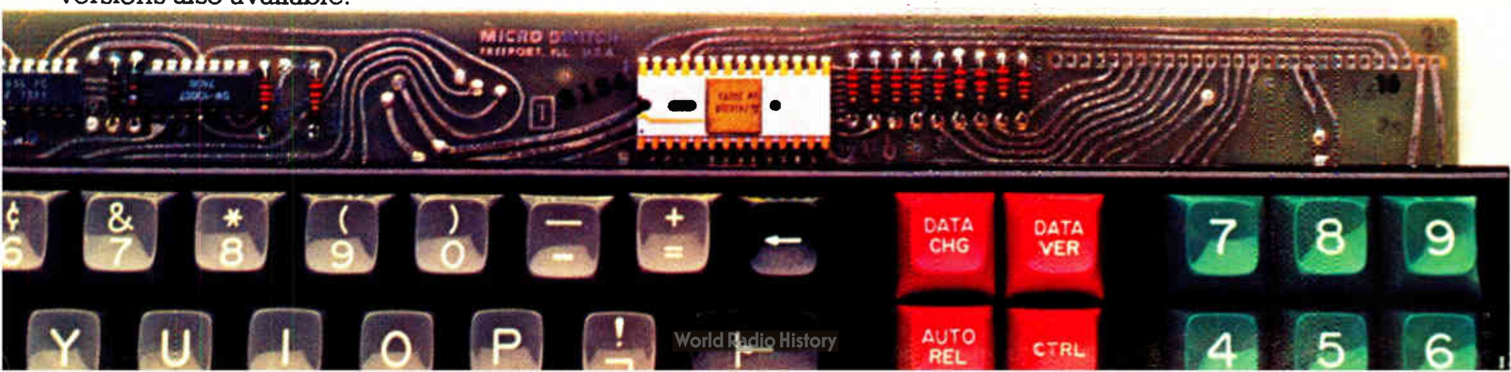
Snap-action V3, SM and SX switches offer wide variety of actuators, electrical capacity and termination.

Mercury switches offer hermetic sealing, a variety of electrical capacity and broad temperature ranges at a low cost.



AML manual devices for low installed cost, electrical flexibility and attractive panel appearance. Series 8 miniature manual switches provide small size and wide variety of operators. DM offers inexpensive snap-in panel mount design.

Solid state keyboards provide high reliability no mechanical keyboard can offer. Panel sealed versions also available.



Components

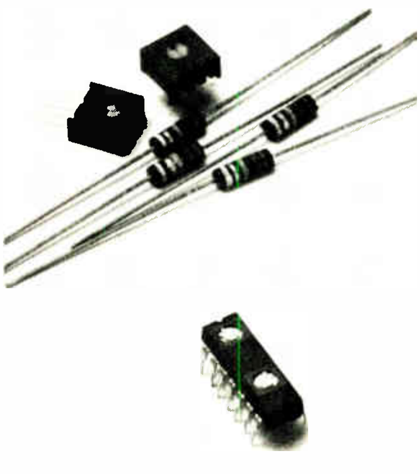
Pots include fixed resistors

Complete trimmer circuits for analog ICs are housed in standard DIPs

To a greater degree than one might expect, the arrangements of fixed and variable resistors used for trimming analog integrated circuits are highly standardized. To trim a given operational amplifier, for example, most users will use the same two fixed resistors in series with the same trimming potentiometer.

Having made this observation, Bourns Inc. has developed a line of new trimming components that consists of arrangements of trimmers and fixed resistors in nine standard configurations and a variety of values. Called Multi Function Trimmers, the new units are housed in dual in-line packages, ranging from a six-pin DIP containing one fixed resistor and one trimmer to a 14-pin device with four resistors and two trimmers (photo). A 16-pin DIP with four trimmers and no fixed resistors is also available.

The advantages of the new approach are many: the time and cost of designing circuits is reduced, the amount of board space required by an analog IC and its peripheral components is cut, and manufacturing is speeded because the new trimmers can be handled by standard automatic insertion equipment. In addition, the DIPs are compatible with automatic test equipment, reducing incoming-inspection costs.



The nine units in the MFT line all operate from −55°C to +125°C and can dissipate a maximum of 0.25 W at 85°C (0.10 W at 125°C). Their individual components drift a maximum of 100 ppm/°C and track to within better than 50 ppm/°C. Available resistances vary from model to model, but generally fall in the range from 100 Ω to 500 kΩ. Individual trimmers with values as high as 500 MΩ are possible.

The model 7126 dual voltage divider shown in the photo implements the most popular operational-amplifier trimming circuit. It contains two identical networks, each of which consists of a trimmer with a fixed resistor hung on each end.

Bourns Inc., Trimpot Products Division, 1200 Columbia Ave., Riverside Calif. 92507. Phone Bill Galvan at (714) 781-5204 [341]

Thermal reed switch handles 0.5 A at 120 V ac

A temperature-responding ferrite and a reed switch constitute an inexpensive temperature-sensing device. OHD series thermal reed switches, built into plastic housings, have ratings of 0.5 A at 120 V ac. They always operate at the same temperature because they sense by means of the Curie point of Thermorite. The ferrite is permanent, and the contacts of the reed switch are durable, so that the switch has a long life. Switching temperatures between 60°C and 130°C are standard, but special settings are available. Maximum differential is 10°C.

The sensor provides quick thermal response because the Thermorite is in direct contact with the object being monitored. The switch has a high mechanical resonance frequency (2 to 3 kHz) and is glass-encased in nitrogen to prevent both corrosion

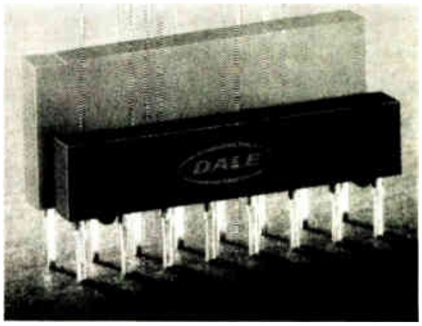
of the contacts and explosion.

George Ulanet Co., 413 Market St., Newark, N. J. 07105. Phone (201) 589-4876 [343]

Thick-film resistor network stands only 0.195 in. high

Up to nine resistors for high-density packaging are provided by a thick-film resistor network with an above-board height of 0.195 inch. Available in 6-, 8- and 10-pin models, the MSP networks have a maximum power rating of 1.70 w (10-pin package). Individual resistors have a maximum power rating of 0.18 w.

Standard resistance range is from 10 Ω to 1 MΩ with 2% tolerance, and



the standard temperature coefficient is ±100 ppm/°C over an operating temperature range of −55°C to 150°C. Networks are available from stock to meet requirements for pull-up, pull-down, voltage-divider, impedance-balancing, and other applications.

Dale Electronics Inc., Box 74, Norfolk, Neb. 68701. Phone Dave Dossett at (402) 371-0080 [344]

Subassemblies

Optical coupler switches 7.5 W, drives triacs

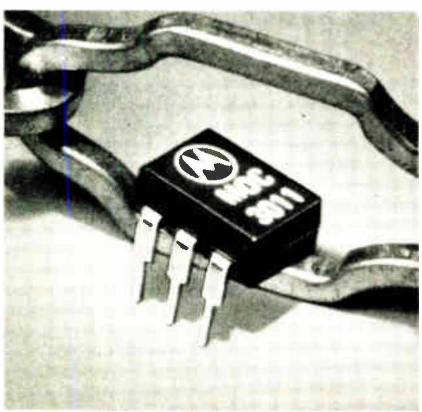
The missing link between low-power controllers such as microprocessors and high-power ac switches like triacs is supplied by the MOC3011 optical coupler. Used alone, the unit switches power-line loads up to 7.5 w. Let it drive a high-power triac, and it switches kilowatt loads.

Housed in a six-pin dual in-line package, the coupler contains a gallium-arsenide infrared-emitting diode, which is energized by currents of 10 mA at voltages as low as 2 v. A transparent insulator able to withstand 7,500 v carries the infrared radiation to a monolithic photosensitive circuit in the same DIP. This circuit's output simulates that of a small triac: it can switch ac loads up to 100 mA and can sustain output voltages up to 250 v in the off condition. Output characteristics of the coupler also eliminate complex interface circuitry.

Motorola's annular ring technology, silicon-nitride passivation, and ion-implanted elements are combined in the monolithic chip to provide the moisture resistance and temperature stability necessary for operation in such appliances as microwave ovens.

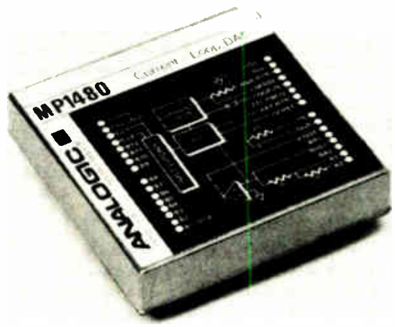
Available from stock, the MOC3011 sells for $1.60 each in hundreds.

Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, Ariz. 85036. Phone Harold Frede at (602) 244-4556 [381]



Current-loop d-a converter aims at process control

Designed for use in industrial process-control systems, the MP1480 is a 12-bit current-loop digital-to-analog converter with a built-in storage register. Operating over the standard current range of 4 to 20 mA, the converter has a slew rate of



2 mA/μs and a half-least-significant-bit settling time of 10 μs. Packaged in a shielded module with dimensions of 2 by 2 by 0.375 inches, the MP1480 sells for $135 in small quantities. In hundreds, the price drops below $100 each. Delivery time is 12 weeks.

Analogic Corp., Audubon Road, Wakefield, Mass. 01880. Phone (617) 246-0300 [383]

Analog dividers provide high accuracy

A series of two-quadrant hybrid dividers that interface with microprocessor-based systems contains units with maximum 25°C errors of 1%, 0.5%, 0.25%, and 0.10%. These error figures are true maximums, including the effects of offset voltage, feedthrough, scale-factor errors, and nonlinearity in both quadrants. Designated models SGR 503 through SGR 506, the dividers have small-signal bandwidths of 1 MHz and full-power bandwidths of 200 kHz. Slew rate is 25 V/μs. For small quantities, prices range from $49 to $160 depending upon accuracy. The compact devices occupy less than

half a cubic inch and weigh less than an ounce.

SGR Corp., Neponset Valley Industrial Park, P. O. Box 391, Canton, Mass. 02021. Phone Ann Ripley at (617) 828-7773 [384]

Switching supplies are board-mounted

A line of multiple-output switching power supplies consists of units packaged on printed-circuit boards and fitted with connectors. At 65 watts, efficiency is a minimum of 75%. Units having up to five outputs are available from the company. In hundreds, a five-output model sells for $152; delivery time is six to eight weeks.

Etatech Inc., 187-M W. Orangethorpe Ave., Placentia, Calif. 92670. Phone (714) 996-0981 [385]

Isolation amplifier withstands 6.5 kV peak

The model IA286 isolation amplifier is a compact module with dimensions of 2.52 by 3.52 by 0.63 inches and an input/output isolation-voltage rating of 5,000 v dc continuous and 6.5 kv dc peak. The input circuit presents a common-mode impedance of 10^9 Ω in parallel with 10 pF and a differential impedance of 10^{12} Ω in parallel with 3 pF.

The amplifier gain can be adjusted from unity to 100. Its nonlinearity is no more than 0.1%, and its temperature coefficient is less than 0.025%/°C. The IA286 sells for $58 each in hundreds and is available from stock to 30 days.

Intronics Inc., 57 Chapel St., Newton, Mass. 02158. Phone Richard Sakakeeny at (617) 332-7350 [386]

Microprocessors

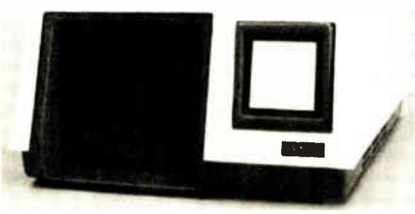
Flexible system uses floppy disks

Development package can also become a building block for end user

Many microprocessor development aids can be used only to develop and debug hardware and software for microprocessor-based systems. But when Mostek Corp. introduces its AID-80F microcomputer development system next month, it hopes to give users not only a development tool, but a package that can be used as a building block for end products.

For $5,995, customers will get the complete system: a Shugart Associates Inc. dual-floppy-disk drive, power supply, front panel, and six-slot card cage with processor, memory, and disk-controller boards. Unlike makers of other disk-based development systems, Mostek plans to unbundle hardware and software so that it can be purchased piece-by-piece by the user.

For Mostek, it is a back-door entry into the computer business. "The fact that our development system is built around software and boards that are available to original-equipment manufacturers opens up a new market for us," says Bryan D. Knox, applications engineer for the Carrollton, Texas, firm. "Its constituent elements will be sold separately, and we plan to make software available separately, too, on an OEM basis with limited and unlimited licensing arrangements." That way, the development station could be configured into such end products as inventory-control systems, industrial supervisory controllers, communications concentrators, and small business computers.



The system is designed around Mostek's version of Zilog Inc.'s Z80 microprocessor; it will support software development for that device, or with an optional $850 AIM-72 board coming in the second quarter of 1978, it can be used to debug software written for the firm's MK3870 and MK3872 one-chip microcomputers. Disk space is configured to hold up to 500,000 bytes, or 1 megabyte if the optional double-sided disk is chosen. Random-access memory totals 32 kilobytes and can be expanded to 64 kilobytes by 8 bits with boards that also carry four input/output ports.

But the system's real strength is in its software, specifically a powerful new peripheral-interchange program for file maintenance and exchange of data between peripherals. "Other systems offer some kind of file-maintenance ability," Knox says, "but our program has that plus the ability to handle other peripheral devices." It will copy data from disk to disk, between disks and peripherals, or between any two peripherals with a single instruction, he adds.

Besides a monitor that is similar to Digital Equipment Corp.'s PDP-11 monitor, a disk-based text editor, and Z80 assembler, the AID-80F comes with a one-pass relocating linking loader that allows users to append new programs to existing system resources. Mostek also provides a second linker program with a library search capability so that linking and loading can be done in the conventional two-pass manner as well. The system's Z80 debugger will step through programs stored in random-access memory instruction by instruction. Hardware single-step and in-circuit emulation of the Z80 will be marketed as an $1,195 option.

Mostek Corp., 1215 W. Crosby Rd., Carrollton, Texas 75006. Phone (214) 242-0444 [371]

Motorola aims display at original-equipment market

Motorola Inc.'s new general-purpose display terminal intends to be many things to many people: to the process-control industry, it is a neat little stand-alone package that even houses the analog-to-digital conversion electronics; to systems companies, it builds a low-cost business microcomputer when complemented with some disk memory; and to the Phoenix Microsystems division, which makes it, there is no better vehicle to sell the company's Micromodule board products.

The Epic 68 is aimed at two markets: original-equipment manufacturers and sophisticated end users, according to Ken Hanley, systems product manager at the Motorola division. "A systems OEM can take the Epic, add some user-oriented firmware or hardware, and make up anything from a passive monitor to a complete information-processing system," he says. The market for the terminal, therefore, is more like that in which Conrac Corp. sells its display monitors, rather than that of, say, Hazeltine Inc. or Beehive International, which are designed principally for terminal applications.

The Epic contains slots for eight Micromodule boards. The bare-bones version of the terminal, which costs $2,960, has just enough in it to allow users to program it as a minimally intelligent terminal. One stand-alone application for down-range sonar detection has an interface board, an a-d converter board, and a third board for calibration, all inside the Epic box. Another application is an automated tool-crib monitor for a naval shipyard. "It doesn't take long to put together a system like this," Hanley maintains. "Just plug in the off-the-shelf modules and put some software around them, and you can get the thing to market quickly."

Motorola Inc., 5005 East McDowell Rd., Phoenix, Ariz. 85008. Phone (602) 244-6900 [372]

Semiconductors

C-MOS EPROM draws 6 μW

At 5 volts, read-only memory offers access time of 200 to 280 nanoseconds

When designers of low-power microcomputer systems need a programmable read-only memory, they want one that has a low power drain. That is why Intersil has developed the IM6603/04, a 4,096-bit ultraviolet-light-erasable complementary-metal-oxide-semiconductor PROM with a total standby power dissipation of 6 μW at 5 v dc.

The 24-pin device is fabricated with Intersil's low-threshold, ion-implanted silicon-gate C-MOS process. A single metal-mask change makes the memory available in either of two configurations—as a 1,024-by-4-bit device (the IM6603) or a 512-by-8-bit unit (the IM6604).

Organized as two separate 64-by-32-bit arrays, the PROM discards the conventional C-MOS structure in favor of a shared design that allows the fabrication of large-scale integrated devices. With it, one n-channel device may be shared by several p-channel devices. The PROM array consists of 4,000 standard p-channel floating-gate transistors, with the peripheral input/output and control circuitry being straight C-MOS.

The devices have a quiescent power dissipation on the order of nanowatts. When driven at 5 v, the devices typically draw no more than 15 nw, at 10 v no more than 50 to 100 nw. Access times on the 6603/04 are 200 to 280 ns at 5 v and 150 to 200 ns at 10 v. Power consumption in the active mode is dependent upon cycle time, temperature, and supply voltage. For a 450-ns cycle time, 25°C, and 5 v, it ranges from 8 to 32 mw.

According to Gopal Ramachandran, product marketing manager, the IM6603/04 has a unique circuit technique that permits its operation at different voltage ranges. It has an extra power supply pin for the output buffers and a unique unbalanced buffered address latch that allows the IM6604 to replace an existing multiple-supply C-MOS erasable PROM, the 2704, by supplying address strobes to the pin that was formerly used for substrate bias.

Data retention on the 165-by-150-mil device is estimated to be better than 100 years at 70°C. Programming is performed by avalanche injection of electrons into selected floating gates. The device may be erased with standard high-intensity ultraviolet lamps.

Available now in sample quantities, the IM6603/04 is priced at $16 each in lots of 100 or more when housed in plastic, or $24 each for the ceramic version.

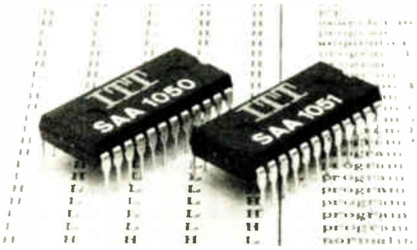
Intersil Inc., 10900 N. Tantau Ave., Cupertino, Calif. 95014. Phone (408) 996-5000 [411]

Two-chip set uses infrared pulses to control TVs

Drawing upon the expertise gained from developing integrated circuits for remote control of TVs by ultrasound techniques [*Electronics*, May 13, 1976, p. 87], Intermetall GmbH will soon offer a two-circuit IC kit that relies on infrared light as the transmission medium for the control commands.

Infrared methods for controlling TV functions are already in widespread use, particularly in some West European countries. But what Intermetall, the German member of the ITT Semiconductor Group, has "leapfrogs the competition," says Marijan Lorkovic, product manager for integrated circuits.

The IC kit, consisting of the SAA1050 transmitter and the SAA1051 receiver circuits, enables users to design an IR link over which up to 16 different systems or subsystems can be remotely controlled. The systems may range from a simple model train to an elaborate color TV set with all the latest features. The



subsystems may be, for example, the circuitry for channel selection or on-screen display of the channel number. After being addressed, each unit or feature can be controlled by up to 64 instructions.

Says Lorkovic, "The large number of instructions gives equipment designers not only flexibility now but also a big reservoir of control applications for the future." In fact, the development of the kit, he adds, was prompted in part by what TV producers are envisioning for their receivers: Viewdata, Teletext, intelligent games, and other features that will eventually make a set more like a home data terminal than a mere entertainment medium. But even now, as digital functions are increasingly being used in TV receivers, a large repertoire of instructions should come in handy, he asserts.

The SAA1050-SAA1051 transmitter-receiver kit will be available as samples early next year and in large numbers in late spring. The kit, priced at $10 in volume quantities, will go to market in the U. S. and Europe at the same time. The transmitter IC is a complementary-metal-oxide-semiconductor device, and the receiver IC is a p-channel silicon-gate circuit. Both come in as a 24-pin plastic package.

The receiver works with a photodiode that picks up IR pulses from the transmitter and feeds them through an amplifier to the SAA1051, which converts the instructions into signals that can be serially applied to a data bus. Over this bus the different pieces of equipment and subsystems can be addressed, with the 64 instructions available for each address.

Intermetall, 600 Woodfield, Suite 732, Schaumburg, Ill. 60172; Intermetall GmbH, P. O. Box 849, Freiburg, West Germany [412]

Data handling

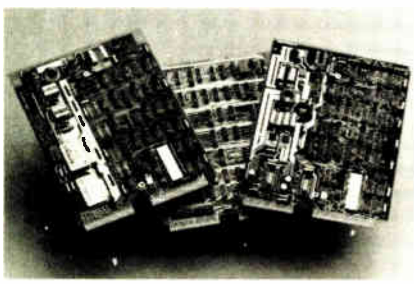
Data General markets boards

Minicomputer firm offers series of analog interfaces that plug into microNova

Convinced that microcomputer users will increasingly want "one-stop shopping" for all their needs, including analog input/output interfaces, engineers at Data General Corp. have developed a series of boards for their own microNova—the first such interfaces available for the 16-bit machine. Datel Systems Inc., Canton, Mass., is expected to introduce similar products next month, and this step is welcomed by Edward Zander, marketing manager for Data General's Microproducts group.

"If users feel they have a number of sources for microcomputer I/O boards, it gives them a good feeling about the microcomputer itself," Zander says. It is even better, in his opinion, if the interface subsystems are also supplied by the microcomputer manufacturer.

Data General's series consists of three boards: a digital I/O interface, an analog-to-digital board, and a digital-to-analog board. They all plug directly into the microNova chassis to give it stand-alone data-acquisition and control capabilities. The model 4222 digital I/O interface is a subsystem that takes the microcomputer's serial I/O bus and presents it to the outside world as 16 parallel-input and 16 parallel-output lines. The unit also furnishes two strobe-output lines and a single strobe-input line.



The model 4223 board is a complete a-d subsystem. It incorporates two eight-channel multiplexers, a differential-input instrumentation amplifier, a sample-and-hold unit, and a 12-bit successive-approximation a-d converter. Its 16 single-ended or 8 differential inputs are program-controllable. The subsystem offers jumper-selectable input-voltage ranges of 0 to 5, 0 to 10, ±5, and ±10 v. A complete conversion requires 33 μs maximum.

Model 4224 is the dual-channel d-a interface, a 12-bit subsystem providing selectable full-scale output of 0 to 5, 0 to 10, ±5, or ±10 v that will settle to within ±0.01% of full scale of desired output value in 7 μs. Each channel's output range is individually set.

Zander concedes that prices for the model 4223 a-d board and 4224 d-a interface unit are a bit high. The former will sell for $1,150 in single quantities, and the latter for $800. However, substantial discounts for quantity orders are available. Further, the user gets Data General software for the units at no additional charge. The software is the company's existing Sensor Access Manager, a library of device handlers and subroutines that control transfers between user programs and analog and digital sensor devices.

The model 4222 digital I/O subsystem will sell for $400 in single quantities. Delivery time of all three boards is 90 to 120 days.

Data General Corp., Route 9, Westboro, Mass. 01581. Phone Edward Zander at (617) 366-8911 [361]

Redesign takes heat off ¼-inch-tape transport

In its short six years of existence, the ¼-inch-tape cartridge has become a data-storage standard in word processing and data communications, as well as in many other applications. But it runs into a reliability problem with the transport that drives it. The drive's frequent starts and stops heat the cartridge up, causing the tape to warp and be thrown out of alignment and often shortening tape life to well under the 5,000 passes guaranteed by cartridge manufacturers.

Kennedy Co.'s new transport, however, dissipates too little heat to be harmful, thanks to redesigned circuitry that greatly reduces its power requirements. A dual-voltage power supply and power amplifiers make it possible to use a shell-wound motor that consumes 22.6 watts during start-up and 8.2 w while running, according to Russell Bartholomew, vice president of marketing. In contrast, most cartridge transports, including Kennedy's earlier units, have a three-voltage supply with peak demands of 150 w to 300 w and running-time dissipations of 37 w to 70 w.

Besides eliminating overheating and warpage, the model 631 thus saves significantly on the amount of electricity consumed. To date, between 4,000 and 5,000 of the earlier, first-generation units have been manufactured.

The bidirectional model 631 transport can be equipped with one, two, or four read/write heads, with maximum unformatted storage capacity of 720 kilobytes per track. Normal operating speed is 30 inches per second, with 25 in./s as an option. Using a phase-encoded format at a recording density of 1,600 bits per inch, the drive has a transfer rate of 48,000 bits per second at 30 in./s, 40,000 b/s at 25 in./s. Start-stop time is 25 milliseconds at 30 in./s and 30 ms at 25 in./s.

The transports are 6.5 in. wide by 4.75 in. high by 8.625 in. deep, and weigh 3.75 pounds. Power requirements are +5 v regulated and +24 v unregulated. The 5-v line draws 200 mA and the 24-v line draws 900 mA during start-up and 300 mA running.

The model 631 is priced from $500 to $795 depending on speed and number of tracks, with quantity discounts. Delivery time is within 60 days.

Kennedy Co., 540 West Woodbury Rd., Altadena, Calif. 91001. Phone (213) 798-0953 [362]

Packaging & production

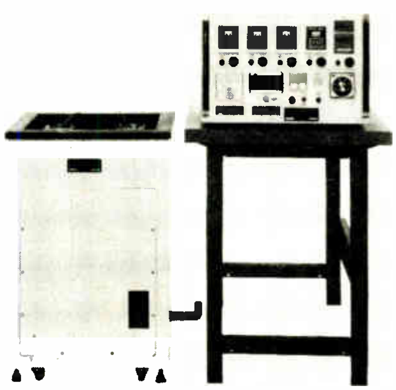
Metallic bumps plated on ICs

Electro-deposition technique prepares chips for tape-automated bonding

Tape-automated bonding, or film-carrier packaging, is now well established as a method for mass assembly of popular integrated circuits in plastic dual in-line packages. However, the lack of specially modified or bumped chips that can take the heat and pressure of mass bonding to the copper microinterconnects of the film carrier [*Electronics*, Dec. 25, 1974, p. 62] has held back the application of this technique to hybrid thick- and thin-film assemblies. Hybrid manufacturers, who found chips on film carriers an attractive alternative to bare chips, usually require only relatively small quantities of chips, and semiconductor manufacturers simply were not willing to bump chips in these quantities.

A new laboratory plating system for the electro-deposition of gold, silver, copper, or solder bumps on IC wafers should do a lot toward breaking this bottleneck. International Micro Industries' model 149 is designed for hybrid manufacturers who intend to bump IC wafers to prepare chips for tape-automated bonding.

The new machine includes an automatic power supply for plating through apertures in either thick (35-micrometer) dry-film photoresist or thin (2-μm) liquid photoresist. Its current regulation maintains a fine metallic deposition in the bump area and minimizes mushrooming of the bump. The machine's power supply monitors and automatically regulates the plating current as the plated area increases.



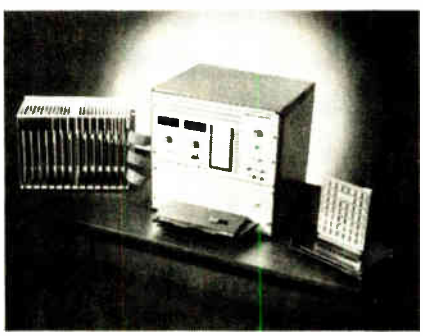
The machine has two workholders, each of which can accept wafers as large as 5 inches. The system is priced between $13,000 and $14,000. Delivery is 10 to 12 weeks.

Tom Angelucci, president of Integrated Micro Industries, points out that earlier plating machines could not effectively use the low-cost, high-yield liquid resists because lateral bump growth forced the use of higher-cost dry-film resists. The controlled-current supply of the model 149 eliminates this effect, giving a prospective users of the machine an opportunity to avoid the lamination, removal, and material costs of dry-film resists.

International Micro Industries, P. O. Box 604, Cherry Hill, N. J. 08004. Phone (609) 424-3112 [391]

Benchtop memory tester runs at 10 MHz

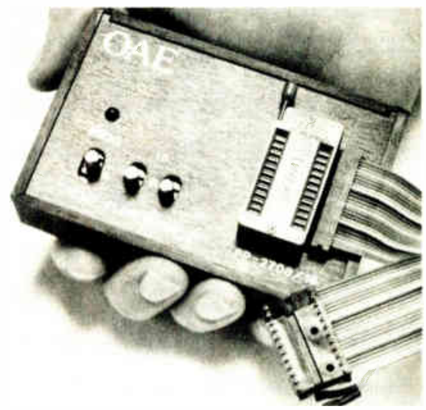
The M-5 memory test system is a dedicated, benchtop unit designed for the production testing of memory chips, boards, and systems and for functional burn-in testing as well. The basic system, which is controlled by an 8080A microprocessor, contains a pair of 8-bit address generators and can produce 16-bit data patterns. A third address generator can be added, and the word length can be expanded to 40 bits in 8-bit increments. Other options available for the 10-MHz tester are a real-time clock, an integrated-circuit handler, a wafer prober, and the circuitry needed for interfacing the system to an environmental chamber. The basic unit sells for $10,200.



Micro Control Co., 7956 Main St. N. E., Minneapolis, Minn. 55432. Phone Wayne Peterson at (612) 786-8750 [393]

Piggyback PROM programmer is priced at only $295

Plug the PP-2708/16 PROM programmer directly into any 2708 or TMS-2716 memory socket, place the programmable read-only memory to be programmed into the zero-insertion-force socket, and then simply push a button and a proprietary interface technique dumps the memory data over the eight lower address lines. Because of the simple interfacing technique and because all timing and control sequences are handled by the programmer, only a short software routine is required. The unit is simple, requires no additional power supplies, and sells for only $295 ($249 in kit form). It is equipped with 10-turn trimming potentiometers. A five-foot flat cable with a 24-pin plug is provided to connect the programmer with the socket of the 2708 or the TMS-2716.



Oliver Audio Engineering Inc., 676 West Wilson Ave., Glendale, Calif. 91203. Phone (213) 240-0080 [394]

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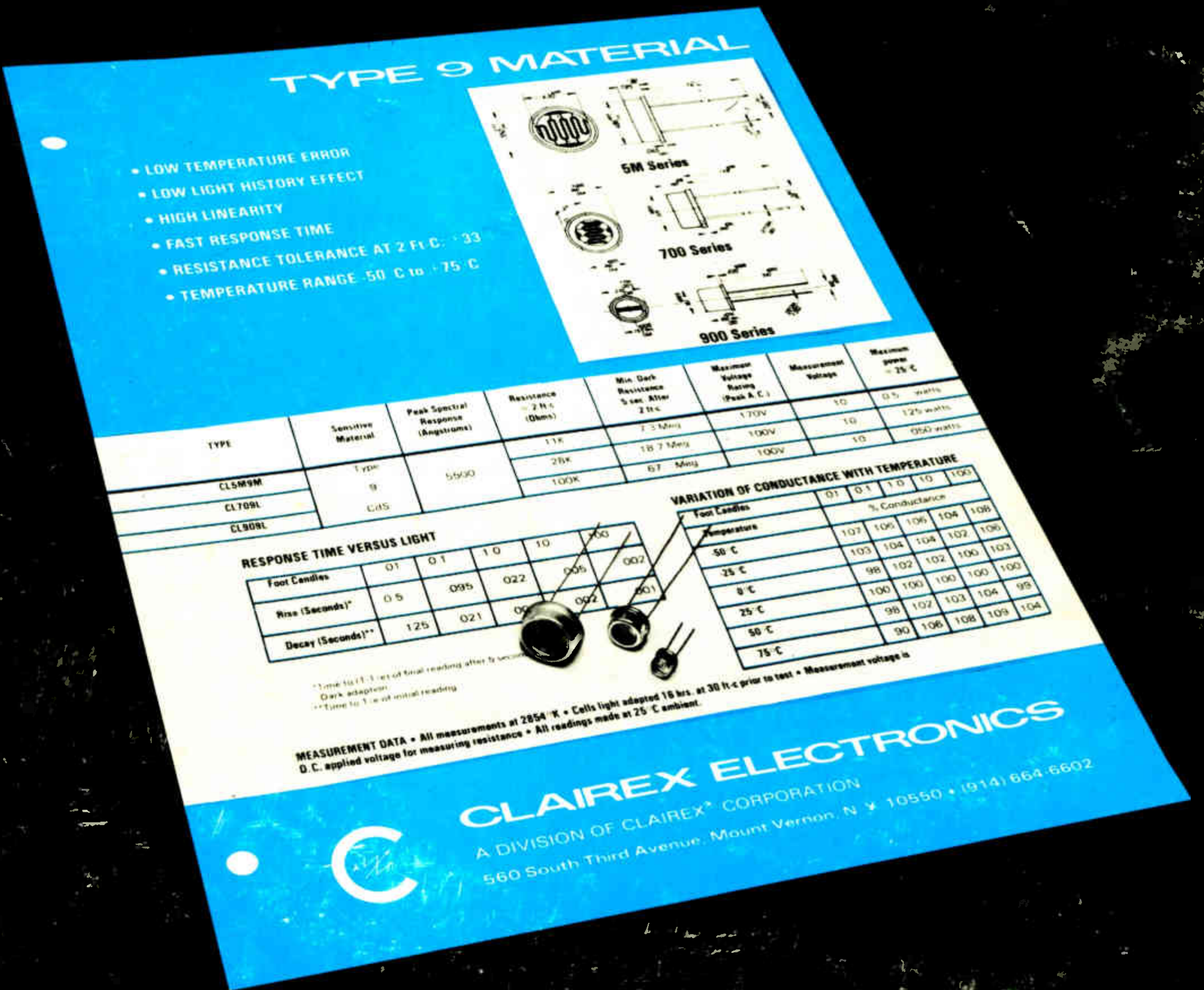

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