DECEMBER 21, 1978

INDUSTRY LEADERS PINPOINT 1979'S CHALLENGES/105

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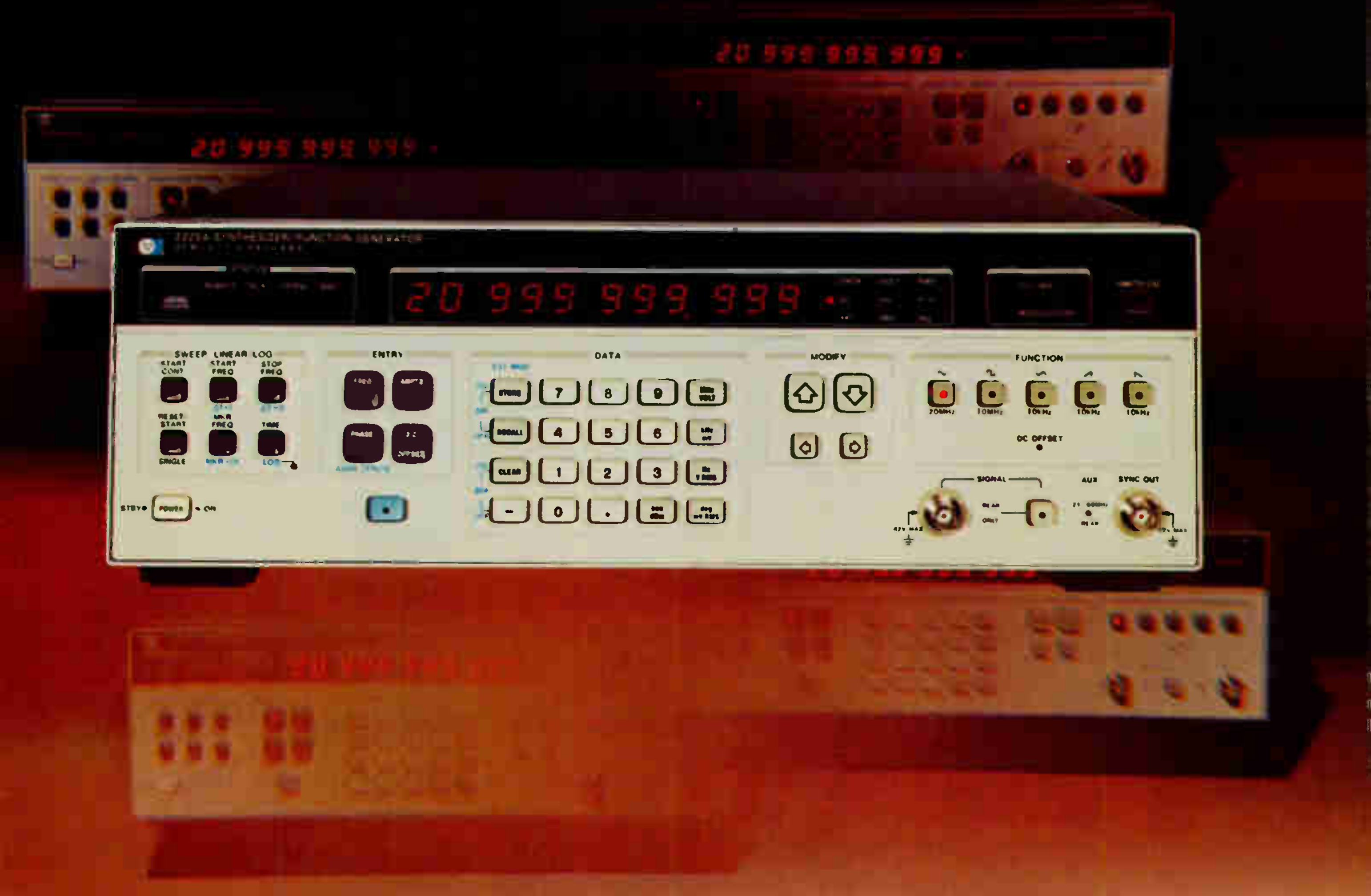

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Electronics

The International Magazine of Electronics Technology

Vol. 51, No. 26 • December 21, 1978

Highlights

Electronic executives view 1979, 105
Most of the 23 top officers interviewed don't expect a recession, but some do see a downturn. In general, there is a restrained feeling of optimism, coupled with continued uneasiness about the Carter Administration's attitude toward business.
Cover is by Richard Rosenblum.

HP approaches $2 billion, 74
Now 43% of the company's total sales, data-processing products are the leading segment in Hewlett-Packard's $1.73 billion year. These and international sales account for much of the 27% growth over fiscal 1977.

16-bit processor looks to future, 81
The Z8000 microprocessor works in 8- and 16-bit applications and has an advanced architecture that allows expansion. The larger of two versions can address 8 megabytes of memory.

All about ready-to-go fiber-optic links, 89
The concluding part of a special report on designing with fiber optics looks at the tradeoffs to be considered in buying off-the-shelf data links. Included is a user's guide in table form.

And in the next issue . . .
The annual market survey and forecast for the U. S., Western Europe, and Japan . . . detecting failures in microprocessor systems . . . an easy-to-use quad in-line package for 16-bit processors.

Electronics

Publisher's letter

If anyone can be called a pioneer in microprocessors, it's Masatoshi Shima, manager of high-end microprocessors at Zilog Inc. In his present position Shima was responsible for the design and development of the Z8000 16-bit microprocessor, the subject of the cover article (p. 81).

But that is only the latest in his string of significant contributions. Previously Shima was responsible for the design and development of the Z80 family at Zilog. Prior to that, as supervising engineer for Intel Corp., he participated in the development of the 8080. He performed the detailed design of the 8080 CPU and of the production tester for the 8080 system.

That's not all for this 35-year-old engineer. While an employee at Busicom Corp. in Japan, he worked with Intel in Santa Clara, Calif., on the functional specifications of the MCS-4 microcomputer family that included the 4004 microprocessor. Thus he was in on the design of four successive microprocessors—the 4004, 8080, Z80, and Z8000.

This background is reflected in the technical article. A graph on page 83 shows the progress over a seven-year period of what Shima likes to call the four generations of microprocessor architecture. This progress is measured in performance defined as the number of distinct instructions × data types × addressing mode ÷ average execution time. It's a startling reminder of how fast microprocessor capability has expanded.

Equally startling is a table reflecting chip complexity from first production in 1974 of the 8080 to first production of the Z8000 in 1978. For example, the number of transistors has gone from 4,800 to 17,800 and the packing density from 72 gates per square millimeter to 148 gates per mm^2.

Perhaps the prime significance of the work Shima describes in his article is the break with the 8-bit architectural mold made by the Z8000. Intended for application in either a microcomputer or a minicomputer, it has full 16-bit minicomputer-like architecture and goes beyond that to include 32-bit operations.

A good way to get a handle on what's in store for the coming year is to ask the top people, the policy shapers. That's what we have done again this year in our annual executive outlook (p. 105). Our field editors interviewed 23 top managers of companies in the United States, Europe, and Japan.

While the range of viewpoints on the coming year was wide, there was a common thread. Most of the top brass are concerned with the general global economy and international trade. Americans are particularly worried about inflation, state and local taxes, and about the shortage of engineers.

Significantly, there is no consensus concerning a recession. If anything, most of the executives are more bullish than many economists, although they see some slowing of business in 1979.

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Readers' comments

Obeisance to Pascal, inventor

To the Editor: In your article about the programming language Pascal ["Pascal becomes software superstar," Oct. 12, p. 81], you attribute my choice of its name to the high esteem in which I hold the French philosopher's teachings. Actually, I am neither capable of fully understanding his philosophy nor of appreciating his religious exaltations. Pascal, however, was (perhaps one of) the first to invent and construct a device that we now classify as a digital computer. He did so at the early age of 16, when he was called upon by his father, who was a tax collector, to assist in the numerous and tedious calculations.

The p-code compiler was developed (also mainly by Urs Ammann) as a side product of the compiler for Control Data Corp.'s code, after we received several requests for assistance in implementing Pascal on other computers. It turned out to be the key for making Pascal widely known and available.

Niklaus Wirth
Zurich, Switzerland

Unhealthy difference

To the Editor: The first page of "Tackling the very large-scale problems of VLSI: a special report" [Nov. 23, p. 111] displayed two photomicrographs, both without scale attached—an oversight common in almost all technical journals. The caption says the photos are "approximately to scale," which is probably not the case.

From my examination, the photo shown is not only an order of magnitude out of scale, but is probably not influenza virus at all.

I am afraid Mother Nature still has a significant edge on man's attempts to miniaturize his information storage and processing devices, as it would take 10 to 20 of the viral particles to stretch across one of IBM's metal lines, and I doubt if IBM memories can survive, reproduce, and adapt to their environment as well as the influenza.

Owen Sharp
Los Gatos, Calif.

■ *The viruses are indeed influenza type*

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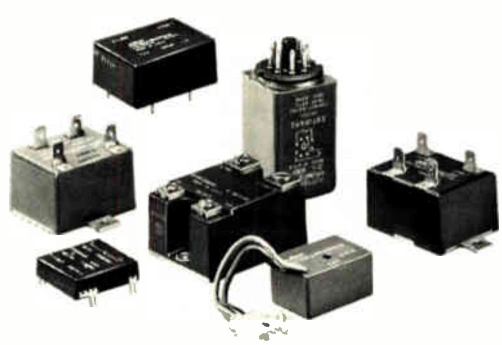

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Readers' comments

A. According to Mr. Racaniello, they were freshly isolated from a human throat washing and as such are filamentous, reaching a length of 1 micrometer or more. Had the viruses been grown in the lab, he notes, they would have taken on the more characteristic and significantly smaller round shape.

The virus photomicrograph, however, is not exactly in scale with the IBM circuit, the result of a misscaling in the layout. A true representation would have the viruses reduced approximately one third.

Need: in the eye of the beholder?

To the Editor: The editorial "Watching the spectrum slip away" [Oct. 12, p. 24] states, "The arrangement [at the World Administrative Radio Conference of one nation, one vote] could hurt the heavy spectrum users that need the space and are not anxious to share it." I question the use of "need" ("need" being defined as something necessary). After all, the multiplicity of a-m stations, spewing out their indistinguishable junk (and, for that matter TV stations, too), and the inane chatter of most CB'ers would never, if judged by any impartial jury, be considered "need," but only "luxury." On the same basis, but viewed by international values, I question the "need" for many present uses of other bands. Perhaps your own viewpoint is, by international values, no less "nationalistic and political" than those you are speaking against, and in fact even less valid?

Barry A. Pask
Winnipeg, Man.
Canada

Corrections

In "Fast-acting voltage detector protects high-current supplies" (Nov. 9, p. 115), Q_1 should be an npn transistor, and Q_2 a pnp transistor. Also, the + and − ports of the 741TC should be transposed.

The Japanese price for the Canon Inc. FPA-211A and FPA-112FA step-and-repeat aligners for fine-line photolithography is about $265,000 each, rather than the figure given in the Nov. 23 International Newsletter (p. 69).

Excellence in DMM's: The S-D 4½-digit family.

Model 7241A 4½-digit bench multimeter

Model 7244A. This 20,000 count DMM is identical to bench Model 7241A (featured at right) but includes the IEEE-488 interface. Current ranges not included when the 7244A is ordered.

Model 7344A Thin Line DMM. In only 1¾" of panel height you can make IEEE-488 Bus controllable measurements with ±0.2% basic DC accuracy. This low cost system DMM comes standard with DC volts, true RMS AC volts, K ohms, autoranging, IEEE-488 interface and rack mount hardware.

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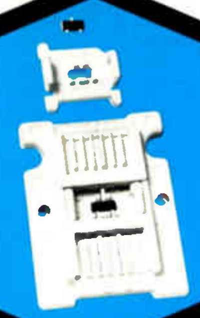

People

Postmaster General Bolger wants mail to pay its way

What many regard as an inordinate rush by Postmaster General William F. Bolger to have the United States Postal Service provide electronic mail delivery—called electronic message service (see p. 36)—may come as a surprise to those who know something of his background. Although he has spent his entire working life in the postal bureaucracy, he sounds more like a free-enterprise capitalist every day.

Talk about making the Postal Service competitive in the burgeoning market for electronic mail has been growing louder since Bolger assumed office last March. Recently, the crescendo has brought telecommunications equipment and service companies close to panic.

With 37 of his 55 years spent with the post office, Bolger believes the service has long suffered from "a welfare mentality" because of Government subsidies. The postmaster general contends that is now changing, and he intends to push harder on getting the mail service on a pay-as-you-go basis by employing electronic technology wherever it is at all possible.

Pushing ahead. Should the USPS be permitted to offer electronic message service as "mail," or should it be competitively developed by private industry? "What that role should be is a very basic, fundamental public policy decision that must be made by the elected representatives of the people," Bolger says, neatly sidestepping the issue. But until that decision comes, the postmaster general is determined to push ahead on the premise that he is "not going to be caught off guard and unprepared; we are not locked into subsidized lethargy anymore."

Justifying his position in the face of telecommunications industry opposition, Bolger argues that the USPS's success is not guaranteed. "We recognize that marketplace forces have killed off virtually every other form of home delivery service," he says, "and we also recognize that if we don't hustle and take steps to compete to keep our volume, our days may be numbered, too."

New stance. Decrying the U. S. Postal Service's "welfare mentality," William F. Bolger does not want his organization to be "locked into subsidized lethargy anymore."

Raphael of National sees changes for 16-bit devices

The era of 16-bit microprocessors will be slow to emerge because the benefits of the more powerful devices are not as obvious to the user as those of 8-bit microprocessors or 16-K random-access memories. That's the view of Howard Raphael, newly appointed director of microprocessor operations at National Semiconductor Corp., Santa Clara, Calif. His responsibilities include managing the introduction, expected late next year, of a 16-bit microprocessor that uses the company's XMOS shrunken n-channel metal-oxide-semiconductor process.

Tools and teaching. Microprocessors users "will first have to be taught how to take advantage of the new, higher-performance chips," he says. Moreover, makers must provide tools and capabilities that make the 16-bit devices even more attractive, continues Raphael. He joined National about a year and a half ago as marketing director for microprocessor components. For five years before that he was manager of low-

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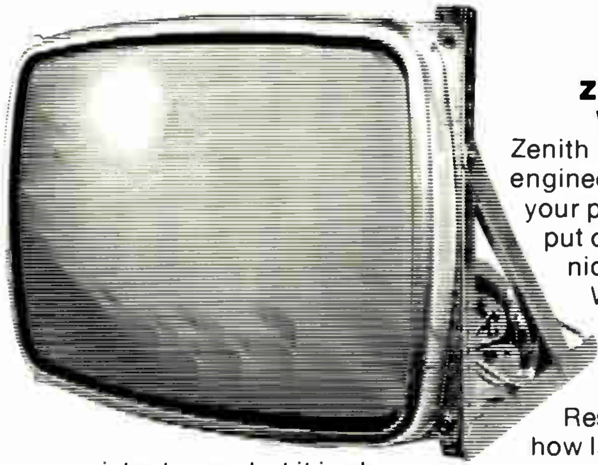

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Teacher. Users must be taught the benefits of 16-bit microprocessors, Raphael says.

end microprocessors at Intel Corp.

"Reducing software costs will be a major goal for semiconductor manufacturers in the coming decade," Raphael predicts. Accordingly, he sees more software being developed with high-level languages and multiprocessing schemes to take further advantage of the new devices' inherently greater power.

"Semiconductor companies will also be taking a hard look at overall systems costs." To this end, he sees new developments in packaging and power-supply design. He also sees more memory and input/output circuitry shoe-horned into the microcomputer chip. Moreover, there will be more combinations of linear and digital processing on a single chip.

Word lengths will proliferate. Word size has gone from 8 to 16 bits and it will increase beyond even 32 bits. "Who knows, some day we might have 64-bit devices," he says.

But the size of its data word is not always the best way to judge a microprocessor. "It's really memory and performance requirements that separate devices into low-, medium-, and high-end categories," Raphael says. "Customers may think in terms of word length, but they buy in terms of performance." □

Parallel testing keeps your memory traffic moving.

Your production line is probably spewing out a virtual river of memory devices: RAMs, ROMs, EPROMs up to 65K x 8 bits. Your test system can't be a bottleneck. It must pace the flow, not choke it.

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- ☐ 65K x 4 bit RAMs with multiplexed addresses, four at a time with two at each test head:
- ☐ 65K x 8 bit RAMs and 4K x 8 bit ROMs two at a time, one in each test head:
- ☐ 65K x 8 bit RAMs or 4K x 8 bit ROMs time sequential with a different device at each head.

On-the-fly timing edge control provides test accuracy and reproducibility for production testing of dynamic MOS and bipolar memories.

The 5581 can be used as a stand-alone tester or as a satellite to the Xincom III distributed test

Editorial

Playing ball with the wage hike ceiling

What do Pete Rose and the American Electronics Association have in common? The answer is that both sought exemptions from the 7% ceiling on pay increases proposed by President Carter—though Rose, the baseball superstar just signed as a free agent by the Philadelphia Phillies, received his before the electronics people got theirs.

Having lost an earlier appeal based on the premise that the electronics industries' increased productivity offsets inflation and helps keep prices down, the AEA shifted to a more easily verified reason: a labor shortage. The rationale is that key personnel will be impossible to keep at high-technology electronics firms unless they are offered wage increases exceeding 7%.

The association has a point. Though the Government must be chary about exceptions—after all, any inflation disincentive like wage ceilings is only as effective as the number of persons it covers—it is inclined to make narrow exceptions, and the electronics industries have been made one of them. With all the recent talk of America's losing its technological lead to other nations, this certainly is not the time to discourage innovators. The exemption won't.

Light at the end of the fiber

Don't sell your copper stocks yet. The glowing promise of fiber-optic data links is by no means diminishing, but the makers of such systems are learning what previous purveyors of exciting new technologies have found out before them: the rules of the American marketplace must be followed.

Thus, though the excitement spreads rapidly, the market doesn't. One analyst describes what's going on as "widespread prototyping": sales of small quantities (often just one or two). The slow growth is agonizing to some companies, as they see very little of the fuss filtering down to the bottom line. And things won't be easier if all the manufacturers listed in the chart—and more—on page 92 stay in there and fight it out.

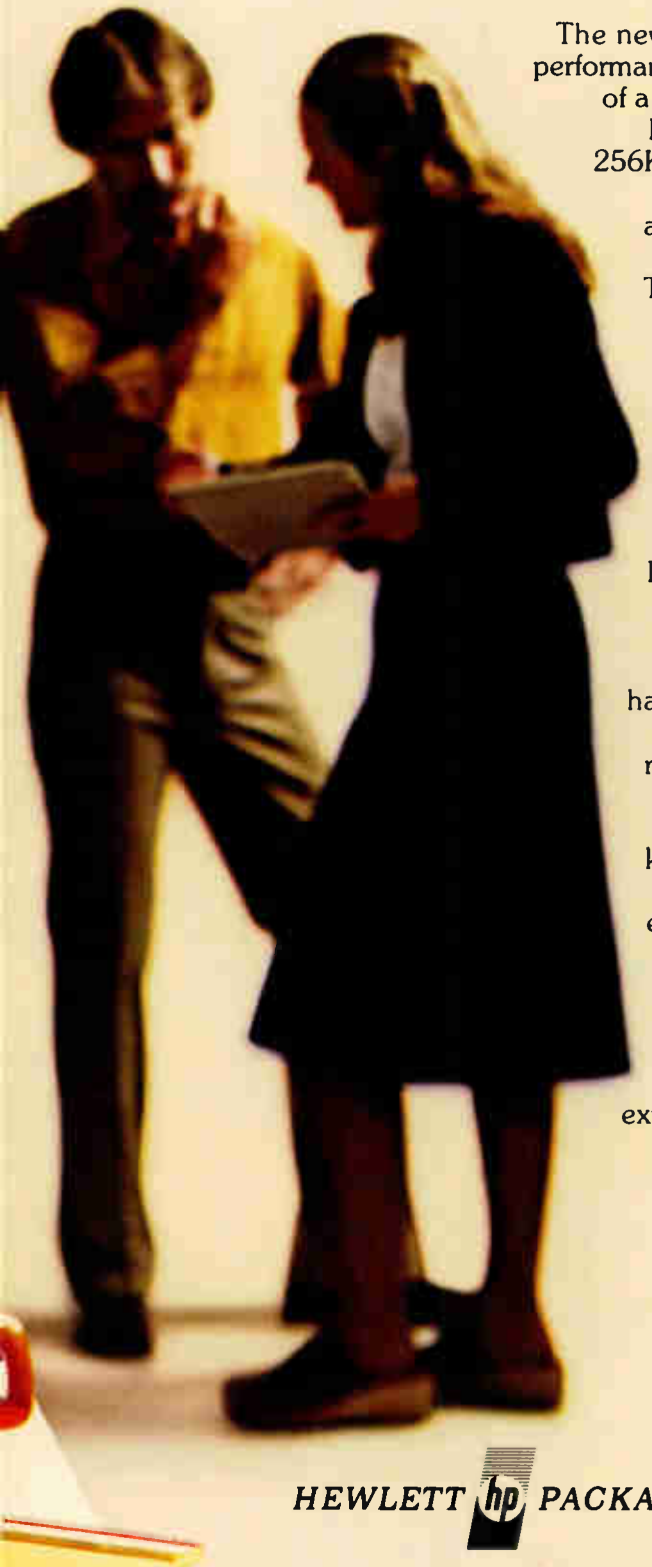
However, one of the cruel rules of the new-technology-marketing game is called shakeout, and there are signs that it already has started in the fiber-optic system business. Siecor Inc., for one, says it is going to quit marketing ready-to-go links and "concentrate on what we know best—the production of fiber." Other large companies whose specialties lie outside the systems business may well follow suit.

Encouraging them is the fact that two of the big potential users of fiber-optic links are nowhere near the crossover point. One, the Bell System, may be installing systems slowly and with much fanfare, but that's not the same as instant profit for suppliers. And the biggest potential volume user for analog links, the cable television industry, has been trying for 20 years to live up to that potential.

So what about those copper stocks? Well, in applications where there is no strong environmental reason for using fiber—for example, where space is available, or where there are no lightning problems—the value of using fiber is such that it may not be competitive with copper. So though there are no insurmountable technological barriers to fiber-optic transmission systems, it is clear that there are other kinds of problems.

Introducing HP's System 35.

Under its friendly exterior lurks the power of a minicomputer.



The new System 35 delivers minicomputer performance while retaining those friendly characteristics of a desktop computer. Consider these features:

Big Memory—you choose from 64K to 256K bytes of internal read/write memory, of which all but 12K bytes are available for your programs and data. With 256K bytes, System 35 can manage an array of over 30,000 12-digit floating-point numbers. That's big problem-solving capacity.

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Meetings

Third Biennial University/Industry/Government Microelectronics Symposium, IEEE, Texas Tech University, Lubbock, Texas, Jan. 3–4.

Modern Data Communications Seminar, George Washington University, Washington, D. C., Jan. 3–5

Microprocessor Programming Course, IEEE Continuing Education Program, Albuquerque Inn, Albuquerque, N. M., Jan. 4–6.

Winter Consumer Electronics Show, Electronic Industries Association, Las Vegas Convention Center, Las Vegas, Nev., Jan. 6–9.

17th Conference on Decision and Control, IEEE, Islandia Hyatt House, San Diego, Calif., Jan. 10–12.

Radar Signal Processing Seminar, George Washington University, Washington, D. C., Jan. 15–19.

Conference on Reliability and Maintainability, IEEE, Shoreham Americana Hotel, Washington, D. C., Jan. 23–25.

Fourth Automated Testing for Electronics Manufacturing Seminar and Exhibit, Benwill Publishing Corp. (Boston), Marriott Hotel, Los Angeles, Jan. 23–25.

Communication Networks Conference & Exposition, The Conference Co. (Newton, Mass.), Sheraton Park Hotel, Washington, D. C., Jan. 30–Feb. 1.

Microelectronics Measurement Technology Seminar/Exhibit, Benwill Publishing Corp. (Boston), Hyatt House, San Jose, Calif., Feb. 6–7.

Phase-Locked Loops Seminar, George Washington University, Washington, D. C., Feb. 12–13

International Solid-State Circuits Conference, IEEE, Sheraton Hotel, Philadelphia, Feb. 15–17.

Sixth Energy Technology Conference and Exposition, Electric Power Research Institute (Palo Alto, Calif.), Sheraton Park Hotel, Washington, D. C., Feb. 26–28.

Intelcom 79—Second International Telecommunications Exposition, Horizon House International (Dedham, Mass.), Dallas Convention Center, Dallas, Feb. 26–March 2.

Digital Encoding and Processing of Voice and Video Seminar, George Washington University, Washington, D. C., Feb. 27–March 1.

Nepcon West 79, Industrial and Scientific Conference Management Inc. (Chicago), Anaheim Convention Center, Anaheim, Calif., Feb. 27–March 1.

ICE 79—International Computer Expo, Marcom International Inc. (Tokyo) and Golden Gate Enterprises Inc. (Sunnyvale, Calif.), Tokyo Harumi Fairgrounds, Tokyo, Feb. 28–March 2.

Fifth Annual Conference and Exhibit on Industrial and Control Applications of Microprocessors, Information Gatekeepers Inc. (Brookline, Mass.), Sheraton Hotel, Philadelphia, March 19–21.

Technical Symposium East '79, Society of Photo-Optical Instrumentation Engineers (Bellingham, Wash.), Hyatt Regency Hotel, Washington, D. C., April 2–5.

25th International Instrumentation Symposium, Instrument Society of America, Sheraton Hotel, Anaheim, Calif., May 7–10.

NCC 79—1979 National Computer Conference, IEEE, American Federation of Information Processing Societies, *et al.*, New York Hilton and Americana Hotels, New York, June 4–7.

Second Joint Intermag—Magnetism and Magnetic Materials Conference, IEEE and American Institute of Physics, Statler Hilton Hotel, New York, July 17–20.

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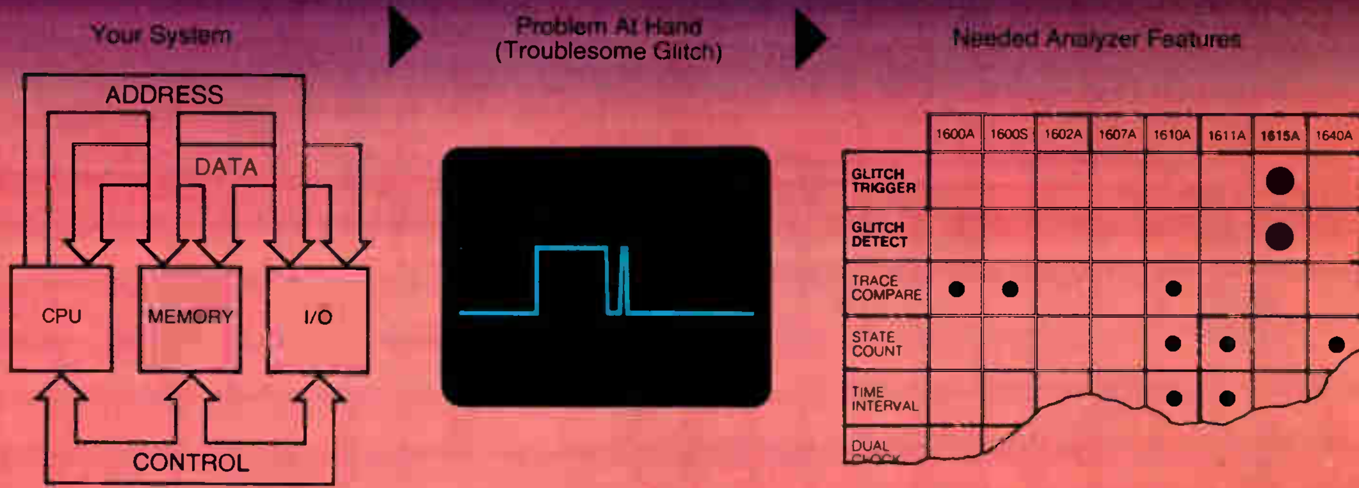

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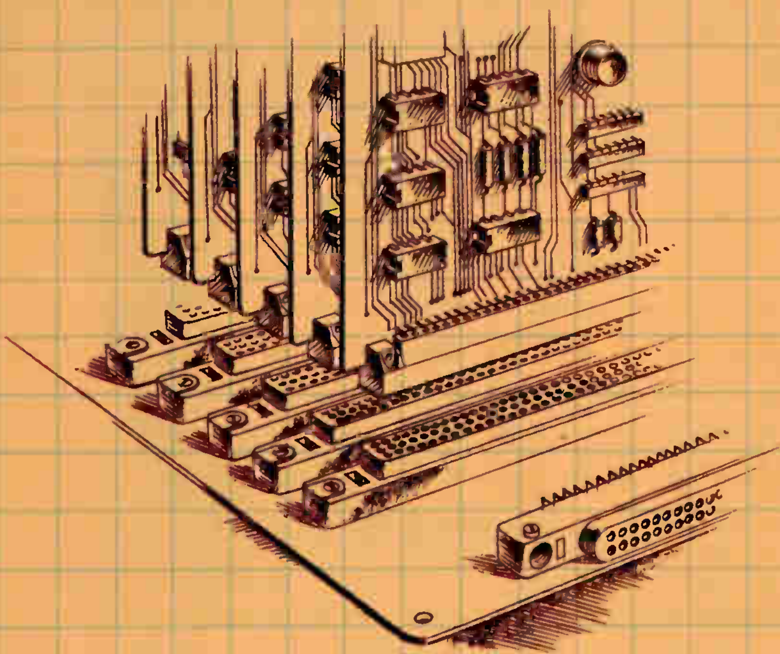
PCB Simplicity with Bendix Brush Connectors.



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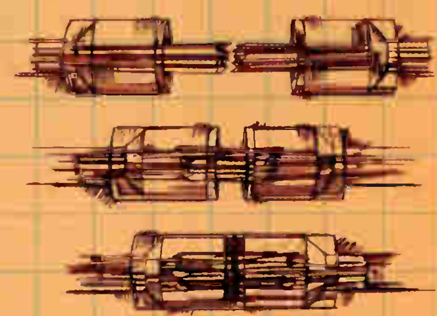

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Bendix

We speak connectors.

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Electronics newsletter

TI's Hall-effect device could open car market

A new Hall-effect device from Texas Instruments Inc. could satisfy the auto industry's need for magnetic sensors for every possible monitoring and control function in the cars of the 1980s. The linear device, first of a family, will be introduced next month. **Called the TL 173, it can sense down to 250 gauss,** four times the sensitivity of present-day magnetic-field devices. The device puts out a linear voltage of 1 mV/G and can resolve a 1-G change, which results in a change in output of 1 mV.

Semiconductor equipment makers warned of invasion

U. S. makers of equipment for semiconductor manufacturing may join their customers as targets for competition from Europe and Japan, warns Wilfred J. Corrigan, president and chief executive officer of Fairchild Camera and Instrument Corp., Mountain View, Calif. **"Your prices are high but your service is not prompt,"** Corrigan scolded the equipment makers at a dinner session of their trade organization, the Semiconductor Equipment and Materials Institute, in Palo Alto, Calif.

"When you have a problem with Japanese equipment, they put two men on an airplane that afternoon; the guy in [nearby] Sunnyvale doesn't respond that quickly," he chided. In carving up a market that tops $1 billion, the equipment makers are "very visible" to overseas competition, and the luxury of high prices and poor service may soon be one they cannot afford, he says.

Datapoint seeks color graphics for terminals

Though no product is yet available, Datapoint Corp. of San Antonio, Texas, is well into a program to develop software for color graphics for its line of multifunction terminals. Most computer graphics systems on the market today are oriented toward computer-aided design or simulation, but **Datapoint's graphics development is focusing on the business data-processing market,** says Herbert B. Baskin, vice president of the firm's western development center in Berkeley, Calif. Among other things, the company is developing techniques that would allow up-to-the-minute display of the contents of any on-line computer data file in appropriate graphic form. Such a capability, though not technically startling, is currently unavailable, Baskin says.

Four 32-bit computers due from Prime

Known for extending the capabilities of minicomputers through the use of virtual memory, Prime Computer Inc. is now extending its product line as well. Expected in January from the Wellesley Hills, Mass., company are four new 32-bit computers topped off by the model 750, **a unit that will feature prefetching of instructions and a cache memory.** At the same time, its Primenet networking software is being revamped to give it more distributed processing capabilities.

Electronic phone to be sold in U. S. by Bell Canada

Look for Bell Canada to introduce a fully electronic phone for the U. S. market early next year. To have push-button dialing compatible with all North American telephone exchanges and a feature that repeats the last number dialed, it will be available in April. The phone is similar to the one being test-marketed in Canada [*Electronics*, Nov. 8, p. 8]. Though the Montreal-headquartered firm is not the only company working on a phone with no electromechanical parts, **its marketing has been aggressive** — the $79.95 phone will be sold in telephone stores.

Electronics newsletter

Nova 4 uses bit slices instead of TTL

Since it was introduced some 10 years ago, Data General's Nova minicomputer has become one of the most popular with original-equipment manufacturers. This position now may be enhanced with the addition of the Nova 4 line. Based on bit-slice microprocessors instead of transistor-transistor logic and offering an expanded instruction set, the Westboro, Mass., company's new machines are said to **operate some 50% faster than the current Nova 3 line, yet sell for about half as much.** Available in three versions—the Nova 4/C, 4/S, and 4/X—the new line ranges in price from $2,500 to $14,300, including memory, power supply, and chassis. The Nova 4 may also hamper the makers of Nova-emulating minicomputers, who have capitalized on the price-performance advantage of their machines over the two-year-old Nova 3 [*Electronics*, June 22, p. 88].

Univac bows in minicomputers with 16-bit V77-800

For its debut in minicomputers, Sperry Univac is unveiling a high-performance 16-bit machine that features a three-board central processing unit with 150-ns cycle time. Designated the V77-800, it will be the first new machine produced at Univac's Irvine, Calif., minicomputer operation, acquired from Varian Data Machines in June 1977 for some $40 million. The all-new mini comes with cache memory, handles up to 16 terminals, and **is twice as fast as Varian's V77-600, which it replaces as the top of the line.** The 800 will start delivery in July, 1979, and will sell for $100,000 and up.

Signetics to offer a family of ISL gate arrays

Ready to capture large-scale integration sockets as computer system designers upgrade from smaller Schottky parts, Signetics Corp. is about to spring a family of semicustom gate arrays built from integrated Schottky logic, **itself a combination of low-power Schottky transistor-transistor logic and integrated injection logic,** both developed by Signetics' parent, Philips of the Netherlands. The arrays will feature a fast typical propagation delay of 5 ns, low power dissipation of 200 μw per gate, and a speed-power product of 1 pJ. The 8A1200, a 1,200-gate array, will be ready in sample quantities in early 1979 and in production at midyear. It will be followed by 600-, 800-, and 2,000-gate arrays. Signetics and Philips also will be offering subnanosecond emitter-coupled-logic 400- and 600-gate arrays that Philips is expected to second-source from Germany's Siemens AG, which is discussing the deal with Valvo, Philips' German-based components producer.

Addenda

Mostek Corp. is ready to start construction of a semiconductor wafer fabrication, manufacturing, and engineering plant in Colorado Springs, Colo. Plans call for about a 100,000-ft^2 facility initially, with production slated to begin within two years, according to Mostek chairman L. J. Sevin. **A labor shortage at the firm's Carrollton, Texas, headquarters was a factor** in choosing the Colorado site, he says. . . . As an update to its WCS/30, Wang Laboratories is introducing two office information systems. Called the OIS/100 series, **the two are the OIS/130 and 140.** The 130 has a 32,000-character memory and the 140 can support 32 peripherals. Comparable figures for the 30 are 16,000 and 14. . . . In yet another application of electronics technology to labor-intensive functions in the office, Pitney Bowes Inc., the postage-meter maker, has set up a central computer **that can be queried for code numbers to reset meters.**

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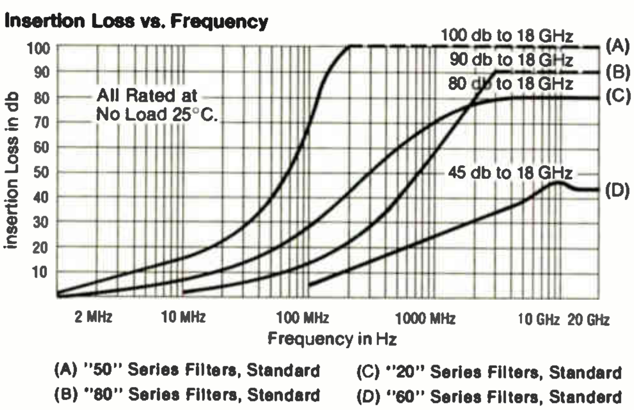

You get across-the-board design coverage with three basic space-saving lines. The standard "20," "30" and "50" series, and the matching premium (P)-performance series. And the low-capacitance "60," "70" and "80" series that allow high-speed digital logic signals to pass through but attenuate interference in the high megahertz (500 MHz and up) and gigahertz ranges. You also have .025² post filters, an industry first from AMP.

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0.5-500 MHz		6.5	8.5
Isolation (dB)		Typ.	Max.
0.5-5 MHz	LO-RF	50	45
	LO-IF	45	35
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Simple cell design for dynamic RAM scraps capacitor

Small one-transistor cell employs two thresholds to store bits, could be basis for future dense RAMs

TI may have sounded the death knell for the conventional dynamic-RAM cell. That may be putting it strongly, but the stunning simplicity of its new approach gives every indication of being a breakthrough in memory design.

The feasibility of the approach, which requires only a single transistor, has been proven by researchers at Texas Instruments Inc. in Dallas. The cell stores bits by trapping charge in two regions within the transistor, rather than storing it on a capacitor, as do present random-access-memory designs. Thus the transistor has two thresholds.

A late paper at the International Electron Devices Meeting in Washington, D.C., earlier this month detailed the operation of what TI calls a taper-isolated dynamic-gain RAM cell. The cell structure is smaller and far simpler to fabricate than conventional cells. It requires one layer of polysilicon, as opposed to two or three in present RAMs.

Moreover, it provides a signal that is easy to sense—a current is read, rather than a charge (in the form of a small voltage) detected. Also, TI says the cell can retain data for as long as a minute without the refreshing required every few milliseconds by conventional dynamic RAMs.

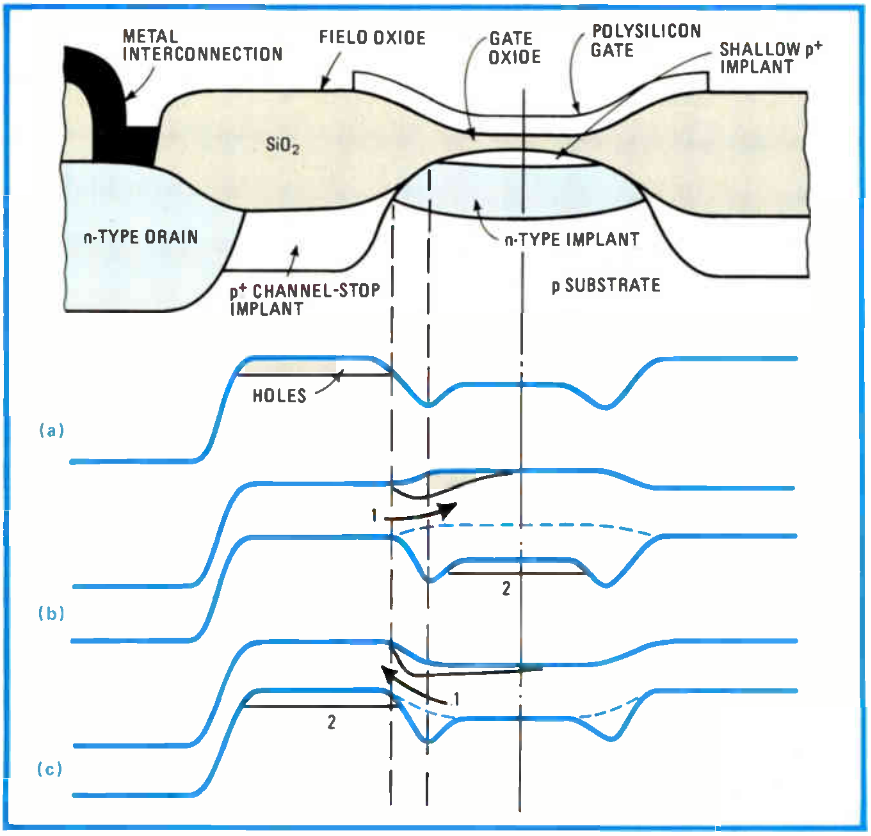
The new cell could thus be a major development. It, or a variation, could become the building block for 256-K or larger chips.

The taper-isolated cell gets its name from the tapered shape of the oxide on either side of the thin channel, or gate, region, as shown in the cell cross-section below. Also called a "bird's beak," the taper is a side effect of conventional planar processing (which purposely embeds oxide into silicon to smooth a chip's profile).

The secret of the cell—how a single transistor can have two different gains or stable states—is based on the difference in surface potential between the n-type material under the taper region and that under the thin gate oxide.

The surface-potential distribution across the channel resulting from the taper structure supports the two states because of the potential wells,

Simple. RAM cell, top, relies on tapered oxide to store 1s and 0s. Cell is in 0 state with transistor at high threshold. Holes are trapped in channel stop, shown in potential distribution curve (a). Pulsing gate negatively moves holes into channel region (b), lowering threshold of cell transistor and changing state to a 1. Positive gate pulse returns holes to channel stop region, resetting data to 0 (c). The cell is read by sensing transistor's current.



or dips, at either end, as shown in the potential distribution curve (a). The shape of the potential distribution traps holes (positively charged carriers) either between the two wells or in the channel stop, a p-type diffusion area adjacent to the drain that supplies the holes.

Operation. A 1, represented in the cell by a lower threshold voltage (or higher transistor gain) is written by driving the gate electrode with a negative pulse, which raises the channel potential. Holes trapped in the channel-stop region (a) then rush into the gate area, where they are trapped after the pulse ends (b).

A 0 is written into the cell with a positive pulse on the gate while no current flows through the transistor. Here the tapered oxide comes into play: since the channel oxide is thinner than the tapered oxide, the surface potential under the channel region increases faster than that under the tapered region. The result (c) is that the potential well flattens out, allowing holes trapped in the gate region to flow back to the channel stop.

According to Pallub K. Chatterjee, member of the technical staff at TI's Central Research Laboratories, test versions of the cell have shown a 2.5-volt difference between 1 and 0 states, for applied voltages of 6 to 7 V. "There is still much characterization of the cell to be done," he says. "For example, we have to check its behavior over a wide temperature range, and its tendency toward soft errors must be examined." He suspects, however, that the cell will be far less sensitive to soft errors caused by alpha particles than conventional dynamic RAM cells. □

Components

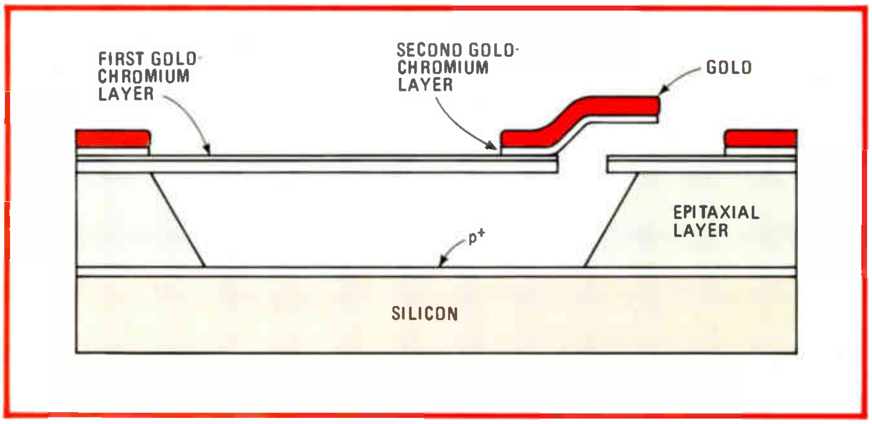
Semiconductor unit switches mechanically

Over the last decade, silicon technology has electronically taken over more and more electromechanical switching and control functions that were formerly the domain of bulky switches, relays, and solenoids. Adding insult to injury, it turns out that integrated silicon devices can be made with important and powerful mechanical characteristics.

Kurt E. Petersen of International Business Machines Corp.'s Research division in San Jose, Calif., has developed what he calls micromechanical switches and circuits fabricated from three-dimensional solid-state structures. Essentially four-terminal voltage-controlled switches, they are compatible with conventional integrated-circuit manufacturing procedures, he says in a paper delivered early this month at the International Electron Devices Meeting.

The devices pave the way for integrating mechanical and electronic functions on the same chip. Applications suggested by Petersen include analog-signal switching and optical-image storage.

Cantilever. IBM's micromechanical switch relies on a cantilever 76 micrometers long and made of a thin metal-coated membrane of silicon dioxide. The 3,500-angstrom-thick membrane, bearing a narrow contact electrode and a wider deflection electrode, is suspended over a 7-μm-deep well etched into a silicon epitaxial layer, shown in the figure.



Cantilever. Micromechanical switch developed by IBM relies on semiconductor processing to form a cantilever that can be electrostatically deflected like a switch contact.

Fabrication begins by heavily doping a silicon wafer with boron, forming a p-type region. Next an epitaxial layer is grown, followed by a deposition of silicon dioxide. Then a thin chrome-gold metalization is deposited. A series of photolithographic exposures, etchings, and gold platings forms the cantilever. Extra gold structures are deposited for contact electrodes.

Switching action takes place when the membrane is electrostatically deflected downward into the well by a voltage applied between the deflection electrode and the p^+ silicon layer at the bottom. Switching times have been less than 40 microseconds with deflection voltages of about 60 volts. Increases in the deflection voltage shorten the switching time, but tend to produce contact bounce.

Petersen applies his micromechanical switch in an optical storage element that also relies on the electrostatic deflection of thin membranes. Instead of a narrow cantilever, he uses four thin, metal-coated rectangular leaves supported at a single common point over a well.

The micromechanical switch, made on the same substrate, applies charging or discharging pulses to the leaves. If the contact electrode is raised to 16 V and the switch activated by a 60-V pulse, the capacitance between the leaves and substrate will charge up to 16 V and the leaves will deflect. When the switch is released after a 100-μs pulse, the leaves will remain charged in the deflected position for several hours.

Viewed under a schlieren optical system, each group of four undeflected leaves appears dark, while each group of four deflected leaves appears brighter because the light strikes them at a different angle. Combining groups of the leaves could form a matrix-addressed image-storage unit. IBM is evaluating display designs of 1,260 elements arranged as 36 five-by-seven dot alphanumeric characters.

According to Petersen, switching times of under 10 μs with voltages of less than 30 v and current-carrying capability greater than 100 milliamperes will ultimately be attainable. Some switches have had lifetimes in excess of 2 million actuations at current densities of 5×10^4 amperes per square centimeter. Next step with the still-experimental devices is to integrate electronic functions with the mechanical. ☐

Business

Electronics firms get guidelines exemption

A very critical labor shortage of engineers and high-level technicians in California's Silicon Valley and other segments of the U. S. electronics industries exempts those jobs from President Carter's 7% wage hike guidelines. The final guidelines issued Dec. 13 by the President's Council on Wage and Price Stability adopts almost verbatim an exemption proposed less than a week earlier by the American Electronics Association, Palo Alto, Calif.

"That is very, very good news," exclaimed an elated Kenneth C. D. Hagerty, AEA's Government operations vice president, when told of the White House action.

Employers must meet four conditions when "pay-rate increases in excess of the standard are necessary to attract or retain employees in a particular job category because of an acute labor shortage," according to the council. Using the last two years as a base period, the guidelines require employers to show "abnormal increases" in: the proportion of vacancies in the quarter immediately preceding, the time required to fill vacancies "despite intensive recruiting," and entry-level pay rates over the base years. In addition, a local government employment service agency must certify that "an acute labor shortage exists" in exempt categories.

What constitutes "abnormal increases" is deliberately not defined to permit a measure of flexibility for individual companies with varying degrees of recruiting difficulty.

The plan was the AEA's second shot at an exemption after the White House rejected ones sought earlier on the basis of inflation-offsetting productivity increases. The council "brushed aside the productivity argument," Hagerty says, on the grounds that it could not be measured effectively or objectively.

Survey. As ammunition for its successful proposal, the AEA had Price Waterhouse & Co., the accounting firm, survey 27 association companies across the country to document its argument. "It was a 'quickie' survey limited to five simple questions," Hagerty explains.

Firms were asked how many electronics employees and unfilled positions they had, if they offered incentives to new workers or to employees for recruitment, and if personnel shortages affected their growth.

There were 26 respondents, and 24 said that lack of available personnel was hampering growth. Also, 16 companies said they were giving employees bonuses to help find recruits, and 12 said they offered new employees incentives to join.

As of Oct. 31, the 26 firms had 266,529 electronics employees and 16,084 positions still open. In California the AEA shows more than 10,000 unfilled technical jobs in electronics industries, a figure expected to be 40,000 by summer. ☐

Talks. National Semiconductor's Roy J. Brant, left, discusses exemptions for electronics firms to the wage guidelines with Barry Bosworth, director of the Council on Wage and Price Stability, center, and Joseph Talbot, the council's senior economist, right.

Consumer

Magnavox introduces video disk unit

The nation's first video disk system, introduced just last week by Magnavox Consumer Electronics Co., has a lot going for it—and a lot going against it. Called Magnevision, it uses a laser to read out pictures stored on a disk resembling an audio record.

Quality of the picture, displayed on the buyer's television set, is better than can be obtained with video cassette recorders, according to the Fort Wayne, Ind., company. And the 200 or so programs initially available will be priced attractively; the range is from $5.95 for "how to" programs on up to $15.95 for recordings of recent movies.

However, the price of the player, based on technology and parts from parent Philips' Industries of the Netherlands, is high—at $695 perhaps too close to the low end of what video cassette recorders sell for. And the VCRs not only play packaged programs, like the video disks, but they record programs off the air. Moreover, list price is some $300 under Magnavox' manufacturing cost. The company plans only 20,000 players in the first year.

By being first, however, Magnavox is trying to make a big impact. "We expect, if we do our job, to

Disk player. Magnevision video disk unit from Magnavox plays 30- and 60-min.-per-side programs from MCA Discovision.

become the standard," says a company spokesman.

The Magnavision player uses two kinds of 12-inch disks: a 30-minute-per-side record spinning at a constant 1,800 revolutions per minute, and a 60-min.-per side record playing back at a variable angular velocity. Information is stored in pits burned into the disk by a laser during manufacture. The pits' patterns contain the analog representations of the picture and sound, read out by a helium-neon laser. The records are made by MCA Inc., Philips' partner in developing the player.

Unperturbed by the Magnavox introduction is its only announced American competitor, RCA Corp., New York, which says it has still not decided to put its system into production [*Electronics*, Feb. 2, p. 44]. Its goal, says a spokesman, is a player costing about half that of the video cassette recorders—or under $400. To this end, RCA is developing a player using a capacitive pickup stylus, which results in a much simpler player. Moreover, the disks for the player can be turned out using standard audio-recording processes.

A system closely related to RCA's is under development at JVC, the Victor Co. of Japan [*Electronics*, Oct. 26, 1978, p. 67], and Matsushita and AEG-Telefunken have worked on stylus systems with mechanical pickup. Other companies working on laser-based playback systems include France's Thomson-CSF and Japan's Hitachi Ltd. □

Language translators get another entry

At the beginning of last month there were none and now there are two. Two hand-held language translators, that is, both made possible by the availability of inexpensive one-chip microcomputers and large-capacity semiconductor memory chips.

Craig Corp., Compton, Calif., a consumer electronics supplier, early this month showed off its M-100, similar in appearance and operation to the translator introduced late in November by Lexicon Corp., Miami, Fla. [*Electronics*, Dec. 7, p. 50]. Both store words and phrases in English and other languages, and display a translation from one language to another after a word or phrase is keyed in. Both use an 8-bit 3870 microcomputer from Mostek Corp., Carrollton, Texas, and plug-in function or language modules having a 1,500-word vocabulary.

Architecturally, the two machines are different, however, and this affects price. Craig puts its microprocessor into the keyboard unit, its memory into the plug-in module. Lexicon, on the other hand, views the keyboard unit as a general-purpose interface; both memory and microprocessor are in the module. According to Lexicon, the handheld device is thus suited to a greater variety of functions, some not even developed yet.

Trilingual. Craig's unit, designed by Hedgewood Corp., San Francisco, will sell for $200 with an English module when it goes into production next spring. The user also needs to purchase an additional module, at $25, for each foreign language to be translated. At $225, the Lexicon device includes one English-to-foreign-language module, but additional combinations cost $65. While

Interpreter. Craig Corp.'s electronic language translator sports 43-key, dual-function keyboard and 16-character fluorescent display. Language modules plug in from below.

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Lexicon's interface approach is flexible, the Craig M-100 seems to hold the edge on translating versatility. Three modules may be plugged in simultaneously. The unit can translate between any two of the languages and also provide a phonetic readout. Lexicon accepts only one plug-in at a time.

Craig, too, builds in usefulness beyond translating. In addition to the 64 bytes of random-access memory in the 3870, the keyboard unit contains 2 kilobytes of read-only memory. This combination allows the keyboard unit to function as a four-function calculator and metric converter. Each memory capsule contains 32 bytes of RAM and 32 kilobytes of ROM.

Craig's president, Peter Behrendt, hopes to sell more than 100,000 units in 1979. Asked whether the price-cutting of the calculator market might occur here, he replies, "I can't see prices eroding more than 20% over the next two years. The chips can't get much cheaper." □

Boeing picks Rockwell flight computers

Another winner in the furiously waged battle for the lucrative subcontract work in Boeing's next generation of passenger aircraft has been announced. The Seattle, Wash., aircraft manufacturer has chosen Rockwell International Corp.'s Collins Avionics division, Cedar Rapids, Iowa, to supply digital flight-control computers for both the 767 jumbo jet and the narrow-body 757. Aboard each craft will be three flight control computers for what Boeing calls the DAFDS (digital autopilot flight-directing system). It provides automatic pilot and automatic approach and landing capabilities and accepts steering commands from a separate flight management computer. Still to be named is the supplier of the flight management computers.

Avionics

Boeing craft to use Honeywell laser gyro

Seldom does a major procurement award bring smiles to the face of a competitor. But the recent award by Boeing Commercial Airplane Co. to Honeywell Inc. for a laser-gyro–equipped inertial reference system for its upcoming 757 and 767 aircraft did just that.

Boeing's decision gives the new laser gyro technology an imprimatur that could open up other civilian and military markets in the next decade, says Robert W. Benzinger, marketing manager for strapped-down laser gyros at Sperry Rand Corp.'s Sperry division, Great Neck, N.Y. "Boeing's acceptance of a strapped-down laser gyro is a major milestone."

The $100 million–plus award was made last month for up to 1,800 inertial reference systems for 600 airplanes. It is expected to be followed by orders to equip as many as 1,400 more Boeing aircraft, says Robert W. Mueller, director of commercial aviation marketing at Honeywell's Avionics division in Minneapolis, which will build the systems.

More. That's only the beginning. Sperry's Benzinger predicts that sales and repairs of laser-gyro–equipped inertial systems and parts for military and commercial rotary and fixed-wing aircraft will hit $1 billion a year within 10 years.

The market for less accurate laser gyros for tactical military hardware, Sperry's specialty, is even larger: "tens of thousands of units in the next five years, at up to $20,000 per unit," he adds. This price is well under half of what each Honeywell system will cost Boeing.

Industry officials say the laser gyro will have a lower life-cycle cost than conventional tuned-rotor mechanical systems. Honeywell's version is the culmination of 15 years' research partially supported by the Department of Defense.

In addition to center of gravity and drift drawbacks, the mechanical system is large and bulky because of the gimballed platform housing needed to simplify computing of position and attitude.

In the Honeywell inertial reference system, however, two contra-rotating 0.6328-micrometer beams from a helium-neon laser are reflected through a triangular cavity by mirrors, and a photodiode readout digitizes the light frequency.

The two beams start with the same frequency, but as the aircraft turns, a frequency differential that is proportional to the angular turning rate appears. Combined with accelerometer inputs, the frequency changes from three gyros in each inertial reference system—one each for yaw, pitch, and roll axes—provide position velocity, attitude, acceleration, and rate data for cockpit-display and flight-control computers.

Gyro processor. Each reference-system has a dedicated processor for the gyros, explains Earl W. Carson, project engineer for laser gyros at Honeywell. Nine custom large-scale integrated chips process signals from the gyros and accelerometers and perform housekeeping functions at a clock rate of 3.84 megahertz.

Overall logic and control is performed by a 16-bit processor package, using four 4-bit 2901 bit-slice microprocessors. Honeywell claims that the radial-position accuracy of the system during test-bed operation was 0.89 nautical mile per hour, compared with a Boeing requirement of 2.0 nmph.

Next test of the popularity of laser gyros comes in the spring when the military announces winners in several gyro procurements for aircraft and for tactical systems. □

Communications

Postal Service's plan stirring opposition

When it comes to electronic mail, the U.S. Postal Service is doffing its tortoise image and running like a rabbit to inaugurate new services on both domestic and international

fronts. Its actions are producing opposition from telecommunications service and equipment companies, as well as from the executive branch, from Congress, and from the Federal Communications Commission.

Opponents from industry contend that the USPS is exceeding its authority by extending into a new competitive marketplace. Government critics argue the Postal Service is moving ahead before a national policy has been set on electronic message service [*Electronics*, Dec. 7, p. 58].

Now. The controversy centers around Postmaster General William Bolger's disclosure early this month that the first USPS domestic electronic message service will begin before the year ends. (See related story on p. 10). Known as E-COM, for electronic computer-originated messages, the service for volume mailers will employ Western Union Telegraph Co. facilities to transmit messages from computers at the companies to terminals at 25 receiving post offices in major cities.

At these sites the messages would be put in the standard mail stream for two-day delivery anywhere in the country. Depending on a user's volume, charges would be between 30 and 55 cents per page.

Next spring, the Postal Service also will begin a year-long test of Intelpost, an international electronic mail system. It will send facsimile messages between the U.S. and seven foreign nations via a Communications Satellite Corp. system.

Bolger believes the domestic E-COM system has great promise for companies with a single message to send in a hurry to thousands of people—for example, a product recall by an auto company. The post office estimates that 750 companies have the message volume and computer capacity to use E-COM, and another 125 service bureaus could accept and batch transmissions from smaller companies. Western Union's service contract covers 15 months of tests by the USPS, plus an option for three additional years.

Protests. Government opposition to the E-COM plan is being led by the National Telecommunications and Information Administration of the Department of Commerce. NTIA's chief, Henry Geller, an assistant secretary of commerce, says the Administration opposes "E-COM before the establishment of national policy on this issue." That policy will not be formulated before early 1979, after E-COM begins operating.

A court injunction could, however, be sought by an affected industry organization. Many opponents feel jurisdiction over E-COM and its use of spectrum should rest with the FCC.

Geller hints at the kind of compromise the White House may try to make. He observes that the USPS should be restricted to delivering electronic communications services offered by others. It "should not provide the electronic communications function or service." □

News briefs

Distributed processing offered by GE

General Electric Co.'s Information Services division is selling intelligent terminals to go along with the traditional computer services it has been offering. The new service, called Marklink, provides distributed processing capabilities—each intelligent terminal maintains local files and processes data while communicating with files and applications software maintained at one of the company's three computer-service centers.

In effect, GE now competes with vendors of distributed processing hardware as well with its traditional time-sharing service competitors (some of whom have started offering hardware to users). It also says it offers applications software that hardware vendors do not. Moreover, it can offer interactive transaction processing, not yet offered by other service companies, for tasks like order entry, hotel reservations, and inventory management.

Arthur B. Sims, manager of Marklink in Rockville, Md., is quick to point out that it does not signal a re-entry into the hardware business for his company, which once manufactured mainframes. GE is buying Texas Instruments' 990 minicomputers for its terminals, each of which supports up to 16 work stations. "Marklink is more a service than hardware," he says.

The new service uses a new multistream data-communications protocol, also developed by GE, that allows work stations at the same site to share a communications link, reducing phone-line charges. Price for the equipment ranges from $21,260 for a single work station to $93,290 for a unit with 16.

Intersil to acquire Datel Systems

An agreement in principle worth some $17 million was reached earlier this month for semiconductor maker Intersil Inc., Cupertino, Calif., to acquire Datel Systems Inc., the Canton, Mass., supplier of data-acquisition equipment and panel meters. For its last fiscal year, Datel had revenues of $19.2 million; Intersil, $102.1 million.

Atari moves up to personal computers

Atari Inc., a leading maker of TV game cartridges, is moving into computers. Last week, the Sunnyvale, Calif., manufacturer announced the $450 model 400 and the $900 model 800, to be shipped during the third quarter of 1979. Both systems work with an ordinary TV set and use modified versions of the 6502 microcomputer—the same chip used in Atari's video games.

Memories

IBM drops prices across the board

The latest round of memory system price cutting from International Business Machines Corp. means that the computer giant has lowered prices across the board. Earlier this month it cut the purchase price of mainframe semiconductor random-access memory for its big System/370 machines some 30% to $75,000 per megabyte (down from $110,000) and reduced rental rates for the memory by 20%.

These cuts follow the Armonk, N.Y., firm's moves at the lower end, when it announced it would sell

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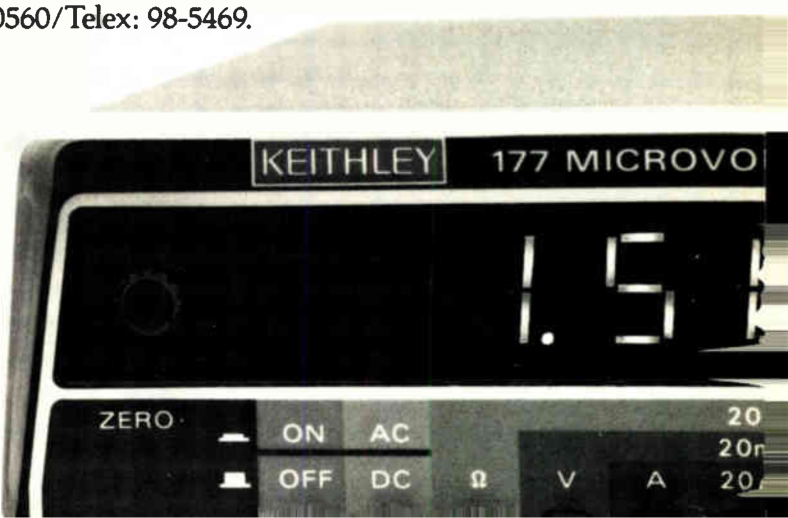

memory for its new model 8100 minicomputer system for $18,000 per megabyte [*Electronics*, Oct. 26, p. 88]. This price sharply undercuts the heretofore lowest price of $32,000 per megabyte, charged for its minicomputer-system memory by Hewlett-Packard Co.

At the same time it was dropping mainframe memory prices, IBM said it has developed a new 4-K static RAM that will replace its old standby, a 2-K chip. The new RAM will allow double the memory capacity of the top-of-the-line 3033 computer to 16 megabytes, the company says. (These new memories will be available during the third quarter of next year.)

No surprise. Industry observers had been expecting the price cuts by IBM, as a reaction both to the aggressive pricing of the independent vendors of add-on memory and to the falling prices of semiconductors. Traditionally, the add-on vendors have sold memory for 30% to 50% under IBM's price.

However, the price cuts may have come at an inopportune time. "They are already production-limited on System/370 memory, so they probably would have preferred not to cut prices," says William Becklean, an IBM watcher in the Boston-based technology analysis group of the Wall Street firm of Bache Halsey Stuart Shields Inc. "But customers were aware of the lower prices available and IBM had to pass along the declining costs of semiconductors. I view it as a move IBM would have preferred not to make."

Price cuts by the add-on vendors are not likely to follow immediately. The vendors are counting on insufficient IBM capacity to supply new customers. Their prices now range from just about even with IBM's to 30% below.

Moreover, they feel they can continue to compete effectively if they stay ahead in employing denser chips. "We're planning to go to 16-K dynamic chips next year, which will help us remain price-competitive," says Richard Andrieni, marketing vice president at Intersil Inc., Cupertino, Calif. □

Communications

U. S. wants more broadcast space

Major spectrum increases for a-m radio broadcasting and two-way domestic communications satellites will be proposed by the United States in January to the International Telecommunications Union in Geneva. At the same time, the U. S. will push for increased sharing of the ultrahigh-frequency band by broadcasters with both fixed and mobile communications services and for expansion of high-frequency shortwave allocations for amateur, maritime, and broadcast users.

The proposals were adopted by the Federal Communications Commission earlier this month and endorsed for the executive branch by the Department of Commerce's National Telecommunications and Information Administration (NTIA). The telecommunications union will circulate the U. S. position paper among the 153 other member countries before the World Administrative Radio Conference convenes in September. The conference meets every 20 years to agree on common regulations for international telecommunications. The proposals adopted by the FCC in Docket No. 20271 are expected to run about 300 pages when finally submitted by the State Department, which will negotiate for the U. S. at Geneva.

5300 stations. Redesign of all a-m radio receivers would be required under the American plan, which would add about 14 new channels and some 700 new stations, a 15% increase from the nearly 4,600 now licensed. The existing 535-to-1,605-kilohertz broadcast band would be enlarged by a 1,615-to-1,800-kHz band to be shared with other services and an 1,800-to-1,860-kHz band exclusively for broadcasting.

More controversial is the proposal to share nearly the entire uhf band, 470 to 890 megahertz, among fixed and land-mobile services as well as television broadcasters. Beyond

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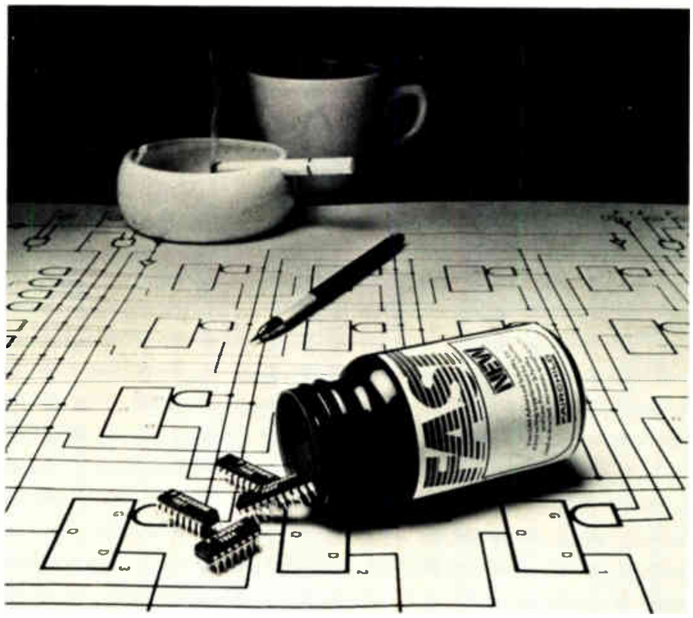

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74F02PC	2.6	3.5
74F04PC	2.5	2.7
74F08PC	3.6	4.1
74F10PC	2.7	2.9
74F11PC	3.7	4.2
74F20PC	2.8	2.9
74F32PC	3.5	3.9
74F64PC	2.8	3.6

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Electronics review

heightening the long-standing dispute between these two diverse interests in the domestic marketplace, the proposal is likely to anger Canada. Canadian TV broadcasters use uhf to reach markets near the border. Potential TV interference by U. S. land-mobile users is expected to stir Canadian protests.

Satellites. The FCC also wants to double the available satellite communications spectrum in the Western Hemisphere to accommodate new domestic satellites in the 12-to-14-gigahertz band. It wants to make the entire range of geostationary orbits available equally to both broadcast and two-way services, separating the assignments of each into 500-MHz segements.

Large-scale, direct two-way satellite services using large numbers of very low-cost earth stations to bypass existing terrestrial systems are also covered in the plan. It seeks changes in WARC allocations and technical specifications to permit these new services in the 2.5-to-6-, 10-, and 12-to-14-GHz bands as technology is perfected. Such services would include electronic mail, voice, fascimile, and slow-scan television.

Possible development of a land-mobile satellite using some 20 MHz of the 806-to-890-MHz band for two-way digital voice and data communications in mountainous and rural areas is also suggested by the U. S. The FCC also concurred in a proposal to permit increased use of the 3-to-30-MHz shortwave band by amateur, maritime, and broadcast interests by tightening specifications for satellite antenna pointing and for spurious emissions from transmitters and by converting shortwave radio broadcasting to single-sideband. □

Word processing

Wang combines printer, copier

An office copier is one thing, and a printer is another, right? Wrong, says Wang Laboratories Inc., the Lowell, Mass., manufacturer of small computers and word-processing gear.

It has combined the two functions in what it calls an Image Printer. Its purpose is to give big users of word-processing equipment the fastest output device yet.

The printer turns out 18 pages per minute—a rate equivalent to 4,500 characters per second [*Electronics*, Dec. 7, p. 35]. Similar electrophotographic, nonimpact printers are available that are considerably faster, but the Wang machine sells for $35,000, notably less than their $200,000 price range.

Microprocessor-based electronics that control the unit fit in a column, shown in the photo on page 44, attached to a dry-toner xerographic copier. Added to this machine is a cathode-ray tube that creates an line of information at a time to be printed. An array of fiber-optic cables transmits the picture to the reusable image-transfer medium—the photomaster—that is at the heart of a xerographic copier.

There are two photomasters in the unit, alternately receiving a page, and each transfers the electrostatic image formed on its surface to plain bond paper. The paper then picks up dry toner in the shape of the image and heat fuses the two. (The company acquired the technology for forming images from the CRT from Coburn Corp., East Hartford, Conn., last year.)

The fiber-optic array transfers some 90,000 dots per square inch with quality, Wang says, as good as that of any typewriter, as well as of the daisy-wheel and ink-jet printers often used to print documents in a word-processing system. The firm is not emphasizing its use as an office copier, however.

The microprocessor—a Zilog Inc. Z80—directs the flow of work to the printer from the word-processing system and controls which of four fonts and six type styles will be used in the printing process. "The work in the system will be automatically queued on a first-in, first-out basis, or the timing can be programmed by users," notes Joseph J. Sapienza, product manager for peripheral

MISSION IMPOSSIBLE? NOT FOR HUGHES.

The mission:
Build two different kinds of spacecraft. To take two different flight paths to Venus. And send back to Earth a stream of new information.

Orbiter arrives.
The first spaceship was Orbiter. Crammed with a dozen scientific instruments, it was launched last May by NASA. 300-million miles later, it arrived at Venus. But it's still traveling. It's now on a series of 243 one-day elliptical orbits around the planet—studying its atmosphere and mapping its terrain, close in and far away.

Multiprobe arrives.
The second spaceship was Multiprobe. Carrying 18 instruments, it was launched in August by NASA on a more direct 220-million mile trip. At a point 7.8 million miles from Venus, it divided into five fact-finding probes. And then these probes, including the parent "bus" that took them there, entered Venus' atmosphere to explore five widely separated planet areas. The information they beamed back about the planet's winds, clouds, and atmosphere will help clarify the mystery of how our own weather operates here on Earth.

A hostile neighbor.
The twin mission was the most complex unmanned space venture ever undertaken. What made it still tougher was the downright hostile nature of our nearest planet neighbor, as experienced firsthand by Multiprobe.

920° hot.
Venus has a surface temperature of 920°F.—hot enough to melt tin or lead. Its surface pressure is as crushing as the ocean 3,000 feet deep. Its atmosphere is almost pure carbon dioxide. And its dense clouds aren't innocent water. They're sulfuric acid.

Aluminum blankets.
But scientific ingenuity at Hughes took up the challenges. For example, Multiprobe's fragile internal electronics were guarded by blankets made of special aluminized plastic sheets with great resistance to intense heat.

Titanium shells.
Special titanium shells proved to be ideal pressure vessels. Light in weight, they still could resist corrosion and 1,400 pounds of pressure per square inch.

A diamond window
Finally, our designers needed an unusual window for an instrument that senses radiant energy. Typical window materials weren't rugged enough. Sapphire windows used for other probe instruments would block infrared wavelengths. Solution: a 13-carat diamond window the size of two pennies stacked together. It worked.

90 revealing minutes.
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With its printer, Wang Laboratories also announced two companion word processing systems: the Office Information System/130 and OIS/140. With more capacity and performance than earlier models, they have up to 924 kilobytes of memory, and disk capacity to 170 million bytes (up from 10 million bytes). They can support 32 peripherals, up from 14. Prices for the OIS/130 start at $22,600, including a 10-megabyte disk, central processing unit, and an archive diskette. Deliveries begin next March. The OIS/140 prices start at $26,000 for a master disk, CPU, archive diskette and 26.8-megabyte disk drive, with deliveries beginning in June. □

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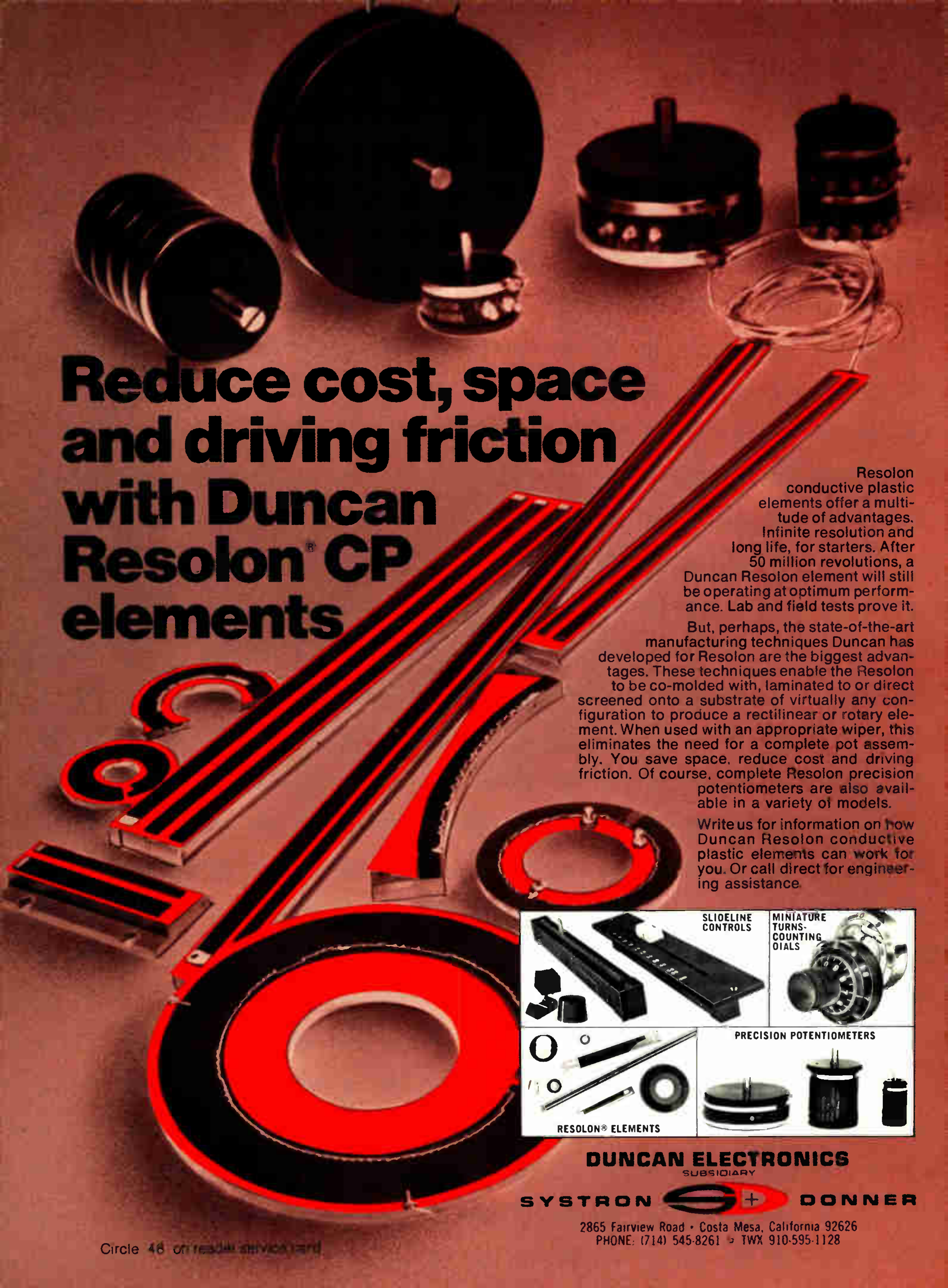
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U. S. pressures Tokyo to open telecomm market to imports

A team of six high-level American telecommunications industry specialists have been called to Tokyo at the "urgent request" of U. S. deputy special trade representative to counter Japan's refusal to open its telecommunications system to U. S. products. **Nippon Telegraph & Telephone Public Corp. has refused for what it calls technical reasons to be included in any listing of Japanese organizations subject to a new General Agreement on Tariffs and Trade.** Alan Wolfe, the deputy representative, responded by calling on the Electronic Industries Association to send a team of specialists to answer specific Japanese concerns. Included in the group making the week-long visit are representatives of Western Electric, GT&E, ITT, Northern Telecom, and Rockwell International's Collins Telecommunications division, plus an EIA staff executive.

At the same time, the EIA says it has postponed indefinitely its selling mission to Japan scheduled for February, pending resolution of the telecommunications issue. Mixed reports from the U. S. export mission to Tokyo in October, led by Commerce Secretary Juanita Kreps and Texas Instruments' chairman Mark Shepherd, **"indicate continued difficulty under today's conditions** in successfully selling into the Japanese market," the EIA explains.

15% sales rise for aerospace forecast for 1979

U. S. aerospace sales of $42.9 billion next year will maintain the 15% growth achieved in 1978 and result in the number of jobs topping the 1 million mark for the first time since 1970. That is the year-end forecast by the Aerospace Industries Association, which sees civil aircraft sales volume, led by commercial transports, soaring by a third to $10.8 billion from the 1978 level. **Military aircraft sales will still account for the industries' largest single market,** however, rising 6% to nearly $14 billion. Space hardware sales, strengthened by the space shuttle, will top the $4 billion mark for the first time in a decade with an 11% increase. The missile market of $6.5 billion will reflect an 8% gain on 1978, while nonaerospace equipment business will climb by 12.5% to $7.5 billion, the AIA says. Electronics represents more than 40% of aerospace volume, according to Government economic estimates.

FCC to weigh Telenet acquisition plan by GTE

General Telephone & Electronics Corp.'s $59 million plan to buy its way into the packet data-transmission market by acquiring Telenet Corp. of Vienna, Va., is raising more questions at the Federal Communications Commission than at the Justice Department's antitrust unit. **The acquisition would effectively give the Stamford, Conn., company a turnkey capability in the new market while American Telephone & Telegraph is still trying to get FCC clearance for its Advanced Communications Service,** which includes packet switching [*Electronics*, Dec. 7, p. 83]. Although Justice Department officials see no immediate antitrust threat in the GTE takeover because Telenet is small, the Federal Trade Commission still must sanction the plan. The FCC also will review the proposal and is not expected to move quickly.

Telenet's agreed sale price of nearly $22 per common share is well above the open market price of approximately $18, a mark of support for packet switching technology's viability. That is especially true since Telenet continues to be a losing operation, dropping $3.5 million in 1978's first nine months on $6.5 million in revenues from operations in 170 U. S. cities and 22 foreign countries.

Washington commentary

How OMB is killing the reorganization of Federal data processing

Time has run out for the Federal Data Processing Reorganization project. The program is a flop, say an increasing number of participants in the 18-month effort, even though the President does not yet have the final report. They are placing the blame squarely on the Office of Management and Budget, which the White House charged with determining how the Government can make more effective use of the 11,000 computers on which it spends $4 billion a year.

President Carter is getting his report late because the OMB has been busy rewriting its 1,500 pages of 100-plus recommendations. These were submitted by 10 study teams staffed by 55 volunteers, 20 of whom were senior people from industry, universities, and local government. Critics contend that OMB is watering down the recommendations to the point where any changes will be largely cosmetic in nature.

For example, a strong recommendation that the President create a new post of Special Assistant for Information Technology is being dropped, says OMB's Wayne Granquist, associate director for management and regulatory policy. And, while Granquist says he agrees with the study teams' goal of improving oversight and management of Federal information technology, he disagrees with their recommendation that OMB should do it by naming a new information technology chief within its own ranks. So much for expert recommendations.

The dissenters

Dropping those recommendations from the final report is already troubling some team leaders. The Pentagon's Robert Cooper, who as an army planner in the office of the Secretary of Defense served on the study's national security team for a year, believes the changes will result in a dissenting minority report for the President. "Management of information technology is broken in the Federal government," says Cooper, and it will take a strong presidential initiative to repair it. But President Carter is unlikely to get that message from OMB, partly because of its own frequent leadership changes and partly because it has always played the adversary of other agencies in its attempts to curb their spending plans.

The Department of Interior's Harris Reiche, who chaired the study's acquisition team, concurs in OMB's leadership failure with the observation that "the 'M' in OMB is about as meaningful as the 'S' in General Services Administration." Reiche, a realist, does not expect much "top-level action" as a result of the reorganization study. While he found the draft document "highly stimulating," he seriously doubts that the President will ever get to read it. Granquist and OMB director James McIntyre, he points out, "could forward the report [to the President] untouched, but they will be listened to more than the report itself."

Mismanagement at the top

There is a certain irony in the fact that White House handling of the Carter-mandated study is showing precisely the same symptoms that each of the 10 reorganization teams separately identified as the Government's outstanding problem with computers: bad management at the top. The report's "discussion draft" is loaded with histories of senior agency managers who, intimidated by the technology, delegated major systems design and acquisition duties to middle managers, rather than integrating data processing into the agency's overall requirements.

But not all thoughtful bureaucrats are depressed at the prospect of presidential inaction on the computer reorganization plan. The Treasury Department's Paul Oyer, former head of the Federal computer user group, suggests that one way to clean up what he calls "the veritable junkyard" of computers in the Government inventory would be declaration of a two-year moratorium on procurement rules. "Let agencies buy whatever they want and can afford," Oyer declares. "The worst that could happen is that users might wind up paying 10% to 15% more than they should. But in return they would gain two years in available technology," compared to the five years now lost during the prolonged procurement process. Oyer concedes that his recommendation is unlikely to be adopted and "could get me thrown out on my tail." Nevertheless, it is a concept that fascinates the Department of Defense, where the average system is six years older than comparable hardware in the private sector.

Realist Reiche, who also chairs the Government's inter-agency committee on data processing, believes he has a better idea for Federal computer managers who would salvage something from the study. "Don't wait for management to move at the top," he counsels, "but go ahead and do whatever you can do. You will be surprised at what can be done." The success of that formula depends of course on the competence of the manager in each case. In any case, it is no substitute for the clear national policy and program for Federal data processing that should evolve after 18 months of expert analysis.

Ray Connolly

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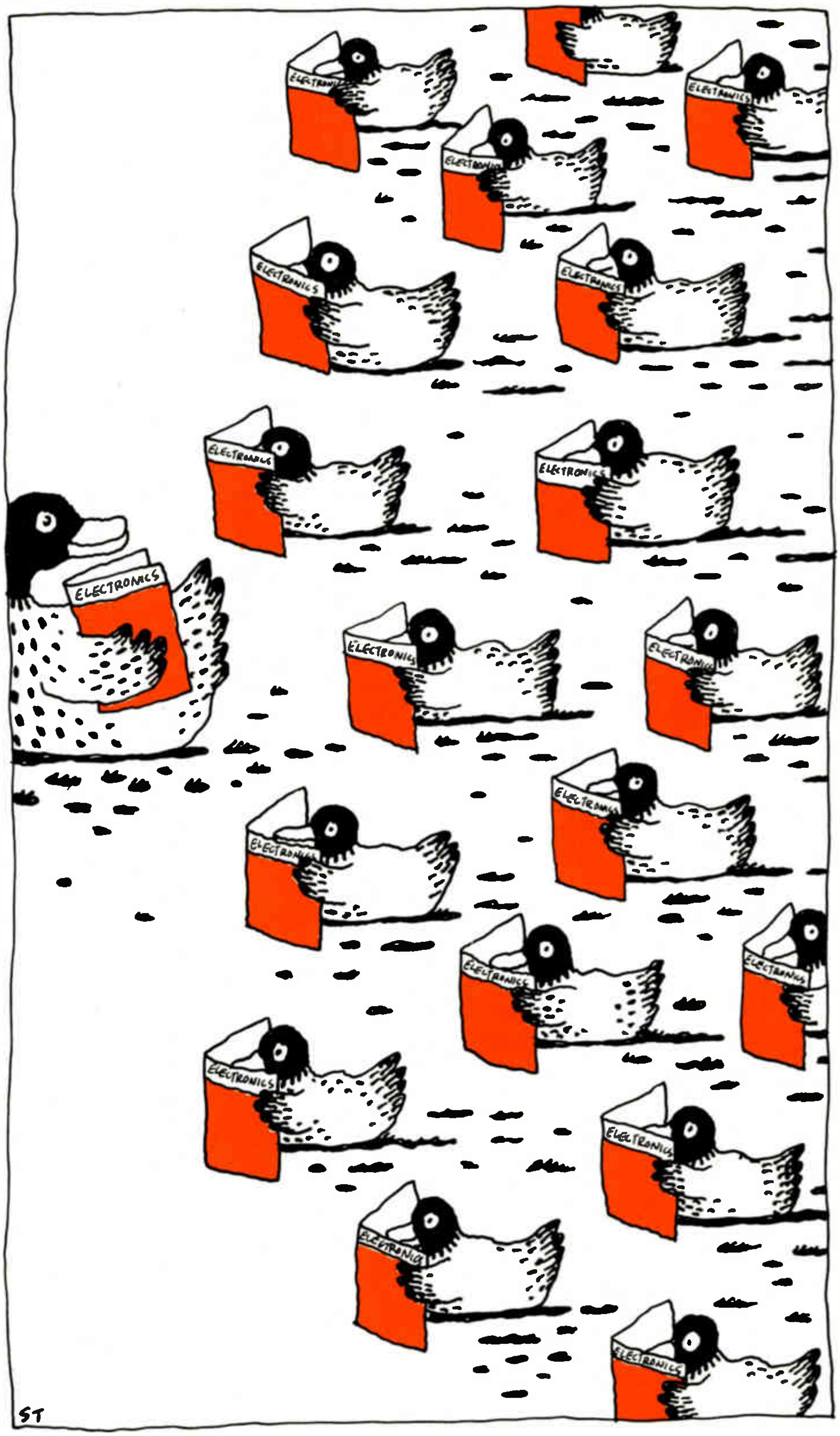

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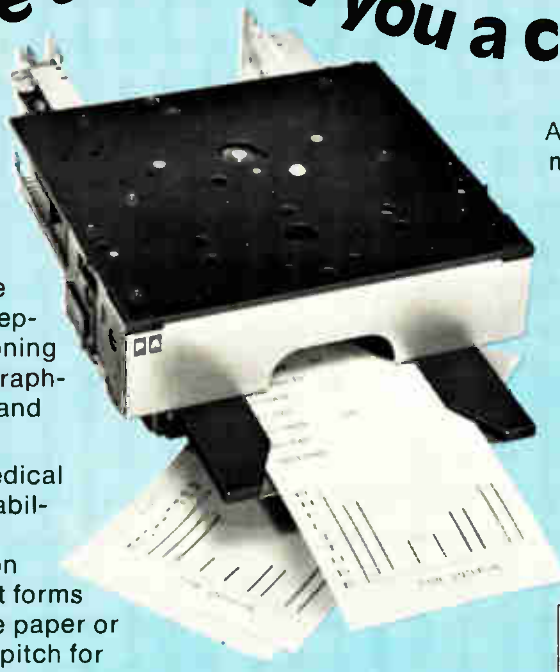

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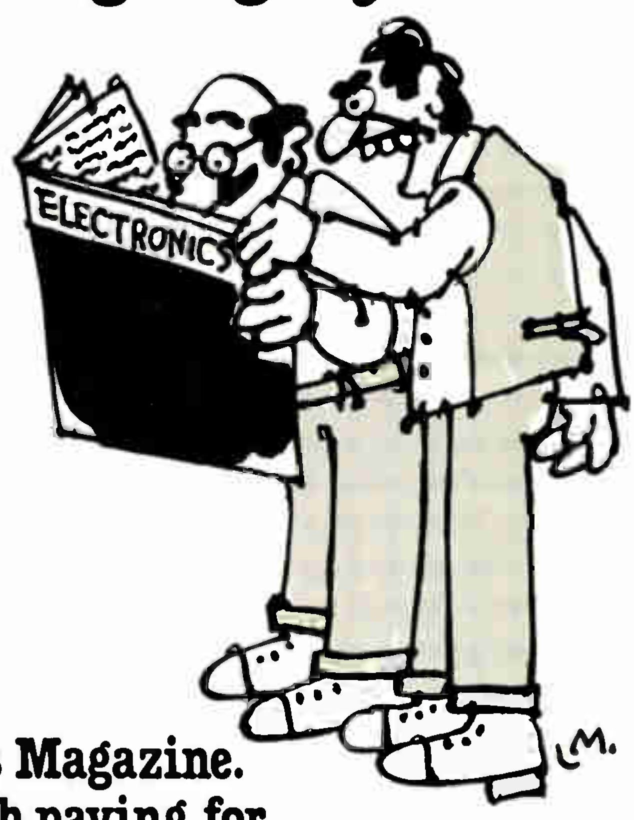

Electronics Magazine. The one worth paying for.

Another video player to be introduced into the U. S.

Coming in February from Universal Pioneer Corp. is a laser-readout video-disk player intended for commercial users. Like Magnavox's just-introduced home-entertainment player (p. 33), it uses Philips' Industries technology; in fact, it comes from a joint Japanese venture of Pioneer Electronic Corp. of Japan and MCA Inc., the U. S. firm that is Philips' partner in developing the technology. **Universal Pioneer Corp. will start shipping the first players to MCA at the rate of 500 a month** and will market the unit elsewhere in the world itself. The unit uses disks playing for 30 minutes on a side and features microprocessor-controlled random access, playback of stills, and slow and fast playback.

Solar-power station with 160 panels to deliver 2 kW

One of Europe's largest solar-power generation stations, comprising 160 photovoltaic solar panels and capable of delivering 2 kW dc in good sunlight, will be built by Ferranti Electronics Ltd. **Output from the Oldham, England, solar bank is stored in a battery and inverted to a 240-V, 50-Hz supply.** The station will use Ferranti's newly introduced MST300 36-cell solar panels, which can deliver 1.1 A at 14.4 V each. To be in operation by the middle of next year, the station is financed by the European Economic Community.

Chip for phone keeps user up to date

A one-chip 4-bit microcomputer that will make push-button telephone sets much more versatile will be available in sample quantities in mid-1979 from West Germany's Intermetall GmbH, lead house of the ITT Semiconductors Group. Built into the set, the SAA6002 complementary-MOS microcomputer **figures the time of day, the number dialed, the length of the phone call, and elapsed rate pulses.** It feeds this data to an eight-digit liquid-crystal display. For automatic dialing, its random-access memory, with a capacity of 96 4-bit words, can store four often-used numbers with up to 14 digits and as many as 10 numbers with 22 digits.

Single-chip transversal filter uses 256-stage CCD

Now in layout at Edinburgh University's Wolfson Microelectronics Institute is a 16-pin, 256-point programmable transversal filter for extracting signals from a noisy background in medical, sonar, and telecommunications research applications. The 180-by-150-mil chip has **a 256-stage charge-coupled-device delay line and 256 single-MOS-transistor four-quadrant multipliers.** Input samples are successively delayed and multiplied by a set of weighting coefficients programmed in by the user, and all products are summed within each 2-MHz clock period. Just a year ago, Reticon Corp., Sunnyvale, Calif., introduced a 64-element programmable transfer filter using CCDs that was the first commercially available device of this kind [*Electronics*, Dec. 8, 1977, p. 34].

NEC adds low-end model to mini series

Nippon Electric Co. has started sales of its NEAC MS10 minicomputer, a step-down model of the MS30 and MS50 introduced in February. It features the same bipolar bit-slice–based architecture, instruction set, and 700-ns memory-cycle time as the larger MS30, but with a maximum memory of 64-K 16-bit words. **At 6.6 megabytes per second, the MS10 has the fastest bus transfer speed available in Japan.** About $15,000 will buy a small system with 32-K words of memory that can handle distributed-processing, communications- and industrial-control applications. Housed in a lowboy rack, it includes CPU, power supply, and controllers for a floppy disk, teletypewriter, and other input/output equipment.

Facsimile service set between U. S. and Switzerland

RCA Global Communications Inc. is expanding its international digital facsimile service to include Switzerland, as well as Japan. Users can typically transmit 8½-by-11-in. graphics in less than a minute **and non-Roman script can be accommodated just as in the Q-Fax service to and from Tokyo.** Any specialized common carrier interconnecting with Q-Fax can tie into the new service without modifications. Radio Suisse Inc. will serve as the Switzerland link.

Hitachi shows single-mode laser diode

To demonstrate the performance of its new buried-heterojunction gallium-aluminum-arsenide laser diode, Hitachi Ltd. used it to transmit the entire very-high-frequency television band in Tokyo. Using frequency-division multiplexing techniques, **a composite multichannel signal was sent through an optical fiber and received by an avalanche diode.** Second harmonic distortion of the modulated carrier was more than 60 dB below the fundamental signal. The highly efficient device can achieve 10-mw continuous-wave output and pulse output of 100 mw while maintaining good linearity. Initial production of the HLP3000 series will be 1,000 units per month, with the price ranging from $1,000 to $1,750 each.

Western companies join with Japanese companies on consumer products

Britain's General Electric Co. Ltd. and Japan's Hitachi Ltd. are about to form an English joint venture to manufacture TVs and audio equipment for the UK and European markets. The agreement follows hard on the heels of a similar tieup between Britain's Rank Radio International Ltd. and Japan's Toshiba Corp. Meanwhile, Hitachi has agreed to provide the U. S. firm General Electric Co. with video tape recorders using the Video Home System format, replacing a GE pact with Matsushita Kotobuki Electronics Industries Ltd. **The VHS format, developed by the Victor Co. of Japan, has picked up another supporter in Europe.** Telefunken GmbH, the entertainment electronics arm of the AEG-Telefunken group, will market JVC video recorders under its own label.

Addenda

The Carrollton, Texas, semiconductor maker, Mostek Corp. **is looking at possible sites in Eire and Scotland** for a European production unit. It has also decided to build a plant in Colorado Springs, Colo. (p. 26). . . . Hard on the heels of a Brazilian tieup for German computer maker Nixdorf [*Electronics*, Dec. 7, 1978, p. 65], the Italian state-owned telecommunications group, STET, says it is signing **a $100 million pact with Brazil's Telebras for the supply of equipment and know-how for the extension of the telephone system.** . . . Siemens AG will supply about $50 million in teletypewriter equipment to Kuwait, Oman, Saudi Arabia, and the United Arabic Emirates, **including a Telex switching center** and several thousand electronic typewriters. . . . Sweden is ordering $110 million of **Sky Flash air-to-air missiles from British Aerospace's Dynamics Group.** . . . Israel firms will build radar, electronics, and other systems **for the 75 General Dynamics F-16As** the country has ordered.

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digital

Mail-sorting system reads typed addresses and verifies zip codes

Latest such system in Europe reads many fonts; multiprocessor setup routes by zip and destination

To put more zip into its service, the Bundespost (West Germany's post office) has installed a letter-sorting system that automatically scans typed addresses, picks out the zip code and the associated postal destination, and checks whether the two agree. Now in service at the main post office in Wiesbaden, the system handles the most labor- and cost-intensive part of mail service.

The German system, like one set up by the French postal agency, marks letters and postcards with fluorescent ink and uses this coding to route the items into their destination bins. Processing mail at a rate of some 60,000 items per hour, or nearly 17 per second, it misroutes no more than 4 out of 1,000 items.

At the heart of the system are two address-reading machines, each handling per hour about 30,000 items with typed addresses. These machines are the result of a Bundespost-funded $10 million research, development, and production contract that started in 1969, according to Heinz Müllauer, head of the AEG-Telefunken team that developed them.

The address reader scans the address, and a multiprocessor system developed by AEG-Telefunken recognizes and classifies the characters of the zip code and the postal destination. Mail is fed to the reader from a stacker that uses the stamps' fluorescence as a guide to ensure that all items are oriented the same way.

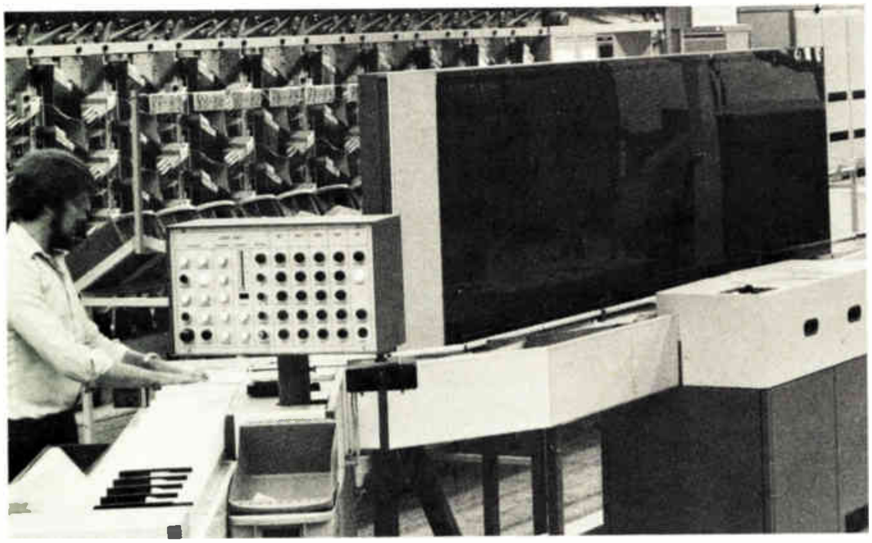
In the Telefunken reader's scanning section, two high-power lamps illuminate a 60-by-150-millimeter field in which the address is certain to be found on the mailed item. The darkness of the characters determines the intensity of light reflected, which then goes through a beam-shaping lens and hits a linear array of 512 integrated photodiodes.

Scanning. As the mail races through the scanner at 3 meters per second, the array scans the 60-by-150-mm field in 1,250 vertical columns spaced 120 micrometers apart. In this process, the array produces some 640,000 picture dots. Each dark picture dot represents a tiny part of one scanned character.

All picture dots whose darkness-density pattern indicates the whereabouts and the position of the address within the field are fed into a random-access memory and subjected to a number of processes executed by the multiprocessor system. Any impurities or specks in or on the paper are recognized by their irregular topological characteristics and are suppressed so that they undergo no further processing.

Next, the multiprocessor picks from the address block those lines that most likely contain the zip code and the postal destination. It then operates on small areas having a 16-by-16-dot format. The character in each area is segmented and normalized. In this step, an approximation algorithm determines whether a character is a capital or lower-case letter or a digit. These three classifications are weighted, and a subsequent comparison tells what the character's most probable status is.

A side-by-side arrangement of the characters yields the zip code and



High reading score. Mail-sorting system at Wiesbaden post office routes 60,000 items per hour, misrouting only 4 in 1,000 items. Machine at right reads typed addresses.

the associated destination. This result, Müllauer explains, is verified as being correct only after being compared with memory that contains all postal destinations and zip codes used in West Germany—about 15,000 in all—as well as the most common foreign destinations and codes. By checking whether the zip code agrees with the destination, the system all but eliminates errors.

Finally, the multiprocessor triggers a mechanism at a printing station that marks the item with a bar code of fluorescent red ink corresponding to the destination. The sorting equipment uses this code to route the mail along high-speed belts into destination bins.

Others. Since 1976, the French Postal Ministry has used similar machines, built by Recognition Equipment Inc. of Dallas, Texas, that sort over 80,000 letters per hour each. According to Frank Bray, manager of postal systems development at REI, these machines (called LI/PAP for *lecteur, indexeur, prétrieur d'adresses postales*) read zip code and street address, and mark the item with two bar codes so that mail can be automatically sorted locally.

Two earlier sorters, installed in 1973 and 1974, recognize a limited number of fonts. On the basis of their performance, the French post office ordered four LI/PAPs, specifying the ability to read all fonts used in the French mail. REI is also supplying optical-character recognition subsystems to the French and Dutch postal services. These will be attached to native transport and sorting systems. And the company has a contract to define a specification for an automatic sorter for the United States Postal Service by April of 1979.

In Canada, the post office uses no fewer than 44 machines, built by Leigh Instruments Ltd. of Ottawa under license from Nippon Electric Co., to sort mail at its main sorting centers. These machines read zip codes only, which in Canada include capital alphabetical characters.

If the Wiesbaden system works well, West Germany will automate its 60-odd main sorting centers. □

Government expands developmental aid to include communications and computers

Signaling its determination to make France competitive in electronics, the government is committing more money to the fight. The fast-developing plan for government aid to the semiconductor industry is being supplemented with a series of measures that will benefit the communications and computer industries as well. France will spend some $500 million over the next five years on research and development projects and direct grants to manufacturers, on purchases of advanced electronics equipment, and on stimulating use of electronic equipment.

The government has not yet announced exactly how it plans to allot its aid. However, it seems clear that part of the money will help to develop advanced data-processing equipment and to stimulate the growth of data processing in business, industry, and government.

The government also is moving ahead with its integrated-circuit plans by putting its seal of approval on a joint venture between National Semiconductor Corp. and the Saint Gobain Pont à Mousson conglomerate [*Electronics*, Dec. 7, p. 66]. Moreover, it is providing a new market for its electronics industries by signing an industrial cooperation agreement with China (see "Chinese pact to benefit electronics firms").

Plans. Among the projects likely to benefit from the $500 million are large data-storage devices and existing time-shared computer networks where the French see a gap. However, a hefty chunk will accelerate the arrival of new technologies in everyday life.

For example, the minister of industry, André Giraud, says the government will install at least 10,000 microcomputers, costing around $2,000 each in French schools by 1984. This project is a major part of plans to inculcate familiarity with information-processing techniques and digital logic.

The posts, telegraph, and telephone service also will play a key role in the new plan, and Norbert Ségard, secretary of state for posts and telecommunications, says the

Chinese pact to benefit electronics firms

Another boost to France's electronics industries may be found in the industrial cooperation agreement signed with China. "The deal covers the whole range of electronics and data-processing equipment," as well as software and know-how, says Jean-Claude Pelissolo, director of the industry ministry's electronics and data-processing agency. One Chinese aim is a license to make the Level 64 computer of CII-Honeywell Bull.

Official French sources say the volume of business looks significant, even taking a worst-case view. The firms involved, which include some of the country's biggest electronics firms, are hopeful if slightly less confident.

The full list of the companies and major product lines are: Benson SA (computer graphics), CAP-Gemini-Sogeti (software), CII-Honeywell Bull, and its subsidiary Réalisations Etudes Electroniques (data processing), Compagnie Générale d'Electricité and subsidiaries (heavy electrical equipment and telecomms), F.R.B.-Connectron (connectors), Isostat (switches), Logabax SA (small computers and peripherals), Pyral SA (magnetic media), Sagem (telexes and telecommunications), Société Anonyme de Télécommunications (communications), Thomson-CSF and subsidiaries (products in almost every electronics sector), and TRT (radioaltimeters, modems, etc.) The government says that no specifically military equipment was included in the deal, though France may supply devices such as radar.

PTT will introduce fast copier service, using PTT lines and a new facsimile unit. Estimated market in the 1980s is several million units priced between $450 and $700 each.

Other communications plans include a pilot videotext project in Vélizy, southwest of Paris. It will give some 3,000 subscribers access to information over TV receivers.

A piece of advanced equipment for the telephone system will be a multifrequency IC for handsets. The goal is to turn every set in the phone system into an inexpensive data terminal by the end of the 1980s.

The government sees considerable French assets in hardware and software for computer-aided design, so part of the $500 million will go to encouraging industry to use CAD. The money will be used for for a variety of purposes with a view to seeing 2,000 systems installed in the country by 1983.

Similarly, industry minister Giraud hopes to encourage the automation of industrial processes. He estimates the installed base for electronic process-control equipment at $9 billion, with an $0.9 billion annual market. With the new loan program, he is forecasting for 1983 a $14.4 billion installed base and $1.8 billion annual market.

Another big boost for electronics industries could come from a decision to launch a French communications satellite, rather than participate in a joint European project. "The government is due to make a decision at the beginning of the year," says Gérard Théry, director general of telecommunications.

For semiconductors. As well as setting the computer and communications plans, the government has approved the planned joint venture between National and Saint Gobain. The two companies are negotiating on a firm to be 51% French-owned that will manufacture metal-oxide-semiconductor circuits in France. They are hoping for at least $45 million in government loans for the $114 million startup costs.

The French IC plan includes setting up a specialized research unit of CNET, the national telecommunications research center. Money also will go to Thomson-CSF and to EFCIS, the IC maker jointly owned by Thomson and the state's nuclear energy agency, for development of very large-scale ICs, with targets of 2-micrometer minimum dimensions by 1981 and 1-μm by 1983.

Moreover, Thomson and EFCIS are spending an estimated $10 million in government subsidies on Motorola MOS technology for IC production in Grenoble [Electronics, Nov. 23, p. 170]. State contracts also are supporting Thomson's work in linear bipolar circuits and the fast bipolar logic development being carried out at the Philips subsidiary, La Radio-Technique Compelec (RTC).

As well as the National–Saint Gobain linkup, the French high-technology company Matra is dickering with the U. S. semiconductor maker Harris Corp. Chances for a deal appear dim, but Giraud says it has not been abandoned. □

Japan

Disk packs in bits, spindle packs in disks to boost capacity to 804 megabytes

Increased recording and track densities, plus more disks on a spindle, give a new line of mass-storage systems coming from several Japanese companies better than 800 megabytes on a spindle. The new disk units also feature a new coding scheme and an improved magnetic head core, both of which contribute to the capacity hike.

Engineers at the Musashino Electrical Communication Laboratory say spindle capacity for their new design is 804.39 megabytes. The just introduced STC 8650 disk system for Storage Technology Corp., Louisville, Colo., can put 635 megabytes on a spindle by doubling track density over previous STC models. The same capacity is achieved in the new 33502 from Control Data Corp., Minneapolis, by hiking both tracking density and the number of recording surfaces. IBM Corp.'s biggest present disk system, the 3350, holds 317.5 megabytes on each spindle.

The recording density amounts to 8,500 bits per inch times 650 tracks

Well-packed cabinets. Boosted capacity is a feature of disk systems to be used in an NTT information processing system. Each spindle can store disks holding 804 megabytes.

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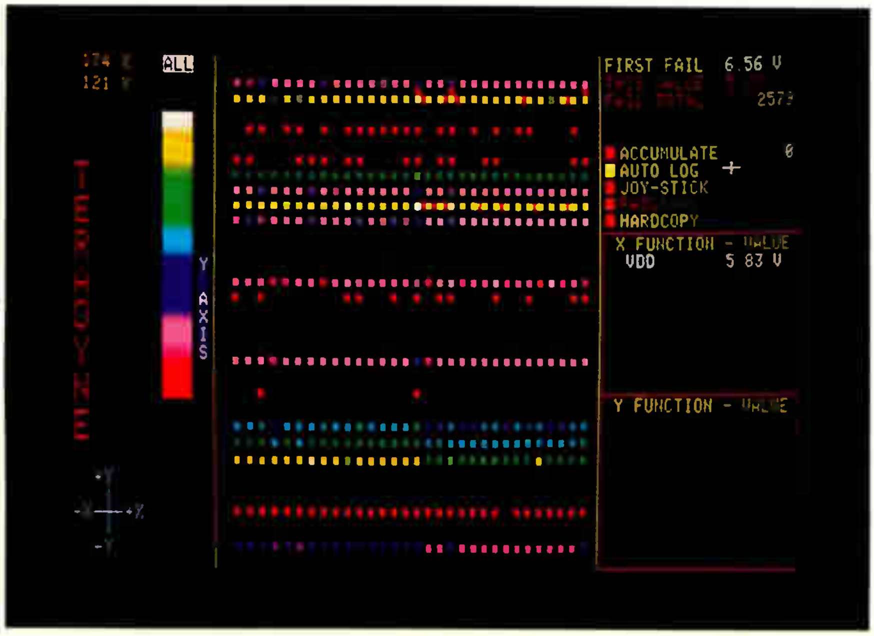
Real-time bit mapping

A dazzling new way to evaluate semiconductor memories.



A visual presentation of failing bits under varying test conditions is essential to any understanding of a semiconductor memory's failure mechanism. To date, the most any test system has had to offer in this respect is a CRT raster scan, which displays failing bits in real time but which usually lacks any means for storing the data. As the dots disappear from the CRT screen, the data and any possibility of computer analysis disappear along with them.

Real-Time Bit Mapping, recently developed by Teradyne, goes so far beyond the conventional techniques for bit-fail analysis that it is sure to become *de rigeur* in any evaluation of memory performance. Beyond that, it is of major value on the memory production line, where it serves as a real-time monitor of device quality.

Available as an option with the J387 Memory Test System, RTBM permits on-the-fly modification of a test program (the standard production-test program, as a rule) and real-time display of the resulting bit failures. The display is in full color, with the accumulating layers of bit failures shown from one end of the spectrum to the other. An address descrambler ensures that the bits are shown in their correct topological positions. The operator uses a joystick to pilot a cursor around the screen, changing program levels and timing, selecting operating modes, recalling patterns, and in general feeling like Luke Skywalker at the controls. The display also reports operating mode, level values, x-y addresses, bit-fail counts, and various other items of interest. The 19-inch screen is big enough to serve as both scoreboard and bit map for most memories, but if greater resolution is needed, any portion of the display can be instantly expanded.

The color terminal and the joystick are the most spectacular aspects of RTBM, but the basic ability to catch, accumulate, and process bit-failure data is available with or without the color terminal. The RTBM capability opens up all kinds of possibilities. One can, for example, use it as a bit-masking device in a search for "soft" errors. One bit-fail pattern can be used as the mask for subsequent passes, or the mask can be inverted so that all bits except those masked are ignored.

But to the engineer, nothing can match the sensation of shifting into checkerboard and watching a kaleidoscope of bit failures change before his eyes. From now on, anything less will be distinctly second class.

TERADYNE

Circle 63 on reader service card

to the inch. A key improvement that makes this possible is a double coating of the gamma-iron ferrite recording medium, the developers say.

For high densities, the ferrite coating must be applied in an extremely thin layer and then polished highly. However, crippling defects in the coating may result. The Musashino solution is two even thinner coatings, totaling 0.7 to 0.8 micrometer thick. The second layer tends to cover defects in the first, while its defects tend to be over usable areas of the first layer.

Also contributing to the high density is a newly developed coding scheme, which improves the data readout margin. A flag bit is inserted between bits 4 and 5 of each 8-bit byte. This bit is 0 if the byte has five or more 1s; with four or less 1s, the data's complement is recorded and the flag is 1.

In the nonreturn-to-zero-invert recording method, each 1 is a transition from a given voltage level to its opposite and 0s are not recorded. The NTT coding scheme maximizes the number of 1s recorded, increasing the number of transitions and thereby improving the recovery of the clock and of the margin.

Another aid to the density hike is the improved magnetic core for the read/write head. Crosstalk and inductance are cut, which contributes to closer packing of the bits.

In use. The disk system will be used in computers for the TSS information processing systems of the lab's parent, the Nippon Telegraph and Telephone Public Corp. It provides 20 recording surfaces per spindle (the top systems from CDC and IBM have 20 and 15 surfaces, respectively), with maximum configuration of 32 spindles per system for a total of 25.6 gigabytes.

The new disk systems will be made for NTT by the three firms supplying the computers: Nippon Electric Co., Hitachi Ltd., and Fujitsu Ltd. While the companies are not willing to telegraph their marketing plans, they undoubtedly will offer similar systems with their own computers eventually. □

Great Britain

CAD language aids design of VLSI chips

Efforts to use computers to simplify the design of very large-scale integrated circuits have been directed at the layout process. Now GEC's Hirst Research Center has developed a language that allows a designer to describe his ideas concisely at an early stage and check them by computer simulation before a single gate has been specified.

The language was developed, says General Electric Co. Ltd.'s computer-aided design group, because "the design of digital VLSI microcircuits is fast approaching a level of complexity that is beyond man's intellect to handle." Because the language, called Hartran for hardware translation, is close to Fortran, the group believes it will eventually find wide application.

Using Hartran, any logic system can be described in terms of register transfers and combinational logic blocks with a series of Fortran-like statements. Once the system has been specified, a simulation is run to see if it behaves as it should.

This stage of the program also points up untestable circuit elements, thus allowing test functions to be defined and incorporated on the chip. This may well be one of the tool's most significant features, since circuit designers are saying that one major problem of VLSI is identifying untestable nodes and providing some method of testing them [*Electronics*, Nov. 23, p. 115].

Shopping list. Once the system is checked, a logic synthesis program converts the designer's software concepts into a listing of hardware—gates, flip-flops, adders, counters, and so on—called up from a library of standard logic functions. U. S. CAD efforts, notably at Rockwell International Corp. and American Microsystems Inc., have been directed further downstream in the design process. They aim at automating chip layout after the logic has been designed and specified.

The hardware list is the end product of Hartran. At this stage the printout is handed over to a mask-layout engineer, who usually completes the mask set on an interactive graphics terminal. LSI design thus becomes an exercise in logical programming, says Geoffrey Bown, who heads the CAD group at Wembley. He adds that software engineers tend to take to Hartran more easily than hardware engineers.

The aim of the language "is to get an LSI design right the first time by systematizing the design procedure," Bown says. Hartran allows an engineer to describe his ideas precisely, and automatically generates documentation charting the design procedures. Thus a company that has automated layout can use it at the conceptualization stage to produce a circuit schematic, then use its own program to lay out the gate array on the chip.

Hartran also eases communication between designers and allows comparison of two different approaches to the same problem. Initial experience with the language justifies Bown's confidence: so far the CAD group has produced two TV-game microcircuits of about 1,000 gates that worked right the first time.

Familiar language. Starting point for Hartran is the scientific language Fortran, which already includes simple logic and arithmetic statements. Additional statements were created to define register-transfer operations and other functions specific to digital logic design.

Because Hartran is so close to Fortran, the Hirst research group was able to write a compiler that translates all the statements into basic Fortran. This means that programs written in Hartran can be run on virtually any scientific computer using the resident Fortran compiler.

Fortran compatibility and Hartran's use of the standard typewriter set of characters are two features that will promote use of the language. Initially, though, Bown thinks that the concept will be taken up within the GEC group. □

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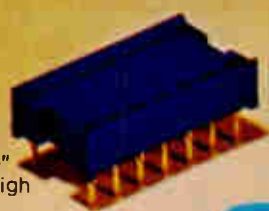

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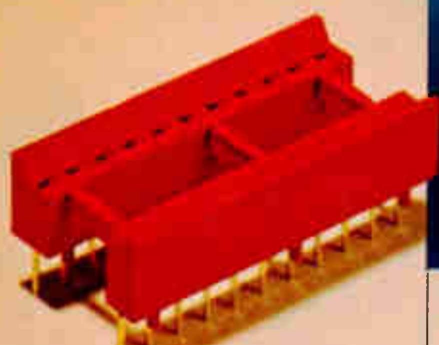

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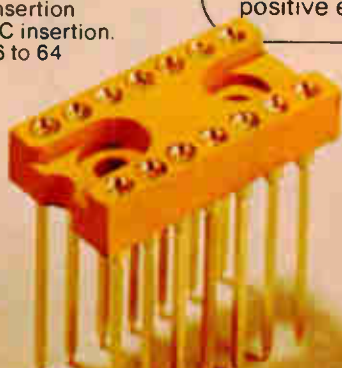

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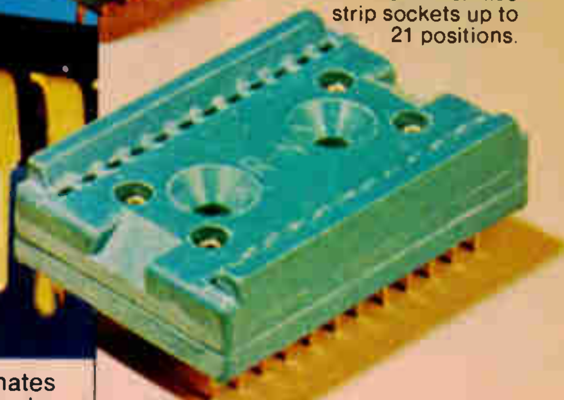

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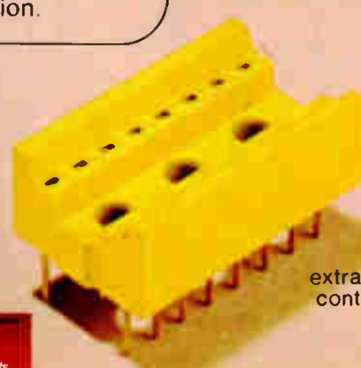

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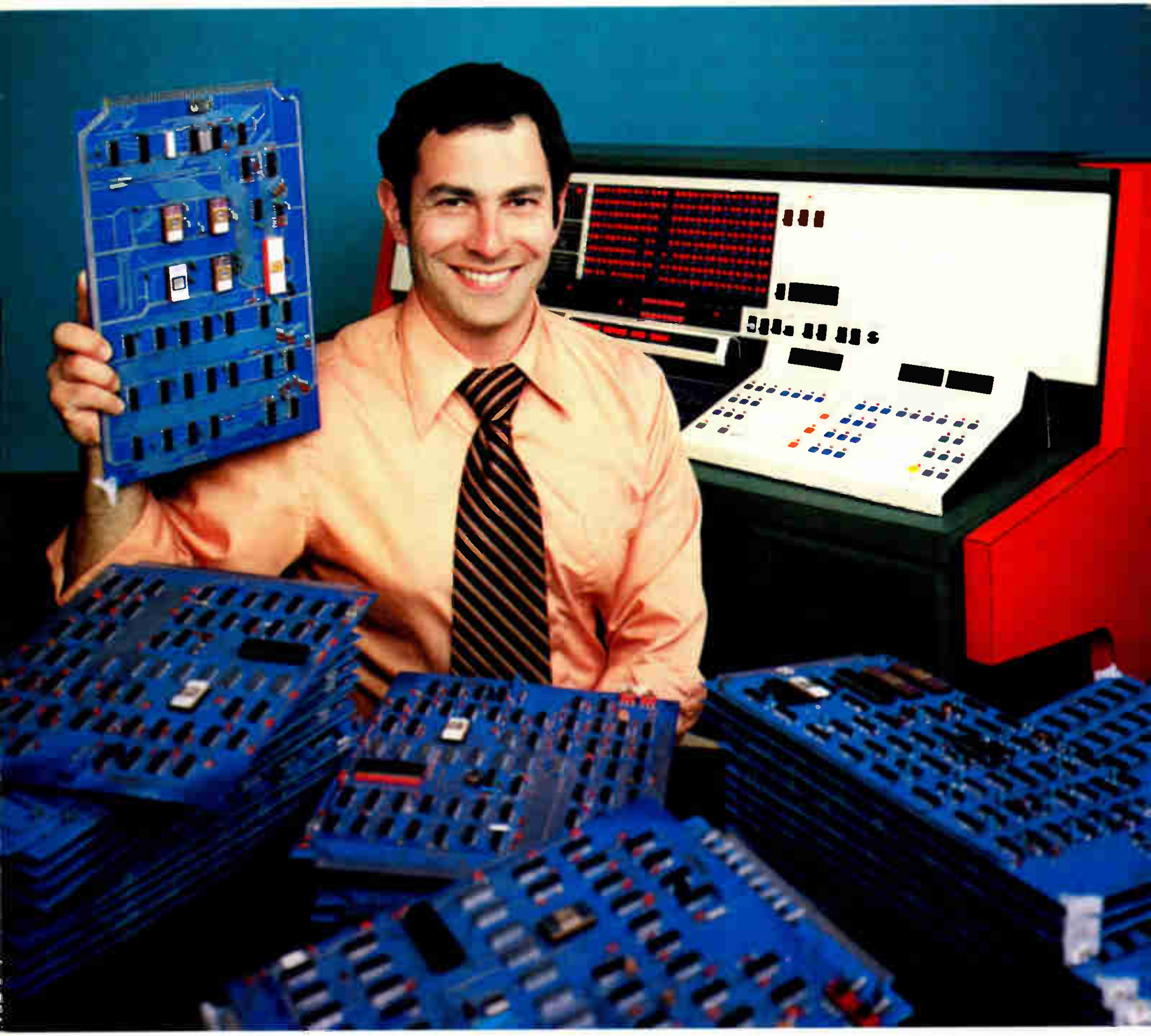

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APL makes splash in small computers

Programming language is growing in popularity among makers of personal and hobby systems as replacement for Basic

by John G. Posa, Microsystems and Software Editor

A combination of strong computational power, efficient memory use, and relatively easy programming are making a language called APL popular on a growing number of small, inexpensive computers—even personal computers using pint-sized microprocessors. Some say it may one day surpass Basic.

The first maker of personal computers to implement APL—which stands for, logically enough, A Programming Language—was the VideoBrain Computer Co. of Santa Clara, Calif. VideoBrain, a division of Umtech Co., offers a version of APL dubbed APL/S for its machine, which uses the F8 microprocessor. "The S stands for two things: subset and structured," explains senior software engineer Frank Wang. The APL cartridge is VideoBrain's first to allow user programming.

The company's use of the APL derivative is a departure from the common practice among makers of personal computers to use Basic. But Ted Haynes, product marketing manager for VideoBrain, feels APL/S can outpoint Basic. "APL/S is structured whereas Basic isn't," he says. "Every segment of the program has a unique entrance and exit. The result is a program with no need for line numbers that is easier to read, write, and debug." Moreover, APL/S is more memory-efficient than Basic. "For the same tasks, it uses about one third as much random-access memory," says Haynes.

The VideoBrain cartridge contains 13 kilobytes of read-only memory and 1 kilobyte of RAM, and the interpreter allows two modes of use. "In the immediate mode, the VideoBrain acts like a sophisticated calculator," says Wang. "This allows the user to execute rather elaborate computations without actually writing a formal program. In the programming mode, one designs complete APL/S programs, and the RAM is used during this mode for parameter storage. APL itself is very applications-oriented," he says. "It is strong with respect to computational power the way Pascal is strong with regard to general-purpose programming. Basic is in between."

For some time now, Bill Gates of Microsoft Co. has been talking about introducing his own version of APL, to be called APL–80. According to Gates, president of the small Alburquerque, N. M., software house. "The project has been under way for about 2½ years and we plan to announce it in about 2½ months."

Aims at 8080. Gates plans to target the 8080 microprocessor, as he has done with other languages. He hopes to offer a majority of APL features found on lárger computers, probably omitting those portions of the language that have to do with a multiuser environment. "APL–80 will be 99% real APL," he says.

Gates sees interest in the language mounting. "There's an incredible amount of enthusiasm out there," he states. "If people like APL, they really like it and they get hooked on it." But Gates does mention that APL users are often not first-time programmers. "It isn't meant for beginners," he says. "It's more for people who've had a touch of the language on large machines." As for APL's potential, he is slightly dubious. "It is not going to take over the world, but it does have its place. It's best suited for things like statistical processing and economic forecasting." As for compactness, Gates puts it succinctly: "It's super-terse."

Vanguard Systems Corp. of San Antonio, Texas, recently announced an APL interpreter for the Z80

Bullet. APL/S cartridge gives such systems as VideoBrain capability of performing complicated computations in simple language.

microprocessor on floppy disk that it licenses for $300 [*Electronics*, Oct. 12, p. 172]. John Howland, chairman of the computer science department at San Antonio's Trinity University, formed the firm 2½ years ago for consulting projects.

With Philip VanCleave, who did much of the coding, Howland designed APL/Z80, in many respects the first full-blown version of APL to be offered for a microprocessor. Using 27 kilobytes, it implements just about all of the primitive functions and operations for APLSV (for APL, Shared Variables—see "A simple, elegant system"). The few primitives not offered are easily written as defined functions.

Howland picked the Z80 for many reasons. "It has 16-bit arithmetic capabilities, binary-coded-decimal instructions, instructions for moving and comparing blocks of memory, and multiple index registers," he says. Unlike Microsoft's Gates, Howland says he probably will not develop APL for any other 8-bit machines because they just do not have what it takes to yield an adequate response time during program development.

Power and fun. "APL is the most powerful programming language in terms of ease of programming. It's fun in APL," says Howland. "Now that it can be offered on a system with a total cost of $5,000 to $6,000, it's a real boost to APL programming and it will make available applications that were not cost-effective in the past—for example, for educational institutions that couldn't afford the time-sharing costs on a mainframe."

Vanguard Systems is negotiating contracts with various hardware manufacturers. "Nearly all Z80-system vendors are interested, including Cromemco, Digital Group, and Zilog itself," says Howland, predicting that "in a very short time, APL will be widely available, like Microsoft's Basic." He also envisions hardware made for APL. "As we reach larger degrees of integration, one will see a processor or set of chips for APL's exclusive use," he says. "We'll see more devices like Western Digital's Pascal machine [*Electronics*, Oct. 12, p. 155]. The only impediment is that the people now designing integrated circuits are not that software-oriented yet. But the new 16-bit devices are headed in the right direction."

"We're now evaluating 16-bit machines, and within a year we'll have APL running on a 16-bit microprocessor," he predicts. "We're looking at Intel's 8086, Zilog's Z8000, and Motorola's 68000. At first glance, the 68000 looks the best, but the others have their own strong points. For example, the 8086 has good decimal arithmetic capabilities, so we will just have to wait and see."

Summing up. Howland feels "there have been some Fortrans, Cobols, and some operating systems, but with APL there exists a level of sophistication that just can't be reached with those systems."

Exidy Inc. of Santa Clara, maker of the Z80-based Sorcerer personal computer, already plans to use Vanguard's APL. Like the VideoBrain, the Sorcerer uses a read-only-memory cartridge to house silicon software. The package, which is actually an 8-track stereo cartridge fitted with a printed-circuit board, is also where it plans to put the Vanguard system. According to Paul Terrell, marketing manager, "we don't know if Basic is the right language and we don't want to restrict our users. So if you want another language, you just plug in another cartridge."

Won't fit. The Sorcerer's ROM packs have room for four, 24-pin read-only memories. This means that even with 16-K ultraviolet-light–erasable programmable ROMs, the 27-K Vanguard system will not fit. But Exidy is determined to make it go. "We're looking at the bigger ROMs, the 64-Ks," says Terrell, "But I'm told that we'll have to wait at least 12 weeks for delivery. It appears the whole world is getting into ROMs. Vanguard has already partitioned its system into 16-K and 11-K parts, just in case. If we have to, we'll read in the 11-K portion from a cassette tape or some other medium and write it into the Sorcerer's RAM until we get the bigger ROMs."

"There's a big market out there that IBM has created," he continues. "There are a lot of computer programmers in love with APL." □

A simple, elegant system

APL, which stands for A Programming Language, was developed in the late 1950s by Kenneth Iverson, a professor at Harvard University. He invented this simple, elegant notational system to fill a need for a pithy way to represent mathematical expressions, describe and analyze various topics in data processing, and teach his classes.

In 1960, Iverson joined IBM Corp. There, with the help of Adin Falkoff and other interested researchers, an interpretive version of the language was adapted for the System/360. In 1973, IBM released APLSV. The appended SV stands for Shared Variables—a means whereby a number of users may communicate information. More recently, the language has surfaced on less expensive machines: IBM's 5100 series of business computers, Digital Equipment Corp.'s DECsystem 2020, Hewlett-Packard Co.'s 3000, and the newly introduced Interactive Computer Systems Inc.'s System 900 (see p. 125), to name a few of the computers in question.

APL's primitive functions, of which there are about 60, fall into two categories, scalar and mixed. Scalar functions can be used with scalar arguments and arrays on an item-by-item basis. Mixed functions apply to arrays with various ranks and may produce results that vary from the original arguments in rank and shape. The scalar functions can be subclassified as monadic and dyadic, which are defined for one and two arguments, respectively. The primitive operators, which currently number five, modify the action of scalar dyadic functions and some mixed functions, resulting in a great number of new functions.

APL uses alphanumerics, Greek letters, and some uncommon mathematical symbols to represent the functions and operators. These make APL programs appear cryptic to the beginner; in fact, the language is easy to learn. With a little practice, powerful routines can be generated with a few simple key strokes.

Solid state

ISSCC advances on all fronts

Spotlight at February's meeting in Philadelphia will be on the coming generation of digital and linear circuits

by Raymond P. Capece, Solid State Editor, and Nicolas Mokhoff, Components Editor

A look at the program for the 1979 International Solid State Circuits Conference will likely cause people to forget that 1978's session was held on the West Coast and say that on the whole they'd rather be in Philadelphia. Those attending the conference in the stately old City of Brotherly Love from Feb. 14 through 16 will hear about developments in several circuit areas that are significant, if not breakthroughs. The listings on these pages, only highlights at that, are proof of the progress in memories, logic, analog, and data-acquisition circuits, as well as in functional large-scale integration.

Glimpses of the future. Integrated-circuit technology is far from stagnant, and if the developments to be reported at the Philadelphia Sheraton Hotel do in fact provide a sneak preview of future products, then next year's market will be equally active. Glimpses of next-generation circuits appear in several areas. Besides three papers on 65,536-bit random-access memories (one with redundant bits), for instance, a very high-speed 16,384-bit static RAM and a 128-kilobit read-only memory are presented. Hearken, also, to a 4,096-bit RAM built with emitter-coupled logic for eye-popping 15-nanosecond access time and dissipation under a watt.

In the logic area, an 8-bit microprocessor slice and a bipolar 5,000-gate array are new. Echoing the emphasis on very large-scale integration that was the theme of the International Electron Devices meeting earlier this month, is an entire session at the ISSCC devoted to computer-aided design techniques. It includes papers on graphics tools,

ISSCC DIGITAL HIGHLIGHTS

Session	Circuit	Source	Features
MEMORY			
1.1	65-mW 128-K ROM	Nippon Telegraph & Telephone	200-ns ROM with 2-μm patterns uses direct-electron-beam data writing.
1.3	Self-refreshing 4-K RAM	Intel	200-ns pseudo-static RAM draws only 6-mA active, 10-μA standby current.
1.4	Full-wafer 1-megabit RAM	NT&T	Polysilicon die-interconnects and defect-tolerant design build a 350-ns million-bit RAM.
1.5	Taper-isolated dynamic-gain RAM cell	Texas Instruments	Capacitorless one-transistor RAM cell is simplest yet.
9.2	25-ns 4-K static RAM	Intel	Single-5-V n-channel designs yield 200-ps gate delays.
9.3	ECL 4-K RAM with 15-ns access time	Siemens	ECL 1,024-by-4-bit RAM is compatible with 100-K family, draws 900 mW.
9.4	16-K C-MOS-on-sapphire RAM	RCA	Buried contacts build small (1.78-mil²) cells using 5-μm features.
9.5	16-K-by-1-bit static RAM	Intel	45-ns n-channel RAM dissipates 550 mW.
12.3	5-V-only 2-K-by-8-bit dynamic RAM	Mostek	Pseudostatic design with 120-ns access time dissipates 150 mW.
12.4	64-K dynamic RAM	National Semiconductor	Design uses triple-polysilicon stacked-capacitor cell.
12.5	64-K V-MOS RAM	Siemens	Design employs V-groove n-channel MOS.
12.6	Fault-tolerant 64-K RAM	Bell Laboratories	Industry-compatible 100-ns RAM has redundant bits.
LOGIC			
3.1	3-gigabit ECL multiplexer	Philips Industries	Emitter-coupled-logic design for super-high-speed multiplexing, demultiplexing.
3.2	ECL subnanosecond 8-bit slices	Fairchild Camera and Instrument	8-bit-wide slices (1,000 gates/chip) build a 64-bit processor with 25-ns cycle time.
3.5	Comparison of ISL and I²L	Philips Research Laboratories	Integrated Schottky logic outperforms injection logic.
6.1	5,000-gate I²L masterslice	Hitachi and NT&T	Oxide-isolated I²L yields 10 ns/gate in 124-block cell array.
6.3	1-μm MOSFET PLAs	IBM	Programmable logic arrays emulate an 8-bit microprocessor with 13–21-ns gate delays.
6.4	Subnanosecond masterslice array offering logic plus memory	Siemens	Bipolar 512-gate arrays with 128 bits of on-chip RAM build an 80-MHz 4-bit slice.
8.1	Silicon MESFETs for VLSI	Texas Instruments	Subfemtojoule power-delays can be measured on amplifier, oscillator, and divider circuits built with 1-μm FETs.

SOURCE: *ELECTRONICS*

ISSCC LINEAR HIGHLIGHTS			
Session	**Circuit**	**Source**	**Features**
ANALOG CIRCUITS			
2.6	Dual-tone multi-frequency receiver	Silicon Systems	Single metal-gate C-MOS chip uses switched-capacitor filters to detect tone pairs.
7.1	Chirp Z-transform processor	Texas Instruments	N-MOS chip calculates discrete Fourier transform from 1 kHz to 1.5 MHz.
7.5	Programmable analog second-order filter	University of California, Berkeley	N-MOS switched-capacitor filter has programming of gain and Q.
10.5	Gallium-arsenide FET circuits	Rockwell International	GaAs substrate is used for microwave transmission lines with 0.5-dB/cm attenuation at 12 GHz.
11.5	N-MOS operational amplifier	Signetics	Chip uses body effect cancellation to achieve open-loop gain of 25,000.
16.3	Microprocessor with on-board a-d and d-a converters	Intel	E-PROM-programmed processor takes analog inputs, processes them digitally, outputs analog.
DATA ACQUISITION			
11.1	C-MOS-on-sapphire a-d converter	RCA	Monolithic 6-bit expandable converter operates at video (15-MHz) speed.
11.2	Fully parallel a-d converter	TRW	Bipolar 8-bitter can convert 35 million samples per second.
11.4	Two-step parallel a-d converter	Philips Research Labs	2.4-by-2.5-mm chip samples inputs up to 5 MHz to yield 7 bits.
14.2	12-bit d-a converter	Advanced Micro Devices	Bipolar part insures monotonicity to 12 bits.
14.3	13-bit a-d converter chip	Matsushita Electric Industrial	Mixed-process IC resolves 13-bits to ½-LSB accuracy.
14.5	Simultaneous integration a-d converter	Nippon Electric	Si-gate C-MOS chip uses single +5-V supply, achieves 12-bit resolution.
14.6	12-bit a-d metal-gate n-MOS chip	University of California, Berkeley	Chip uses 4-bit resistor network and 8-bit capacitor array.
DEDICATED LSI CHIPS			
15.4	Signal processor	Stanford University	IC multiplexes and amplifies six real-world sensors up to 100 dB.
15.5	Monolithic pacemaker	Penn State University Arco Medical Products	C-MOS chip incorporates programmable pace-making system.
16.1	Automatic character reader	Catholic University of Louvain	Device detects and outputs data on character contour of a 32-by-24-bit digitized pattern.
16.2	Sound generator	General Instrument	N-MOS IC stores sound effects in either program or data ROM.

SOURCE: *ELECTRONICS*

device simulation, testing, and automatic test-pattern generation.

However, the digital developments hardly overshadow the linear circuits, as evidenced by the progress in digital-to-analog converters, filters, and microwave circuits. Besides monolithic d-a converters that feature high speed and monotonicity over a full 12 bits, a few other gems worth mentioning will surface at two data-acquisition sessions: such as a 100-ns strobed comparator that resolves down to 100 microvolts and a monolithic bi-FET quad analog switch able to withstand overvoltage surges of 20 volts.

Communications. What the various coder-decoder chips were to last year's telecommunications session, the filters and associated peripheral chips for codecs are to this year's. Attendees will learn the superiority of switched-capacitor techniques in integrated-circuit filter designs from at least three papers: an n-channel metal-oxide-semiconductor filter chip, a complementary-MOS device for a two-chip pulse-code-modulated codec, and a single-chip dual-tone multifrequency detector built with metal-gate C-MOS.

Also on the telecommunications agenda are an eight-channel codec and charge-coupled-device filter subsystem built with only five ICs and an optically coupled cross-point array that can directly tie to a conventional telephone.

The digital telecommunications industry, just coming into its own, will have its participants hold a full-fledged evening panel session, centered around integrated filters. Moderated by P. R. Gray of the University of California at Berkeley, the panel participants will include experts from Bell Laboratories, Texas Instruments, Intel, Bell Northern Research, Mostek, and Siemens.

That panel is just one of the evening sessions (a carryover from a successful program at last year's ISSCC) that are studded with various industry stars. Topics include very large-scale integration, millimeter-wave and microwave ICs, high-density RAMs, next-generation microprocessors and microprocessor support circuits, lithography, precision analog techniques, and even technology for the home computer. □

Electronics abroad

Clouds part for West Germans

Recovery expected to continue, with makers of consumer, computer, industrial, and communications gear to benefit

by John Gosch, Frankfurt bureau manager

For West Germans, the summer of 1978 was very rainy. But with the rains came a change in the economic climate: the low that had lingered from early 1977 through mid-1978 passed through, followed by the leading edge of a high.

That was enough to lift the economy 3% this year. And the recovery will continue next year, economists expect. Confidence has picked up among industrialists, exports are rising, consumer spending remains high, and the pump-priming started last year by Chancellor Helmut Schmidt's coalition government is becoming effective. With all that going for it and with inflation solidly under control, the West German economy should be good for a 4% gain. The sole chill factor is high unemployment, almost a million out of a work force of 26 million.

With the improved economic climate, the country's electronics markets will prosper. "The new year should develop more positively," remarks Hanno Gauger, director of sales and marketing policy at Siemens AG. A cursory look at the major market sectors shows why.

Given the national craving for home entertainment, consumer-equipment makers should register a gain. Computer manufacturers are wallowing in orders, and that means they will be busy throughout 1979. After years of sluggish growth, the industrial electronics sector is finally picking up as the newly confident industrialists invest in plant and equipment. Furthermore, the Bundespost, West Germany's post office which runs the public communication lines, will continue its massive spending. Benefiting from it all will be producers of test and measuring gear. About the only market expected to stay flat or post moderate gains at best is that for medical electronics equipment.

All this spells a sizable increase in next year's total electronics consumption. Manfred Beinder, chief economist at the ITT subsidiary Standard Elektrik Lorenz AG, pegs the rise at between 8% and 9% in real terms. That tallies, essentially, with the results of *Electronics'* annual survey, which evaluates markets in current monies. The consensus forecast: equipment markets of $11.35 billion in 1979, up 10% from this year's $10.32 billion; components gaining much less, up just 3% to $2.86 billion next year. (Dollar amounts are reckoned at $1 equals 1.95 Deutschmarks.)

Computers. West Germany's computer makers sailed smoothly through the last patch of rough business weather, registering real gains of 8% to 9% according to market researchers at Siemens AG. Next year there is a spurt in the offing, according to *Electronics'* survey. It forecasts consumption of computers and related equipment at $4.34 billion, more than 15% better than this year's $3.75 billion.

Small systems will bound upward to 20% or more, and terminals will do even better. For terminals, the computer consultant Diebold GmbH pegs the increase in incoming orders at 30% to 40% this year. Large systems are alive and well, too, reports Jochen Rössner, a marketing specialist at Sperry Rand's Univac division.

The Soccer World Cup made 1978 a reasonably good year for

WEST GERMAN ELECTRONICS MARKETS FORECAST
(IN MILLIONS OF DOLLARS)

	1977	1978	1979
Total assembled equipment	9,489	10,315	11,349
Consumer electronics	3,568	3,676	3,757
Communications equipment	1,145	1,305	1,570
Computers and related hardware	3,267	3,754	4,336
Industrial electronics	602	622	675
Medical electronics	587	605	624
Test and measurement equipment	222	248	274
Power supplies	98	105	113
Total components	2,658	2,774	2,856
Passive and electromechanical	1,190	1,213	1,247
Discrete semiconductors	424	434	445
Integrated circuits	393	448	491
Tubes	651	679	673

(Exchange rate: $1 = 1.95 Deutsche marks)

Note: Estimates in this chart are consensus estimates of consumption of electronic equipment obtained from a survey made by *Electronics* magazine in September and October 1978. Domestic hardware is valued at factory sales prices and imports at landed costs.

color television, so that entertainment electronics sales edged up to $3.68 billion, according to *Electronics'* survey. Next year there is no big event to hype sales of color sets, a market "showing signs of saturation," in the words of Johanna von Ronai-Horvath, head of market research at Schaub-Lorenz, an ITT entertainment-electronics company. Since color TV is dominant in consumer electronics, only slight growth looks likely for 1979—to $3.76 billion. About 45% of the money can be credited to sales of color sets, which should run about 2.85 million units, von Ronai figures.

Although it is still at its beginnings, the market most watched next year will probably be the one for video cassette recorders (VCRs). Estimates vary, but everybody agrees that sales will go up sharply. Wieland A. Liebler, a marketing specialist at Saba Werke GmbH, checks in with 80,000 units for 1978, 150,000 for 1979, and 240,000 for 1980.

Communications. Next year, the Bundespost will boost its spending for telecommunications by 12.5% with an outlay of $2.77 billion. As always, much of the money will go for cables and nonelectronic gear, but there will be plenty to keep communications hardware makers busy. There is lively ordering from nongovernment sources, in addition, for things like private automatic branch exchanges and data-transmission equipment. *Electronics'* survey forecasts communications markets at $1.57 billion next year, up better than 20% over this year's.

West German components markets perked up a little this year after a fairly dismal 1977 but no one expects them to bubble much next year. The markets should rise 3% to 4%, predicts Helmut Schütt, a market researcher at Siemens. *Electronics'* survey puts sales for next year at $2.86 billion, up only 3% over 1978's estimated $2.77 billion.

As always, semiconductors will do better than passives and tubes. Sales of discrete devices will stay flat, but integrated circuits will post a rise that will lift semiconductor markets to $936 million, some 6% over this year's estimated $882 million. □

Second in a series examining European markets.

Circle 73 on reader service card

Circle 140 on reader service card

Companies

Computers help HP near $2 billion

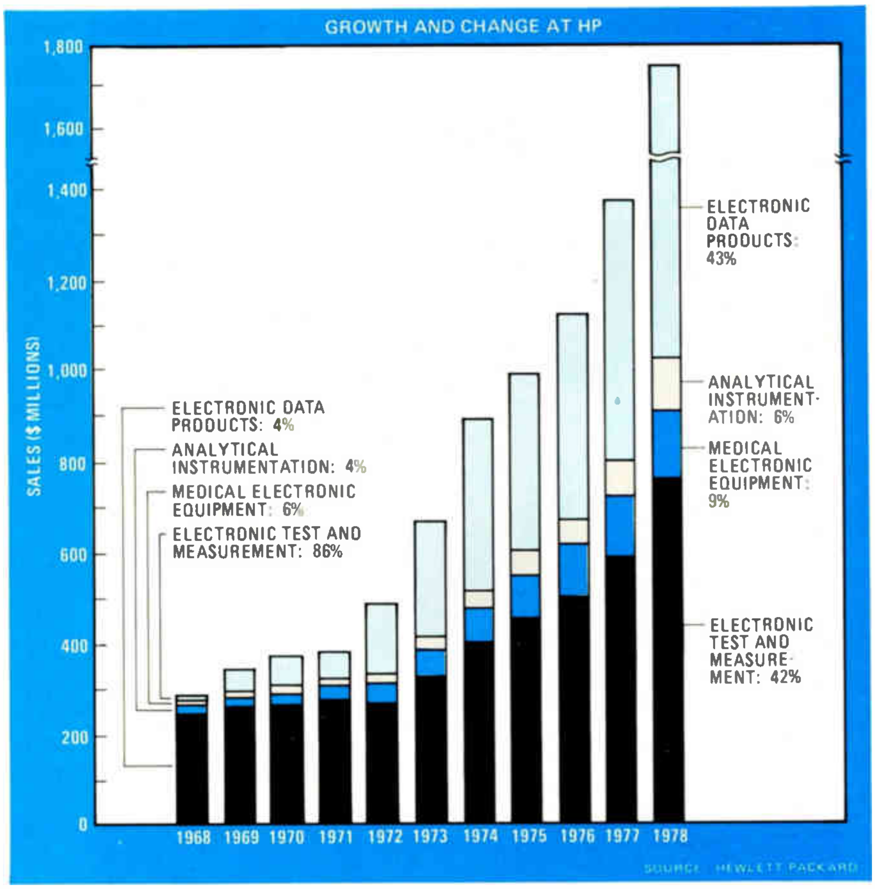
Sales of data products now top instrument totals, and coupled with foreign business have fueled 1978's 27% rise

by Robert Brownstein, San Francisco regional bureau

Only a decade ago, Hewlett-Packard Co. had sales of $275 million, with $11 million of that in electronic data-processing products. Now, according to just released fiscal 1978 results, the Palo Alto, Calif., company's EDP sales have multiplied an astounding 68 times to become the leading element in HP's $1.73-billion year. Add to that the strength in international sales—orders jumped 35%, $88 million—and it is easy to explain the 27% increase over last year's numbers for a gain of $234 million. It's also easy to see why HP will soon be a $2 billion company.

Overseas orders account for 48% of 1978's total bookings of $1.87 billion. Furthermore, says John A. Young, president and chief executive officer of the company, "our international business should help offset any downturn in U. S. business later on in 1979." Thus he is confident that HP will continue to grow in the coming year.

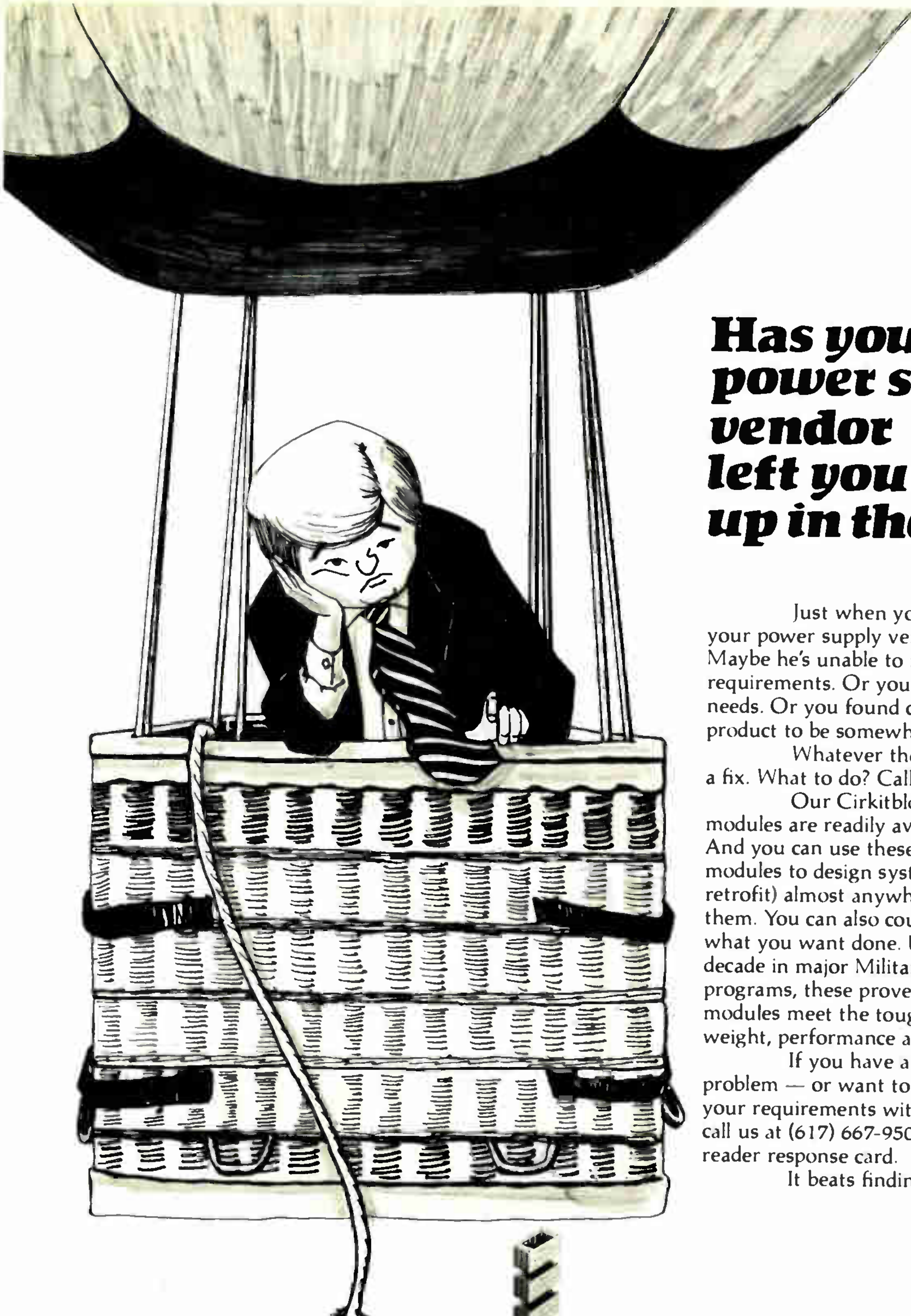
No shift. With the emergence of data products as the major sales factor, will the company devote more resources to research and development in that area and concentrate less on what had been its traditional bread-and-butter lines—instruments? "Absolutely not," Young says, "not when instruments are growing at about 25% per year and keeping pace with the growth in data products."



But industry analysts question whether HP can continue that policy over the next several years, since the computer market is growing much more rapidly than the instruments business. "They'll have to answer a philosophical question in the next five years of which business they want to be in," says Charles T. Casale, vice president at Bache Halsey Stuart Shields Inc.'s Boston-based technology market research group.

Test and measurement instruments truly have been keeping up; they have stayed at 40% or more of total sales for the last five years. However, while instrument sales over the last 10 years have grown a respectable three times from $236 million in 1968 to approximately $727 million in this year, the rise of data products sales to 43% of the total from 4% over that same period has been nothing short of meteoric.

As with any new product area, however, pretax earnings tended to fluctuate considerably, mirroring the ploughing back of profits, and the vagaries of the learning curve. In 1974, for example, pretax earnings were $71.5 million on sales of $371.8 million worth of data products. The following year, with sales increasing to $386.8 million, pretax earnings fell to $54.5 million. In 1976, with sales increasing to $447.1 million, earnings dropped to only $52.6 million, while earnings for the more



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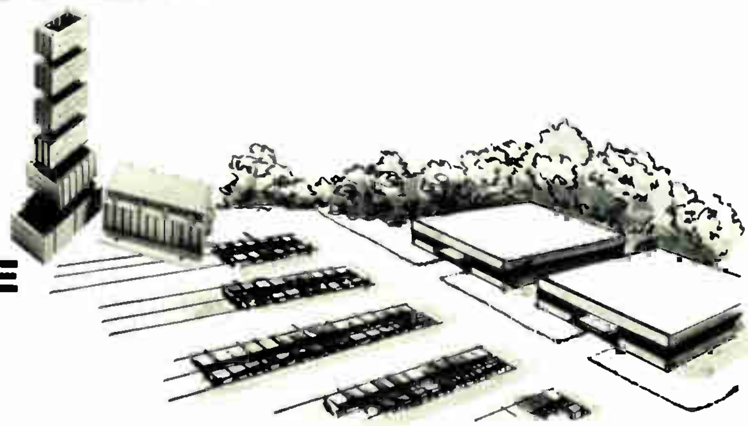

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mature instrumentation product areas increased steadily.

Staying ahead. HP was buying future earnings with its reduced returns because it was committing itself to advanced technologies. It was one of the first to jump on the semiconductor memory bandwagon while others were still relying on core and was therefore able to benefit from the rapidly decaying costs of that memory technology. This year, HP scientists shrunk the bulk of the logic on nine central-processing-unit printed-circuit boards into three complementary-MOS-on-sapphire chips [*Electronics*, Oct. 12, p. 39], and those chips became the kernel for two new computer systems—the model 300 and model 3000 series 33.

Meanwhile, helping EDP development was the cross fertilization between the computer and instrumentation groups. Computer system development has often depended on design tools that did not exist. Consequently, the instrument group invented them and in doing so created a new product area for itself—logic analyzers.

The 'next bench.' These analyzers sprung from what William E. Terry, vice president and general manager of the instrument group, calls the "next-bench syndrome," in which a product is spawned by thinking about another group's problem.

As HP moves closer to the $2 billion mark and Young completes his first year at the helm, he must choreograph the interplay of resources—material and human—to keep HP on the track established during the leadership of David Packard and William Hewlett. "There will be no surprises," he says. "Much of what is happening now has been planned for years in advance." The basic mandate to "sell solutions to problems rather than hardware" remains in effect, he adds.

Asked if HP's success in the computer market will cause a shift in its basically conservative approach to new markets products, Young answers with a Packard quote: "More companies died of indigestion than died of starvation—they bit off more than they could chew." □

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Consumer electronics

Radio control: more than a toy

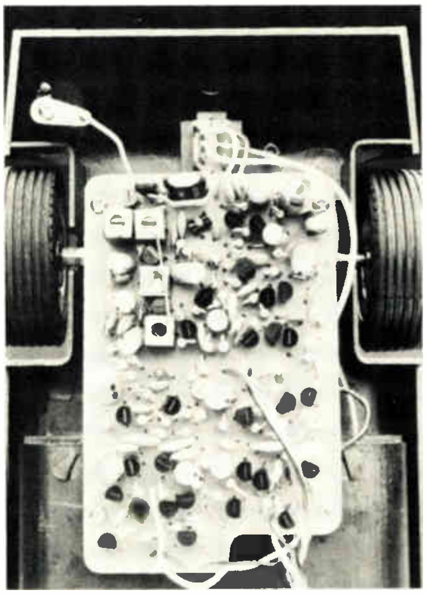
Hobbyists' demand for authenticity and performance is driving force behind trend to product sophistication

by John Javetski, Consumer Electronics Editor

Almost lost in the blitz of electronic games that defy players to match wits with a tiny computer is the steady popularity of radio-controlled toys. Unlike their newer cousins, these cars, boats, and planes are not just seasonal sales phenomena—they enjoy good year-round sales, particularly among dedicated hobbyists.

Not only do people who enjoy "driving" scale-model Porsches or Corvettes around the living room want their models when they want them, but they want realism. So manufacturers are forever searching for inexpensive ways to add car-, boat-, or plane-like features to their products. And this usually means applying electronics.

Suppliers are sold out. What kind of features? Lewis Polk of Polk's Hobbies in New York City reports that this year's crop of radio-controlled toys is loaded with frills like honking horns and blinking lights and performance features like proportional steering, whereby the car is driven remotely with a hand-held steering wheel. The performance features, explains Polk, are the main reasons why "consumer demand has kept suppliers sold out all year long. That's in all categories, from the $12.88 toys that just start and stop to the proportional-steering, proportional-speed hobby machines that cost $70 and up."



Not quite Detroit. Radio receiver over rear axle uses discrete devices to decode and implement model-car operator's demands.

One of the reasons for the spread in price is that almost all the electronic components in the cars are discrete bipolar transistors. Most vehicles use what is called a digital proportional-control system. In this system, the operator's hand-held transmitter sends a 27-megahertz radio-frequency signal to the receiver in the car. The transmitted signal contains up to eight commands, which are encoded as the widths of pulses in a train that amplitude-modulates the carrier. The commands are from scanned switches (on/off control) or potentiometers (speed and steering).

The receiver is usually a superheterodyne circuit that detects and decodes the command signals, then applies them to drivers or servo amplifiers for each channel. A typical receiver has 40 transistors and is powered by C or AA batteries. In toy cars, the receiver is mounted on the same pc board as the discrete servo drivers. In hobby models, the servo-driver functions are performed by integrated circuits.

What next? The existence of these servo-driver ICs, first produced by Signetics Corp. of Sunnyvale, Calif., indicates the direction of the radio-control and related electronics market. Several semiconductor manufacturers are believed to be working on linear chip sets that will do some or all of the coding/decoding and modulating/demodulating functions for the vehicles.

Earlier this month, National Semiconductor Corp. of Santa Clara, Calif., announced a two-chip, four-channel transmitter-receiver for remote control [*Electronics*, Dec. 7, p. 36]. Signetics, Texas Instruments Inc. in Dallas, and Sprague Electric Co. of North Adams, Mass., are reported to be working on similar parts, which should sell for $1 to $2 in large quantities. □

Turning a phrase

Certainly unique among radio-controlled cars is Heuristics Inc.'s Robot 1, a foot-long racer that follows spoken directions. Retailing for $199, the car is designed to work with an Apple II personal computer and Heuristics' $189 SpeechLab voice-recognition plug-in peripheral-control card. The computer controls the car, but the operator controls the computer. After training it to understand pronunciation of simple commands like left, right, and stop, the operator can program the computer with more complicated commands like "Come here." A standard control module is also supplied for manual operation. Robot 1's range is 300 feet.

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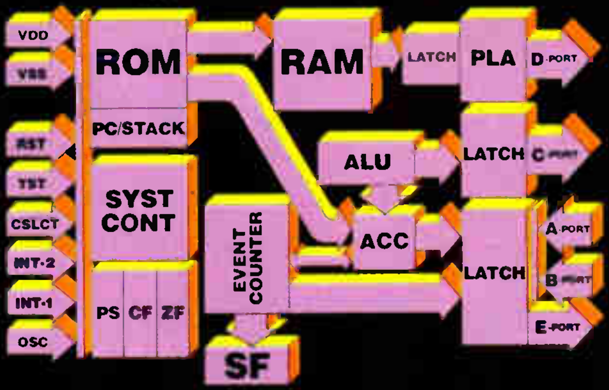

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Instruction Cycle Time		10μs	10μs	10μs	10μs
Instruction Set		75	57	68	75
Instruction Memory	Instruction ROM	Internal 1024 x 8 bits (8192 bits)	Internal 768 x 8 bits (6144 bits)	External 1024 x 8 bits (8192 bits)	External 2048 x 8 bits (16384 bits)
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Two versions of 16-bit chip span microprocessor, minicomputer needs

Larger, 48-pin package addresses 8 megabytes of memory; regularity of instruction set makes programming easy

by Masatoshi Shima, *Zilog Inc., Cupertino, Calif.*

☐ A microprocessor would gain ready acceptance if it could fit immediately into applications of current 8- and 16-bit microprocessors and at the same time have an advanced architecture that was expandable to ensure long product lifetime. The Z8000 from Zilog Inc. meets the first goal easily—and does so with 10 times the throughput of existing microprocessors. To meet the second goal, the Z8000 has departed from the traditional byte-oriented microprocessor design and moved toward the more regular architecture of minicomputers.

With many of the architectural features of minis and some pluses as well, the Z8000 is designed for minicomputer as well as microcomputer applications. To begin with, it handles seven data types, from bits to word strings, and offers eight selectable addressing modes. Its 81 distinct operation codes combine with the various data types and addressing modes to form a rich 414-instruction set more powerful than that of most minicomputers. Moreover, the set exhibits a high degree of regularity: more than 90% of the instructions can use any of five main addressing modes with 8-bit byte, 16-bit word, and 32-bit long-word data types.

Among its architectural resources are a large number of on-chip registers—24 16-bit registers in all—that dramatically reduce the number of memory references needed in programming. Sixteen of those registers are general-purpose, and all except one can be used as index registers without restrictions.

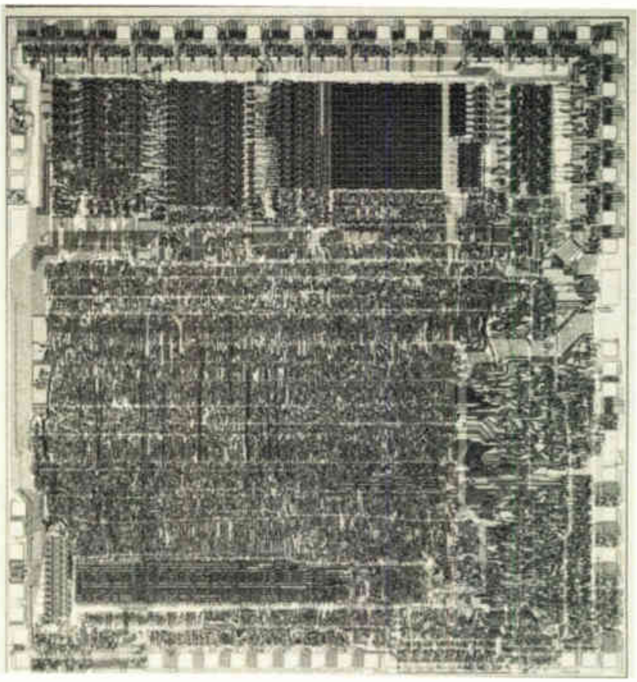
Also aiming at minicomputer applications is the Z8000's large direct-memory-addressing capability of 8 megabytes. Instead of treating it as linear space, however, the Z8000 organizes memory into a set of 128 segments of up to 65,536 bytes each. A segmented space is closer to the way the programmer uses memory—each procedure and data space, either local or global, resides in its own segment. To further facilitate use of all that space, a memory-management chip will work with the Z8000 in performing the dynamic relocation and memory protection needed in a large system.

Two versions

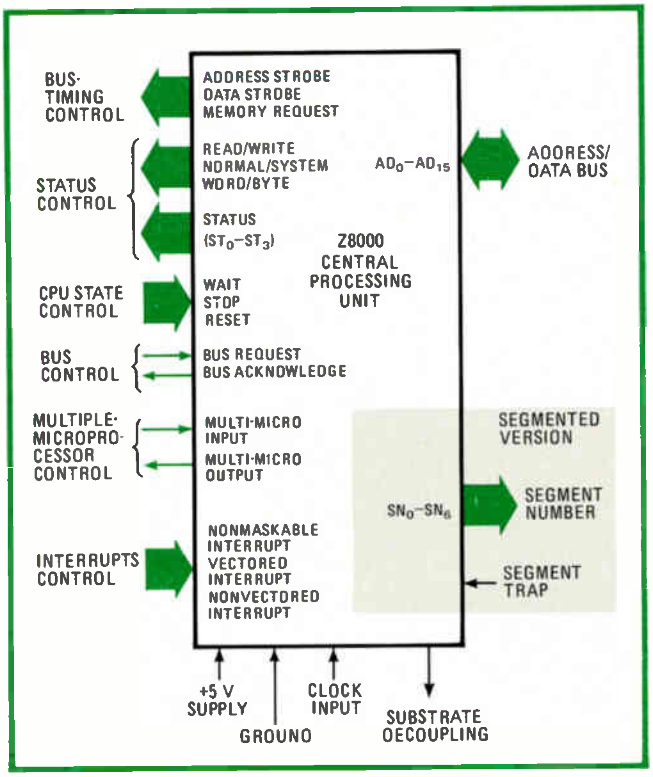
But because the Z8000 must satisfy existing microprocessor needs, two versions are offered. Besides the 48-pin memory-segmented version with 23 lines that addresses 8 megabytes, a 40-pin chip is offered with 16 lines to address 64 kilobytes—the equivalent of one segment. Expansion is guaranteed from the 40-pin to the 48-pin version: the segmented Z8000 can run any nonsegmented code in any one of its 128 segments using a load-program-status instruction.

Finally, the Z8000 boasts two operating modes, system and normal, that keep operating-system and applications programming separate, as in computer systems. Each mode has a separate stack, and the arrangement isolates global features like privileged instructions from normal programming.

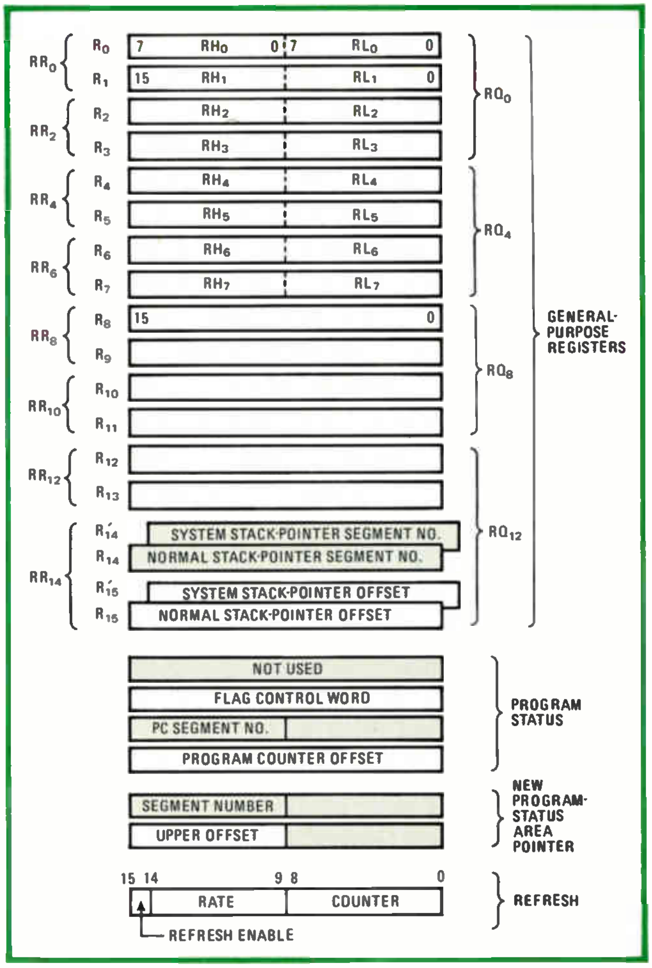
An n-channel metal-oxide-semiconductor chip built with scaled-down depletion-load silicon-gate technology, the Z8000 squeezes about 17,500 transistors into an area of 238 by 256 mils. Its density—148 gates per square millimeter—surpasses that of previous microprocessors (see also "Genealogy of the Z8000," p. 83). The chip uses a 5-volt supply and requires a single-phase 4-megahertz (250-nanosecond) clock for timing. As at



Dense. The 16-bit Z8000 central processing unit is built with scaled n-channel depletion-load silicon-gate technology. The chip, which crams about 17,500 transistors into a 238-by-256-mil or 39.3-millimeter-square area, has a density of about 148 gates/mm².



1. Two versions. The Z8000 fits microprocessor sockets with its 40-pin nonsegmented version, which has 16 lines for directly addressing 64 kilobytes of memory. The minicomputer-like 48-pin version adds 7 segment-address lines; it can address 8 megabytes.



2. Registers. Sixteen 16-bit registers are organized into high and low bytes (RH and RL), 32-bit long-words (RR), and 64-bit quad-words (RQ). Four words, including the program counter, contain the program status and two more point to the new-program-status area.

least three clock cycles in the central processing unit are required for one memory cycle, the Z8000 needs memory devices with a cycle time of 750 ns and an access time of 430 ns.

As shown in Fig. 1, the Z8000 has in addition to its address and data buses and clock and power-supply inputs six types of control buses: bus-timing, status, CPU-state, interrupt, bus, and multiple-microprocessor control. The three bus-timing control outputs coordinate the data flow over the chip's address/data lines. An address strobe signals that addresses are valid, and a data strobe times the window for valid data in and out of the CPU. The memory-request line is a timing signal that eases interfacing to dynamic memory.

CPU status

The next bus provides information on the CPU's status. A read/write line gives early status of the forthcoming cycle, while a normal/system line indicates which of the two modes the CPU is in for the current cycle. A word/byte line indicates whether the CPU is accessing 16 bits of data or 8 bits. The four status-control lines form a 4-bit word that indicates several bus statuses, including memory-request, stack, first- and subsequent-word instruction fetch, interrupt acknowledgments, internal operation, and others.

The next of the control buses are three CPU-state inputs. The reset line initializes the CPU. A wait line signals the CPU that data transfer is not ready. The stop line halts internal CPU operation (although dynamic memory is still refreshed). The CPU can be stopped each time the first word of an instruction is fetched.

A pair of lines governs the control of all the Z8000's buses. Driving the bus-request input low instructs the CPU to put all its address/data, bus-timing, and status-control lines into a high-impedance state so that other devices can use them. The CPU signals it has relinquished control with its bus-acknowledge output.

Another pair of lines is used with certain instructions to coordinate multiple-microprocessor systems. The multi-micro output line issues a request, while the input line recognizes outside requests. Thus any CPU in a multiple-microprocessor system can, for example, exclude all other asynchronous CPUs from being able to access a critical resource.

Finally, there are three interrupt inputs and, in the segmented version of the Z8000, a trap input. Interrupts are asynchronous events triggered typically by peripherals needing the CPU's attention, and traps are synchronous events resulting from the execution of specific instructions that occur each time the instruction is executed with the same set of data. The two are handled in a similar fashion by the Z8000.

The Z8000 is a register-oriented machine, placing little constraint on the use of its 16 general-purpose

Genealogy of the Z8000

The changes in microprocessor architecture from the first-generation 8-bit devices to the fourth-generation Z8000 have been both swift and dramatic. Developments have been guided alternately by technology limitations and by the hardware and software demands of users.

Thus, the shortcomings of the first 8-bit microprocessor, the 8008 developed in 1971, were technological. Metal-oxide-semiconductor processing was relatively new and set limits to circuit complexity. Also, microprocessors were actually offshoots of calculator designs, being developed by semiconductor and not computer houses. So performance and features left much to be desired.

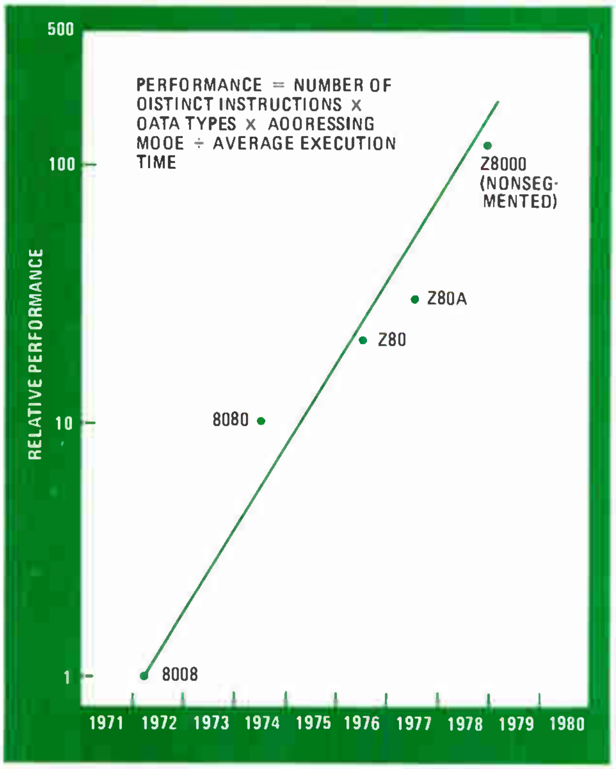
Advances in processing technology gave microprocessor designers a powerful tool with which to build the next generation of microprocessors—n-channel silicon-gate MOS that boosted circuit speeds by a factor of four over previous p-channel technology. Thus, the 8080, born in 1974, began the second generation of microprocessors.

By the time the third generation of microprocessors entered the design stage, users had become more sophisticated and were involved in high-level languages. Data-processing applications grew in popularity, and the disk-operating system was introduced. It was those software requirements that indicated the areas needing improvement, and the Z80 addressed the problem with software-oriented features. It added a large number of new instructions and a second register set, two index registers, and better interrupt handling. Still, because the Z80 maintains source-code compatibility with the 8080, many critical bottlenecks were inherited.

The Z80 marked the final exploitation of the original microprocessor structure and instruction format. Attempts to add capabilities would require two or three 8-bit instruction fetches—and exceedingly poor use of memory bandwidth and space. Moreover, the increasing popularity of high-level languages, plus a demand for much larger addressing space fueled by the plummeting costs of memory, outstripped the capabilities of an 8-bit microprocessor. The various trends toward large programs, complex distributed intelligent systems, and advanced memory management all pointed to a 16-bit architecture.

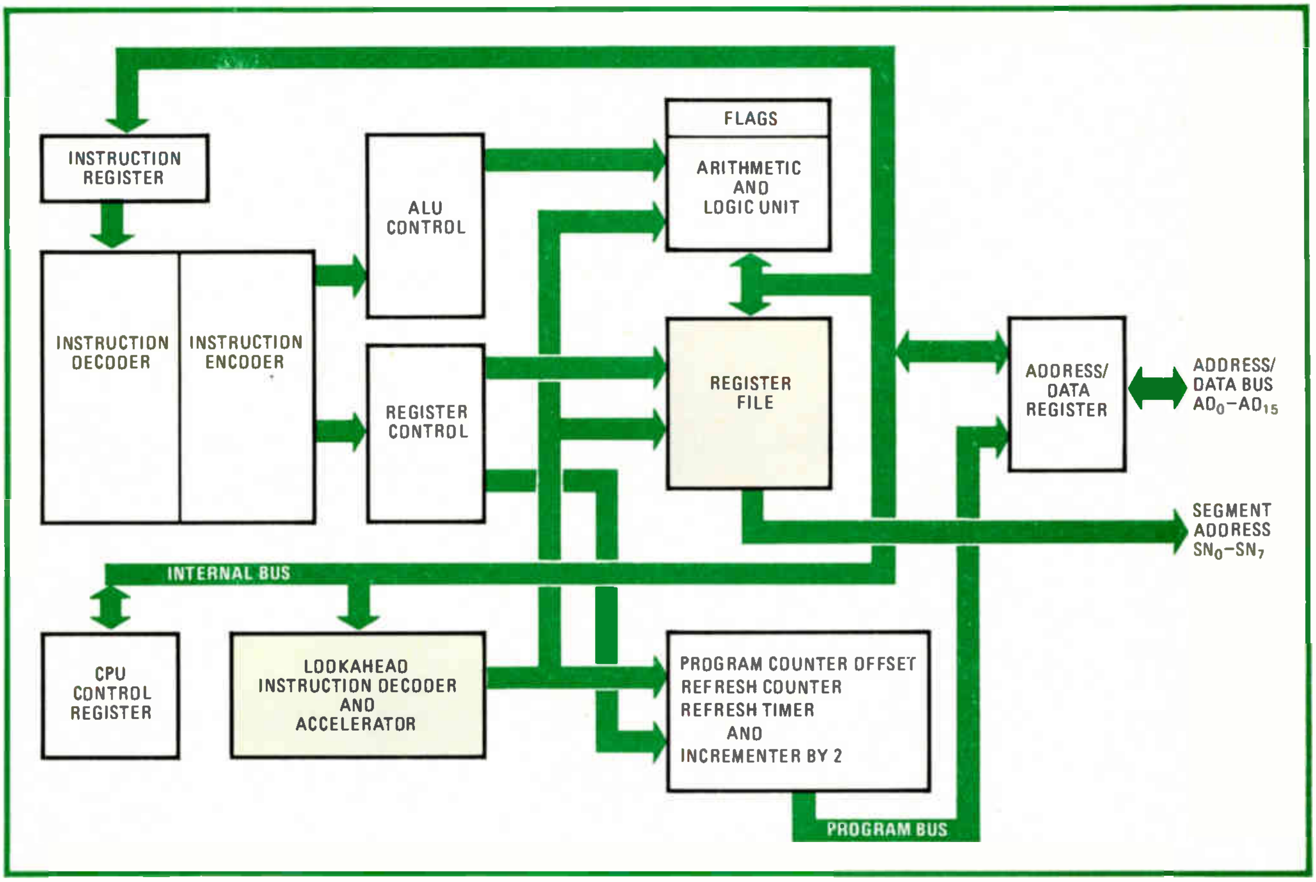
But it was Zilog Inc.'s conclusion that a chip with minicomputer performance could not last a decade without 32-bit operations and memory segmentation. Thus it chose the more advanced approach of the Z8000.

The table compares microprocessors. The companion graph indicates relative performance; though the equation provides no absolutes, it serves as an indicator for both hardware and software since it takes instructions, addressing, data types and speed into account.



<table>
<tr><th colspan="5">COMPARISON OF MICROPROCESSOR CHARACTERISTICS</th></tr>
<tr><th></th><th>8080</th><th>Z80</th><th>Z80A</th><th>Z8000</th></tr>
<tr><td>Date of initial production</td><td>1974</td><td>1976</td><td>1977</td><td>1978</td></tr>
<tr><td>Power consumption (W)</td><td>1.2</td><td colspan="2">1.0</td><td>1.5</td></tr>
<tr><td>Number of transistors</td><td>4,800</td><td colspan="2">8,200</td><td>17,500</td></tr>
<tr><td>Number of gates</td><td>1,600</td><td colspan="2">2,733</td><td>5,833</td></tr>
<tr><td>Chip size (mm^2)</td><td>22.3</td><td>27.1</td><td>22.4</td><td>39.3</td></tr>
<tr><td>Density (gates/mm^2)</td><td>72</td><td>101</td><td>122</td><td>148</td></tr>
<tr><td>Number of distinct instructions*</td><td>34</td><td colspan="2">52</td><td>81</td></tr>
<tr><td>Combination of number of distinct instructions and data types*</td><td>39</td><td colspan="2">60</td><td>149</td></tr>
<tr><td>Combination of number of distinct instructions, data types and addressing modes*</td><td>65</td><td colspan="2">128</td><td>414</td></tr>
</table>

*The numbers represent a conservative counting method. The user sees much larger number of instructions in assembly-language notation.



3. Architecture. The Z8000 boosts throughput with a look-ahead instruction decoder and accelerator on its internal bus. Thanks in part to the regularity of the instruction set, an instruction actually begins execution while it is entering the instruction register.

registers. Indeed, with but one exception (the stack pointer), no registers are ever implied in an instruction and none whatever have special restrictions. Bottlenecks found in early microprocessor designs, like dedicated accumulators, are thus avoided, so that programming is efficient and straightforward. All 16 of the 16-bit registers (R_0–R_{15}) can be used as accumulators. All except R_0 can be used as index registers, base registers, and as memory pointers for indirect addressing.

A flexible register architecture

As shown in Fig. 2, the flexibility of the registers is afforded by a unique arrangement of overlaps and pairs. The 16 8-bit registers (RH_0–RH_7 and RL_0–RL_7), all of which may be used as accumulators, are overlapped with the first eight 16-bit registers (R_0–R_7). The eight 32-bit long-word registers (RR_0–RR_{14}) are register pairs, and the four 64-bit quad-word registers (RQ_0–RQ_{12}), which are used by a few instructions such as multiply, divide, and extend sign, are register quadruples.

In the nonsegmented version of the chip, the last 16-bit general-purpose register, R_{15}, is the stack pointer. In the segmented version, the last two registers, R_{14} and R_{15} (or long-word register RR_{14}), are needed to hold the stack pointer, with R_{14} storing the segment number while R_{15} contains the offset. The only instructions that use the stack pointer exclusively are call, call relative, return, and return from interrupt; the push and pop instructions can use any register as a stack pointer. However, all instructions can manipulate the stack pointer, since it is in the general-purpose register group.

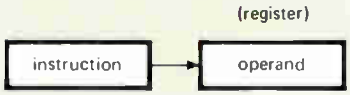
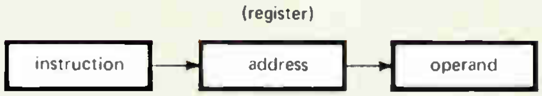
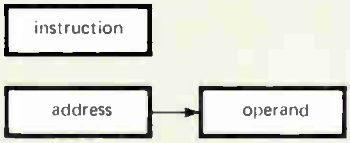
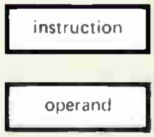
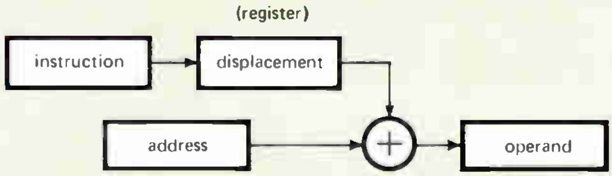
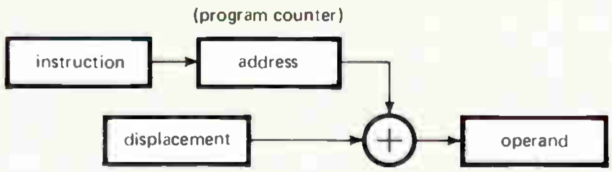
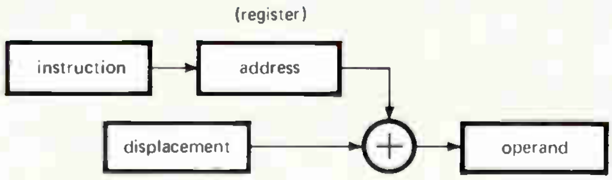
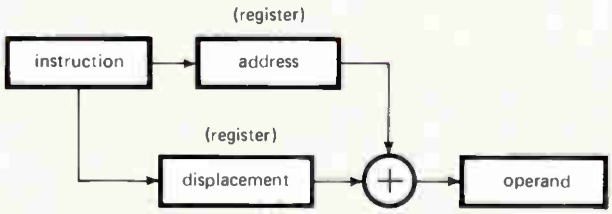
The two running modes of the Z8000 each have a copy of the stack pointer—one for the system mode and another for the normal mode—as implied by the primed registers R_{14}' and R_{15}' in Fig. 2. Although the stacks are separated, the normal stack registers can be accessed in the system mode by using the load-control-word instruction. Having two sets of stack pointers facilitates task-switching when interrupts or traps occur. The normal stack is always kept clear of system information, since the information saved on the occurrence of interrupts or traps is always pushed on the system stack before the new program status is loaded.

In addition to the general-purpose registers, there are the program-status registers, which contain the flags, control bits, and program counter. In the 40-pin nonsegmented version of the Z8000, the program status is held in two 16-bit registers: the first is the flag and control word, the second is the program counter. In the segmented version, program status is a full four words: the flag and control word, a two-word program counter, and a word reserved for future use.

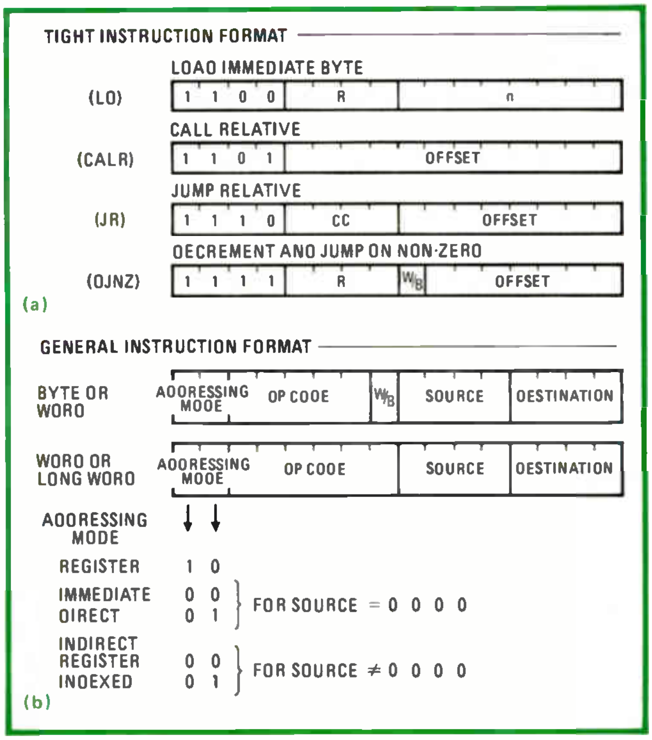
Another register holds the pointer for the new-program-status area. It comprises two words in the segmented version and one word in the nonsegmented version. Lastly, a refresh register contains a 9-bit counter for automatic refresh of dynamic memories.

The Z8000 executes instructions by stepping through

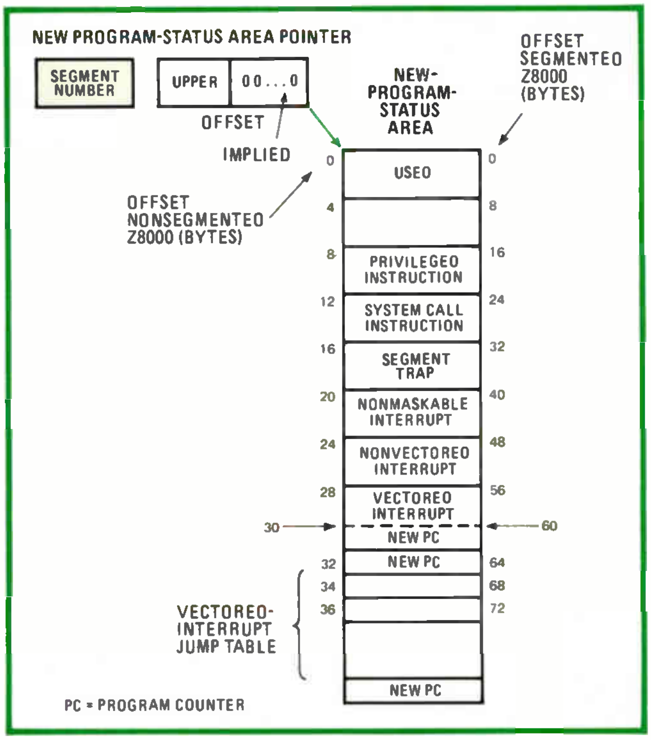
Z8000 ADDRESSING MODES

Mode	Diagram	Operand value
Register		the content of the register
Indirect register		the content of the location whose address is in the register
Direct address		the content of the location whose address is in the instruction
Immediate		in the instruction
Index		the content of the location whose address is the address in the instruction, offset by the content of the working register
Relative address		the content of the location whose address is the content of the program counter, offset by the displacement in the instruction
Base address		the content of the location whose address is the address in the register, offset by the displacement in the instruction
Base index		the content of the location whose address is the address in the register, offset by the displacement in the register

Many modes. Over 90% of the Z8000's instructions work with any of five main addressing modes, proof of the chip's software regularity. A load-addressing instruction that accepts all eight modes accommodates any other operand-addressing scheme desired.



4. Instruction formats. Tight format (a) uses only one 16-bit word, is executed quickly, and saves memory. General format (b), used for bytes, words, or long words, specifies the addressing mode using the 2 address-mode bits and the source register number.



5. Program status. The new-program-status area pointer is two words long; the 7 most significant bits in the second word specify the beginning of an area in memory from which the new program status is fetched in response to interrupts and traps.

a set of the following basic machine cycles: memory read or write, input/output-device read or write, and internal data execution. Since the memory cycle uses three clock cycles to fetch the instruction or data from memory or to write data into memory, each machine cycle also uses a minimum of three clock cycles, though for complex operations it can extend to as many as eight.

The matter of timing

Ideally, for optimum throughput, all instruction time should be memory-cycling time; no clock cycles should be wasted on other phases of the instruction cycle. Simulations of a wide variety of benchmark programs have shown that, on the average, the effective memory cycle time (also called the bus-utilization time or bus efficiency) of the Z8000 is 80% to 85% of the instruction time and up to 90% if jump instructions are excluded. This efficiency is a significant improvement over the 65% to 70% of the 8-bit Z80 microprocessor.

One reason for the high efficiency of the Z8000 is its look-ahead instruction decoder and accelerator, shown in the architectural block diagram of Fig. 3. Since the look-ahead is tied to the internal bus, and since the instruction set is very regular, an instruction can actually begin execution while it is still being stored in the instruction register. The look-ahead makes for a significant improvement in throughput, for example, in the case of direct and indexed memory addressing (the most frequently used addressing modes after register address), in which the Z8000 does not require any additional clock cycles to decode the instruction in deciding whether it is short or long offset. The load-register-to-register instruction has been optimized to require only the three clock cycles of its memory access. In most instructions, in fact, the data-manipulation time is fully overlapped with the fetching of the first word of the next instruction.

Throughout the design of the Z8000, meticulous attention was paid to accelerating and optimizing each instruction in proportion to its statistical importance. Some instructions and data references are aligned in a single word to speed execution, simplify logic, and get a larger range when the relative addressing mode is used.

To further increase execution speed, as well as to reduce memory usage, the most frequently used instructions in the Z8000 have been coded as one word. Among these are jump relative, decrement and jump on nonzero, load immediate byte, load immediate word, and call relative. Moreover, the sophisticated, interruptible, preprogrammed block and string instructions can execute memory-to-memory data manipulations as fast as 888,000 bytes per second.

Extra instructions

A number of powerful instructions not found on previous microprocessors were added to the Z8000 repertoire. There are those that handle the new data types—instructions like multiply and divide that manipulate 32-bit long-words—and other instructions that load and store multiple words. And there are instructions that increment and decrement the contents of any register or memory location by any number from 1 to 16. Finally, multiple addressing modes for the push, pop, load, and store instructions enhance performance.

An important part of microprocessor design is the

The Z8000 family

Even a minimum system based on a Z8000 microprocessor executes instructions fast and is easy to program. Soon to be available is a family of associated chips that will extend these advantages to complex Z8000-based computer systems and networks.

The members of the family include:

- The Z-MMU memory-management unit that takes care of memory segmentation and protection and address translation.
- The Z-UPC universal peripheral controller, a Z8 single-chip microcomputer used as a general-purpose programmable peripheral device with the Z8000.
- The Z-CIO counter and parallel-I/O chip, with three programmable 16-bit counters, two 8-bit bidirectional I/O ports, and a 4-bit I/O port.
- The Z-SIO serial-I/O circuit, which has two full-duplex channels and is capable of handling asynchronous and bisynchronous protocols at data rates of up to 880 kilobytes per second.
- The Z-MBU microprocessor buffer unit, a 128-by-8-bit first-in, first-out buffer that can be cascaded to any depth to connect asynchronous parallel processors to the Z8000 when multiprocessing.
- The Z-FIFO first-in, first-out buffer memory, also 128 by 8 bits, for expanding the Z-MBU depth or interfacing I/O ports to user equipment.
- The Z-bus RAMs, a pair of random-access memory chips—a 2,048-by-8-bit fully static RAM and a self-refreshing 4,096-by-8-bit pseudo-static RAM—for small local storage.

instruction format, since logic complexity (and hence chip size) depends heavily upon its complexity. Designing into the instruction set total software regularity (where all instructions can use all data types and addressing modes) is ideal, and that goal is one towards which the Z8000 has striven.

Of the eight selectable addressing modes (see table), the five main modes—register, indirect register, immediate, direct address, and indexed address—can be used with nearly all instructions, excepting a few such as rotate and shift instructions. The three other addressing modes—relative address, base address, and base indexed address—have been added to all load and store instructions. To save memory space, the relative addressing mode applies additionally to jump, call, and decrement and jump on non-zero instructions. Some instructions have built-in autoincrementing and auto-decrementing addressing modes. Finally, a load-address instruction, which can use all of the eight addressing modes, supports even the most sophisticated operand-addressing schemes.

Instruction formats

The formats for Z8000 instructions are shown in Fig. 4. The 2 most significant bits in the instruction word determine whether the tight instruction format (a) or the general instruction format (b) is used. Use of the tightly coded instruction—a single word—reduces instruction-memory usage and speeds execution.

As long as the 2 most significant bits are not both 1s, the general instruction format applies. Those 2 bits in conjunction with the source-register field in the instruction are sufficient for specifying any of the five main addressing modes. As shown in Fig. 4b, an all-zero source specification distinguishes immediate or direct addressing from indirect and indexed addressing, both of which require a source register. Source and destination-register fields in the instruction format are 4 bits wide for addressing the 16 general-purpose registers.

The Z8000 does not have memory-to-memory arithmetic instructions. However, it performs memory-to-memory transfers on a sophisticated set of preprogrammed block-transfer and string-manipulation instructions and offers store immediate, push immediate, and compare immediate instructions. That arrangement provides a more compact instruction format with more op codes available for additional instructions than would be possible with the general memory-to-memory addressing mode used in the Digital Equipment Corp. PDP-11 minicomputer, which has two sets of addressing modes and register fields.

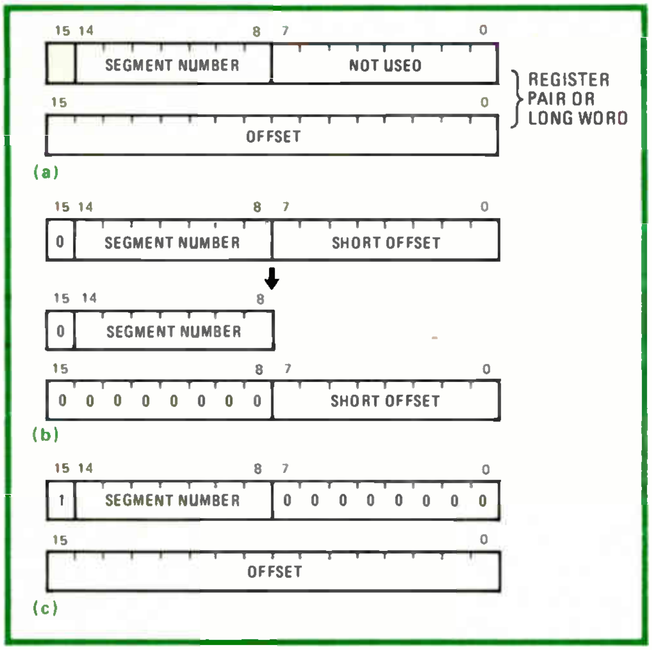
Interrupts and traps

The Z8000's seven interrupts and traps, both internal and external, are arranged in priority. The three interrupts are all external inputs: nonmaskable interrupt, vectored interrupt, and nonvectored interrupt. The vectored and nonvectored interrupts are maskable. Of the four traps, the only external one is the segment input, which is found in only the 48-pin segmented version of the chip. The remaining three traps occur when certain instructions limited to the system mode are called in the normal mode, or for the system-call instruction, or for an illegal instruction. The descending priority order of the traps and interrupts is: internal traps, nonmaskable interrupts, segment trap, and vectored and nonvectored interrupt.

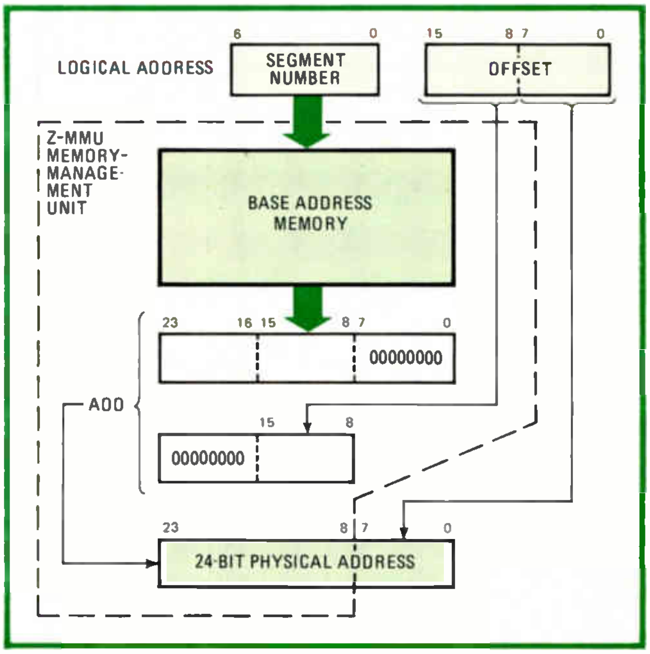
When an interrupt or trap occurs, the program status, which is contained in two 16-bit words in the nonsegmented version and three words in the segmented version, is pushed onto the system stack followed by an additional word. This extra word typically indicates the reason for the occurrence.

In the case of an internal trap, the reason word is the first word of the trapped instruction. In the case of the segment trap and for all interrupts, the reason is the vector on the data bus that is read by the CPU during the interrupt- or trap-acknowledge machine cycle.

The previous program status thus having been pushed on the system stack, a new program status is fetched from the new-program-status table (Fig. 5) that is specified by the new-program-status area pointer. As in Fig. 2, that pointer is the most significant byte in the new-program-status area pointer register. In the case of the segmented version of the Z8000, the pointer is two words in all—the segment number is specified by the 7 most significant bits of its second word. After the interrupt or the trap has terminated, a reset sequence is entered. A new program status is then fetched from a fixed location



6. Address representation. Segmented addresses appear as a long word (32 bits) when represented in a register or in memory (a). In an instruction, however, an address can be a single word (b) or a long word (c) if it is within the first 256 locations of a segment.



7. Memory management. The Z-MMU memory-management chip carries out the memory relocation from logical to physical address by adding the 16-bit offset value to a 24-bit base address associated with each segment. Two Z-MMUs handle all 128 segments.

in memory at the beginning of segment 0.

Facilitating the separation of operating-system programming from applications programming are the system and normal operating modes of the Z8000. The distinction is made by privileged instructions, which can only be executed in the system mode and are trapped when encountered in the instruction flow of normal-mode operation. Those instructions include all input/output instructions, halt, enable/disable interrupt, load control word, store control word, load new program status, return from interrupt, and all multiple-microprocessor instructions.

High-level languages, sophisticated operating systems, large programs and data bases, and decreasing memory prices are all accelerating the trend towards larger memory space in microcomputer systems. But even when it is available, questions are raised: how is it best accessed by a programmer? and what memory-management mechanism best allows the system to manage its memory on the user's behalf? In answer, the Z8000 proposes a segmented addressing scheme.

The segment number is an unsigned 7-bit integer ranging from 0 to 127; the offset is an unsigned 16-bit integer ranging from 0 to 65,535.

When represented in a register, a segmented address is always a register pair or long word (Fig. 6a). The two words may be manipulated separately or together by any of the word and long-word register operations. All segmented addresses exist in memory as a long word.

A segmented address in an instruction, however, has two different forms: either with a long offset (Fig. 6c), in which the address occupies two words, or with a short offset that is one word. The short offset, which, as shown in Fig. 6b, implies that the most significant 8 bits of the offset are all zero, can be used whenever the address is within the first 256 locations of a segment. That representation permits very dense encoding of addresses and is convenient not only for indexed addressing, but for direct addressing when short data segments are used or when subroutines start at the beginning of a segment.

Memory-management chip

Those addresses manipulated by the programmer, used by the instructions, and appearing at the output of the Z8000 are called logical addresses. Transforming the logical addresses, which comprise the segment and offset concatenation, into a 24-bit physical address is the job of the Z-MMU memory-management unit (see "The Z8000 family," p. 87).

That transformation of logical address into a physical address, called relocation, is performed by this chip as shown in Fig. 7. A 24-bit origin or base is logically associated with each segment. To form the 24-bit physical address, the Z-MMU adds the 16-bit offset to the base for the given segment. (In operation, the Z8000 sends out the segment number half a clock period ahead of the 16-bit offset address to compensate for the time the unit needs to do this.) Thus the Z8000 can directly address half of a 16-megabyte physical memory space.

In addition to relocation, the Z-MMU provides segment management and protection from undesired writeover. Each such unit stores 64 segment entries that consist of the segment base address and its attributes, size, and status. Segments can vary in size from 256 bytes to 64 kilobytes in increments of 256 bytes.

Using a pair of these units with the Z8000 accommodates all of the 128 segment numbers. Moreover, several Z-MMUs can be used together to accommodate several translation tables, although only a single pair may be enabled at any one time. □

What designers should know about off-the-shelf fiber-optic links

In choosing between available links, would-be users need to be aware of possible tradeoffs, says Part 3 of this fiber-optic design series

by Harvey J. Hindin, *Communications & Microwave Editor*

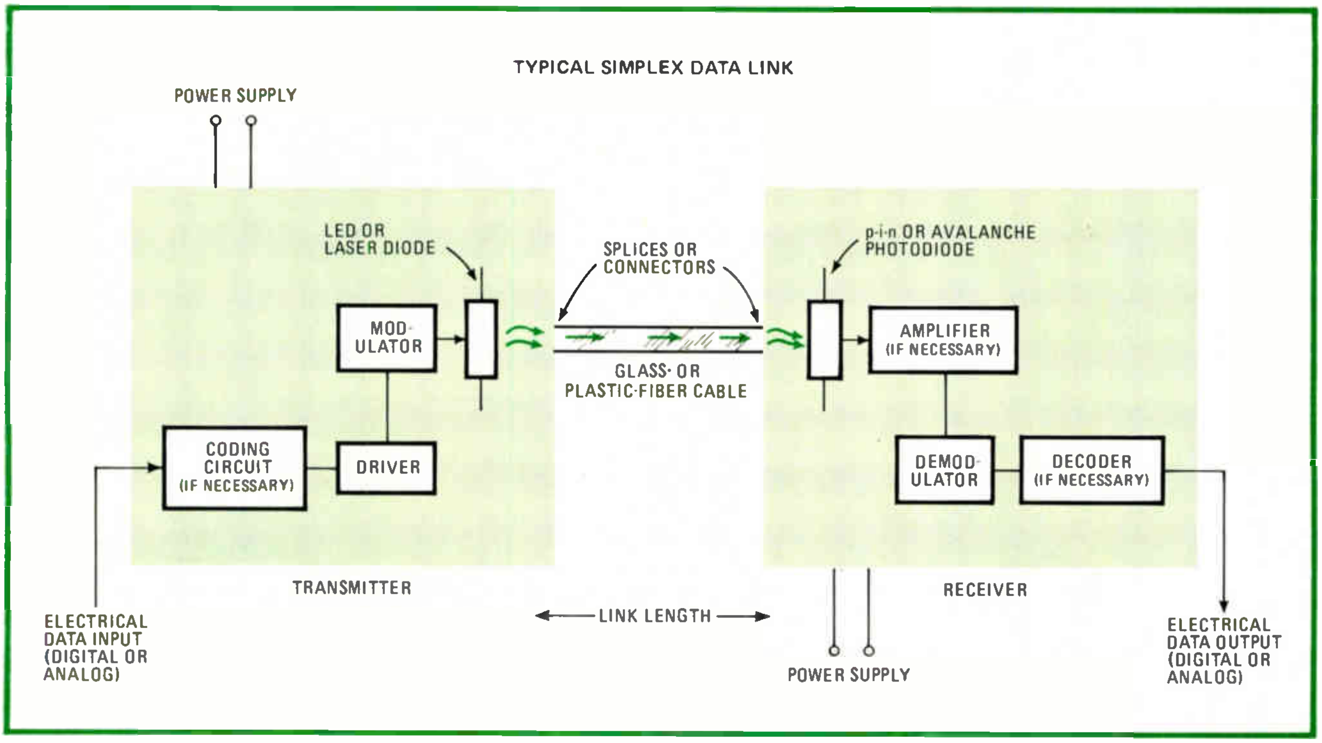
☐ Over a dozen companies have already invested many thousands of hours and a lot of money in building fiber-optic links that are ready to go. So most new would-be users are better off buying one than attempting to build their own. That decision, however, still leaves them with the problems: which model? and from whom?

The purpose of every fiber-optic link (Fig. 1) is to accept either digital data or analog waveforms at its input and transmit them to the receivers at its output, preferably without any alteration—that is, in a "transparent" fashion. Fiber optics' talent for this job is far more marked than its relatively intangible drawbacks (Table 1). But being a new technology, it presents a rather confusing picture, especially to the novice.

To quote Irwin Math, president of Math Associates in Great Neck, N. Y.: "In many cases, the concept of a complete ready-to-go link is not quite what the user thinks it is. For example, everything from a light-emitting diode in a connector mount to a complete module with power supplies, modulation circuitry, interfaces, and buffers is called a transmitter, and everything from a poor-response-time, nonlinear phototransistor useful only at low data rates to a standard package with an avalanche photodiode, demodulator, and reshaping networks is called a receiver." Most industry observers agree with Math and explain the confusion by saying that "what is complete to one user is only parts to another."

A cautionary word

Table 2, which is based on data sheets from and interviews with representative manufacturers of fiber-optic links, is intended to give the user a handle on this situation. But it can only be considered a starting point. Key electrical, mechanical, and optical specifications are listed. However, they can be and are interpreted differently by different makers; test conditions are many and varied; and there are many restrictions on the data. So it



1. Typical. A fiber-optic data link may be digital or analog. The transmitter converts an electrical input into an optical signal by modulating an optical emitter drive current. The light travels along the fiber to a light-sensitive diode that changes it back into an electronic signal.

TABLE 1: FIBER-OPTIC DATA-LINK PROS AND CONS

WHY?		WHY NOT?
• handles high voltages without isolation transformers • eliminates ground loops • does not attract lightning • is noninductive • will not pick up any electromagnetic, radio-frequency or electromagnetic-pulse interference • does not radiate any signals and has no noise emission problems • is difficult to tap since link would have to be broken • is free from cross-talk • is free from sparking	• cannot short-circuit • is explosion-proof • has an effective bandwidth orders of magnitude greater than copper • needs few repeaters because of low loss • weighs less than copper system • has fewer storage problems because smaller than copper system • can be extensively multiplexed • can be easily upgraded in bandwidth • has no need to comply with electric codes	• as a new technology, may suffer from customer acceptance problems • may cost more if advantages do not have sufficient cash value • may need personnel to be trained to handle it properly • may have inferior product support, compared to older systems

is all-important to deal directly with a manufacturer and ask how suitable a given link is to a particular application (Table 3). If answers are not forthcoming in understandable terms, then another vendor should be tried. A user should not have to be an expert in coding techniques or optical technology to buy a link for a purely electrical application.

To keep Table 2 to a reasonable size, only typical models and options from the manufacturers represented are included. The overall aim was to list general-purpose systems low enough in cost for use on a volume basis in relatively simple applications. On the one hand, this criterion ruled out units with extensive multiplexing capabilities and special-purpose transmitter and receiver sets designed for, say, studio-quality color television transmission. On the other hand, it excluded kits from companies like Augat Inc. and AMP Inc., since they would seldom be ordered in volume to meet a system requirement. Moreover, although kits allow the designer a great deal of flexibility, they hardly fall into the ready-to-go category.

Most of the entries in Table 2 are self-explanatory. But to tie them together, some supplementary background information is useful.

Preliminary considerations

If data must be both entered and received at either end of a link, the system must have duplex capabilities; otherwise a simplex, or one-way, system will do. Since either a waveform or a data stream must be reproduced, it is clear whether an analog or a digital system is needed. In the latter case, if the data source has a standard Electronic Industries Association RS-232-C data-communications interface, then the most efficient link will be one that interfaces directly to it without further conversion.

Link distance is usually a known quantity, and the chart shows which links are suitable. The other system parameters that the manufacturer quotes should also be maintainable up to the maximum link length. If not, there may be some unpleasant surprises, so that it is better to find out in advance what the tradeoffs are, if any. Conservative practice indicates careful link margin calculations (Fig. 2), and a vendor should be able to provide them.

The link's environment is also important. Temperature, dust, humidity, shock, and vibration all have to be considered. How are the connectors and housings sealed? Most links are contained in metal boxes, some are potted, and only a few are hermetically sealed. Moreover, though the fiber cable itself neither radiates nor picks up electromagnetic radiation, the electronics in the transmitter or receiver does and may need shielded enclosures. Also, if the fiber link is replacing an older system, it may have to use the existing power supply voltages. Power converters may be necessary or, alternatively, certain of the available links may be eliminated from consideration.

Not so obvious

Performance requirements are often less easy to identify and satisfy. For example, take the question of whether the receiver module should be direct-coupled. This capability is important if the system is being designed for unknown data formats that might have components down to dc or include long runs of binary 1s or 0s or data bursts, which correspond to strong dc components.

Straight dc coupling is perhaps best here, but there are ac coupling techniques using special coding (see p. 94) and dc restoration techniques that can simulate the necessary dc response, though at the cost of possibly introducing errors for certain codes and configurations. Still, provided the link lives up to its maker's specifications and these are adequate for the application, it does not matter to the user what is happening inside the fiber-optic receiver.

Digital waveform considerations are important also to keep errors to a minimum over a wide range of operating temperatures. For example, nonreturn-to-zero waveforms will allow higher transmission rates than return-to-zero. Though the waveform to be transmitted is predetermined in some systems, in others it may be possible to use a data formatter to provide different and more suitable coding.

The waveform may even become distorted (and the error rate go up) if an LED transmitter is used at the elevated temperatures at which it is least efficient. As before, it is necessary to check that the quoted specifications must be maintained over the whole temperature range. Most of the devices on the chart work up to 50°C.

Even here, there are sometimes tradeoffs to be made. For example, whereas a wide temperature range may cause amplifier and comparator drift when the receiver is dc-coupled, an ac-coupled version using the 50% duty-cycle Manchester code should be able to do the job, because amplifier transimpedance drift is eliminated.

Don't make it worse

The manufacturer cannot allow the system to degrade the bandwidth or the bit rate of the transmitted signal. This also holds for the analog signal-to-noise ratio and the digital bit error rate. So the manufacturer's specifications for these parameters, provided the test conditions and measurement techniques used to obtain them are understood, indicate straightaway whether or not the product is suitable.

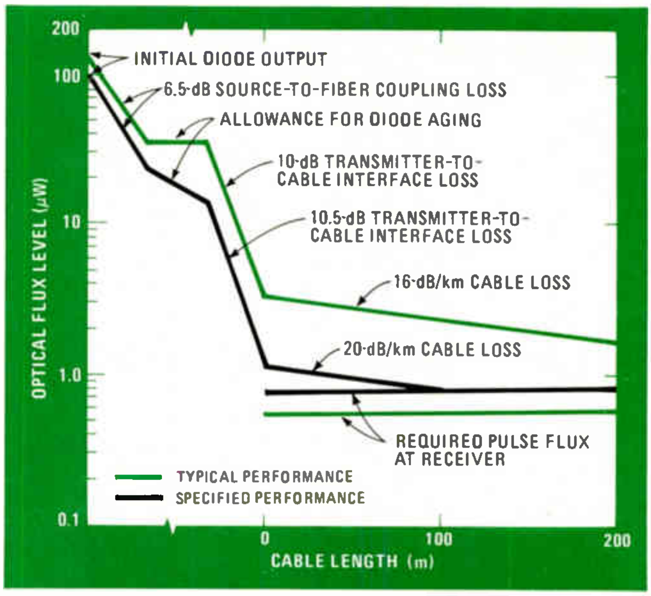
Given the bandwidth or bit rate, the manufacturer has determined the optical power necessary to provide the necessary signal-to-noise ratio or bit error rate for the kind of detector he is using. For some applications, in which the system must be able to operate over all the ranges of the variables (including environmental factors such as temperature), it is extremely important to do this conservatively.

The fact that all the operating characteristics of the component parts must be known to obtain this error information tends to favor the vertically integrated manufacturers, who have control over all their sources. But the problem can also be minimized by a reliable supplier who does adequate designing and testing.

For the transmitter, the manufacturer can choose between an LED and an injection laser. Both of them can be selected to emit radiation at the wavelength at which the matched fiber will introduce minimum loss.

Comparatively speaking, LEDs are the less expensive. Their drive circuits are less complex and the voltages they require are lower in magnitude than those of lasers. Also, LEDs last up to 50,000 hours or more, whereas lasers last only thousands of hour (although this figure is improving rapidly in developmental items).

LEDs are somewhat better for analog links than lasers because their transfer characteristic (light output versus drive current) is fairly linear. This linearity minimizes distortion and consequent problems with the signal-to-noise ratio. However, linearization circuits are commonly used with lasers, and their higher coupled power into



2. What's the budget? Adequate energy must reach the receiver to insure that the bit error rate or signal-to-noise ratio never exceeds the maximum allowed. The manufacturer (Hewlett-Packard in this case) must ensure this for the entire operating temperature range.

the fiber—typically 10 decibels—makes them the preferred source when the application is a broadband, long-distance, analog link.

For digital applications, LEDs have an upper bound of about 50 megabits per second. They are not monochromatic emitters, unlike lasers, and their emission spectrum causes pulse dispersion, which either reduces the effective bandwidth or increases bit error rate, as the case may be.

In contrast, injection laser diodes are particularly useful for digital links operating above 50 Mb/s. Their spectral width is typically an order of magnitude narrower than that of LEDs, so that pulse dispersion is less of a problem and distances and error rates can be better. In addition, their rise times are faster than those of LEDs and modulation rates can be higher.

The problem here is that lasing threshold current depends on temperature and at the same time output power is not at all linear with respect to input current. While feedback circuits and temperature compensation provide a solution, they add to cost and complexity and worsen reliability. So difficulty of access and service may eliminate lasers from consideration. In any case, few makers of simple, ready-to-go links use them.

Making the connection

In general, the less expensive plastic fiber is more lossy than glass and is used for shorter runs. It is important to use the right kind of cable, since the different step-index and graded-index types have widely varying pulse-dispersion characteristics.

Here again the manufacturer has to determine the right choice of cable numerical aperture, diameter, and so on, in terms of the rest of his system, so that his recommendations are to be followed closely if the user has to buy his own cable.

Mechanical specifications are also important if the

TABLE 2: A USER'S GUIDE TO FIBER-OPTIC DATA-LINKS

Company	Galileo	IPI Centronic	ITT Electro-optic Products	3M Co.	Plessey Opto-Electronics and Microwaves	Olektron	Burr-Brown	TI
Model number	DL-2	DTI	T-614/ 615	3550	DML-40D	AM-DDL-AS-10100K	3712T, R	TXED455-C025/489
Type	simplex	simplex	simplex	duplex	simplex	duplex	simplex	simplex (needs drivers)
Maximum link length (meters)	1,000	200	1,500	100	2,000	1,000	options	50
Bit rate or bandwidth	10 kb/s to 10 Mb/s	dc to 3 Mb/s	dc to 5 Mb/s NRZ	100 kb/s to 10 Mb/s	0.1 Mb/s to 30 Mb/s	0 to 20 kHz	dc to 20 kb/s	0 – 67 Mb/s RZ or Manchester
Bit error rate or signal-to-noise ratio	10^{-9}	10^{-8}	10^{-8}	10^{-10}	10^{-10}	10^{-8}	10^{-9}	10^{-13}
Data format restrictions	NRZ or biphase	RZ	none	50% duty	RZ, NRZ possible	RS-232-C	none	none
Calibration or tuning needed	no	yes	no	yes	no	no	no	no
Coupling	ac	dc	dc	ac	ac	dc	dc	dc
Link monitor	optional	no	no	yes	no	yes	no	no
Input loads	–	1	1	1	1	RS-232-C	1	n.a.
Output loads	–	1	4	20	1	RS-232-C	2 – 4	n.a.
Compatibility	TTL	TTL	TTL	TTL C-MOS	TTL	n.a.	TTL	TTL, C-MOS
Transmitter, receiver voltage and current	4 W at 110 V ac 85 W at 110 V ac	+5 V dc at 150 mA +15 and +5 V	+5 V at 200 mA +5 V at 75 mA −5 V at −75 mA	+5 V at 300 mA ±7 to ±15 V at 10–25 mA	+5 V at 300 mA +12 V at 150 mA	10 W at 110 V ac	+5 V at 60 mA ±15 V at +20 and −17 mA	2 V at 100 mA 5 V
Transmitter and receiver dimensions	2.7 x 4.2 x 6 in. both	2 x 1.25 x 1.5 in. both	1.9 x 0.80 x 0.3 in. both	2.7 x 1.25 x 0.385 in.	105 x 28.5 x 33 mm both	4.5 x 6 x 2 in. transceiver	1.6 x 3 x 0.64 in. both	0.35 x 0.6 x 0.48 in. both
Package	metal case, pc-board-mountable optional	potted and pc-board-mountable	metal case, pc-board-mountable	plastic, pc-board-mountable	metal case	metal case, pc-board-mountable	metal case, pc-board-mountable	plastic, pc-board-mountable
Operating temperature (°C)	0 – 50	0 – 75	−20 – 50	0 – 50	−20 – 50	0 – 50	0 – 70	<80
Small-quantity price (approx.) ($)	950	495	750	695	1,950	1,200	132	188

	RCA	Math Associates	Valtec	Meret	Hewlett-Packard	Siemens	Canoga Data Systems	Nippon Electric	Radiation Devices
	C-86003E	XD-1000 RD-1000	TTK	MDL-4211	HFBR −0010	A5/D10 analog or digital	CRS-1000	Neolink 10 D	FAT-4H FAR-3H
	simplex	both	duplex	simplex or duplex	simplex	simplex or duplex	both	simplex	simplex
	1,500	2,000	1,000	2,000	100	5,000	1,000	500	1,000
	dc to 20 Mb/s, NRZ	dc to 2.0 Mb/s, NRZ	dc to 10 Mb/s	dc to 2 Mb/s, NRZ	dc to 10 Mb/s, NRZ	dc to 10 Mb/s or 1 Hz to 5 MHz	0 – 56 kb/s	0 – 10 Mb/s	15 Hz to 10 MHz
	10^{-9}	10^{-8}	10^{-9}	10^{-10}	10^{-9}	10^{-10} 60 – 70 dB	10^{-9}	10^{-9}	52 dB
	RZ or NRZ	none	50% duty	none	none,biphase under certain conditions	none	RS-232-C	none	none
	yes	no	yes	no	no	no	–	no	yes
	dc	dc	dc	effective dc	effective dc	dc or ac	dc	dc	ac
	no	optional	yes	no	yes	no	yes	no	no
	3	1	1	6	1	–	RS-232-C	1	n.a.
	4	1	1	6	20	–	RS-232-C	10	n.a.
	TTL, C-MOS optional	TTL, MOS, ECL	TTL	TTL	TTL	TTL	n.a.	TTL	n.a.
	+5 V at 250 mA ±5 V at 30 mA	115 Vac at < 100 mA	115 Vac at 6 VA	+5 V at 10 mA ±12 – ±15 V at 30 and 10 mA	5 V at 125 mA 5 V at 120 mA	2,000 VA	115 Vac	+5 V at 300 mA +5 V at 100 mA	15 – 24 V at < 100 mA 15 – 24 V at < 75 mA
	1.75 x 2 x 1 in. both	6.4 x 12 x 3.2 mm both	6.5 x 4.5 x 2 in.	0.5 x 0.75 x 1 in. both	1.7 x 0.650 x 0.312 in. both	125 x 158 x 51 mm both	7.4 x 4.7 x 2.1 in.	43 x 17 x 17 mm both	5.75 x 2.0 x 0.9 in.
	potted case, pc-board-mountable	metal case, pc-board-mountable optional	metal case	metal case, pc-board-mountable	metal case, pc-board-mountable	plastic	metal case, pc-board-mountable	metal case	metal case
	0 – 50	0 – 50	0 – 55	0 – 70	0 – 70	-10 – 40	0 – 50		0 – 50
	850	415	1,200	800	570		625		825

SOURCE: *ELECTRONICS*

TABLE 3: FIBER-OPTIC DATA-LINK APPLICATIONS

- interfacing computer peripherals to the central processing unit
- interconnects for industrial process-control instrumentation
- avionics, especially for weight reduction
- telephone and other telecommunications in industry and the military, both long and shorthaul
- data communications, especially to standard EIA RS-232-C
- closed-circuit television connections, both supertrunk and local
- printed-circuit-board interconnects
- broadband distribution systems within one building

cable will be subjected to mechanical stress. Pull strength, bending radius, and the number of times cable can be bent must then be considered.

Some cables come furnished with connectors. If not, the cable manufacturer should be prepared to advise his customers on which connectors are suitable. But it is up to the user to make sure they are readily available at a reasonable price. Fiber-optic connector technology is a new art and full of surprises for the uninitiated. Tolerances are a continuing problem, and a poorly attached connector can destroy insertion loss and the system along with it. Splices are an alternative, unless the link length is likely to change, in which case it is of course easier to disconnect connectors.

Is the signal there?

Most of the links listed in Table 2 use p-i-n diodes as receivers. Avalanche photodiodes generally provide higher signal-to-noise ratios at higher bit rates than p-i-n diodes, and their internal gain makes them most suitable for long runs, where high sensitivity is required. But APD gain is temperature-sensitive, so if the application has a wide temperature range, some sort of automatic gain control should be built into the receiver module.

P-i-n diodes take lower bias voltages than APDs (15 to 100 volts compared with up to several 100s) and this makes them somewhat easier to use. They also cost less but are slightly noisier and slower to respond. For strong signals, the APD has no real advantage, since the signal-to-noise ratio's limiting factor is quantum noise—the random times of arrival of the optical signal photons.

What's the code?

Depending on link design, data must be presented to the input port in either coded or arbitrary format. Proper data coding affects the link data rate. For example, Manchester, or biphase, coding often reduces the rate to just half of what could be achieved with aid of NRZ coding because it requires twice the bandwidth to encode at the same bit rate.

Which coding scheme is used for the actual optical pulse transmission is of little interest to the user as long as the data rates required to be transmitted can be handled. It is important, though, to look out for restrictions on the data input format. Time and money may have to be spent doing data formatting, and while simple and well-known circuitry will do, it is another problem to worry about and certainly detracts from a link's ready-to-go status.

The ideal

If long streams of 1s or 0s are expected at the input, the internal coding must be able to accommodate them. Ideally the most general link will take digital data at rates from dc on up to an upper limit without regard to data format and without dc drift problems.

Hewlett-Packard's system (see table) has avoided the dc drift problem by being ac-coupled, but a careful reading of its data sheet reveals that the user does not have the benefit of arbitrary data-format input capability under all conditions. For example, if synchronous transmission (both clock and data transmission) is desired, he must provide Manchester encoding on the input data, and under these conditions the unit operates only down to data rates of 2 Mb/s.

Other manufacturers state that there are no input format restrictions, but they recommend Manchester-coded inputs. Here it is necessary to determine how failure to comply with the recommendations will affect the bit error rate of the data type used in a particular application. Still other vendors indicate that the input data must merely be 50% duty-cycle format, and this must be interpreted carefully.

Meeting the standard

The Electronic Industries Association's data-communications standard RS-232-C and its later versions RS-422 and RS-423 [*Electronics*, June 8, p. 104] provide data control in the form of protocols for the inputs and outputs to computers and remote data-processing equipment such as terminals, printers, and so on. The full protocols include various handshaking routines that provide the user with true conversational-mode, modem-like operation.

In fact, several of the links in Table 2 are really modem replacements, and EIA-type data can be transmitted from one location to another by using them.

As of now, available links feature the RS-232-C protocol. When the full RS-232-C protocol is transmitted through the link, various preprogrammed computer checks can be made on the complete link's operational capability. Just which parts of the protocol will be essential to this and other particular applications must be determined in advance by the user, who will have to work with the manufacturer to see if enough of the protocol is handled by the link under consideration. □

Parts 1 and 2 of this three-part series on fiber-optic links, which dealt with how to estimate their value in use and how to make a preliminary design, appeared in the Nov. 9 and Nov. 23 issues of *Electronics*.

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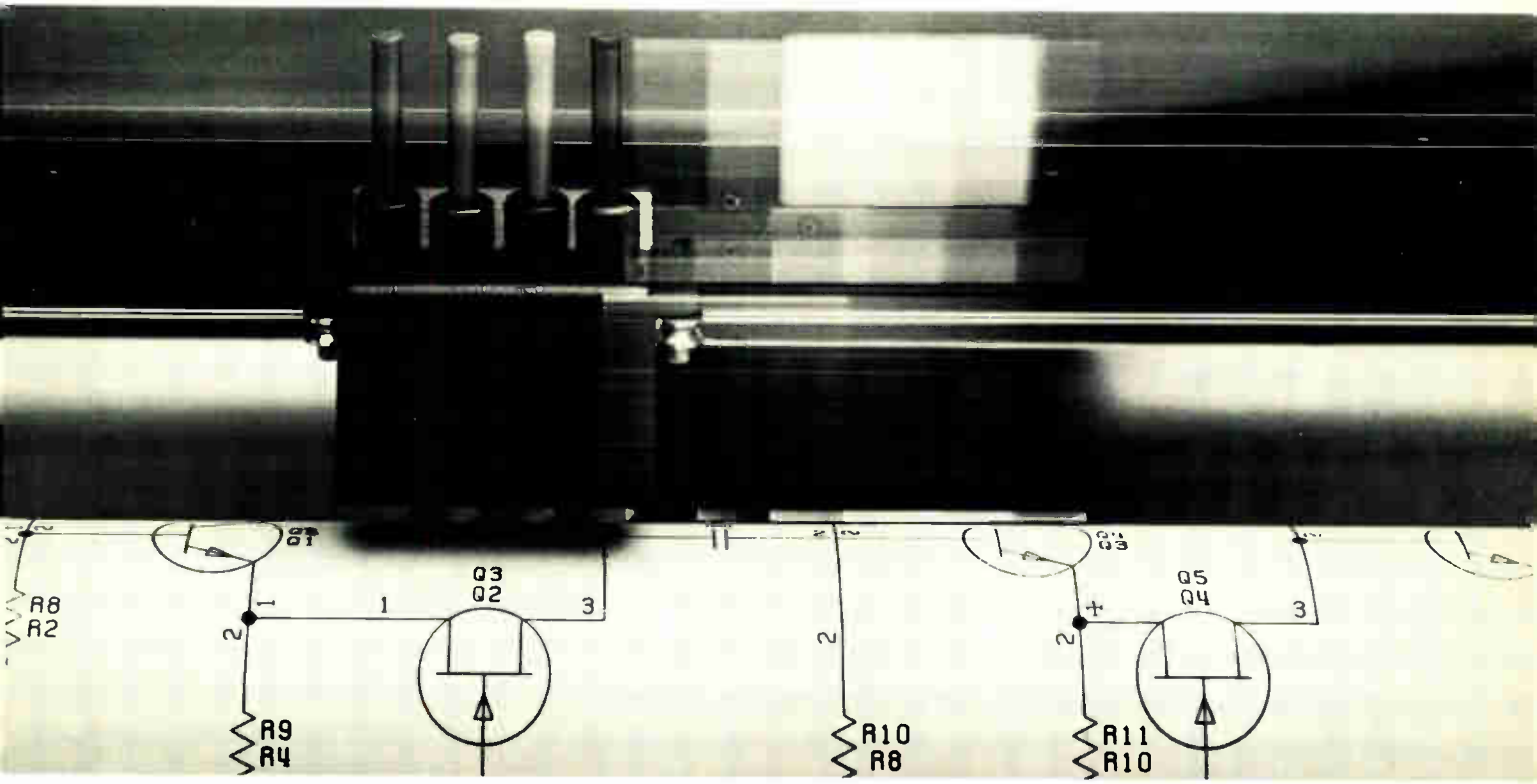

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Diodes adapt V-f converter for processing bipolar signals

by Jerald Graeme
Burr-Brown Research Corp., Tucson, Ariz

Two diodes and one operational amplifier will enable a voltage-to-frequency converter to process bipolar input signals, thus adapting it for operation in absolute-value circuits. Using the integrator of the converter eliminates at least one of the op amps normally required for such absolute-value converters. Moreover, the approach is simpler overall than ones that bias the converter's inputs at a value midway between supply voltage and ground.

When input signal e_i is positive (see figure), diode D_1 becomes forward-biased and D_2 is reverse-biased. Op amp A_1, which isolates the signal from the offset and bias currents of the V-f converter, then acts as a noninverting amplifier with a gain of $1+R_2/R_1$; it creates an integrator feedback current equal to $i_f = 10e_i/R_3$, provided that $R_4 = (R_1+R_2+R_3)R_3/(R_1+R_2-R_3)$. The voltage $e_i(1+R_2/R_1)$ at the inverting input of the V-f converter is then transformed into a corresponding frequency.

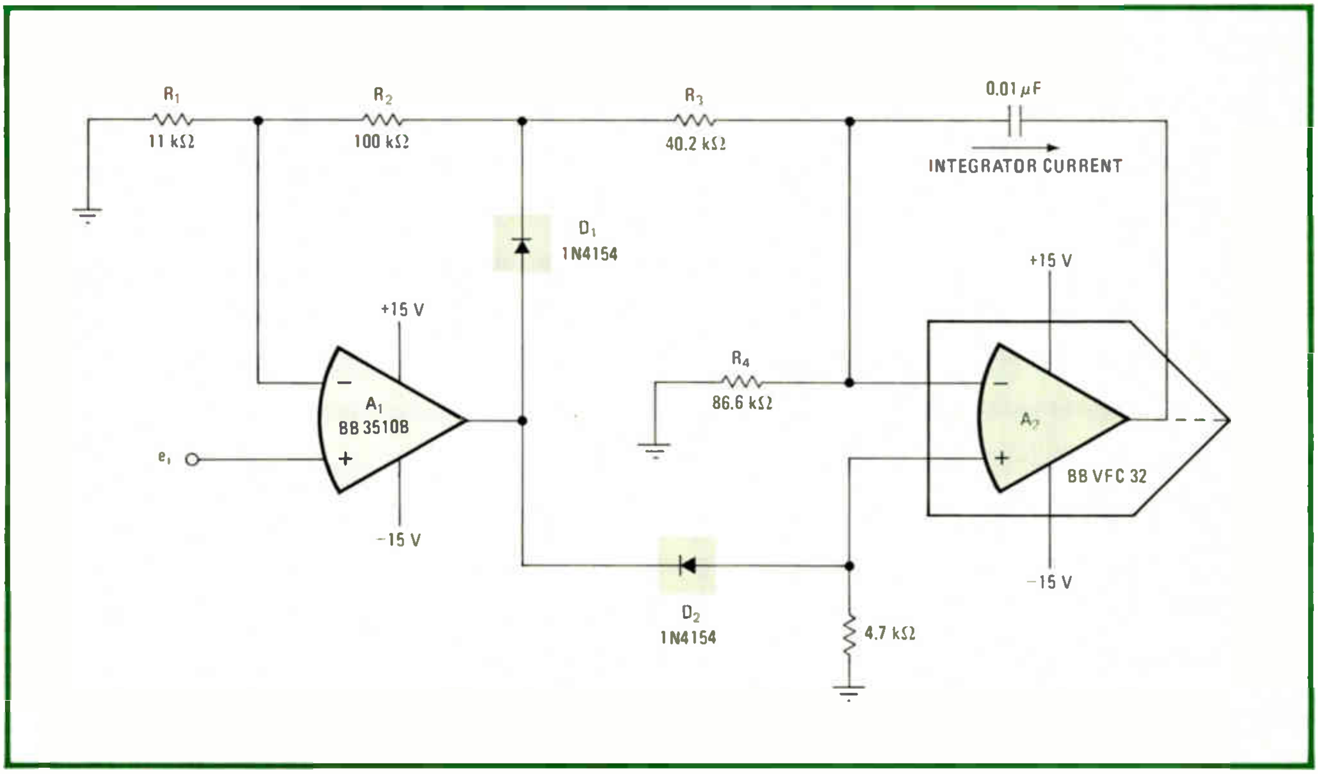
For negative values of e_i, D_1 is back-biased and D_2 is forward-biased, enabling the op amp's output signal to be applied to the noninverting input of the V-f converter. In this configuration, the gain is negative, so that the integrator current generated has the same polarity as before. Thus the V-f converter cannot distinguish positive and negative voltages having the same magnitude, and so generates the same frequency for both signals.

If D_1 and D_2 are replaced with the emitter-base junctions of any general-purpose transistors and the transistors' collectors are used to drive lamps or other indicators, the polarity of the input signal can be displayed. Care should be taken to avoid reverse emitter-base breakdown caused by large input-signal levels by placing diodes in series with the base of each transistor.

The accuracy of the converter is determined by the same factors as affect conventional absolute-value circuits: resistor-ratio matching and the op amp's input offset voltage.[1] It is most important that the R_1–R_4 resistor values be correct for a given gain, as they have a part in equalizing circuit gain for both signal polarities.

The op amp offset voltage must also be minimized. The standard trimming procedure will in effect remove any offset at the point where the diodes switch. The offset at the output of the V-f converter can then be removed by trimming its integrator circuit. □

References
1. J. Graeme, "Applications of Operational Amplifiers—Third Generation Techniques," McGraw-Hill, 1973.



Absolute switchover. D_1 and D_2 switch on alternately as polarity of input signal changes, thus maintaining direction of integrator current. V-f converter cannot distinguish between signal polarities of the same magnitude and so generates the same frequency for both.

Prescaler and LSI chip form 135-MHz counter

by Gary McClellan
La Habra, Calif.

Combining a prescaler designed for very high frequencies with large-scale integrated circuits and a few other devices builds a multifunction frequency counter capable of working at 135 megahertz. The counter, which uses complementary-metal-oxide-semiconductor and emitter-coupled-logic chips, has many desirable qualities, including the ability to measure the period of a waveform, moderate power consumption (100 milliamperes, including displays), good sensitivity (16 millivolts at 135 MHz), and portability.

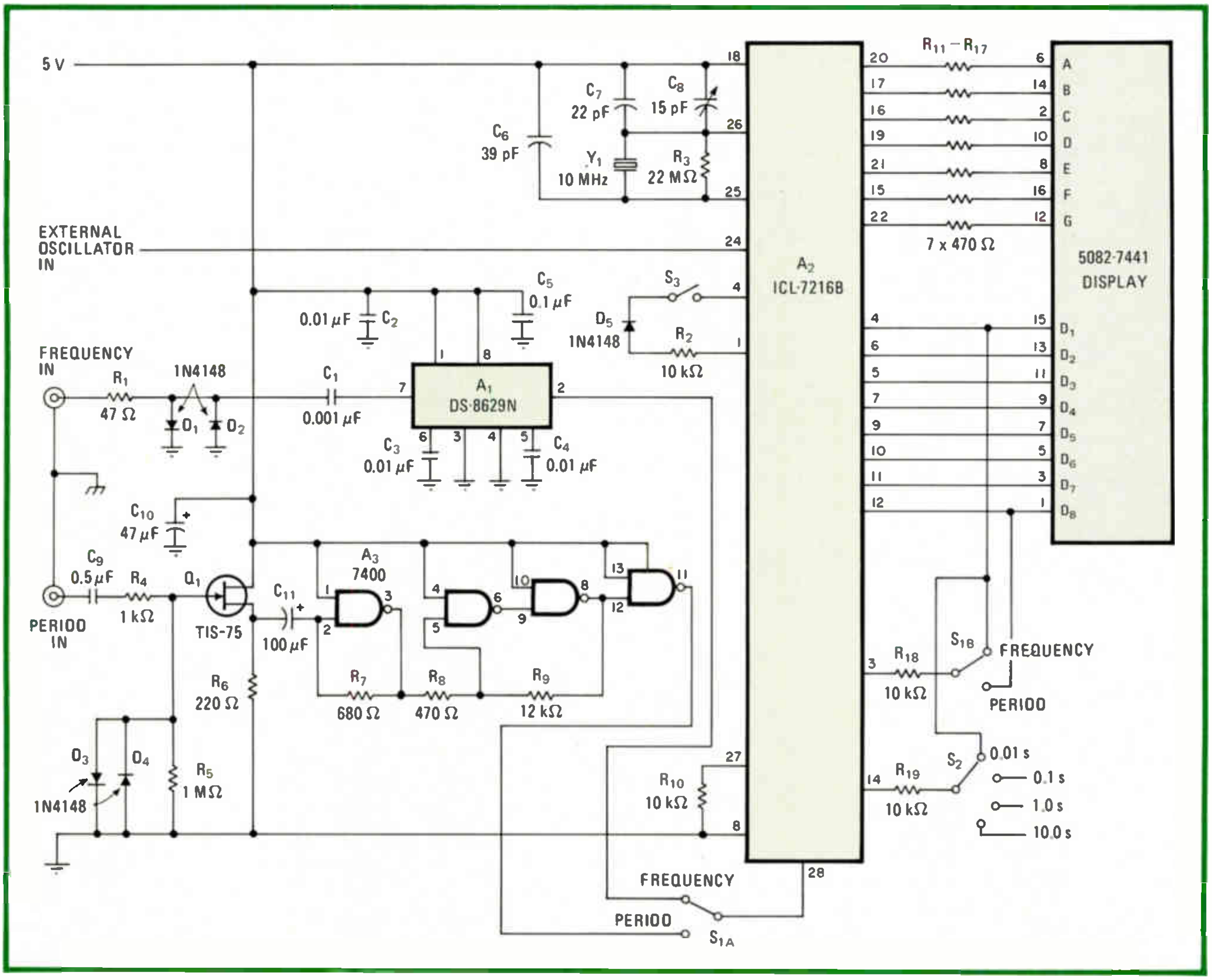
In the frequency mode (selected by switch S_1), signals at the input are limited by the resistance-capacitance network and two diodes (see figure) so as to prevent overloading of A_1, the National DS-8629N prescaler. A_1, amplifies the signal and divides it by 100, and then it is counted by A_2, the Intersil ICL-7216B.

The ICL-7216B contains a counter, a display multiplexer, a seven-segment decoder, and digit and segment circuits for driving A_3, the HP 5082-7441 display. The chip also provides timing for the system, including the necessary oscillator circuitry and frequency dividers to generate the gate, latch, and reset pulses for multiplexing the display and controlling the sampling interval (selected by S_2).

In the period mode, input signals are limited in order to protect Q_1, an impedance converter. A simple preamp and Schmitt trigger, A_3, converts the signal to appropriate levels for A_2.

The counter also has provision for an external oscillator input. When properly used with an external 10-MHz standard, it makes measurements with a high degree of accuracy. S_3 enables the measurement.

Calibration is easy. A signal of known frequency is connected to the frequency input (a 100-MHz signal is ideal), and the 15-picofarad capacitor, which is in parallel with crystal Y_1, is adjusted for a matching counter reading. Accuracy is not greatly affected by the supply



Counting high. Three-chip circuit uses prescaler and LSI chip in frequency counter capable of operating at 135 MHz. Circuit draws total of 100 milliamperes, has good sensitivity, is portable. Counter should be built on double-sided pc board for best performance.

voltage, as the counter holds to within two counts of the displayed frequency over 4.5 to 5.5 volts.

The counter is best built on a double-sided printed-circuit board. Parts layout is not critical, with the exception of the input leads, which should be positioned away from the display. Also, A_1 should have foil running on its underside, to act both as a heatsink and as shielding. □

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.

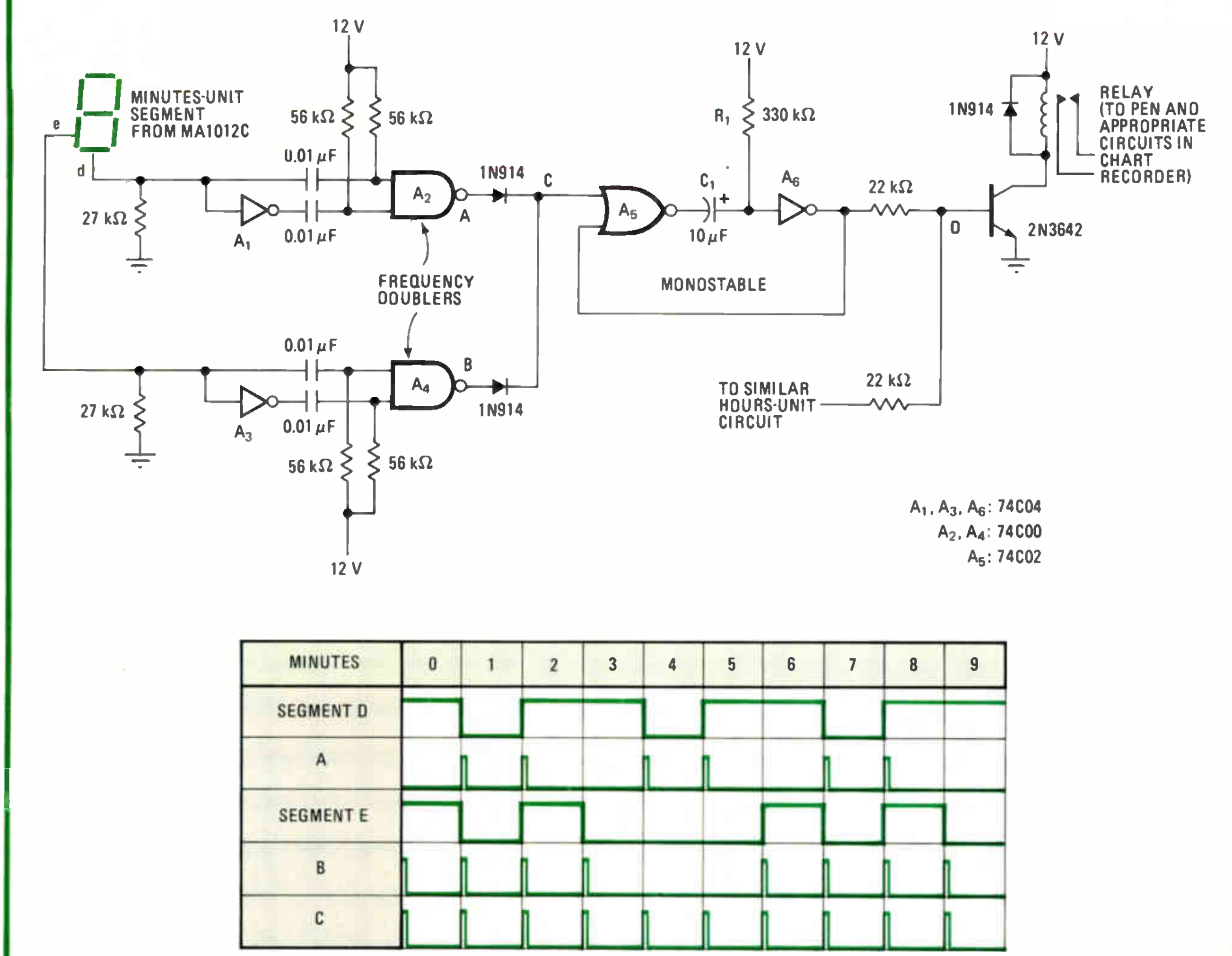
Clock module supplies chart-recorder time markers

by G. J. Millard
Volcanological Observatory, Rabaul, Papua, New Guinea

Utilizing the display segments of a standard digital clock module—or more precisely, the signals that drive them—this circuit enables a chart recorder to mark intervals of 1 minute or 1 hour or both. Use of an already built electronic clock, such as National Semiconductor's popular MA1012C, guarantees a chronometer that is accurate, simple to construct, and low in cost ($25).

The 1-minute markers are developed from the signals that drive segments d and e of the minutes-unit display in the MA1012C. These signals, which are readily accessible, drive two frequency doublers, A_1–A_4, that in turn produce a pulse at point C every minute. The pulse then triggers a one-shot (A_5, A_6, R_1, C_1), which switches the relay on for 2 seconds.

If desired, markers can be generated at 1-hour intervals by connecting segments d and e of the hours-unit display to a similar circuit, the output of which is connected to point D. To differentiate between the minute and hour markers, the relay on-time should be set at 4 seconds by making R_1 in the corresponding circuit 680 kilohms. □



On time. Markers at 1 minute and 1 hour are derived from signals that drive segments d and e of minutes-unit and hours-unit display, respectively, in MA1012C clock module. Relay's on-time is controlled by R_1C_1. Timing diagram details operation for minute markers.

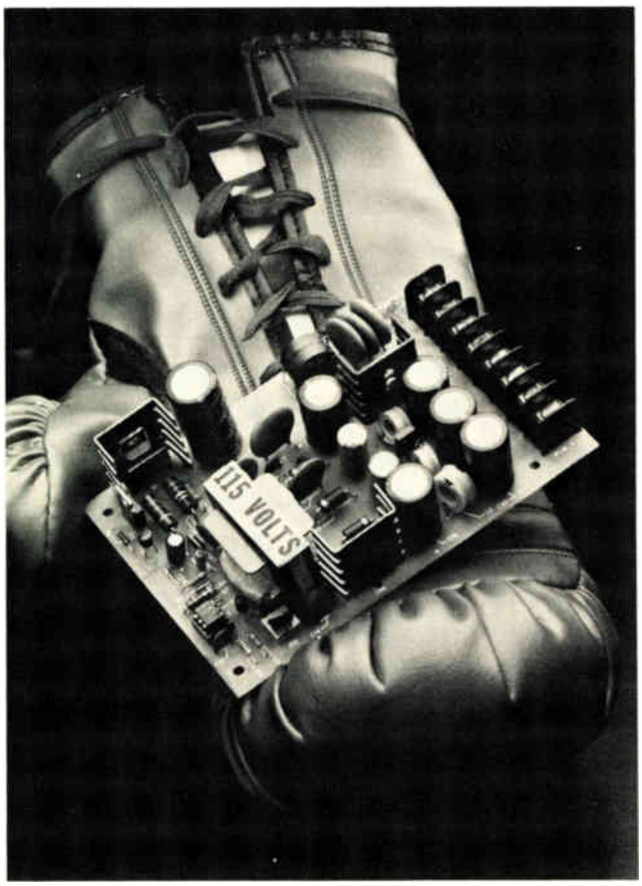
Flyback converters: solid-state solution to low-cost switching power supplies

For the user, close attention to design detail will yield a high-performance system with low production costs

by Robert J. Boschert, *Boschert Inc., Sunnyvale, Calif.*

□ Long a fixture in high-power applications like mainframes and their peripherals, the solid-state switching power supply is only now making its mark in low-power applications where the low-cost linear supply predominates. Momentum for this thrust comes from simplified switcher designs that lower the cost of converting an ac input to multiple dc outputs.

Typically, most switching converters have been custom designs, tailored to solve a particular problem or set of problems. When equipment makers ran into size, weight, or cooling restrictions as they designed supplies into their gear, they ordered the custom switchers.



1. The big punch. The OL25 switcher measures 2.5 by 4 by 6 inches and weighs 12 ounces; yet it delivers a hefty 25 watts of switching power. An adaptation of the flyback converter, the design minimizes both magnetic and semiconductor costs.

With the new standard converters, these manufacturers are finding they can profit from such advantages as improved portability and the elimination of cooling fans, without sacrificing economy. Thus switchers are beginning to show up in volume in such low-power applications as microcomputer systems, home-computer video terminals, and small commercial computer systems.

Minimizing cost

The new switchers may be the product of a common design philosophy, but their different makers do not agree on how to minimize costs. Nor do they agree on what cost-performance tradeoffs to make in most cases. The original-equipment manufacturer, faced with this controversy, can resolve it for his particular applications—but only if he is familiar with some of the basic design considerations in this field.

What he will find for his consideration is such designs as the Boschert OL25 series. These general-purpose, low-power switching supplies are designed to compete directly against linear supplies by reconciling the lowest possible cost with acceptable performance in most cases.

These switchers (Fig. 1) are an adaptation of the flyback, or ringing choke converter, generally used in television receivers' horizontal circuits, xenon flash units, and other very low-cost applications. Other techniques are used by other switcher manufacturers, but the flyback approach minimizes the costs of both magnetic and semiconductor components. The new Boschert line attacks the problem of high regulation costs by novel power-control methods.

The initial choice

In theory, all switchers are alike; in practice, their designers can choose among a number of basic approaches (Fig. 2). Usually they select the one that provides the required performance with no need for added components or a major engineering effort. Often, a better decision is to select a lower-cost and -performance basic circuit and to design in the higher performance with an engineering effort that also seeks to minimize production costs.

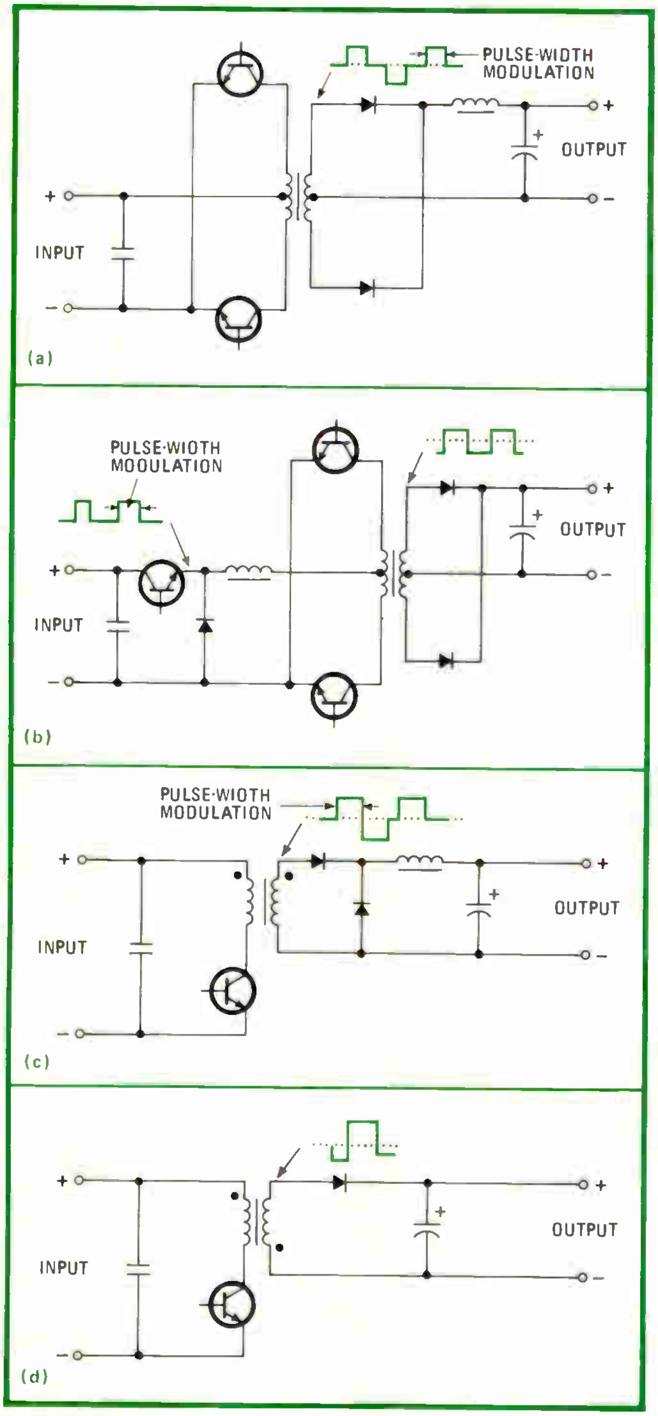
Since the switcher essentially is an electronic system rather than a traditional power supply, it should be evaluated as a system, rather than as the sum of its components. Coming into play are such considerations as consolidation of functions, regulation and ripple filtering, the number of power stages, and energy storage.

Most applications require multiple power outputs. Major savings may be achieved combining a function necessary for each output stage in a shared circuit. For example, the filtering required after the power switch might be combined into a filter circuit at the outputs.

The OEM designer may find that he must allow for tradeoffs in regulation and ripple to take advantage of the switcher's benefits without cost penalties. For example, the designer of a digital system wants a precise +5-volt output to power most of the system.

Almost all switchers directly sense the +5-v output and regulate it to ±1% in order to keep it well within the typical digital component tolerance of ±5%. However, auxiliary outputs usually are semi-regulated: that is, they are dependent upon the regulation provided by the control circuitry for the ±5-v output.

The rationale for semi-regulation is that acceptable performance for low- and medium-power uses can be achieved on the auxiliary outputs without added power-handling stages. One circuit then can regulate all input voltage effects for all outputs, and acceptable load regulation can be met by minimized output impedances.



2. Switching converters. Low cost makes the quasi-square-wave converter (a) attractive. For medium power, the two-stage switchers (b) excel. Forward and flyback converters (c and d) require clever design to offset their higher-priced parts.

A fact of life

Ripple in switching power supplies tends to raise designers' emotions, for it is inescapable. The fast switching characteristics of these units means the phenomenon is inherent, so it is pointless to strive for the lowest possible ripple at any cost.

However, every converter output has a filter, which generally can be designed to reduce ripple to an acceptable level at a nominal cost. Ripple voltage levels within 2% of the dc output voltage usually are low enough for the ripple to become buried in the normal system noise.

In most high-power applications, semi-regulation on auxiliary outputs does not suffice. Therefore, the basic converter's cost should be minimized, and the savings should be used for such performance-improving functions as a linear post-regulator and a filter on each auxiliary output. The quasi-square-wave converter of Fig. 2a is the choice here, because it requires only one power conversion, minimizing semiconductor costs.

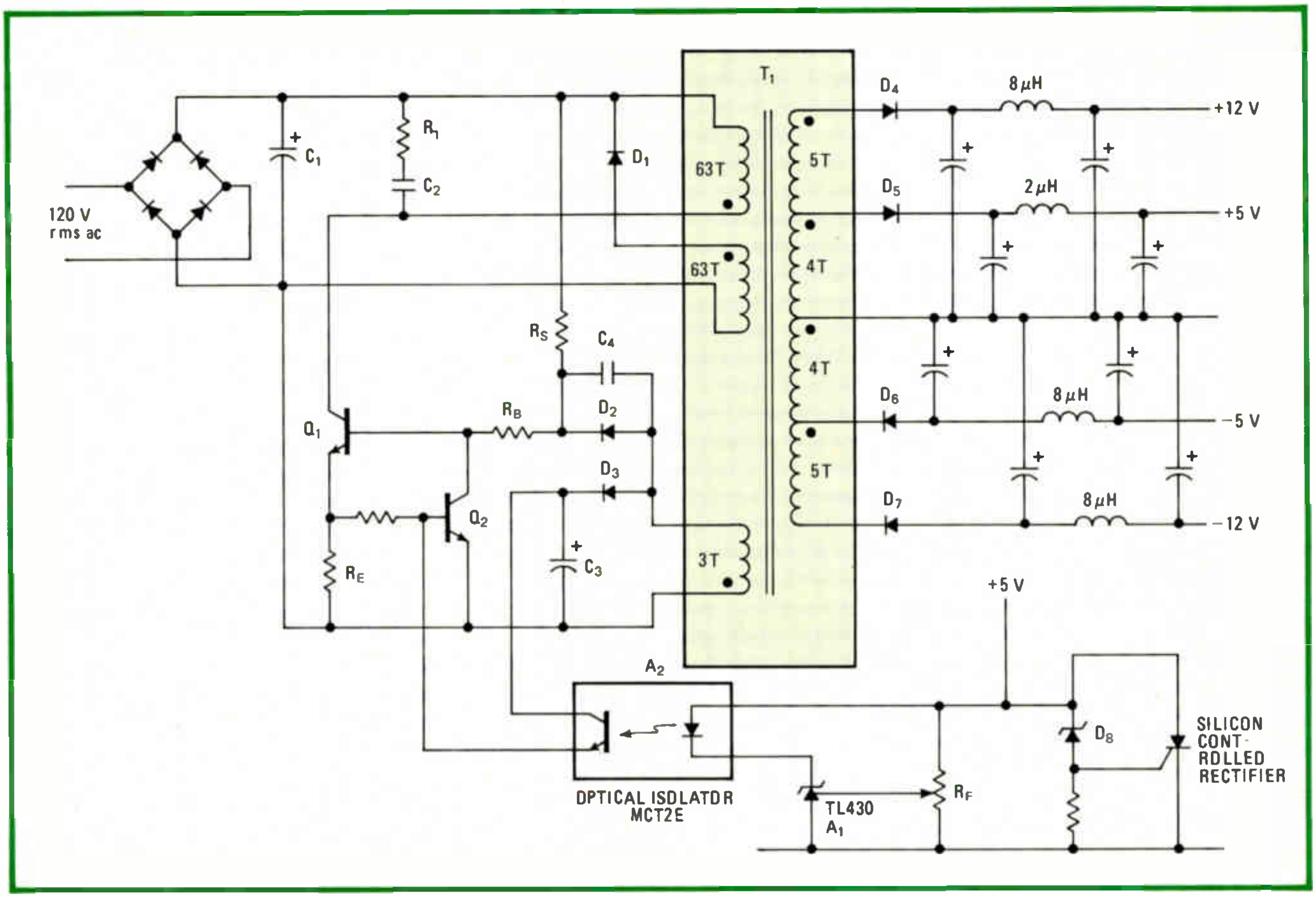
For medium-power applications, the two-stage switcher (Fig. 2b) is the best choice, because its improved power conditioning makes semi-regulation practical. Post-regulators are eliminated and filtering requirements are minimized, but at the expense of additional semiconductor devices in the basic unit.

However, the costs of medium-power semiconductors are reasonable, and the two-stage design shown trades off the cost of added devices against savings down the line. Also, it needs only one primary inductor, whereas the quasi-square-wave unit needs one for each output.

Where flyback fits in

Forward and flyback converters (Figs. 2c and d, respectively) could be used for medium-power applications, but they are too expensive at present component costs. A forward converter needs a large inductor in each output for energy storage. A flyback converter does not need such inductors, but its utilization of power semiconductor devices is less efficient, requiring the use of relatively expensive components.

For low-power applications, efficient utilization of components is less urgent, because the low-power semiconductor devices used are relatively inexpensive. Moreover, the OEM designer can choose a switcher from a number of converters with a single power switch and



3. The OL25 power supply. A novel control circuit to adjust current flow during operation is governed by a feedback from the +5-V output through A_1 and A_2 to transistors Q_1 and Q_2. The ±5-V outputs are regulated; the ±12-V are semi-regulated.

one output change.

Forward converters have been preferred over flyback switchers because of their relatively higher performance. However, a flyback-based power supply can offer equivalent performance to a forward unit if its designer plows back part of the savings in magnetic and semiconductor costs into design improvements. The savings in output inductors more than offsets the slight increase in transformer complexity needed to combine the isolation and storage functions.

Low-cost energy

Yet this more complex double-duty transformer contributes heavily to the flyback converter's major advantage: lower-cost energy storage. Often overlooked as so fundamental a fact of switcher design, energy storage represents a large chunk of total system costs, as well as being a key to the unit's efficiency.

Energy is stored when the power-switching transistor turns on and is delivered to the load when the transistor turns off. Switch-control regulation thus replaces the highly inefficient energy-dissipation techniques used to regulate linear power supplies.

However, most switchers must store their energy in expensive magnetic components. By storing energy in the isolation transformer, the flyback converter eliminates this component expense. Moreover, it needs the fewest components for each basic power-handling function. In fact, one component suffices for each function, because the flyback converter is a single-ended circuit.

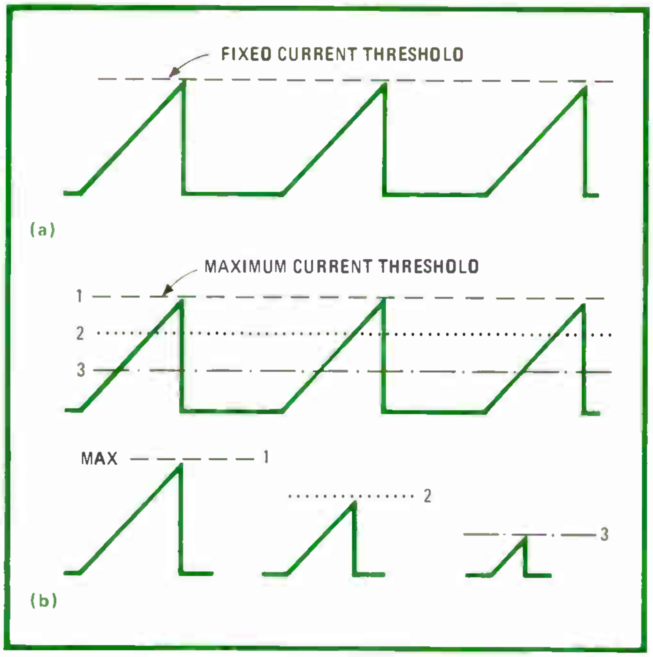
As the Boschert OL25 series shows, the result can be a versatile design (Fig. 3) that provides 25 watts maximum in four continuous outputs over worst-case line-power conditions. The basic model has ±5-v regulated outputs and ±12-v semi-regulated outputs. A modular design approach allows outputs to be tailored for optional voltages throughout a ±40-v range.

The main challenge in flyback design is to minimize the cost of the control circuitry. In general, controlling the output power is achieved by a blocking oscillator power stage that changes state whenever total positive feedback gain from the switching section through the transformer exceeds unity. The blocking oscillator then usually delivers a fixed amount of power.

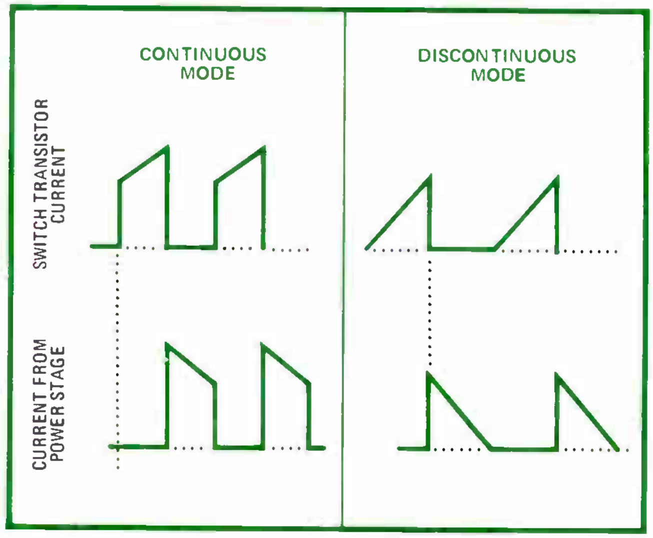
Controlling the power

The OL25 operates as a blocking oscillator under the following control law: output is linearly proportional to current flowing in the primary circuit at the time transistor Q_1 in Fig. 3 turns off. The simplifying assumption is made that output power is independent of input line voltage and operating frequency, so far as the control loop is concerned. Then the control-loop model for the power stage is simply a current source driving the output capacitances.

To adjust power flow during operation, the OL25 implements a novel control circuit. The new technique provides excellent regulation resulting in significant



4. Modulated threshold. The basic oscillator's primary current is limited by a fixed threshold (a), but the OL25's circuit (b) implements a modulated threshold technique that results in a variable duty cycle; hence, the power outputs are constantly regulated.



5. Flux modes. The OL25 converter operates in the discontinuous flux mode because of better cost tradeoffs, despite the greater average power delivery in the continuous mode operation. Also, the continuous mode operation requires complex control circuitry.

savings in the components required for control circuitry. Moreover, the circuitry occupies little more than 10% of the total board area.

In a basic blocking oscillator (Fig. 4a), primary current rises linearly until a preset current threshold is reached, then drops to zero until the end of the cycle. In the OL25 (Fig. 4b), the current threshold is modulated, resulting in a variable duty cycle and power adjustment. The control circuit is designed to home in on that duty cycle, ensuring proper regulation. The circuit programs the current level at which the power-stage feedback exhibits a gain greater than unity. Thus, switching proceeds at the proper duty cycle.

Greater stability

In addition to reducing cost, the technique enhances stability. It results in a 90° phase lag of output currents at high frequencies, instead of the 180° shift characteristic of direct duty-cycle control.

This primary current control simplifies feedback compensator design. Switching frequency for this design is around 20 kilohertz, and operating frequency is inversely proportional to the output power.

The blocking oscillator turns on when the energy stored in the magnetic field of transformer T_1 in Fig. 3 is approximately zero. It turns off at an energy level determined by the base drive voltage, the emitter resistor R_E (the current-sense resistor), and the primary inductor. Stored energy is released to the outputs via rectifiers D_4 through D_7. When the energy in T_1 has been drained to approximately zero, the switching cycle repeats.

Transistor Q_1 provides the desired adjustment of power flow. Q_1 and Q_2 are part of a current-limiting circuit that varies the duty cycle. The adjustment is governed by feedback from the ±5-v output through amplifiers A_1 and A_2, so that a rise in voltage above +5 v produces a compensating reduction in output power and voltage.

Q_1 saturates and the transformer-inductor primary current starts its linear climb. The current increases until the rising voltage across R_E reduces the base current enough for Q_1 to operate in the linear class A mode. Q_1's constant-collector-current characteristics cause current limiting, so the rate of change of current in T_1 decreases; the voltages across the primary and base windings decrease; and Q_1 is driven off.

Now the energy stored in T_1's magnetic field must escape. The voltage on the windings reverses in polarity and increases in magnitude until a decay current path is found. The output rectifiers D_4 through D_7 conduct before input rectifier D_1 conducts. D_1 clamps the leakage inductance spike on the primary switch to the input source voltage.

Q_1 remains off until all energy is drained from T_1 and the output rectifier currents go back to zero. T_1 then rings back with the primary inductance and C_2's capacitance until Q_1 is again biased class A and turns on to repeat the cycle. Output power is a linear function of the current flowing in Q_1 as it comes out of saturation.

Lowering control costs

A major savings was achieved in the feedback control circuit by using +5-v–compatible integrated circuits. One is an adjustable zener diode, the TL 430, a 3-pin package used as an error amplifier. The conventional control circuit is a 16-pin integrated circuit. The other is MCT2E, an optical isolator that does double duty as an optoisolator and as part of the control circuit.

The TL 430 (A_1 in Fig. 3) meets the requirements for feedback control in switching regulators with on-chip functions like the high-gain operational amplifier and a voltage reference. In this application, the +5-v output provides both power and feedback signal. The TL 430's 2.75-v internal reference voltage is compared with the output feedback signal at the wiper of potentiometer R_F.

The optoisolator, A_2, provides the necessary ac line isolation. The alternative would be placing a small transformer in the control loop. In the main power path, T_1 provides the required isolation.

A_1, A_2, and the current-limiting circuit control the amount of power flowing to the secondary. A_1 operates as an inverting transconductance amplifier. When the +5-v output voltage rises, A_1 drives the light-emitting diode in A_2 harder, thereby controlling the current through the latter's output transistor.

The current from A_2 prebiases the base of Q_2, reducing the current required to turn that transistor on. When Q_2 is biased on by a rise in voltage across resistor R_E, Q_1 turns off. The result is output regulation through adjustment of peak current and thereby output power.

The silicon controlled rectifier to the right of A_1 in Fig. 3 is part of a temperature-stabilized crowbar circuit that provides over-voltage protection. The circuit acts as a short when the 5.1-v zener diode, D_8, is overcome and the voltage at the SCR gate exceeds 0.8 v. The SCR selected assures the high rate of current change needed to discharge the output capacitances.

Accounting for filters

Each output filter in Fig. 3 is shown as a π-section filter with an inductor. This is not a general requirement, but it may be needed in some applications to minimize ripple on one or more outputs. Hence, the output stages are designed to accept a small air-core inductor and the additional capacitor required by a π-section filter.

The input filter is standardized. It has sufficient capacity to maintain maximum power output for 16 milliseconds after a line-power interruption.

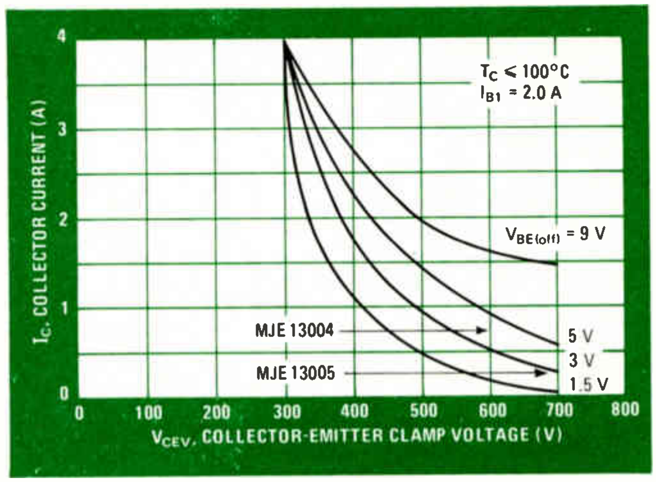
For energy storage, the flyback converter's transformer must be designed in as a multi-winding inductor rather than as a transformer. All power-inductor parameters become critical, and the winding geometry must be planned carefully to minimize leakage inductance.

In designing the transformer-inductor, some general criteria must be met. The magnetic circuit path is usually gapped in the one place where energy is stored. For the most part, the path operates over a flux density range from zero to maximum, typically 3,200 gauss for power ferrite at 100°C.

Core size determines the number of turns and the turns ratio can be derived from a steady-state design equation. For the Boschert OL25, an Electrical Plastics M1187-2 core is used. The turns for the primary and secondary coils are shown in Fig. 3.

The OL25 converter operates in a discontinuous flux mode. This provides a better cost tradeoff then the continuous mode since it reduces the volume of the magnetics components, and control-circuitry costs.

In the continuous mode, the ac flux is small compared to the dc component. Hence the current flowing in the switch transistor at turn-off is much the same as at turn-on, and the average power delivered to the load is greater than for discontinuous operation for a given peak transistor current (Fig. 5). However, the continuous mode requires relatively complex oscillator and control circuitry, shooting costs up.



6. Safe operation. Q_1 was chosen from Motorola's MJE 13004 family of power transistors because it exhibited a reverse bias that allows a proper margin of safety in the converter design. The 75-W npn transistors are designed for high-speed switching applications.

Selecting the power switching transistor (Q_1 in Fig. 3) is a matter of determining the required duty cycle. The limiting factor is the safe operating area of Q_1's reverse bias. Consider the steady-state design equation:

$$\frac{\text{volts} \times \text{seconds}}{\text{turns}}(\text{on}) = \frac{\text{volts} \times \text{seconds}}{\text{turns}}(\text{off})$$

for the on and off states of the ac-power-line input side of the converter. If just the primary winding of the transformer-inductor is considered, the number of primary turns drops out, and the voltage stress on Q_1 can be analyzed.

Using two equations

The voltage stress equals the source voltage plus the primary flyback voltage. If on time equals off time (a 50% duty cycle), flyback voltage equals source voltage. Thus, Q_1 must hold off twice the source voltage plus any spike voltage due to leakage inductance.

On the other hand, keeping the duty cycle as high as practical reduces the amount of current the transistor must pass. The switch current's dc component is:

$$I_{\text{Switch}} = \frac{\text{power output}}{V_{in} \times \eta \times \text{duty cycle}}$$

where η is efficiency. These two equations give voltage-current tradeoffs for various power levels and transistor specifications.

Since reliable operation is the most important consideration, peak voltages must be kept within the limits of presently available low-cost transistors. Compensating for the increases in input voltage by reducing the duty cycle accomplishes this.

One OL25 version for 110-v application operates at a 40%-50% duty cycle, and another version for 220-v application operates at a 20%-25% duty cycle. For both, the transistors are selected from the Motorola MJE13004 family of 75-w npn silicon power transistors. Designed for high-speed switching in inductive circuit applications, the MJE13004 has the reverse-bias safe operating area shown in Fig. 6. □

Top executives look at 1979 with a sprinkling of optimism despite world economic concerns

While some see downturn, most don't expect a full-blown recession in the near term; in the U. S., Carter Administration receives mixed notices on attitudes and actions

ANDREW C. KNOWLES III
vice president, Digital Equipment Corp.

There's no question in Knowles' mind where 1979's problems will lie. "The main concern is the economy. The First National Bank of Boston predicts a prime rate of 12.5% by the end of the first quarter or the beginning of the second quarter, and tight money affects original-equipment manufacturers in that they don't get bullish in their expansion plans."

The ripple effect is already slowing minicomputer sales, but the year looks good. "We'll grow, but it won't be at the 40% rate of the past."

Before the Carter Administration moved to bolster the dollar, DEC was forecasting a flat 1979, but Knowles now looks for a recession: "We think there will be a slide, but we don't know how big it will be."

The high prime rate will put pressure on the economy as the Administration intended. However, the situation should never have been let deteriorate to the point where such drastic moves were required.

"There don't seem to be very many good economists in Washington. I don't think Carter has a good Council of Economic Advisers, nor does the Administration understand the forces behind capital formation. They're economic illiterates. Carter took an adamant position on the capital-gains tax reduction: he was going to veto it."

Fortunately, "there were people like [the late Rep. William A.] Steiger [R., Wis.], who pushed through a capital-gains bill that will help business over the long haul. From about 1957 to 1969, there were 200 new high-technology businesses formed in the Boston area. Since then, only about 50 have been started. I think that is a direct result of the restrictive capital-gains law of 1969."

J. FRED BUCY
president, Texas Instruments Inc.

Next year could be the year of the tightrope. "A recession is not an absolute certainty," but President Carter "will have to walk a very tight line" to avoid a recessionary downturn next year or in the election year that follows. So White House economic policy is definitely a major concern for Bucy.

While the semiconductor business should outstrip the economy as a whole in 1979, "it will be a tighter market." The overall economy will decelerate until the fourth quarter, and then begin to turn up. If all goes well, 1979's real growth will be less than that of 1978 but will still be a positive figure.

That said, he makes it clear that a good bit of his projection depends upon the Carter Administration's ability to avoid triggering a recession. Recent wage and price guideline efforts, coupled with the President's money-tightening moves to support the dollar, have "definitely pulled the threat of a recession forward from where we were thinking it might possibly come."

With the electronics industries in a more favorable position than most, TI is planning to make substantial capital investments next year in numerous growth opportunities. But "business in general is bound to cool off some" on capital spending. "We could see interest rates at 12% to 15%, if things continue at the rate they're progressing now. That would put a real squeeze on major expansions," Bucy says.

Though "it sounds like a strange thing to say two years into an Administration, it's still too early to tell about the true Carter stance toward business." In some instances, the President seems to have reversed his anti-business attitudes.

An example is the tax bill signed this year, which contained some items that Carter had said he would veto. However, in terms of the Administration's pro-business actions to date, "it's hard to separate those taken sincerely from those taken out of political expediency."

"One of the biggest negatives as far as business is concerned continues to be an uncertainty about Washington, both about Congress and the executive branch. Until that uncertainty is removed, business is going to be hesitant to make investments."

SIDNEY L. SPIEGEL
president, Wyle Laboratories' Distribution Group

That Spiegel looks at 1979 as a cooling-off period should raise few eyebrows. After all, he has staked out a position as perhaps the sole bear among usually too bullish electronics distributors. On the other hand, he does not sense a calamitous downswing, either.

"In late October, I told my people: 'Let's make plans based on zero industry growth.' " Until then, the standard 10% annual increase looked likely, but warning signs of skyrocketing inflation and interest rates obliterated that.

Tempering a downside tilt, however, is the fact that "excesses are not as bad as in 1974–75." As usual for distributors, these include double ordering, a jump in accounts receivable, and delivery stretchouts.

Zero industry growth, surprisingly, holds no terrors. A stable period is welcomed because Wyle can "buckle down to the fine tuning that is impossible when business is too good." Improving inventory control techniques is one task that gets overlooked when the priority is to ship parts out the door.

If a downturn falls into a recession, Spiegel will do some things differently. Not only will he ride herd on "who I give credit to, but no supplier will talk me into taking a half million dollars more [worth of electronics products] without having better reasons than last time."

On the plus side, the latest changes in tax laws indicate a better government attitude "to make business more productive." On longer-range prospects for the electronics industries, "I'm not wavering from a positive outlook."

RAYMOND W. PEIRCE
president, Oak Technology Inc.

Unbridled optimism about 1979 may be an unusual outlook this year, but internal reports lead Peirce to predict that the components divisions that make up his subsidiary of Oak Industries Inc. will be able to repeat 1978's record level of sales and earnings. "Generally, we'll match this year's sales increases," which should be "hefty." The rest of the electronics industries will plod through either "flat or slightly increased sales levels," and the rest of the national economy "will have a little problem."

A few little problems are cropping up at Oak, too. Increased costs for employees' fringe benefits is one, and another is a shortage of corporate development planners that would work on new projects.

Peirce also says that the Carter Administration is not much of a friend, especially when it comes to export policy. "The Government is not doing much to alleviate the problems," and doing away with the concept of DISC—the domestic international sales corporation—will hurt. "It's an important factor for the entire industry."

More competition, both in the U. S. and overseas, is the largest storm cloud on the horizon. European manufacturers are turning up in the lucrative Far East market, and Japanese component suppliers look as though they might follow that country's original-equipment manufacturers by moving to the U. S. "Their customers are coming to the States, so they have to consider coming. If they don't, they're risking losing business."

TIMOTHY C. CRONIN
chairman, Inforex Inc.

Like most other chief executive officers, Cronin sees his Burlington, Mass., company in good shape through 1979, but he is not happy with the Government's policies. "It's my judgment that the economic outlook for 1979 is substantially influenced by, if not caused by, Federal policy. We have a Congress and Administration that don't understand basic economics.

"I think they'll conclude that with the measures they've taken to curb inflation—shoring up the dollar and hiking the prime rate—and with the election behind them, the pressure's off. This only addresses the psychology of the issue, not the reality, because there are still substantial Government deficits."

Next year will be one of overall economic stability but not because of Government policy, "and this gives me concern. I see both upticks and downticks." On the downside, high inflation and interest rates "will clearly dampen the economy. I think we'll see substantial delays of computer-installation decisions that will counterbalance all the positive things we have going for us."

Interest rates will be a big factor, Cronin stresses. "The high rates will influence the rate at which people acquire equipment and will lead to an enforced credit crunch. The rental business is cash-intensive; and, while we have more staying power than some others going into 1979 because of our $20 million subordinated debt, small companies don't have much cash. I think that will lead to more fallouts and mergers."

For Inforex, 45% of its revenues are gained in overseas competition with government-subsidized foreign companies, especially in Europe. Yet the Government is making it more difficult to do business overseas—for example, by moving to get rid of DISCs (domestic international sales corporations).

How tough are the foreign competitors? Look at Italy, where the government provided 99% of the funds to start a company in the data-entry business with a system built directly to Inforex specifications. "We can compete with them, but not if we're being attacked domestically, and I don't see that climate changing."

HEINZ RöSSLE
general manager, ITT Semiconductors Group

Especially in December, the view from a Black Forest mountaintop can be heady. Heady, too, are the near-term prospects for the semiconductor business in West Germany, as seen by Rössle from his headquarters in Freiburg.

"The year 1978 will end up as a good one for us, and 1979 will turn out to be a good one too. To be sure, in our industry, a lot depends on pricing, and declining prices will continue to be a nagging problem."

For all the good prospects, however, "doing business is getting tougher and tougher." One thing making it so is the declining value of the U. S. dollar. In effect, that raises the value of the Deutschmark, which in turn makes most German products more expensive on foreign markets.

"Since prices in our business are calculated in terms of dollars, American producers have a decided cost advantage in markets that we also serve. That makes competition pretty tough." He is also a bit apprehensive over the decline in component prices and the German labor unions' demand for a 35-hour week and more vacation time.

Rössle's assessment of the market and business environment pretty much reflects the feelings of other German executives. On one subject, however, his views differ from those of many in the industry: Japan's strong presence in world markets.

A tough-minded businessman not given to fretting over Japanese competition, he declares, "In areas like very large-scale integrated circuits, you can't keep the Japanese out of your markets on technological grounds. After all, they are good. The semiconductor business is a worldwide business, and you simply cannot give one contender an outsider's role if he adheres to accepted marketing practices."

Nor is Japan impenetrable. "It may be tough to do it, but you can enter that market. Once you learn how to do business there, you will find many loyal buyers."

Doing business in Japan involves emphasizing quality and service. Price is not always the prime consideration of Japanese customers. "Many Westerners have not learned the basics of doing business in Japan or are afraid to compete there."

DAVID H. METHVIN
president, Computer Automation Inc.

Especially galling for 1979 is what Methvin calls the No. 1 problem: "the anti-business mentality of government, through and through." On the Federal level, President Carter "is a populist, dumb on economics." In California, even tax-cutting Proposition 13 has not significantly turned around a "soak-business mentality."

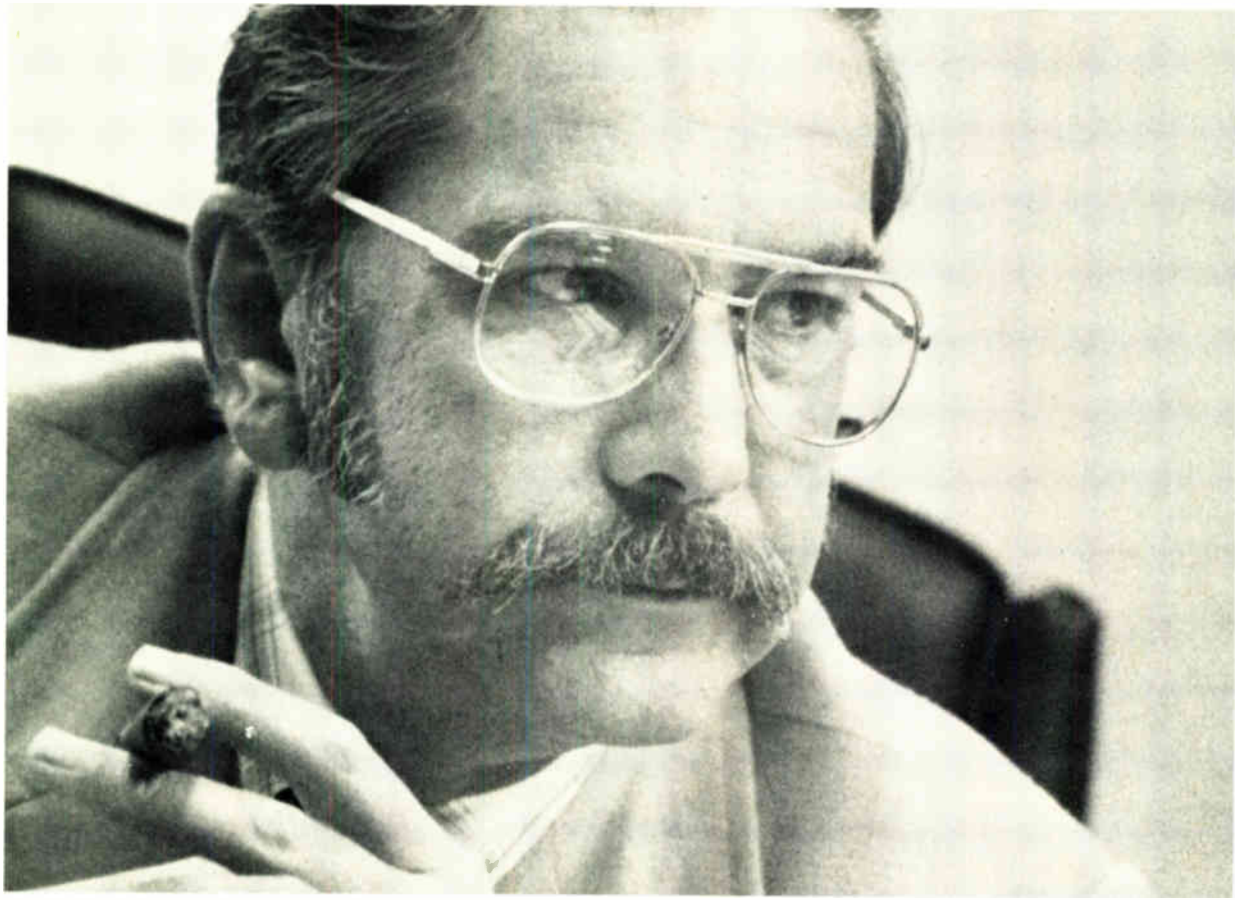
Moreover, "I am convinced we're being set up for wage and price controls." Also, he still intends to move his firm out of the state because of high-priced housing, scarce personnel, and onerous taxes.

"The only question remaining about a 1979 recession is when and how severe." Current and near-term business, "so far looks good," but "lots of signals are flying that remind me of 1973–74," chiefly high inflation and the cost of money. The bellwether indicator is consumer spending: "If it tails off, look out."

The minicomputer industry, booming since its birth, will sail through a slight recession without a hitch. However, a "steep drop would slow the growth rate down." In fact, a mild slowdown would cool some of the excesses.

"It could be good for the industry, because we've outstripped our resources—people, wages, and parts." Methvin's own company, in superheated Orange County, has hit a major roadblock in hiring computer engineers and programmers.

An overseas thrust is more than a prospect, with a $3.5 million new plant in Ireland being the company's major expenditure. There will be little happening in the Orient soon, "because fighting a solid front in Japan has frozen us out."



CHARLES E. SPORCK
president, National Semiconductor Corp.

What troubles Sporck is that business is booming even as talk about a recession spreads. "The marketplace has never been stronger, but at the same time the economists and the analysts say there's going to be a recession."

If a downturn comes, it may be overdue because people have been saying for the last two years that it was six months out. However, "by and large, we don't see any evidence in the markets that there's going to be a recession."

At the same time, he says that the stock market has a way of indicating a downturn—and it has been acting troubled lately. "So, I guess that somewhere out there, in six or nine months or a year, there's going to be a slowdown, downturn, or recession, depending on its severity."

Meanwhile, National has no choice but to operate at capacity to meet the demand. However, the cost of doing business is going up, with new capital investment this year double that of any previous year. The research and development budget, historically 8.5% of sales, is going up both as a percentage and as an amount this year "and will stay the same next year."

The shortage of electronics engineers is another problem. "There aren't enough being turned out anywhere in the world." Although the problem is by far the worst in Silicon Valley, it is troublesome everywhere.

To alleviate the problem, "the first thing we can do is to expand operations outside the valley," something National has been doing for some time that might give it a jump on its competitors, Sporck says. Moreover, the company is working hard at hiring college graduates and generally "competing with our competitors in hiring and training people." He quickly adds that the severe shortage does not just apply to engineers; it also includes the technicians to back them up.

Although local government is supportive of the industry, "I happen to feel that California [state government] could greatly improve its business atmosphere." He names the inventory tax, "an antiquated item that clearly indicates that the state feels that it's easier to tax business than tax income earners themselves. It is a regressive tax that clearly motivates business to go elsewhere."

He invites comparison of California's tax environment and that of Texas, the home state of Texas Instruments. "In Texas, there are no corporate taxes at all, no inventory tax at all, no capital-gains taxes at all. All of those things we have in great abundance in California, and we have to compete with TI." However, California is a better place to live and work.

KENNETH WALTON
general manager, ITT Components Group UK

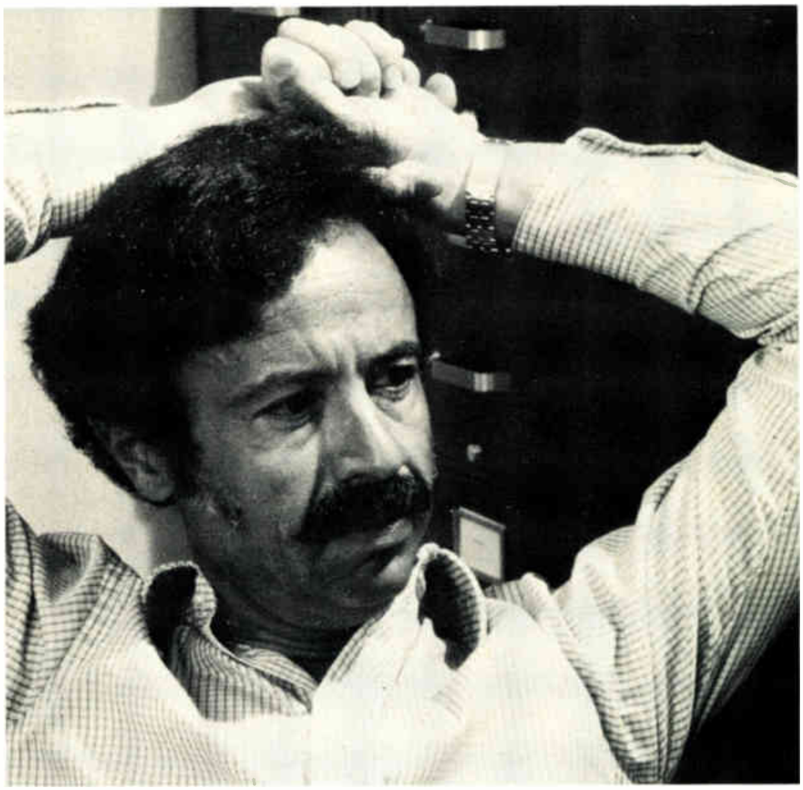
Britain's components makers in particular, and its electronics industries in general, must live with two facts of life. One is increased competition coming from the Far East, and the other is a threatened, union-led domestic wage explosion.

In fact, component imports already account for half the domestic market. "The only way for UK companies to stay alive is to follow the Japanese example and specialize. That way you can improve quality, increase sales volume, and reduce unit costs."

Practicing what he preaches, Walton is moving his company increasingly into the professional electronics sector. Not coincidentally, that is the only bright spot detectable for next year. "I see it as a particularly strong export-based growth area, with large order books from companies like Plessey, the GEC group, and the British Aircraft Corp."

However, the biggest threat to the competitiveness of the UK electronics industries in 1979 could be labor militancy. The unions so far have scornfully rejected the government's 5% guideline for raises.

"It's going to be well above 10%, and I can only predict a further increase in unemployment. I don't think there is going to be any doubt about that." To improve the English economic climate, a reduction in direct taxation and an increase in indirect taxation are necessary.



ANDREW S. GROVE
executive vice president, Intel Corp.

The overall economic picture is blurring into confusion, yet "the segments of the economy into which we supply products seem to be booming," Grove says. "The problem is to figure out how much of a connection there is between the two."

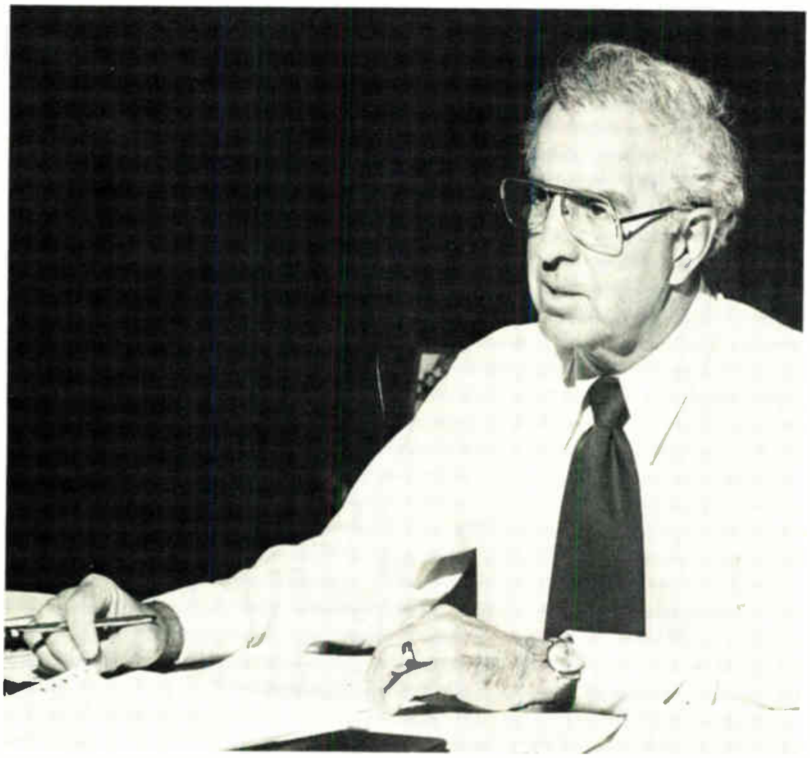
Generally speaking, Intel should grow strongly, partly because its market segments are growing much faster than the economy. In particular, data processing and telecommunications have produced strong demand "two years, back to back." Also significant is the industrial market, where microprocessors have taken hold for control applications.

Although the stock market is down and interest rates are up, a more pressing concern than a recession is "finding the optimum path to be ready for opportunities for products. The trick is to balance between commitment and capacity."

This balancing act concerns Intel because it "definitely was unprepared for expansion" this year, which saw sales grow 50%. Consequently, demand is well ahead of its capacity to produce, leading to lost opportunities. Grove looks for strong growth "if there's no disaster in the economy" but not at another 50%, which would be "suicidal."

Overseas sales expansion should be about the same as the domestic growth, with foreign markets totaling between 30% and 40% of sales. The Japanese challenge probably will not heighten next year, after increasing "a great deal" in 1977 and 1978. Moreover, "we don't see as much change the last half of this year as the same period of last year. The Japanese probably will not expand outside memory products, partly because "the memory market is easier to approach."

Recruitment "over any time period is a difficult problem, especially finding trained engineers. We were trying to fill a larger proportion of our engineering needs out of new college graduates. It wasn't easy, but we met our goals." Helping to ease recruiting is that Intel now can offer work locations outside California to match individual preferences.



JOHN S. SECKER

general manager, Micro Switch division, Honeywell Inc.

What Secker hears about the economy and what he sees in incoming orders are two different things. While forecasters debate whether the future includes a recession or just a downturn, the chief of the keyboard, switch, and components group sees continued healthy growth.

"I'm confused, along with everybody else. Common sense says that there should be a slackening, but we don't see it. No sign of clouds."

The muddled economic picture, with strong demand but an uncertain future, requires constant surveillance to avoid the familiar bugaboo of double ordering. "We're continually scouting our order books for double ordering. It is a danger, but we have not been able to detect duplication."

Attention must go to maintaining continued profit growth despite high inflation and increased costs. To do this, he will concentrate on improving productivity and controlling costs next year. Capital-spending plans are for equipment that will cut costs. "The business is getting more capital-intensive, and we are making more use of technologies."

Increased local costs are a problem, and they are one spur to efforts to increase productivity. For example, the workman's compensation tax in Illinois is among the highest in the nation, and the pinch is starting to hurt. "We're fighting increased local costs. We're feeling it, but we won't change our tactics." In other words, Micro Switch will not run to the lower-cost southern states.

Government efforts to control inflation—higher interest rates, wage and price guidelines, and reduced regulatory burdens—are worth tentative high marks. Secker says that business is inclined to support President Carter's programs for controlling inflation, but all bets are off if the labor movement fails to limit its demands. As for trade, "the intent is to encourage exports," though ideological factors cloud the picture.

While the export rate may be on the rise, the Japanese threat should not increase. Foreign competitors have gone about as far as they can go, and recent unfavorable currency exchange rates are "giving the Japanese a problem."

KAZUO IWAMA

president, Sony Corp.

High on Iwama's worry list is the rapid fall of the U. S. dollar overseas. "I would like to see the dollar and the yen settle down at some set level. We cannot deal with constant changes in exchange rates."

Over 50% of Sony's $2-billion-plus net sales are from overseas markets, which suffer from price changes during currency fluctuations, especially in the vital American market. However, the color TV plant in San Diego has been a great aid in softening the price squeeze, since it uses almost 100% American-made components. That plant has also helped avoid some of the sting of the Orderly Market Agreement (OMA) between the U. S. and Japan to limit the imports of color television receivers into this country.

Although Iwama believes that the American-based plant deflects some of the problems of export limitations, he is still unhappy about the OMA because it gave producers on Taiwan and in South Korea an advantage they quickly exploited. "We consider it unfair for American plants on Taiwan to get the benefits from restriction on Japanese sets. The agreement needs adjustment."

Meanwhile, Sony will continue to promote diversification with its office dictation equipment. The line has become an important companion to audio tape recording products. "Just as video tape technology was transferred from professional and institutional video cassette recorders to consumer VCRs, audio technology developed in office machines can be fed back to broad consumer applications."

TARO KUNINOBU
president, Matsushita Electronic Components Ltd.

A lackluster domestic market, diminishing overseas markets, the weak U. S. dollar, and growing competition from Taiwan and Korea: yet Kuninobu is optimistic. "We have new areas for electronic technology," such as automotive electronics, industrial equipment, and communications systems. Concomitantly, there will be less emphasis on consumer electronics.

Another wellspring for his optimism is his belief in government action. "Basic economics tells us that, if you make a good product at a lower price, it is good for everybody. But now that is not true in international trade relations.

"That is why one company cannot solve trade problems; governments must play a role. Yet I have great expectations for the future."

Trade relations between Japan and the United States are not as bad as publicized, Kuninobu maintains. To improve them, though, he anticipates shifting some production directly to the U. S. in order to maintain a competitive position and to help America's balance of payments. "We should share some of the responsibility for [solving] American import problems. We are aware of it and are changing our strategy to having overseas manufacturing facilities in America,"

For now, he is hoping that, by the end of next year, government action on both sides of the Pacific will stabilize American currency and the Japanese economy.

W. J. SANDERS III
president, Advanced Micro Devices Inc.

For a man in the semiconductor business, Sanders is unusual in that "my concerns for 1979 are literally none." However, that is not the same as saying that the industry's growth will be the same as this year's, because he does join the chorus in expecting a slowdown to a rate between 5% and 10%.

There is a fly in the otherwise smooth ointment. "I absolutely expect problems hiring electrical engineers. There just aren't enough. Through the 1980s, we're going to have a tough time hiring all the EEs we want. We're going to have to develop ways to become more productive with our engineers."

Sanders is not optimistic about President Carter's attitude toward business. "I don't think he understands the way our system works. He clearly doesn't understand the American dream and the concept of incentives for achievement—he looks on them as some sort of ripoff tax benefit for the rich. Carter has plainly come down on the other side, relative to business, on his attitude toward capital gains."

For the nation's 1979 economy as a whole, Carter's recent fiscal moves and the rising interest rates will mean a growth rate in the Gross National Product "that isn't going to make 3% or even 3.5%. So I guess we're assuming for the purpose of planning that the real GNP in the United States will grow only 2%."

However, the Japanese and European GNPs will grow at twice that rate. "So I think that we can be looking at a 4% real GNP growth in the industrial countries that we serve."

JOHN W. ZEVENBERGEN
president, John Fluke Mfg. Co.

Electronically speaking, the Northwest is pretty much an instrumentation region, rather than a semiconductor area. So it has been relatively immune to Japanese competition, and it appears likely to stay that way in 1979.

"Our problem is the reverse," says Zevenbergen. "We're not worried about Japanese penetration of our domestic instrumentation market, but rather we're trying to figure out how to penetrate their market."

He believes part of the problem is lack of a joint venture in Japan. However, "that has not hurt our sales in Europe," which accounts for most of the company's 40% of overseas sales. To increase that market, Fluke will build a sales and service facility in Britain.

The vagaries of the economy are a key concern. Higher interest rates will tighten the money supply and affect "sales of our big-ticket items." As for expansion, however, Zevenbergen says the firm has already completed long-term capitalization plans that will be unaffected by coming high interest rates.

Carter's most recent bill signings indicate a slight shift to a friendlier-to-business posture. However, more action is essential in changing some of the import-export inequities that now exist between the U. S. and foreign nations.

LESLIE F. STEVENS

group vice president, Tektronix Inc.

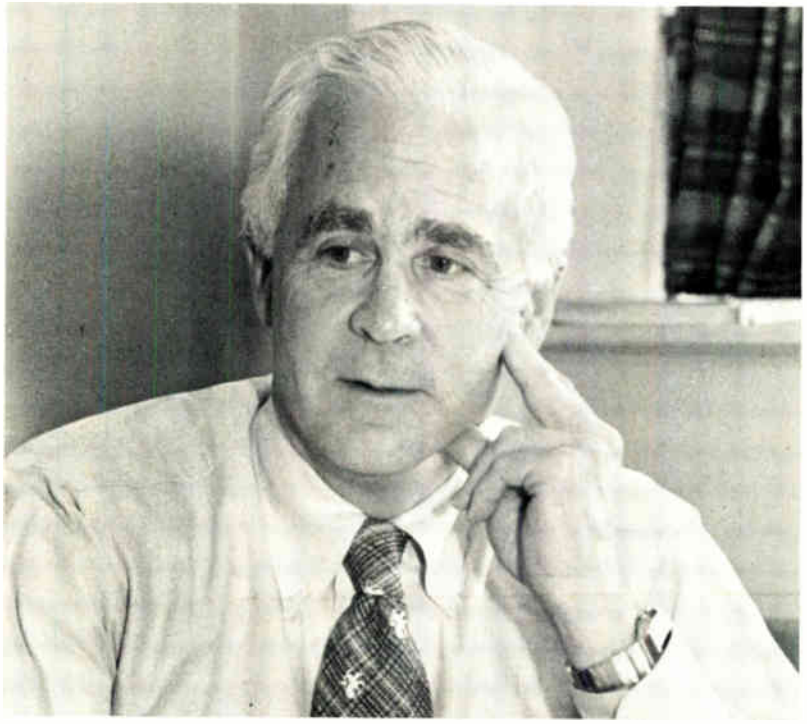
What recession? asks Stevens. The effects of an unpredictable economy on many industries could be worrisome, but he believes the electronics industries as a whole are practically immune. "We're in the middle of a revolution, and I don't see the economy affecting us much."

However, Carter's dollar-saving tactics will definitely slow the overall economy, but not enough to cause a recession. "The classical definition is two consecutive quarters of negative or less than 2% growth in Gross National Product, and, frankly, I don't see that happening."

Also troublesome are the wage and price controls companies like Tektronix will have to adopt in order to safeguard its present and future Government contracts. "It is going to be hard to do and at the same time improve on the delivery of some of our products," says Stevens.

The increased concern about the quality of life is making the job of recruiting fresh talent easier for Tektronix than for its California minicomputer and semiconductor counterparts. "However, the price of houses is rising, but nothing like what's going on down south."

One plus is Oregon voters' defeat of a Proposition 13–like proposal in the recent election. That defuses temporarily the problem of industry having to pay an even larger chunk of local revenues. Also, rainfall has increased in the Northwest since the slack conditions of a year or so ago, and that removes the specter of a shortage of hydroelectric power in the region.



WILLIAM R. THURSTON

president, GenRad Inc.

Racing to keep up with all the business opportunities available is the prime concern for 1979. However, staffing to meet those opportunities is a problem, and Thurston is not happy that some openings are going vacant for months at a time. The reason: high personal taxes in Massachusetts make recruitment from outside the state difficult.

While there is an obligation to think about a recession after such a long expansionary period as the current one, any coming dip is farther off than expected. "This time last year, we thought there would have to be a recession in 1979, but at this point it looks better for 1979 than it did a year ago. The threat of a recession has receded farther into the future."

Before President Carter's recent moves to shore up the dollar, Thurston says he felt there would be no recession until late next year or early 1980. "It might now come a little sooner, but it's likely to be less severe. At least, that's the way it was perceived in Europe when Carter made his move.

"I was there at the time, and the moves came across as massive. It was thought he should have been doing less massive things sooner," but there was relief that something was finally done.

However, Carter's attitude toward business is not encouraging. "I see no sign that he's aware of the relationship between investment and economic prosperity, and that's incredible. He seems to think that only the rich invest, and doesn't want them to get richer. The capital-gains tax reduction was passed, if not over his dead body, at least over his prostrate form."

With all that, though, the 1979 outlook is good. Short-term order forecasting is still strong worldwide, and the big automatic test system business has not slowed at GenRad, even in past recessions.

Customers justify test equipment purchases on the basis of return on investment. "They're looking for a payback in three months to a year, and they'll buy if they have the cash. It may cost them more, but even if they have to pay 10.5% interest instead of 8%, that's a second-order factor if they can see the payback."

JOHN W. DIXON
president, E-Systems Inc.

Continued growth will bless the world of aerospace—yes, aerospace—and the electronics industries in general, says Dixon. However there are some nagging drags on that upward trend, one of which is the acute and growing shortage of qualified engineers and of trained technicians as well.

"Just about everybody has had manpower problems" recently, and the situation will continue to worsen before "peaking out in two or three years." Thus, more in-house technical training will be necessary, together with "some real hard-nosed resource planning to make sure we've got these kind of people to the extent possible."

By shifting technical personnel among various operating divisions, the Dallas aerospace electronics and communications contractor has been able to lessen the impact of the shortage. "I think if I had a single-operation company, I'd be a lot more worried than I am."

A second major problem for business in general, and "one that worries me as much as anything," is capital formation, says Dixon. "The incentive to form capital is just gradually ebbing away. Most government regulations and policies are anti-capital formation."

The recently passed tax law was "just a little bit of a move back" in the right direction, "but I'm talking more about regulations than law." For every step gained one year, it seems that three steps are lost the next year, "so in the long run we're netting out a loss of anything that promotes the formation of capital."

The only solution is to "get some sense into government and the people who regulate business and the climate that induces investment. President Carter said he was going to do that, but he hasn't yet."

In terms of the Carter track record, however, the President "leans more toward business than a lot of people thought he would. On all of the measures where he has differed from Congress, and there have been plenty, the indication has been that he's willing to face the political hazards necessary to better the business environment."

JACQUES BOUYER
chief executive officer, Le Radiotechnique-Compelec

Growth is not an issue in 1979; competition is, says Bouyer. Markets are continuing to expand, but competition from the Far East is turning nasty. "Free trade is a magnificent concept—but we prefer fair trade.

"Southeast Asia is threatening whole sectors of the industry and bringing about structural changes that are not very apparent to the outsider but which are taking place all the same." The problem is not with the underdeveloped countries, where in fact the industrialized nations have a responsibility to foster development.

Japan is the problem, says the head of the Philips subsidiary. "We have to have an agreement of coexistence." He cannot understand why the U.S. lets antitrust legislation handicap American firms where the Japanese competition runs free. Yet another aspect of the problem: European firms do not constitute a trading bloc, but the Japanese firms do.

The big uncertainty next year is the U. S. dollar. Bouyer finds it difficult to imagine a European company managing to drop its prices 20% to compete with a devalued dollar.

Clouds on the far horizon are the American economy and any crises centered around the Middle East and petroleum. "If there is a slowdown in the U. S. economy, there will be much more pressure from American suppliers on the European market and less business for Europeans in the U. S." The dithering dollar, Far Eastern competition, and oil shortages apart, he foresees 1979 as reasonably good.

WILLIAM F. BALLHAUS
president, Beckman Instruments Inc.

If you want no big worries next year, you might try running an instrument company that expects its European sales to "more than overcome any 1979 downturn in the U. S." That is the position that Beckman's Ballhaus finds himself in, so he expects a good year.

The company is readying "lots of new products" to exploit an expected improved business climate in Europe. These sales should grow at double the rate of sales in the U. S. While programming a strong 1979, managers are "alert for changes and can act quickly if it turns," as they did in 1974. The company came through that recession with only slightly diminished growth.

At the same time, first effects of efforts to get tax laws more favorable to individual investors should make themselves felt. One of the electronics industries' most forceful advocates in Washington for changes in capital-gains taxes, Ballhaus says they are "basic to encouraging investments especially needed in high-technology businesses." He was instrumental in helping steer through 1978's tax laws.

"We made a lot of progress in our fight," but more reforms must be sought in 1979. Then investment bankers, venture capitalists, and private investors alike should again become active in helping to form the kinds of new businesses that characterized the electronics industries before 1969.

JOHN H. RICHARDSON
president, Hughes Aircraft Co.

For a company with a future tied to defense spending, some concerns loom bigger than others. One is the jump in front money companies must put up by Pentagon fiat. It is set to reach an all-time high for Hughes in 1979, along with commensurate capital outlays for production equipment and facilities.

Another worry is new rules for the Government's acquisition of equipment, always a ticklish subject with the aerospace business. A change in the procurement process for major weapons systems also is a concern. Pentagon planners now ask prospective contractors to spell out their hardware answers to a mission need. Called competitive concept formulation and source selection, this change could add years and millions of dollars to weapons development. However, Richardson hopes the kinks can be ironed out with practice and cooperation.

Since Department of Defense contractors are especially under the gun of the Administration's voluntary wage and price guidelines, these will hit hard in 1979. Hughes is "taking them seriously and is going to comply," but it is too early as yet to ascertain their effects.

Others in the industry, however, already have observed wage restrictions could lead to another round of job-jumping. But a Hughes recruiting blitz has succeeded in attracting enough engineers and technicians to fill scheduled programs, so this does not loom as a problem for 1979.

"For the year ahead, we expect to grow in engineering and manufacturing, but not quite at the 1978 rate, which was a peak." As high-technology defense systems move from engineering to production, sales figures tend to balloon. "Hughes was fortunate in the 1977–78 period as new programs moved into production.

"A DOD budget that continues to grow in real terms, however modestly, means a healthy market that is stable in the long run." Thus, the trick is to replace projects that are phasing down with new ones.

THOMAS R. SHEPHERD
president, GTE Consumer Electronics Co.

In the hurly-burly world of entertainment electronics, volatile change comes with the territory. However, looking at the coming year from Shepherd's command post in Batavia, N. Y., all is calm and bright with a patina of quiet optimism.

A major concern, as for most chief executives, is the economy. Still, now that the "Carter Administration has become genuinely concerned over its relations with the business community," there is reason to believe that conditions that have irritated many businessmen will begin to get more sympathetic attention in Washington. "We have seen some good moves already, so I have good feelings about the President."

There is no recession in Shepherd's view of the short term, though it is difficult to forecast now what will be happening a year from now. Sales of color TV sets should hover around the 10-million mark after a 10.2-million-unit year.

Further inroads by Japanese set manufacturers are not a matter of concern. "Price increases will stick; we have no plans to lower them and neither do the Japanese; and importers will be faced with stronger cost pressure."

Also in the cards for 1979 are increased capital spending at both Mexican and U. S. plants, because Sylvania expects demand to continue upward. In fact, 1979 will be much like 1978—"slightly lower but not much lower."

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

"Uncertainty about the business and economic outlook for the year ahead seems to be a much bigger factor now that at any time that I can recall," says Campbell, who on Jan. 1 takes over TRW Inc.'s widely diversified Electronics operations based in Los Angeles. Still, "October booking rates were a record, so the economy is not slowing down yet, although we certainly expect it."

For now, TRW is still planning expanded sales for 1979, but "the odds are increasing for some kind of slowdown." Administration moves to defend the dollar by raising interest rates play a major part in raising these chances. At the same time, such a slowdown "would be earlier and milder" than previously expected by observers.

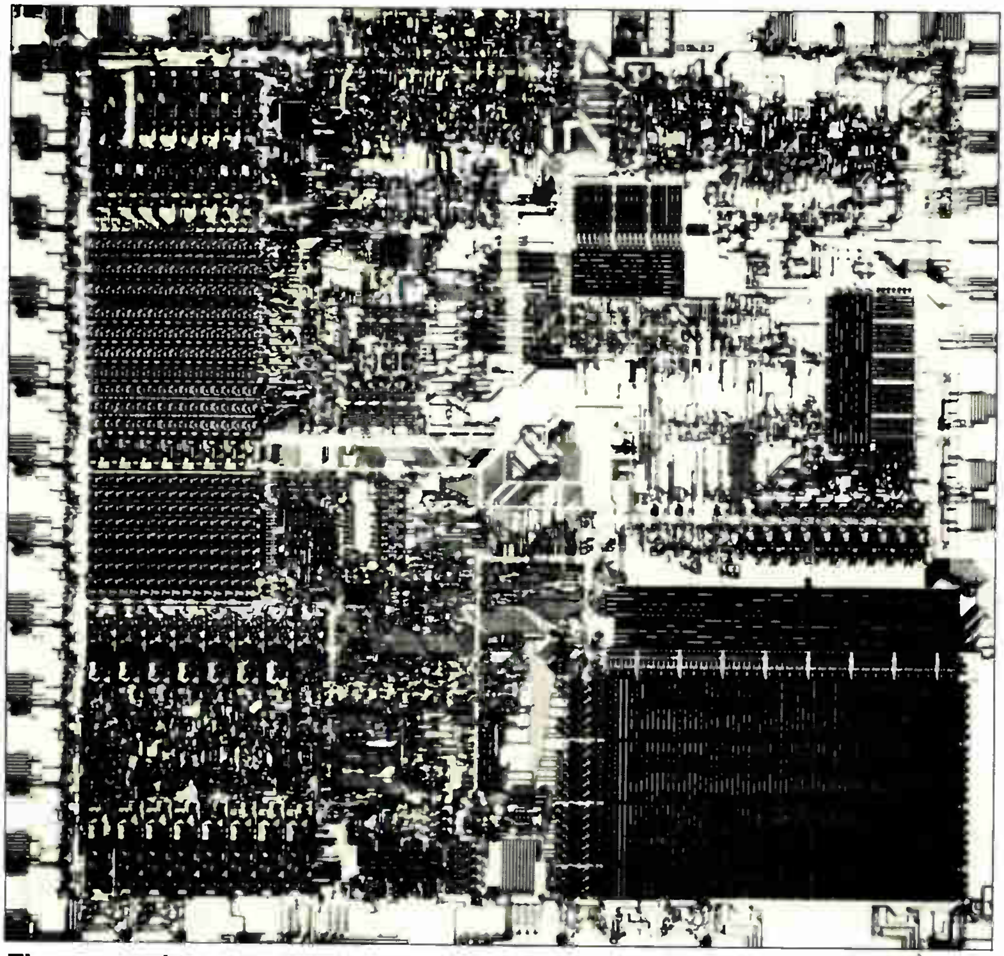
Expansion plans reflect the general uncertainty. TRW contemplates "big capital outlays across the board in all businesses:" components, data-based services, and telecommunications equipment. However, in keeping with the uncertain nature of prospects, "we keep a short string on it," so that changes may be made quickly.

In the government arena, Campbell admits that conflicting policies are "frustrating to see." On one side, business is exhorted to invest, export, and be more productive. On the other actions like minimum wage increases, higher Social Security taxes, and the Humphrey-Hawkins full-employment bill make such activities difficult. Just dealing with regulatory matters engages more and more executive time.

Hiring electrical engineers for California jobs may be a problem, but so is promoting them. The high cost of housing, especially in California, "freezes in place" people who usually would be seeking to move in order to advance themselves. "In an industry that thrives on mobility, this is a very serious matter."

A Business Week Special Report

THE SMART MACHINES



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8080's stack pointer transfers data blocks fast

by Prakash Dandekar
Tata Electric Companies, Bombay, India

By using the stack pointer register as one of the address pointers in this program, a block of data can be transferred from one memory area of an 8080 microprocessor-based system to another in 40% of the time required by traditional routines. Using the stack pointer (SP) saves instruction steps, and because it enables the transfer of two bytes at a time, it is inherently faster than single-byte transfer programs.

The traditional routine for transferring a block from a specified location to the destined area dedicates one register pair (usually H–L) as a source-data pointer, a second pair (B–C or D–E) as a destination-address pointer, and a single register or pair of registers (B, C, D, and/or E) as a byte counter. In such a program, data at an address specified by the source-address pointer is brought into the accumulator and is then stored in a new area indicated by the destination-address pointer. The byte counter is decremented each time this is done. Then a check is made to see if the counter has reached zero, indicating that all bytes have been copied. If the counter is at zero, the routine is terminated. Otherwise, the address pointers are incremented and the storage operation is repeated.

In the 8080, the stack pointer is available for use as an address pointer with the ability to increment or decrement itself. When data is stored in memory (known as a push operation), SP is decremented. During any data loading from memory (known as a pop operation), SP is incremented. It turns out that when SP is used as one of the two address pointers required on the traditional program, an instruction is saved each time the address pointers must be incremented.

The new program is shown in the table. The number of bytes to be transferred should be an even number, as the routine transfers bytes in pairs. Note that most of the processor's time is consumed in the copy loop. It will take the program 50 clock cycles to transfer two bytes of data; the traditional routine needs 39 clock cycles to transfer just one byte. The new program thus leads to a savings of 14 clock cycles per byte copied.

Furthermore, the traditional routine enables transfer of a maximum of 256 bytes. With minor modification to the new program at the PREP1 portion, it is possible to transfer up to 256 words, or 512 bytes. Note that using the traditional routine to transfer more than 256 bytes requires that registers B and C be used as a counter and that instructions be added to check for their decrement to zero. The latter, however, doubles the loop time. □

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.

8080 BLOCK-TRANSFER PROGRAM

```
LOC   OBJ CODE  SOURCE   STATEMENT

2000                          ORG 2000H
3000                     SSTAD  EQU 3000H
3002                     DSTAD  EQU 3002H
3004                     BYTCNT EQU 3004H

2000  2A0030    PREP1:   LHLD SSTAD      ;(SP) = STARTING ADDRESS OF SOURCE FILE
2003  F9                 SPHL
2004  2A0230             LHLD DSTAD      ;(HL) = STARTING ADDRESS OF DESTINATION FILE
2007  AF                 XRA A           ;ACCUMULATOR AND CARRY FLAG CLEARED
2008  3A0430             LDA BYTCNT
200B  1F                 RAR
200C  D1        LOOP1:   POP D           ;DATA BYTES IN (DE)
200D  73                 MOV M, E
200E  23                 INX H
200F  72                 MOV M, D
2010  23                 INX H           ;DATA BYTES STORED IN DESTINATION FILE

2011  3D                 DCR A           ;BYTE COUNTER DECREMENTED
2012  C20C20             JNZ LOOP1       ;LOOP AGAIN IF ALL ARE NOT OVER

2015  76                 HLT
2000                     END PREP1
```

A quick march checks memory

by A. James Laurino
Wilmington, Del.

While forms of what is known as the march test are commonly used by chip manufacturers to check whether a random-access memory has its full complement of independent storage cells, users have no simple way of detecting RAM faults with a microprocessor. The 14-line version of the march test presented here provides an easy way to march memory to check for problems using the 6800 microprocessor. It can also be easily adapted for any other computer system.

This test will show whether each bit location in memory is capable of storing both 1s and 0s and whether storing any bit in a given location causes a change in the other locations. The test may not detect marginal failures, but there is no single, simple worst-case test for all systems.

The program makes two passes through the address range for each bit in the memory word (for example, 16 passes for an 8-bit machine). Test patterns are produced by shifting a single logic-1 bit through the accumulator to see if the bits within each word are independent, and that each bit location can store both 1s and 0s.

The first pass for each pattern stores that pattern in every location. On the second pass each location is read to see if there has been any change. If there has been no change, the program marks that location to show that it has been tested, by performing a logic complement operation. If one location responds to two addresses, then the complement pattern will found when the test reaches the second address affected.

The program is entered at START, which must be an address above the range to be tested. The address range extends from 0 to the value of Top − 1 (e.g. Top must be 1000 hex to test addresses 0 through 0FFF hex). Upon entry, accumulator A should contain 1, and the index register (X) should contain the value of Top.

The locations in the address range to be tested are then filled with the first test pattern, generated by program lines 1 through 5. Each location is checked for a proper pattern and appropriately marked during lines 6 through 11. The next test pattern is generated and the test repeated until all patterns have been used (lines 12 and 13). At line 14, the test is concluded and the results reported.

If the memory is good, then register X will contain the value of Top and A will be zero. If a failure occurs, A will contain the failing pattern and X will have the failing address.

For example, consider the case where address line 5 (i.e., 2^5 bit) is stuck. The first failure would occur at address 20 hex, which would contain FE hex instead of the expected value of 1. □

6800 MEMORY CHECK PROGRAM

Label	Source statement				Comments
Start	DEX		09		Get the highest address to be tested
Fill	STA	A X	A7	00	Put the pattern in the current location
	DEX		09		Go to the next location
	BNE	Fill	26	FB	Continue through the address range
	STA	A X	A7	00	Put the pattern in the last location
Test	CMP	A X	A1	00	Check pattern in the current location
	BNE	End	26	0B	Stop if the pattern is not correct
	COM	X	63	00	Mark the location as tested
	INX		08		Go to the next location
	CPX	#Top	8C	-- --	Fill in the upper address limit here
	BNE	Test	26	F4	Continue through the address range
	ASL	A	48		Shift the one left to the next bit
	BCC	Start	24	E9	Repeat the test until all bits are used
End	SWI		3F		Return to monitor and display registers

TI-59 program convolves functions in time domain

by Fred Fish
Tempe, Ariz.

Performing a convolution in the time domain—that is, a multiplication of two functions in the frequency domain—this TI-59 program, with the aid of the PC-100A printer, easily determines the output of a system, given its impulse response and an input signal. The program solves:

$$f_1(t)*f_2(t) = \int_{-\infty}^{\infty} f_1(\tau)f_2(t-\tau)d\tau$$

where $f_1(t)$ is the impulse response and $f_2(t)$ the input signal. It uses a graphical (numerical) technique and tabulates the results directly as a sampled-time function.

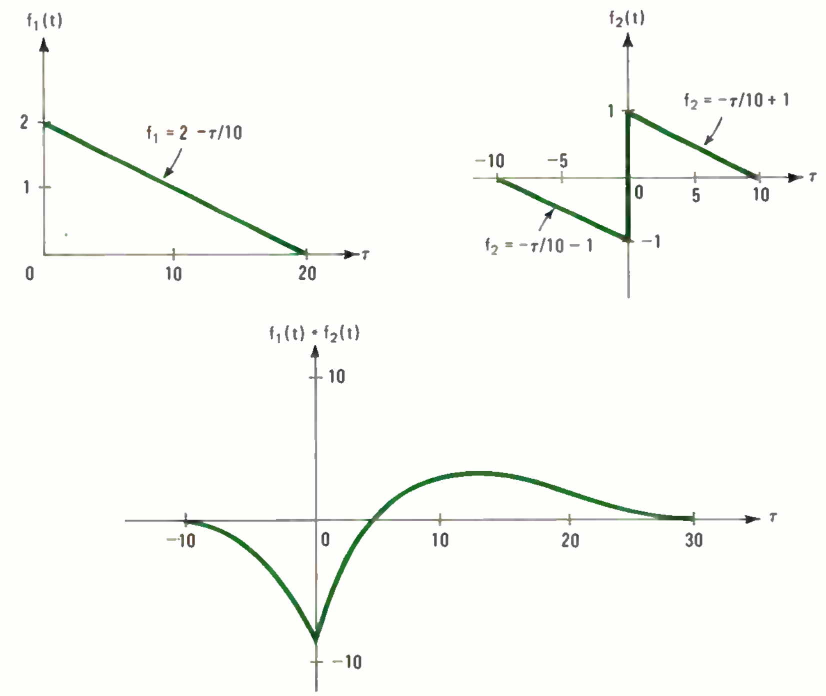
The user need not supply the program with much more than f_1 and f_2 as functions of time, provided he keeps in mind the need to define appropriate time scales and to specify equal sample-time increments for each. Sample values for each function, as shown in the example in the figure, should be the midpoint values for the time interval specified. If discontinuities are present, such as at $t = 0$ for $f_2(t)$, they should fall on the interval's edges (in other words, $f_2(t)$'s value should be specified for odd values of t in this case).

Using the program is very easy. After loading the program into the calculator, the user simply presses key A and follows the printer's instructions, which asks for the minimum and maximum range of t over which $f_1(t)$ and $f_2(t)$ are specified the time interval (Δt), and then the values of $f_1(t)$ and $f_2(t)$ for each value of t called for by the program. The total number of sampled values for $f_1(t)$ and $f_2(t)$ should not exceed 45. It is only necessary to press the R/S key after each entry.

The printer will tabulate $f_1(t)*f_2(t)$ for values of t extending from the minimum t specified—in this case -10 for $f_2(t)$—to the total of the maximum t specified. In the example, $t_{max} = 20+10 = 30$ for $f_1(t)+f_2(t)$. □

Multiplication. TI-59 calculator convolves circuit's impulse function $f_1(t)$ with input forcing function $f_2(t)$ to determine total circuit response, using a numerical technique. Results of the convolution are tabulated as a sampled time function by a PC-100A printer.

t	$f_1(t)$
1	1.9
3	1.7
5	1.5
7	1.3
9	1.1
11	0.9
13	0.7
15	0.5
17	0.3
19	0.1



t	$f_2(t)$
−9	−0.1
−7	−0.3
−5	−0.5
−3	−0.7
−1	−0.9
1	0.9
3	0.7
5	0.5
7	0.3
9	0.1

t	−10	−8	−6	−4	−2	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
$f_1(t) * f_2(t)$	0	−0.38	−1.48	−3.22	−5.52	−8.3	−3.88	−0.58	1.68	2.98	3.4	3.38	3.28	3.02	2.52	1.7	0.88	0.38	0.12	0.02	0

TI-59 PROGRAM FOR NUMERICAL CONVOLUTION

000	LBL	059	4	118	0	177	C′	236	0	295	SUM	354	RCL	413	10
001	B	060	1	119	OP	178	E′	237	0	296	11	355	08	414	STO
002	OP	061	3	120	02	179	B	238	1	297	RCL	356	PRT	415	06
003	05	062	7	121	RTN	180	STO	239	3	298	03	357	ADV	416	LBL
004	CLR	063	OP	122	LBL	181	01	240	OP	299	=	358	1	417	X^2
005	R/S	064	01	123	A	182	ADV	241	02	300	RCL	359	2	418	C
006	PRT	065	RTN	124	CMS	183	D′	242	3	301	01	360	STO	419	RCL
007	RTN	066	LBL	125	ADV	184	B	243	7	302	−	361	09	420	05
008	LBL	067	C′	126	5	185	STO	244	0	303	÷	362	CLR	421	SUM
009	C	068	2	127	1	186	03	245	0	304	RCL	363	R/S	422	11
010	2	069	1	128	5	187	ADV	246	3	305	05	364	PRT	423	RC·
011	1	070	0	129	1	188	E	247	7	306	=	365	X⇄T	424	07
012	0	071	2	130	5	189	E′	248	6	307	STO	366	A′	425	×
013	2	072	0	131	1	190	B	249	4	308	10	367	X⇄T	426	RCL
014	5	073	0	132	0	191	STO	250	0	309	RCL	368	LBL	427	05
015	1	074	3	133	0	192	02	251	0	310	02	369	Σ+	428	=
016	2	075	0	134	1	193	ADV	252	OP	311	+	370	+	429	PRT
017	1	076	OP	135	5	194	D′	253	03	312	RCL	371	(	430	A′
018	0	077	02	136	OP	195	B	254	OP	313	05	372	CE	431	OP
019	3	078	RTN	137	01	196	STO	255	05	314	÷	373	=	432	27
020	OP	079	LBL	138	3	197	04	256	RCL	315	2	374	RC·	433	DSZ
021	01	080	D′	139	2	198	ADV	257	08	316	=	375	09	434	06
022	1	081	1	140	3	199	7	258	PRT	317	STO	376	)	435	X^2
023	3	082	3	141	1	200	5	259	ADV	318	08	377	SM·	436	ADV
024	3	083	4	142	4	201	3	260	R/S	319	LBL	378	00	437	ADV
025	7	084	4	143	2	202	7	261	ST·	320	CE	379	0	438	ADV
026	0	085	0	144	3	203	0	262	07	321	RCL	380	=	439	ADV
027	0	086	0	145	2	204	0	263	PRT	322	07	381	OP	440	RTN
028	3	087	3	146	2	205	0	264	A′	323	STO	382	29	441	LBL
029	7	088	7	147	7	206	0	265	OP	324	00	383	OP	442	A′
030	OP	089	0	148	OP	207	OP	266	27	325	RCL	384	20	443	5
031	02	090	0	149	02	208	02	267	RCL	326	10	385	DSZ	444	1
032	6	091	OP	150	4	209	0	268	05	327	STO	386	06	445	5
033	4	092	03	151	1	210	OP	269	SUM	328	06	387	Σ+	446	1
034	0	093	RTN	152	3	211	03	270	08	329	B′	388	RCL	447	5
035	0	094	LBL	153	7	212	B	271	RCL	330	2	389	05	448	1
036	0	095	E′	154	2	213	STO	272	08	331	1	390	SUM	449	5
037	0	096	2	155	4	214	05	273	X⇄T	332	0	391	08	450	1
038	0	097	4	156	3	215	÷	274	RCL	333	3	392	C	451	5
039	0	098	3	157	2	216	2	275	03	334	0	393	RC·	452	1
040	0	099	1	158	3	217	=	276	GE	335	0	394	07	453	OP
041	0	100	0	159	1	218	STO	277	RCL	336	1	395	×	454	01
042	OP	101	0	160	OP	219	08	278	ADV	337	3	396	RCL	455	OP
043	03	102	3	161	03	220	A′	279	ADV	338	OP	397	05	456	02
044	OP	103	7	162	5	221	RCL	280	A′	339	02	398	SUM	457	OP
045	05	104	0	163	1	222	01	281	RCL	340	3	399	11	458	03
046	RCL	105	0	164	5	223	SUM	282	01	341	7	400	=	459	OP
047	11	106	OP	165	1	224	08	283	+	342	0	401	PRT	460	04
048	PRT	107	03	166	5	225	1	284	RCL	343	0	402	A′	461	OP
049	ADV	108	RTN	167	1	226	2	285	02	344	3	403	OP	462	05
050	RTN	109	LBL	168	0	227	STO	286	=	345	7	404	27	463	OP
051	LBL	110	E	169	0	228	07	287	STO	346	6	405	RCL	464	00
052	B′	111	2	170	OP	229	LBL	288	11	347	4	406	08	465	CLR
053	2	112	1	171	04	230	RCL	289	C	348	0	407	X⇄T	466	RTN
054	4	113	0	172	OP	231	B′	290	0	349	0	408	RCL		
055	3	114	3	173	05	232	2	291	PRT	350	OP	409	04		
056	1	115	0	174	ADV	233	1	292	A′	351	03	410	GE		
057	3	116	0	175	A′	234	0	293	RCL	352	OP	411	CE		
058	3	117	3	176	B′	235	2	294	05	353	05	412	RCL		

Instructions

- Key in program
- Press A
  Printer's routine is initialized
- Following printer's instructions, enter minimum and maximum values of t over which $f_1(t)$ an $f_2(t)$ are specified, the time division increment, and the sample values for each function:
  $(t_{min f_1})$, R/S, $(t_{max f_1})$, R/S, $(t_{min f_2})$, R/S, $(t_{max f_2})$, R/S, (Δt), R/S, $(f_1(t_1))$, R/S, $(f_1(t_2))$, R/S . . . $(f_1(t_n))$, R/S, $(f_2(t_1))$, R/S, $(f_2(t_2))$, R/S . . . $(f_2(t_n))$.
- Press R/S
  PC-100A prints results of $f_1(t) * f_2(t)$ from $t_{min f_1}$ or $t_{min f_2}$ to $(t_{max f_1} + t_{max f_2})$.

Engineer's newsletter

SR-52 program can be plotted without a printer

A calculator program that plots mathematical functions with an SR-52 on TI's companion PC-100 printer [*Electronics*, March 17, 1977, p. 92] is useful even if you don't own the printer, says K. S. Birdi of the Institute of Physical Chemistry in the Technical University, Lyngby, Denmark. He explains that **by replacing the print instruction (*prt) with halt (HLT) each time it appears in the program, the calculator will display what it would have printed.** Hitting RUN then displays the next point that would have been printed. Thus each line of the plot appears, with the function's value indicated by the position of the decimal point amid a field of 1s. The curve, of course, can be easily plotted on graph paper by following the position of the decimal point, Birdi says.

Carbon resistor doubles as low-temp switch

The Kitt Peak National Observatory in Tucson is using some simple electronics to fight a contamination problem due to the evaporation of liquid nitrogen. The N_2 cools a diffusion pump using oil to maintain an optical sensor in a vacuum—but **if the nitrogen completely evaporates, the oil warms up and leaks into the vacuum.** So Tom McGuire, an engineer on the observatory staff, put together a sensor and control switch that guards against the hazard.

The sensor, which goes in the nitrogen, is a carbon composition resistor with resistance of 100 kΩ at 300 K and 200 kΩ at the liquid N_2 temperature of 77 K. A straightforward voltage-divider circuit monitors the resistor, and its output is buffered and compared to a reference. The comparator's output drives an optically isolated solid-state relay, which controls the diffusion pump's heater. The total power consumed by the circuitry is only 225 mw, allowing use of a simple half-wave power supply.

Alumina may not be opaque

It's no secret that light waves, particularly between 400 and 1,100 nm, can cause spurious currents in silicon circuitry. Sometimes the effects are inconsequential, but they can alter device characteristics. Then microelectronic packaging engineers must look at the spectral transmission characteristics of ceramic packages. **They should also bear in mind some surprising findings at the Technical Ceramic Products division of the 3M Co. in St. Paul.** The study indicates that black alumina has a light transmission ranging from 15% to 25% in the 300-to-1,250-nm range. Moreover, brown alumina, usually considered to be opaque, has a 6% light transmission at 1,250 nm.

Packaging workshop plans to explore high-voltage circuitry

The mysteries of packaging high-voltage circuitry will be explored at a two-day workshop held by the International Electronics Packaging Society at the Anaheim Convention Center, Anaheim, Calif. Topics to be covered include the latest advances in packaging, insulation systems, materials and applications, manufacturing methods, failure analysis, test technology, and modeling. **Registration fee for the Feb. 26–27 session will be $15,** and more information is available from William G. Dunbar, Mail Stop 88-22, Boeing Aerospace Co., P. O. Box 3707, Seattle, Wash. 98124.

Jerry Lyman

Chip checks and compares characters

N-MOS device in 16-pin DIP generates block-check and parity codes, detects block and parity errors, and recognizes character sequences

by Robert Brownstein, San Francisco regional bureau

Preserving the integrity of data in its travels within a computer system or over communications lines is no easy task. It requires either extensive dedicated hardware or a lot of processing overhead and software. At least it did until now.

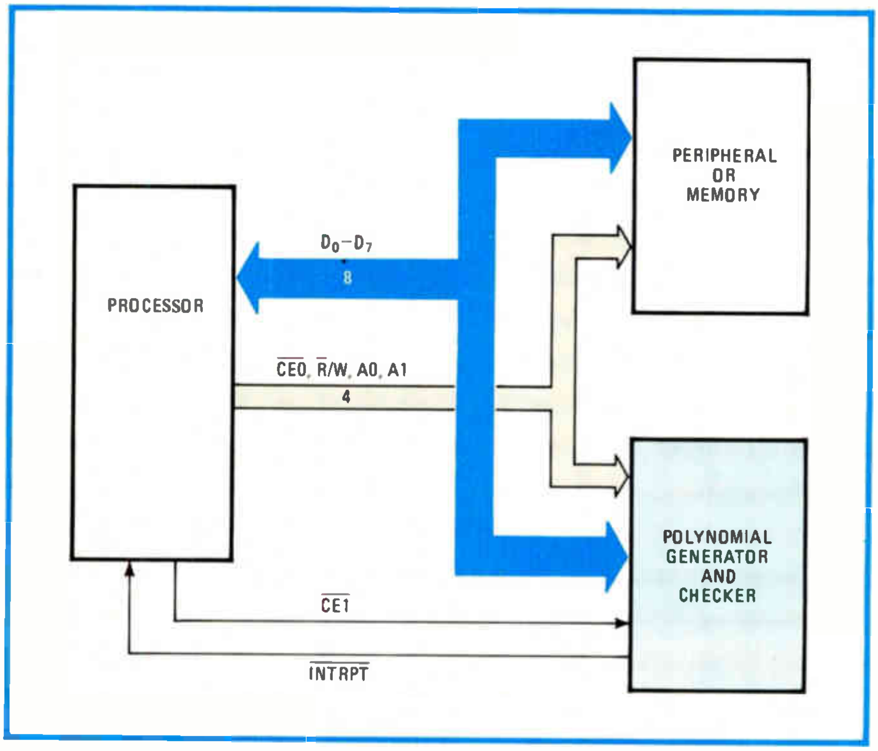
Signetics Corp. is slashing both hardware and software requirements with a large-scale integrated circuit called the model 2653 polynomial generator and checker. A 16-pin n-channel metal-oxide-semiconductor device, the PGC sits on a microprocessor's 8-bit data bus. There it monitors parallel data characters and performs one of the following functions, depending upon the application: block-check character generation, block-check character checking, single-character detection, two-character-sequence detection, or parity checking.

The chip is the first in a series of LSI devices intended to solve problems plaguing data-communications engineers, according to Everett W. Cole, product market engineer. Basically, it relieves a central processing unit of the task of comparing character data with the contents of a software look-up table to determine whether or not to take some course of action. For example, a CPU could be doing other things while ASCII data was flowing between a keyboard and a cathode-ray tube's character generator. If a control character was sent, the checker chip would detect it and interrupt the CPU, which would then read the character and initiate some input/output function. "A PGC can often replace half a board of hardware and significantly reduce software, while at the same time lowering design cost and raising communications speed," states Cole.

"Subroutines like cyclic, vertical, and horizontal redundancy checks are the essence of Bisync block character checking and are the PGC's main targets," says Alan J. Weissberger who created the device and is responsible for technical marketing of data-communications products. Its Bisync normal and transparent modes obviate the need for software usually required to accumulate or not accumulate characters in accordance with the rules established for Bisync character-oriented data links, he adds. (Bisync is IBM's protocol for binary synchronous communications. With it, messages are transmitted in blocks composed of a header or control field, a body or text field, and a trailer or error-checking field.)

In other data-transfer operations, as when an I/O peripheral is communicating with a memory under the control of a direct-memory-access controller, the PGC can be used to monitor the traffic and interrupt the CPU only if it detects an error.

Programmable. Key to the versatility of the 2653 are its bus-oriented architecture and its programmability. When it is initialized by the CPU (using the CE0, CE1, A0, and A1



Efficient. The polynomial generator and checker (PGC) cuts down on the amount of character comparison and redundancy checking that the processor must perform. It generates an interrupt only when it detects a sought-after character or an error.

control lines), the PGC is programmed to produce an interrupt when it detects one or more of the following conditions: a parity error, a block-character-check error, a specified single character, and a DLE (data-link-escape) character followed by a specified second character.

During initialization the PGC is also programmed to selectively accumulate data from which it generates a selected polynomial for one of several character redundancy checks or a longitudinal redundancy (parity) check. When data is being transmitted, the chip generates the specified polynomial, storing the remainder, which the CPU reads and appends to the transmission as a block-checking character. During a receive operation, the PGC generates the same polynomial. However, in this case, it compares the remainder with a stored character and generates an interrupt if it detects an error. For Bisync operation, the PGC is programmed with up to 128 codes, which it uses to distinguish between characters to be accumulated and those to be ignored. The accumulated characters go to a block-character-check generating unit whose intermediate results are stored in a pair of registers. The remainder in the block-character-check registers is the basis of the error-checking scheme.

In addition to ASCII and Bisync, the model 2653 can handle EBCDIC (an 8-bit information code set established by IBM) and SBT (a 6-bit information code set). In particular, a special DLE read-only memory and comparator allows rapid recognition of a data link escape in any of the four codes.

PGCs have transistor-transistor-logic–compatible inputs and outputs and operate from a single 5-V supply. The devices are scheduled for large-quantity shipping during the first quarter of 1979. The price will be between $6 and $10 each in lots of more than 1,000 pieces, according to Cole.

Signetics Corp., 811 E. Arques Ave., Sunnyvale, Calif. 94086. Phone (408) 739-7700 [338]

Computers & peripherals

Desktop unit speaks APL

Under-$20,000 system offers up to 256 kilobytes of virtual memory

Aimed squarely at IBM's model 5110 computing system, the System 900 is a desktop computer that, in its full-blown configuration, not only offers an APL language interpreter, but has 256 kilobytes of virtual memory as well. The heart of the system is one of three computers: the 908, 916, or 924, with respective main-memory capacities of 8, 16, or 24 kilobytes. The prices of the three computers are $9,300, $9,650, and $9,950, respectively.

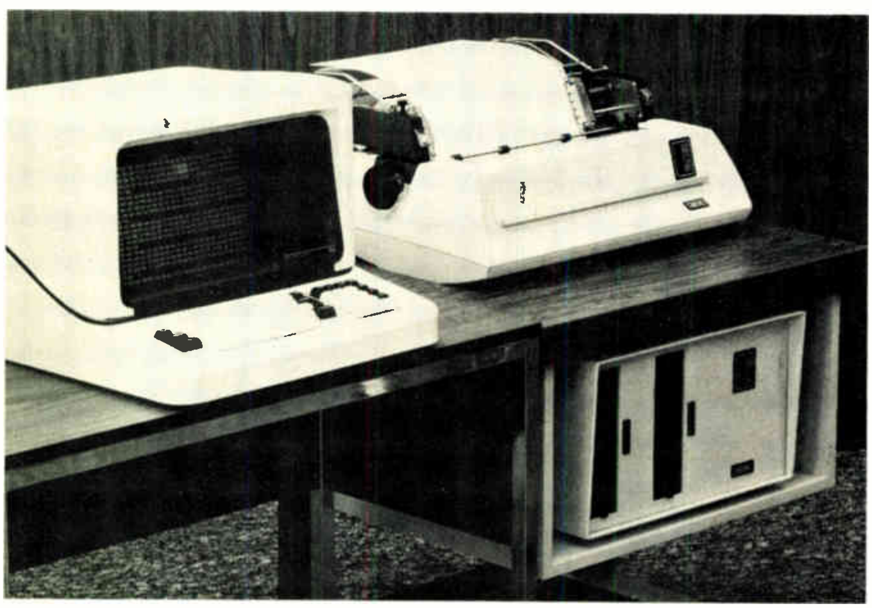
All three computers include a 12-in. video screen capable of displaying 21 lines of 96 characters each, a 48-character keyboard, a numerical key pad with seven functions and a space bar, and a programmable audio alarm.

To form a complete computer system requires the addition of a model DDS-1000 dual diskette drive and one of several printers. The diskettes provide the system's 256 kilobytes of virtual memory. Available printers range from a 45-character-per-second to a 300-line-per-minute unit. Alternatively, an interface card and necessary software are offered for attaching the System 900 to any Centronics printer.

Users who want the System 900 to function as a remote station in a distributed network or as an interactive batch-entry device for a time-sharing system can employ an optional asynchronous communications interface. Programmable to meet the needs of several standard protocols, the interface accommodates transmission speeds from 300 to 4,800 bauds.

Though it is a general-purpose computer capable of handling both scientific and business applications, the System 900 shows its greatest strength in applications involving file access and large data-base retrieval. According to Ted Berg, president of Interactive Computer Systems, the machine can perform a typical random file retrieval in 1 to 2 seconds. The IBM 5110 takes several minutes to perform the same task, he claims. In less specialized applications, he says that benchmark tests indicate that the System 900 is four to five times faster than the IBM system.

Complete systems, including dual diskette and printer, are priced between $15,000 and $18,000. Delivery time is 30 to 60 days after receipt of order.



Interactive Computer Systems Inc., 310 East 46th St., Suite 16W, New York, N. Y. 10017. Phone (212) 697-6906 [361]

16-bit OEM computers pack in features

Although it is best known for its 32-bit minicomputers, the Interdata division of Perkin-Elmer's Data Systems group has also been marketing a line of 16-bit machines for some time. The division has just improved the price/performance ratio of the 16-bit line with the introduction of its Series Sixteen—three new computers that incorporate the latest in LSI transistor-transistor-logic parts and both 4,096-bit and 16,384-bit semiconductor memories. The computers that are being displaced—the 5/16, 6/16, and 8/16—use magnetic-core memories.

Several features that were optional on the old machines are now standard, says marketing manager Gary Doninger. Among them are hardware signed multiply and divide, list processing, automatic restart after a power failure, a serial input/output port, and a line-frequency clock. The new processors, which use a dual-bus architecture, provide 16 general-purpose registers, a set of 161 basic instructions, and 255 interrupt levels.

Resource sharing has been added to Interdata's OS/16 multitasking operating system, so it now can handle as many as 16 terminals for program development, Doninger adds. The operating system also supports batch processing. Two high-level programming languages, Basic and Fortran, are offered.

The model Sixteen 10 can have between 16 and 64 kilobytes of memory and starts at $4,800. The Sixteen 20 can support from 32 to 256 kilobytes at prices ranging from $9,000 to $15,000. Both have a cycle time of 900 ns and use parity checking in memory. Any model 10 can be upgraded in the field to a model 20.

The top end Sixteen 30 has a

memory cycle time of 750 ns and uses full error checking and correction. Maximum memory size is 256 kilobytes. Prices on the Sixteen 30 range from $11,500 to $17,500. Doninger notes that memory expansions are priced at an equivalent of $36,000 per megabyte, which he says is competitive with the recent industry trend to lower minicomputer memory prices.

Interdata Division, 2 Crescent Pl., Oceanport, N. J. 07757 [362]

Floppy-disk drives include controller/formatters

Offered in single- and double-density versions as well as in single- and multi-drive configurations, a series of flexible-disk drives comes complete with built-in controller/formatters. Built around a 6800 microprocessor, the controller/formatter is contained on a single board, which fits inside the drive enclosure. In the space usually required for a single 8-inch flexible-disk drive, a systems designer can now fit a subsystem compatible with an IBM 3740, 3540, or System 3 that has the intelligence needed to respond to macrocommands from the host computer.

The command structure of the new drives is claimed to reduce host software overhead by as much as 50% and to increase throughput by 20% compared to conventional drives. Features include fully automatic data block transfers, automatic diskette initialization in IBM standard 26-sector or selectable 15- or 8-sector formats, a copy function, and automatic sector sizing.

One single-density subsystem can store 256 kilobytes of data in a 26-sector format, 295 kilobytes in 15 sectors, or 315 kilobytes in 8 sectors. The double-density version doubles these figures. For increased capacity, multiple units can be connected in master-slave fashion. The slave units require a minimum of control circuitry and, therefore, permit cost savings of up to 10% over standard daisy-chain arrangements. Prices begin at $935 for small OEM quantities. Delivery time is 30 to 60 days after receipt of order.

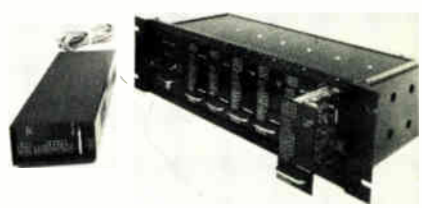
Remex Division of Ex-Cell-O Corp., P. O. Box C-19533, 1733 Alton St., Irvine, Calif. 92713. Phone (714) 557-6860 [364]

Auto-answer modem needs no data access arrangement

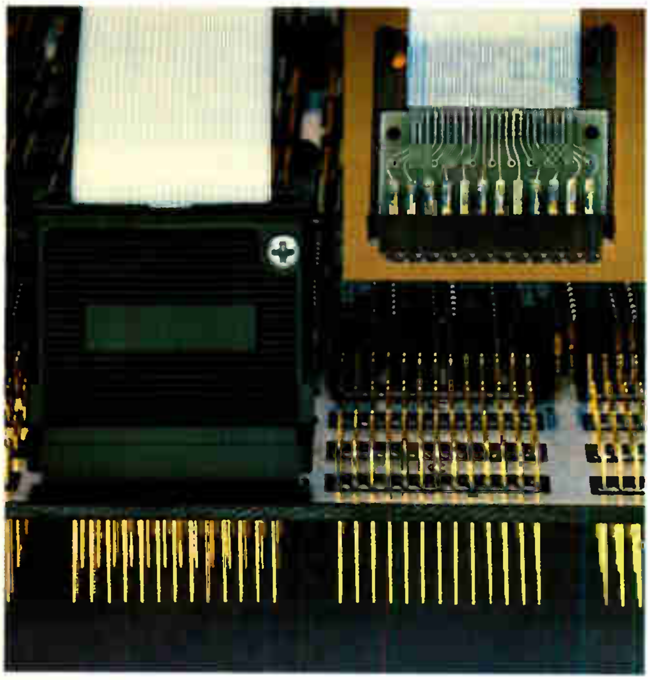
The P-202S is a two-wire modem intended for the automatic answering of computer calls. Capable of both simplex and half-duplex operation, the 1,200-bit-per-second modem connects to the dial-up switched telephone network with no need for a data access arrangement (DAA). Connection is made through either a 97A or 97B jack.

Specifications of the P-202S include a serial binary asynchronous data format, a transmit level of -3 to -12 dBm (programmable by a resistor in the 97B jack), a receiver sensitivity of -48 dBm, and frequency-shift keying modulation. The modem sells for $455 in singles. A card version, which has no enclosure or power supply, is priced at $340 in singles.

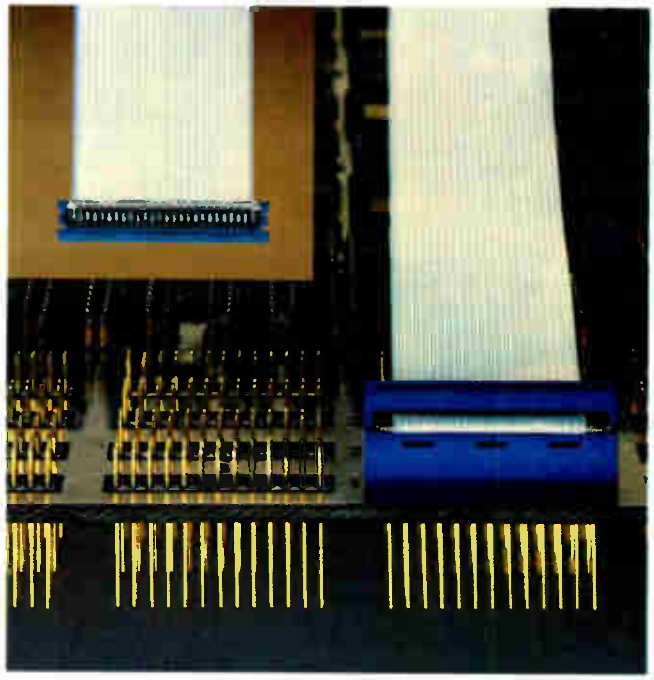
Prentice Corp., 795 San Antonio Rd., Palo Alto, Calif. 94303. Phone Bill Myers at (415) 494-7225 [363]



Berg's TLC* connector terminates transmission line cable without a paddleboard.



Paddleboard assembly–the slow way.



"TLC" connector–the fast way.

Assembly time and the cost of terminating transmission line cable are significantly reduced with Berg's unique "TLC" connector system. Completely eliminating the need for a paddleboard, the "TLC" connector reduces cable assembly time to seconds.

The connector's compact size provides greater signal fidelity and facilitates high-density packaging.

"TLC" connectors terminate any cable with signals on 0.050″ centers. The ground wires are commoned on the buss bar allowing use of a wide range of cable designs with a variety of ground centers and diameters. Pre-deposited solder on the buss bar and signal tabs allow for mass reflow. This produces higher yields and further reduces assembly cost.

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

"TLC" connectors mate with 0.025″ pins or standard Berg headers on 0.100″ grid to form a complete interconnection system.

Look to Berg for innovative research and development to meet your connector needs, today and in the future. For a brochure describing the "TLC" system, write or call:

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

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Microcomputers & systems

Pascal system runs from ROM

Rugged industrial unit both develops programs and utilizes them

The Universal Development System 470 is a rack-mountable instrument that can be used as both a development system and an industrial controller. When fully loaded with floppy disks, random-access memory module, and optional data terminal, the 470 allows development of applications software using the high-level language Pascal.

Once the user's software has been developed, read-only memories can be programmed with the user's code, an interpreter for Pascal's intermediate code called p-code (pseudocode), and run-time support software. The resulting one or two boards of ROM can then be put back into a stripped-down version of the rugged UDS 470 to become a 6800-based microcomputer in an industrial environment.

The UDS 470 from Control Systems Inc., features University of California/San Diego Pascal for program development—a software system expressly formulated to be easily transported from one microprocessor to another [*Electronics*, Oct. 12, p. 81]. Moreover, with Pascal in ROM, this language becomes an alternative to assembly language or Basic for low- or medium-volume applications where program performance and a fast development time are essential.

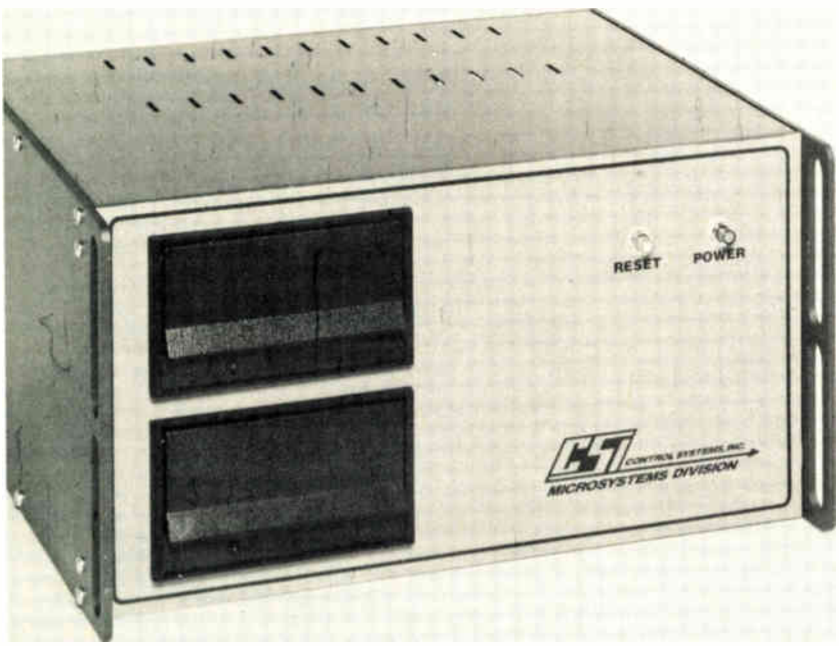
"We make available a version of UCSD Pascal specifically designed to execute directly from ROM or erasable-programmable ROM in dedicated applications where the software development cycle would be prohibitively slow with assembly language," says Dave Allen, technical manager of CSI's Microsystems division. "Although UCSD Pascal was designed to be executed from random-access memory, RAM is expensive and must be loaded from diskette."

ROM, even E-PROM, on the other hand, is much cheaper and "self-booting." Once the user's applications software has been developed, one or two cards of ROMs or E-PROMS are sufficient to store all of UCSD's run-time code, in addition to the applications software itself, at a relatively low cost."

The UDS 470 currently uses the 6800 microprocessor, but it can be upgraded to the 6809 or 68000 when they become available. USCD's 1.5 version of Pascal is being supplied now, but the newer version will be used when released next spring. The system is locked into neither any one microprocessor nor any one version of USCD Pascal.

The cost of the UDS 470 varies from $1,200 to $8,000 depending on the configuration. A development package, for example, having a central-processing-unit card, a 32-kilobit RAM card, a 16-K E-PROM card, floppy-disk drives with interface, power supply, and case would cost roughly $4,000 for one. A controller having the preceding items less the RAM module and disk drives would be about $1,200 each for a quantity of ten. Software and hardware options are also available.

Control Systems Inc., 1317 Central, Kansas City, Kan. 66102. Phone Dave Allen at (913) 371-6136 [371]



Multibus-compatible imager is complete for color or B/W

The RGB-256 is a single, Multibus-compatible board that contains a complete color or gray-scale imaging system. The card can address a 256-by-256 array of picture elements, using nibbles (half bytes) to provide 16 colors or gray levels. Furthermore, two boards can be connected in a master-slave operating mode to yield up to 256 different shades.

The card includes color and gray-scale encoders that can be configured for either the American NTSC or the European PAL standard. It interfaces with a standard color or black-and-white monitor with a single 75-Ω cable.

Synchronizing signals can be generated on board or supplied from an external source like a television camera. The RGB-256 takes 1.4 μs to generate an individual pixel and erases a screen in 33 ms with a single command. Displays can be scrolled vertically one line at a time.

The board requires +5- and ±12-v power. In quantities of 100 or more, it is priced at $1,295. Delivery time is four weeks.

Matrox Electronic Systems Ltd., 2795 Bates Rd., Montreal, Que. H3S 1B5, Canada. Phone (514) 481-6838 [374]

Hard-disk subsystem offers 40 megabytes of storage

For microsystems that require macrostorage, a hard-disk subsystem from Pertec, dubbed the iCOM 4511, supplies up to 10 megabytes in its basic configuration. That configuration consists of a microprocessor-based iCOM intelligent controller and a D3000 disk drive. Since the controller can manage an additional three drives, systems can be configured with up to 40 megabytes.

With five megabytes of fixed storage and five of removable storage, the disk drives operate at speeds of 2,400 rpm. Positioning time is 10 ms track to track, average access time is 40 ms, bit density is 2,200 b/in., and data-transfer rate for the subsystem is 5.0 MHz.

S-100–compatible versions of the iCOM 4511 are priced at approximately $9,000 in single quantities. They are available now.

Pertec Computer Corp., 20630 Nordhoff St., Chatsworth, Calif. 91311. Phone Steve Elsner at (213) 998-1800 [375]

Memory boards take on 16-bit Multibus systems

Expanding to meet the needs of 8086-based products, the MBC series of Multibus-compatible memory boards now includes four additional sizes: 16, 32, 48, and 64 kilowords. Since they are strappable for either single-word or byte memory transfers, the boards can also be used with 8-bit SBC systems.

The boards can be configured for single-bit error correction and double-bit detection. Thus arranged, on-board diagnostics indicate the erring chip and alert the central processing unit—a useful feature for production testing and field servicing.

The boards are available without this capability and with single-bit parity, or without either. Depending on capability and memory size, prices range from $1,375 to $4,250 in single quantities. Delivery time is 30 days.

Mupro, 424 Oakmead Pkwy., Sunnyvale, Calif. 94086. Phone (408) 737-0500 [376]

Pascal-hungry people served processor or complete system

Engineers enticed by the efficacy of Pascal, yet not in a position to build their own microcomputer from the Pascal-oriented chip set introduced by Western Digital Corp. [*Electronics*, Oct. 12, p. 155], can now buy the Pascal Microengine, a computer based on that set.

The p-code computer can be purchased complete with desktop central processor, 64 kilobytes of

random-access memory, dual floppy-disk drives, 60-character/second printer, cathode-ray terminal, and Pascal operating system on diskette, all for about $8,000. The desktop processor can be purchased separately for $2,995.

For the really eager there is a special bonus—until January 1, the processor and system are being offered at an introductory price of $1,995 and $6,095.

Computer Interface Technology, 2080 S. Grand, Grand Centre, Santa Ana, Calif. 92705. Phone (714) 979-9920 [377]

Industrial

Sealed transmitter can be set by user

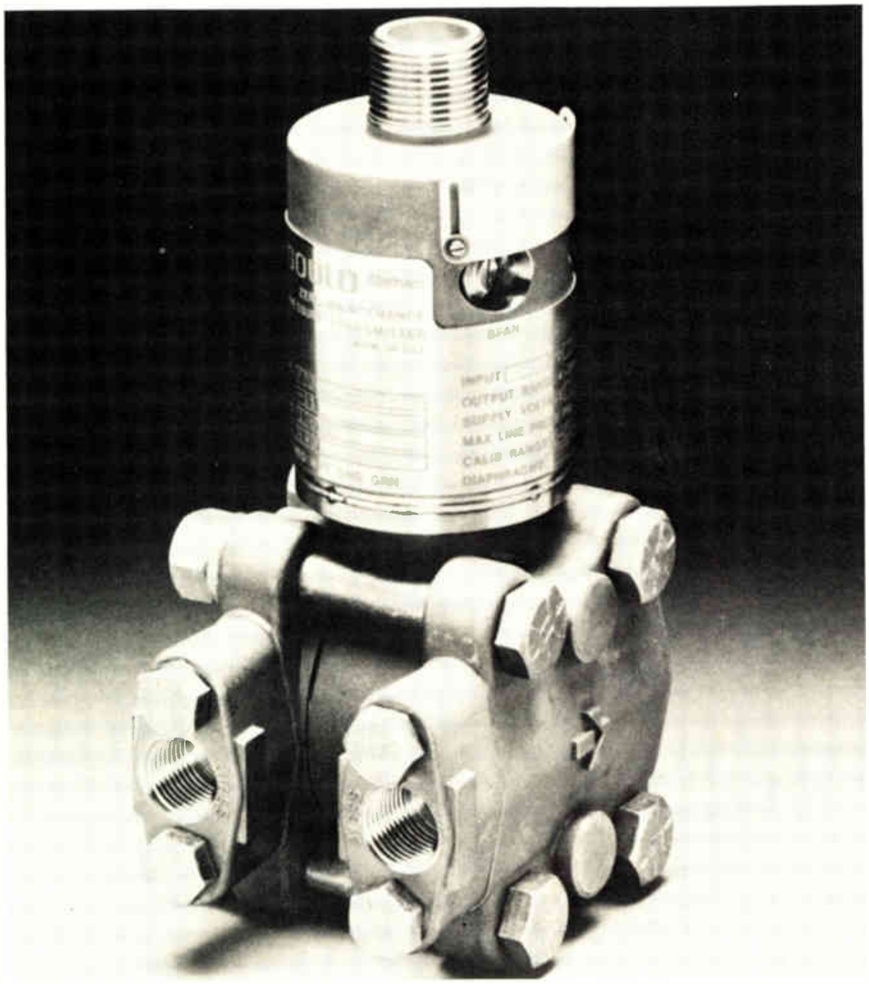
Span and zero are noninteractive, adjustable using rare-earth magnets

Protecting the sensing circuitry of pressure transmitters from the harsh environments they often encounter, while allowing access to that circuitry for span and zero adjustment, is a challenge to design ingenuity. Screw-access ports protected by O-rings have been used, but the seal usually shows some leakage, eventually exposing the circuit to damage. A different technique, used by the P3000 series of pressure transmitters, hermetically protects the electronics while still allowing adjustment of operating parameters.

Inside the sealed 316 stainless steel case, high-energy samarium-cobalt magnets are attached to potentiometers. Adjusting an external, opposing magnet will move the internal magnet and the associated pot. The external magnets may be attached either to permanently mounted external adjustment screws or to a portable tool to prevent unauthorized resetting.

In addition, span and zero adjustments interact by less than 2% of full scale, as opposed to approximately 80% full scale for other commercial devices. Therefore, setting these parameters will not take a season of turning one screw, then the other.

The transmitter electronics consist of a thin-film strain-sensing bridge and dc amplifier that provide a 4-to-20 mA output. This strain-gage approach allows the transmitter's basic design to be easily adapted to the three versions offered: differential, absolute, and gage. The differential unit has a double cavity filled with oil and can measure pressure differences from 30 in. H_2O to 1,000 lbs/in^2; mechanical stops permit overloads as high as 2,000 lbs/in^2, optionally extendable to 5,000 lbs/in^2. The absolute and gage models can measure pressures from 30 in. H_2O to 10,000 lbs/in^2 absolute.



Outputs of the time-proven thin-film sensor are accurate to within ±0.25% of calibrated span, a figure that includes the effects of nonlinearity, hysteresis, and nonrepeatability. The unit is stable to within ±0.25% of its upper pressure limit over a six-month period.

P3000 series transmitters require 12-to-55-v dc power and are offered with a choice of materials for wetted parts, including diaphragm. Of note, too, is the fact that the hermetic case design is such that the measured medium is not in contact with the diaphragm-case weld. For media whose temperatures exceed the basic operating range of −40° to 180°F, remote-sensor capillaries are available in lengths up to 20 ft that extend the range to 1,200°F.

In single quantities, a P3000 differential transmitter sells for $675. Delivery time is eleven weeks

Gould Inc., Measurement Systems Division, 2230 Statham Blvd. Oxnard, Calif. 93030. Phone Bill Duncan at (805) 487-8511 [343]

System measures torque without touching shaft

The model 1200A torsion measuring system can be calibrated by users to measure the torque produced on shafts rotating at speeds up to 14,000 revolutions/min. It performs measurements without the aid of any direct contact, such as slip rings, between the shaft and the display.

The system consists of a 3½-digit display unit containing a power supply and 160-kHz oscillator, a power separator unit and stationary loop, a collar that bolts on to the test

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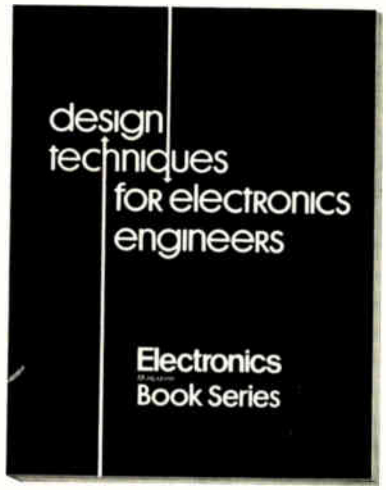

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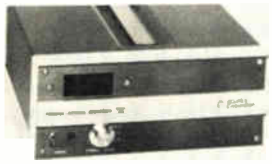


shaft, and a transmitter that plugs into the collar. The stationary loop and collar act as an open-air transformer that transfers power to and signals from a user-supplied strain-gage bridge bonded to the shaft. (Either metal-foil or semiconductor strain gages with resistances of 350 or 1,000 Ω can be used.)

Overall, the system is typically accurate to within ±1% of the display's full-scale value in the operating temperature range from 0° to 75°C, and readings are repeatable to within ±0.05%. Systems can be ordered to accommodate shaft diameters from 2 to 22 in. and they can also be used to measure torsional vibrations up to 900 Hz.

A system designed to work with a shaft whose diameter is in the range from 3 to 8 in. is priced at $4,975. Delivery time is four to eight weeks.

Autodata, Acurex Corp., 485 Clyde Ave., Mountain View, Calif. 94042. Phone Pierre Villain at (415) 964-3200 [344]

Units translate TTL, RS-232 for stepper motors

Built to interface transistor-transistor-logic and RS-232-C communications systems to SLO-SYN stepper motors, the T600 translators provide the sequencing logic and switching driver stages needed for bidirectional control. With the translator, M172 frame-sized motors can deliver up to 0.8 horsepower.

Translators can be purchased as modules, complete with the supply needed to turn 120-, 220-, or 240-V, 50/60-Hz power into the required dc voltages, or as a card set without power supply or housing. The units have internal oscillators that allow off-line positioning in full-step (1.8°) or half-step (0.9°) mode; rates of up to 20,000 half steps/second are achievable. An electronic stabilization scheme helps provide full motor torque when operating in its middle frequency range.

The modular TM600 is priced at $1,050 and the card set TC600 costs $600. Both types are available now.

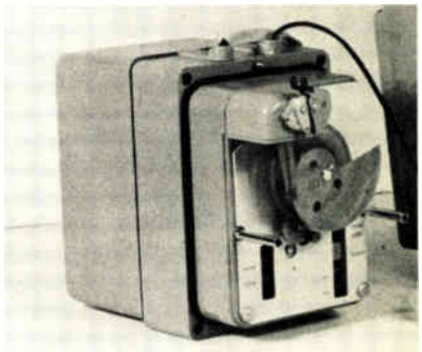
Superior Electric Co., Bristol, Conn. 06010. Phone (203) 582-9561 [345]

Chart-recorder receiver powers transmitter

Working with a WM55A circular chart recorder, the class Z receiver captures the output of any two-wire 4-to-20-mA transmitter. Furthermore, the receiver comes with a supply that will directly power the transmitter, and can be installed in the field.

The WM55A has provisions for up to four pneumatic or electronic receivers or auxiliary devices. The class Z receiver can also drive such devices as class Y integrators.

Dual electronic alarms in the



receiver can each be set between 0% and 100% of full scale without the use of an external meter. The receiver's full-scale transversal time is less than 1.3 s and damping is adjustable. The unit can also accept inputs of 1 to 5 V or 0 to 1 V.

Bailey Controls Co., Wickliffe, Ohio 44092. Phone John Kemp at (216) 943-5500 ext. 2598 [346]

New products

Power supplies

Tiny cube delivers 1.5 to 15 V dc from 120- or 240-V line

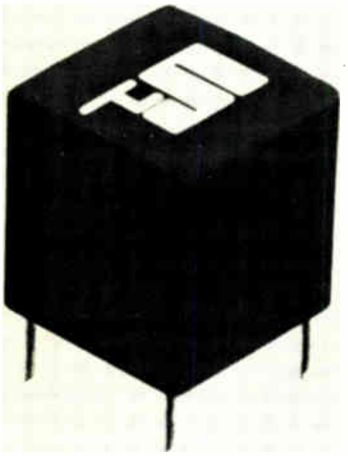
As digital panel meters grow smaller and use less power, how will they retain their ancestors' more appealing features, such as the ability to work from both line and dc power? One answer comes from Microsource Corp. in the form of its μS-A series power supply, a 30-mw unit that fits in a package measuring only ½ inch on each side.

The compact unit comes in versions that operate from line voltages of 120 or 240 v ac and in both cases tolerate line frequencies of 47 to 440 Hz while protecting against line transients. The high-efficiency supply delivers nonregulated, short-circuit–proof outputs whose value the purchaser specifies from a 1.5-to-15-v range. Isolation of output from input is 2,500 v ac.

Although the unit was originally designed with DPMS in mind, Glenn Geist, project engineer for Microsource, says, "I'd hate to put an absolute fix on what we'd like it to be used for, since there are so many possible applications where the supply would fill a demand." Those applications, he says, range from smoke detectors to portable instruments, where the device could be used to trickle-charge nickel-cadmium batteries.

Designed for 0°-to-80°C operation, a μS-A supply costs $7.80 in single quantities, a price that drops dramatically to $2.80 in quantities of 100 to 500. For applications requiring more power, a 60-mw unit in a slightly larger, ¾-by-¾-by-½-in. package is also available. Delivery time is four to six weeks.

Microsource Corp., 7330 Rogers Ave., Chicago, Ill. 60626. Phone (312) 465-8420 [381]



High-efficiency supplies are Motorola's first switchers

Last Spring, when Motorola was fine tuning a new program to produce semiconductor-dense subsystems [*Electronics*, April 13, p. 145], it indicated that a series of switching-regulated supplies would soon make its debut. Unveiled this season is that series of 400-w, 25-kHz pulse-width–modulated supplies. Consisting of single-, dual-, and triple-output supplies, the PS1800 series provides outputs of 5 v, and 5 and 12 v, and 5 and ±12 v, respectively.

Outputs of the high-efficiency (80% for a single output supply to 75% for a triple-output supply) units exhibit ripple and noise of less than 10 mv rms. They vary by less than 0.02%/°C and, in the event of power failure, they hold up, or remain within specification, for 30 ms.

The series features remote on-off, soft start, and overvoltage and overcurrent protection. Without derating, operation is in the −20°–60°C range. In single quantities, a single-output unit costs $495, a dual $560,

and a triple $625. They are available from stock.

Motorola Semiconductor Products Inc., P. O. Box 20912, Phoenix, Ariz. 85036. Phone (602) 244-6900 [384]

Products newsletter

22-GHz analyzer goes down to 100 Hz

Engineers at Hewlett-Packard Co., Palo Alto, Calif., are adding a new yttrium-iron-garnet–tuned mixer to the 8568A spectrum analyzer to boost its top frequency from 1.5 GHz to a whopping 22 GHz. The bottom frequency remains the same at 100 Hz. Designated the 8566A, the improved analyzer has a delivery time of 18 weeks. Users who need its high-frequency capability will have to pay for it: **the 8566A is priced at $47,500, compared with $27,800 for the 8568A.**

V-groove FETs get cheaper

Look for the ITT Semiconductors Group to come out early next year with two V-groove MOS field-effect transistors "whose price will be nearly equal to that of comparable bipolar transistors," in the words of an official at the group's leading house—Intermetall GmbH in Freiburg, West Germany. **The low price is attributable primarily to the TO-92 package housing the transistor,** which Intermetall's highly automated production lines can handle with great ease and economy.

Both transistors are of the enhancement type, have turn-on and turn-off times of 4 μs, dissipate about 600 mw, and can be driven by MOS ICs. One of the high-gain devices, the BS170, is an n-channel unit; the other, designated the BS250, is a p-channel transistor.

Board testers work across the board

Building upon its L135 high-speed test system [*Electronics*, March 2, p. 34], Teradyne Inc., Boston, is introducing a family of four functional board testers—a slow digital, a fast digital, a slow analog-digital, and a fast analog-digital system. **Prices range from $65,000 for the low-speed digital L135A to $135,000 for the high-speed analog-digital L135D.** All four units can accommodate up to 456 static pins or a combination of 432 clock-rate and static pins in increments of six. Deliveries require from 12 to 14 weeks.

Price changes

The following price cuts have recently been announced:

■ The CA-2800 series linear hybrid amplifier line from **TRW RF Semiconductors, Lawndale, Calif.,** has been reduced in price by as much as 21%. At the same time, the firm has boosted distributor discounts to as much as 30% and added a 25-to-99-unit price break for small-volume users. The 21% reduction applies to the CA-2870—a 20-to-400-MHz unit with 33 dB of gain. It has been cut from $59.50 to $46.98.

■ **Motorola Semiconductor Products Inc., Phoenix, Ariz.,** has lowered the prices of 14 optical coupler-isolators an average of 17%. The affected units are the 4N25 through 4N33 and the 4N38. Individual cuts are as high as 39% for the 4N25A and 35% for the 4N25. In small quantities, the devices are priced between 90¢ and $1.40.

■ The high-speed IDM2901A-1 4-bit bipolar microprocessor slice from **National Semiconductor Corp., Santa Clara, Calif.,** which is 30% faster than the standard 2901A, has been reduced in price by almost 50%. The ceramic-packaged version has been slashed from $29 to $14.95 in 100-piece quantities. The plastic-packaged device has also been lowered—from $18.35 to $11.90.

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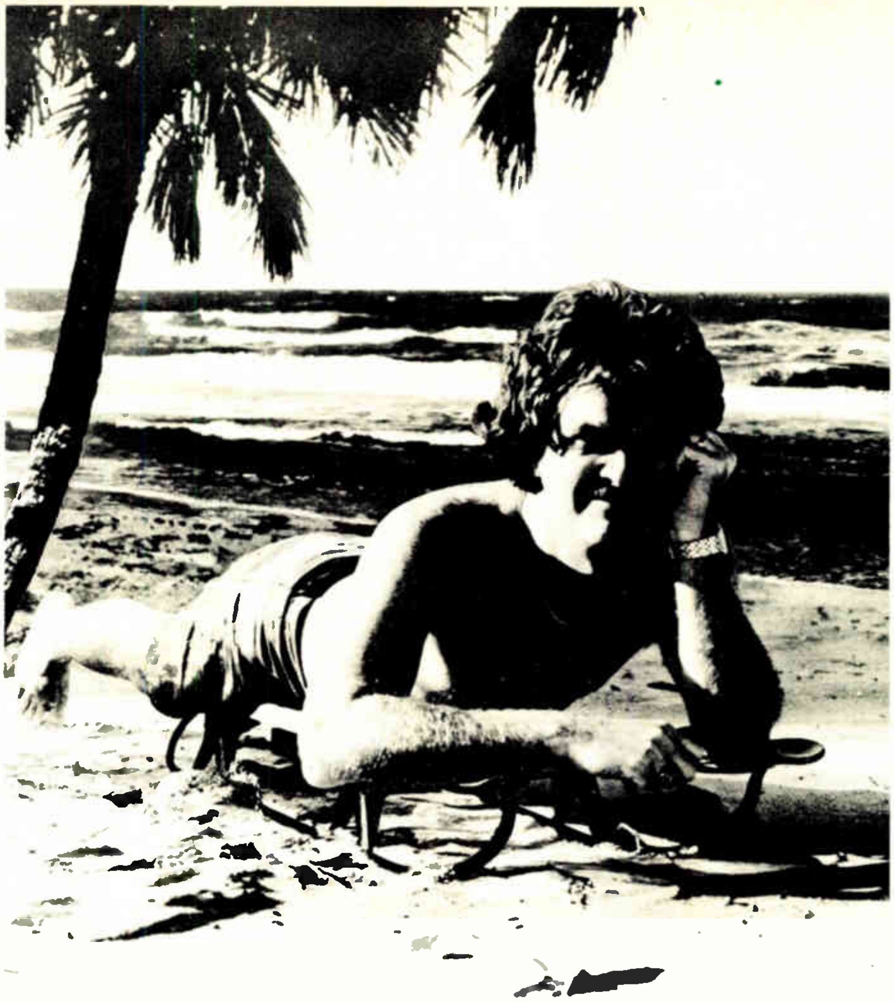

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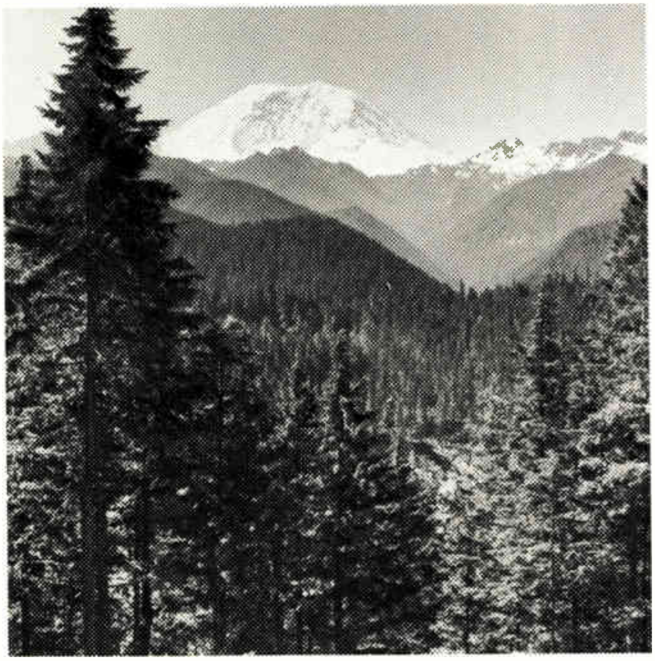

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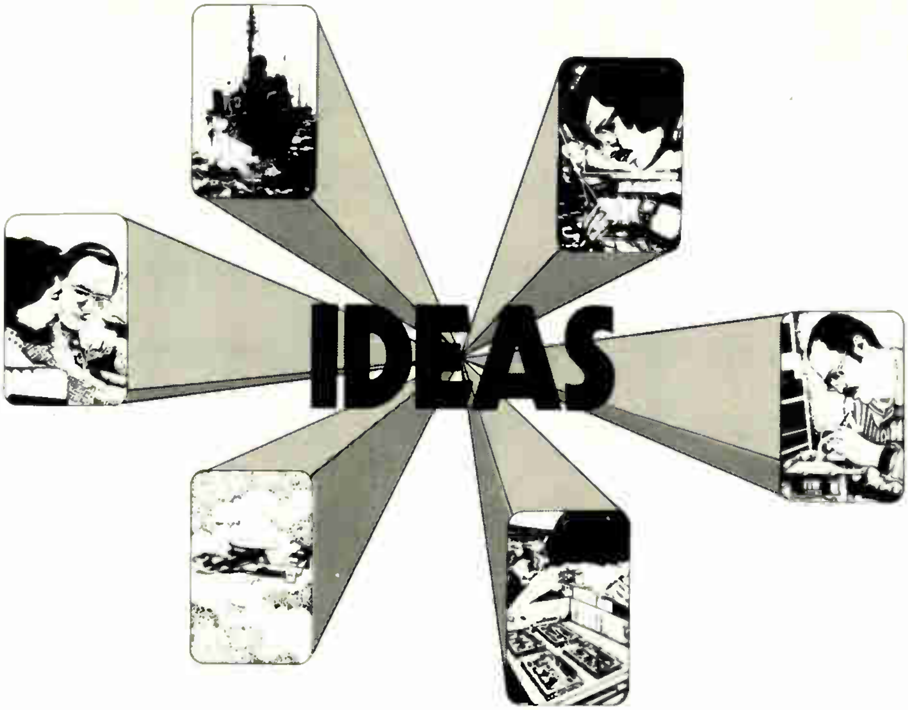

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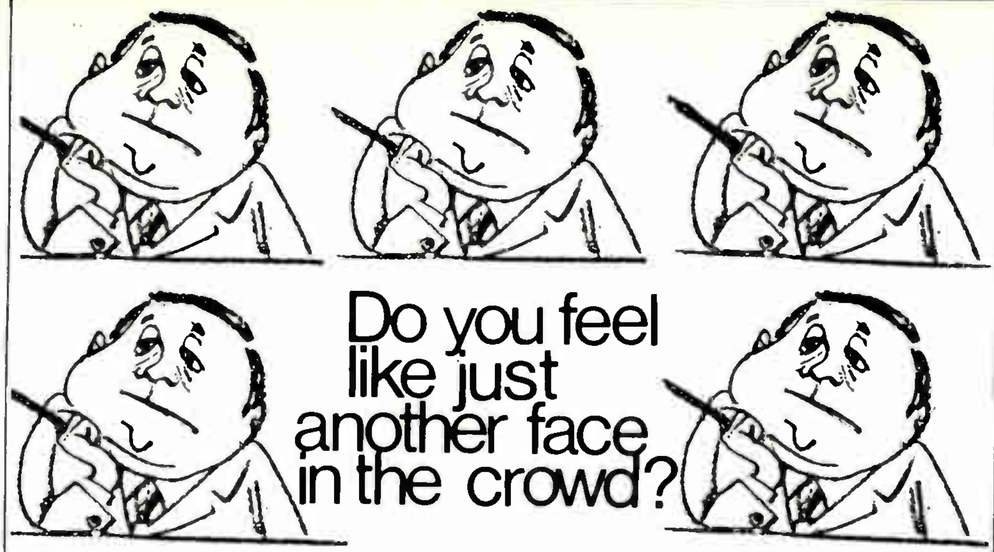

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